ECONOMIC ANALYSIS OF SUBSISTENCE AGRICULTURE IN GARCIA ROVIRA, COLOMBIA

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CHAPTER I

INTRODUCTION

The role of the agricultural sector in a country's economic structure is critical for its economic development. This is particularly true if one considers the contributions of that sector in the following important areas: a) satisfaction of the growing demand for agricultural products for an increasing population and for raw materials for the industrial sector; b) contributions to the acquisition of foreign exchange needed for development through the export of surpluses; c) generation of capital for reinvestment in the sector itself and for strengthening industry and trade; and d) the creation of markets for industrial products (1).

A decreasing participation of the agricultural sector in a country's gross national product (GNP), and in the labor employment indices are two of the basic characteristics of an economic development process. During the period 1950-1970 the Colombian agricultural sector's contribution to the nation's GNP decreased about 10 percent. For the same period the percentage of the economically active population engaged in agriculture declined 13 percent (2). Nevertheless, during 1973 agriculture still contributed about 26.5 percent of the nation's GNP, generates about 75.0 percent of the country's foreign exchange, and employs 39.0 percent of a total labor force of roughly 6.5 million people.[1]

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[1] In developed countries, agriculture represents between 3.0 and

A rate of growth of GNP above 7.0 percent per annum has been achieved during recent years but the inadequate distribution of resources and income, resulting in notorious deficiencies in health, education and housing services are some of the factors still present to preclude a development process consistent with increases in the general level of social welfare.

A dualistic agricultural economy has been created in Colombia with an advanced and highly productive commercial sector and a small-scale type of agriculture operating at the subsistence level, using traditional farming techniques, and within which the majority of Colombian farmers make their living.

Subsistence agriculture is found primarily in the Andes Mountain region of the country. It is an area characterized by high population density, fragmented landholdings, and permanent or seasonal unemployment of the labor force. The farmers' access to sources of credit is limited and the technical assistance available is inadequate. They are faced with serious problems in the marketing of their products and with a lack of sufficient health, housing, and educational services.

As a result, adoption of modern technological methods has been quite limited, levels of production are low and incomes are not sufficient for an acceptable standard of living. The population explosion, malnutrition, illiteracy and problems related to land ownership make the situation even more difficult.

Various programs have been set up in an attempt to find solutions

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7.0 percent of the GNP and is a source of employment for no more than 12.0 percent of the active population.

to this precarious situation: INCORA[2] is in charge of distributing, improving and colonizing land; ICA,[3] through its research and extension services, fosters the level of adoption of new technological methods; CAJA AGRARIA (Agrarian Credit Bank) grants loans and distributes inputs through its agencies in almost every municipality in the country; and IDEMA[4] implements programs to aid the marketing of agricultural products.

The lack of sufficient resources, a limited interinstitutional coordination and ignorance of the socio-economic reality in which the small farmer works have been, among other factors, the principal reasons why those programs which have been implemented to date have not achieved the hoped for success.

Experience has shown that the increased use of new technology as a means of solving the problems of the small-scale farmer is not successful unless it is accompanied by the complementary tools of credit, marketing, education and health. At the same time, measures should be applied which would tend to remove the obstacles presented by an inadequate land tenure system.

A step in this direction is the new Integrated Rural Development Projects (IRDP), defined as "the concentrated and integrated effort of a multi-disciplinary technical team in a given area, with a view toward helping the community achieve the social and economic improvement of the population covered by each project. ICA seeks support for this effort

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[2]INCORA is the Instituto Colombiano de la Reforma Agraria (Colombian Land Reform Institute).

[3]ICA is the Instituto Colombiano Agropecuario (Colombian Agricultural Institute).

[4]IDEMA is the Instituto de Mercadeo Agropecuario (Institute for Agricultural Marketing).

from other official organizations (INCORA, IDEMA, INDERENA, CAJA AGRARIA) and from private entities that have the ability to assist in the development of a region" (3).

In 1974, fourteen projects were operating and eight more were in the organizational stage. Fundamental to their success is the carrying out of studies at the production unit level which will identify the available resources and the problems existing in each region. The general objective of this research was to undertake the basic economic study for the Rural Development Project for the Province of Garcia Rovira.

Objectives of the Study

The specific objectives of this study were:

a) to identify the main agricultural and livestock activities of the zone, the type of technology being used, and the prevalent management systems;

b) to delineate the factors of production or inputs available;

c) to analyze patterns of resource allocation and the associated productivity and income levels obtained by farmers;

d) to identify the factors related to poverty and ways to alleviate it; and

e) to propose strategies and plans of action leading to the achievement of the goals established for the regional development project, given the available resources.

The Region Studied

The province of Garcia Rovira, located in the department of

Santander in the eastern part of the republic of Colombia includes twelve municipalities[5] with an area of 296,000 hectares (Figure 1).

Most of the area, 85.4 percent, is located in cold and high mountainous area; 13.0 percent in the temperate area; and only 1.5 percent in a warm climate area. Temperature varies from 28 to 8 degrees centigrade and the elevations range from about 1,000 to more than 3,000 meters above sea level. Accordingly, average precipitation ranges from 900 to 2,000 milimeters per annum. The dry seasons fall in the period from December to February and June to August while the rainy seasons are from March to May and September to November.

Garcia Rovira's terrain is rough and the soil has little productive potential as a result of its advanced state of erosion. Small holdings of less than four hectares predominate, and the prevalent production methods are typical of a subsistence agriculture.

Population growth has been practically zero from 1918 when the Census reported 97,000 people to 1973 when population was estimated as 113,145 people (75.8 percent rural). The population density is high with 38.3 inhabitants per square kilometer compared to 18.7 for the country. Due to the terrain, communication is very difficult: there are only two main roads connecting the region with important urban centers like Bucaramanga, Cucuta, Tunja and Bogotá. Both roads are unpaved, narrow, dangerous and are frequently blocked by landslides. There are also stretches of passable road leading to some of the villages, but they are blocked during most of the year. A common form of

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[5]Capitanejo, Macaravita, San Miguel, Carcasí, Cerrito, Concepción, San José de Miranda, Enciso, Málaga, Molagavita, Guaca and San Andrés. Maĺaga is considered as the provincial capital.

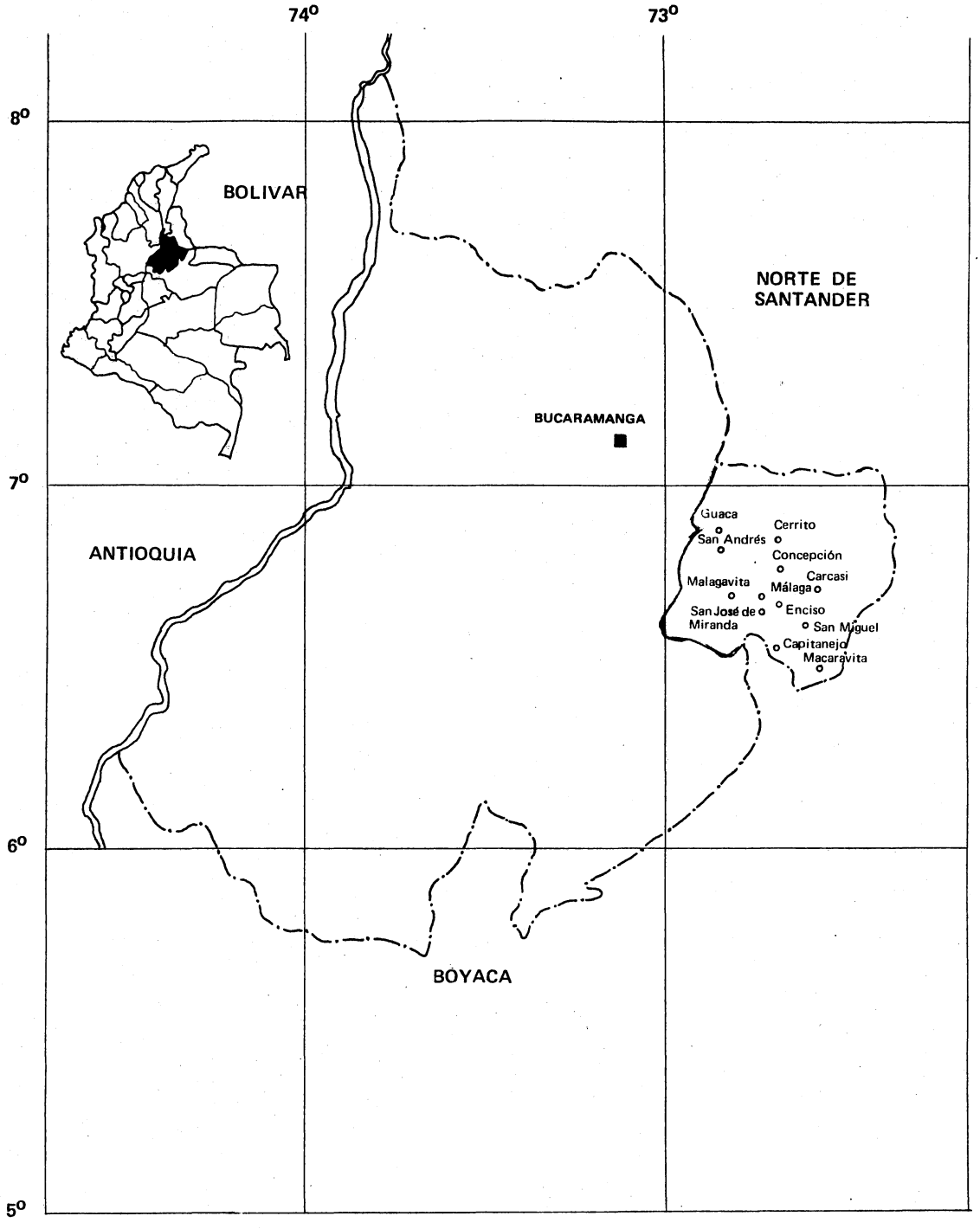

Figure 1. Map of the Department of Santander, Colombia, showing the Garcia Rovira Rural Development Project Area

transportation in the region is horses and mules which traverse narrow trails practically impassable during the rainy season.

Organization of Remainder of Thesis

The rest of the study is organized as follows: Chapter II identifies the components and the problems of the small-scale agricultural sub-sector in Colombia. This is undertaken through analysis of the principal characteristics of the agricultural sector and of the programs that have been put into practice for its development. Philosophy, organization, and execution of the new integrated rural development projects are also discussed.

Chapter III highlights the importance of the farm economics studies for rural development projects. Emphasis is given to some theoretical issues involved in specifying and estimating production functions from farm-survey data. Alternative models, appropriate for productivity analysis in regions like Garcia Rovira which are characterized by a predominance of multiproduct farms, are evaluated.

Methods used in gathering data for the Garcia Rovira Economic Survey are discussed in Chapter IV. The availability and characteristics of the factors of production, production systems, and technological levels of agriculture in the region are also presented.

In Chapter V, an analysis of the sources and levels of productivity and income obtained by farmers is presented as a means to identify the main causes of poverty in Garcia Rovira. This is done, mainly, by implementing productivity analysis models for multiproduct-farms discussed in Chapter III.

Chapter VI, finally, summarizes the study and presents conclusions and recommendations.

CHAPTER II

THE SETTING FOR RURAL DEVELOPMENT

COLOMBIAN AGRICULTURAL SECTOR

An analysis of the Colombian agricultural sector is necessary to understand clearly the social and economic bases of the small-farm subsector, the kind of problems that subsistence farmers are facing, and the possibilities open to farmers to become participants in an economic development process.

Human Resources

Rural Population

Colombia's demographic growth has been rapid. Its population for 1973 is estimated at 22 million, with an annual growth rate of 3.2 percent, compared to 2.3, 3.9, and 2.7 percent per annum for Africa, Asia and South America.

More than 53 percent of the population lives in the Andean and Caribbean regions, mainly in the departments of Atlántico, Antioquia, Boyacá, Caldas, Cundinamarca, Santander and Valle del Cauca. These departments have a population density close to 41.7 inhabitants per square kilometer, while the average for the country as a whole is 18.7.

Extensive internal migration has transformed the relationship between the urban and rural population. The rural population, which was

60 percent of the total in the 1951 census, represented 49 percent in 1972. Colombia has 20 cities of more than 100,000 inhabitants. Their combined population is nearly 7 million, or more than 31 percent of the country's total population. The capital does not dominate the total population as do the capitals of other Latin American countries, and 40 percent of the rural population lives an hour away from urban centers of more than 100,000 inhabitants.

The economically active population, approximately 30 percent of the total according to 1964 census figures, is distributed between the agricultural and the non-agricultural sectors in proportions of 45 and 55 percent respectively. In the latter sector, manufacturing and services are the most important components (4).

Employment

In 1964, eight million people depended on agriculture for their livelihood. Of these, 2.4 million were part of the economically active population and only 1.2 million had permanent employment (5). Moreover, in the urban sector, the International Labor Organization (6), calculates the number of persons seeking employment at half a million. The Word Bank (7) estimates that 50,000 new jobs have to be provided within the agricultural sector each year during 1970-85 to stabilize the present situation.

If the work force continues to increase at the present annual rate of 3.2 percent while employment continues to rise at the same rate of the last two decades, 2.2 percent annually, the unemployment problem could seriously threaten the economic and political stability of the country.

Education

The extent of illiteracy among the population over 15 years of age decreased from 38 to 28 percent between 1951 and 1964. Nevertheless, the absolute number of illiterates has increased to 2.5 million people.

Illiteracy in rural zones, 41.0 percent, is almost three times as high as in urban zones. These figures are due in part to the inferior quality of school services in the rural areas, where 64 percent of the schools offer only one or two years of primary education and there are no secondary or technical training schools (7).

Natural Resources

Land

The total area of the country is 1,138,914 square kilometers, but the orographic characteristics of the Andean Zone, the chemical conditions of the soil in the Orinoco, Amazon and Pacific Coast regions and the tendency to flood in the Caribbean valleys make the arable area much smaller.

Approximately 491,842 square kilometers of agricultural lands have been classified according to their capacity for use (Table I). Of that, 24.7 percent is suitable for agriculture and/or livestock raising, 27.7 percent for woodlands and 13.1 percent requires special soil conservation measures to reclaim the land. No detailed studies have been made of the remianing 647,157 square kilometers. However, most of this territory is located in the Orinoco and Amazon regions and is considered to be in soil class VI; preliminary data would indicate a potential use as woodland. The generally held opinion about the richness of Colombian soil lacks a factual basis.

TABLE I

COLOMBIA: LAND CLASSIFICATION ACCORDING TO CAPACITY FOR USE

Class	Description	Area in Hectares	Percent of Total Area Studied
I	For intensive agriculture or livestock raising; for immediate use	172,936	.4
II	Potentially for intensive agriculture or livestock raising; for seasonal use	977,449	2.0
III	Potentially for intensive agriculture or livestock raising; for occasional use	5,338,744	10.9
IV	For agriculture and livestock raising, with soil conservation measures	4,028,929	8.2
V	For woodlands, livestock raising and permanent agriculture, with soil conservation	1,572,889	3.2
VI	For woodlands	13,629,828	27.7
VII	Can be reclaimed, with soil conservation measures	6,449,887	13.1
	Water	567,375	1.2
	Urban Zones	44,638	.1
	Total Area Classified	49,184,262	100.0
	Unclassified	64,715,738	
	Total Area	113,900,000	

Source: Departamento Nacional de Planeación. Las Cuatro Estrategias. Bogotá: Editorial Andes, 1972.

Land Use. Table II summarizes current patterns of land use. The majority of the country's land, 56.6 percent, is covered with jungle. Only 4.8 percent of the available land area is devoted to agriculture. In addition, 28.7 percent of the land is devoted to the extensive cultivation of pastures, despite the fact that this land could, in large measure, be well used for intensive agriculture or livestock raising, which would considerably increase current indices of production and productivity. Of the nearly 65 million hectares in the jungle, 25 million are economically profitable woodlands with a production potential of 6,000 million cubic meters of wood, a third of which are classified as valuable woods (8).

Farm Sizes. According to the national agricultural census (9) there are 1,135,382 holdings in a surface area of 31,286,624 hectares. Distribution by size indicates that holdings of less than 5 hectares represent 59 percent of the total and take up 3.5 percent of the land area, whereas those of more than 100 hectares constitute 4.5 percent of the total holdings and occupy 68 percent of the land area (Table III).

It should be made clear that the preceding statistics do not take into account factors such as soil quality and access to markets. If these factors are unfavorable even large properties become, in many cases, unprofitable units.

Land Tenure. Private property is the predominant form of land tenure, with 74 percent of the land area and 69 percent of holdings falling into this category. Newly settled land is second with regard to land area occupied but is last with respect to number of holdings, while sharecropping is next to last with respect to land area but is

TABLE II

COLOMBIA: CURRENT LAND USE

Use	Hectares	Total Hectares	Percent
Jungle	61,500,000		
Colonization	2,976,000	64,476,000	56.6
Roads, cities, etc.	2,000,000		
Lakes, rivers, ponds, etc.	3,655,000		
Unusable	2,548,000	8,223,000	7.3
Agriculture and Fallow Land			
Permanent Crops	1,482,838		
Annual Crops	1,828,865		
Fallow	2,193,297	5,505,000	4.8
Pasture Land			
Eastern Plains and Amazon region	13,400,000		
Other regions	19,320,000	32,720,000	28.7
No Apparent Use		2,981,000	2.6
Total		113,900,000	100.0

Source: Departamento Nacional de Planeacion. Las Cuatro Estrategias. Bogotá: Editorial Andes, 1972.

TABLE III

COLOMBIA: DISTRIBUTION OF LAND BY SIZE AND AREA OCCUPIED*, 1970

Farm Size (hectares)	Number of Farms	Percentage of Total	Area In Farms (Hectares)	Area In Farms Percentage of Total
Less than 1.00	251,262	22.13	115,361.45	.37
1.00 - 1.99	170,053	14.98	229,912.46	.73
2.00 - 2.99	108,654	9.57	251,406.84	.80
3.00 - 3.99	80,781	7.11	266,982.51	.85
4.00 - 4.99	54,708	4.82	233,821.98	.75
5.00 - 9.99	154,001	13.56	1,055,745.80	3.37
10.00 - 19.99	115,431	10.17	1,578,032.81	5.04
20.00 - 29.99	48,826	4.30	1,148,602.42	3.67
30.00 - 39.99	30,869	2.70	1,031,538.55	3.30
40.00 - 49.99	20,734	1.83	899,992.19	2.88
50.00 - 99.99	48,551	4.28	3,252,266.06	10.39
100.00 - 199.99	26,801	2.36	3,586,121.88	11.46
200.00 - 499.99	16,505	1.45	4,816,756.25	15.39
500.00 - 999.99	4,886	.43	3,228,917.44	10.32
1000.00 - 2,499.99	2,299	.20	3,334,250.75	10.66
2500.00 and over	1,021	.09	6,256,905.94	20.00
Total	1,135,382	100.00	13,286,624.23	100.00

*Does not include Chocó and National Territories.

Source: Departamento Administrativo Nacional de Estadistica (DANE). Censo Agropecuario 1970. Datos Provisionales - Bogotá, 1972.

second in number of holdings. Mixed forms of land tenure represent similar percentages in land area occupied and number of holdings, with 6.2 and 6.6 percent respectively, taking third place in both cases (Table IV).

There are, in addition, about 470,000 families, out of a total of 1.5 million in rural areas, who are landless agricultural workers or "peones" who live in more insecure circumstances than the small landowners, tenant farmers or sharecroppers (10).

Technological Levels

Mechanization

Soil preparation, sowing and other planting activities are carried out on most farms with hand tools, even though plowing is sometimes done with oxen and primitive plows. Most commercial farms use appropriate agricultural machinery.

The National Planning Department estimates that 23 percent of the agricultural area is mechanized, whereas mechanical power is used in less than 2 percent of the area devoted to cattle raising (8).

Improved Seeds

The Colombian Agricultural Institute, ICA, through its experiment stations, has considerably increased the production of improved seeds. There are, in addition, private companies which produce and distribute them.

The World Bank (7) calculated that the area planted in improved seeds increased from 0.7 percent in 1953 to 45.1 percent in 1967 for wheat; from 0.5 to 22.8 percent for corn and from 0.3 to 12.2 percent

TABLE IV

COLOMBIA: LAND TENURE*, 1970

Type of Tenure	Number of Holdings	Percentage of Total	Land Area (Hectares)	Percentage of Total
Private Property	675,981	68.6	22,053,038.6	74.2
Tenant	52,324	5.3	729,267.6	2.5
Sharecropping	89.010	9.1	824,448.7	9.7
Squatters	45,371	4.6	2,896,607.9	2.8
Other forms	57,029	5.8	1,372,950.4	4.6
More than one form	64,665	6.6	1,836,759.0	6.2
Totals	984,654	100.0	29,713,072.1	100.0

*Does not include Cundinamarca, Choco and National Territories.

Source: Departamento Adminatrativo Nacional de Estadistica (DANE) Censo Agropecuario 1970. Datos Provisionales - Bogotá, 1972.

for beans during the period from 1958 to 1967. Improved seeds are currently being used throughout the areas planted in soybeans, sorghum, cotton and tobacco, whereas they are used in only .4 percent of the area planted in potatoes.

In 1967, 610,000 hectares were planted with improved seeds for 11 different crops. This represents one-third of the total area planted in those crops and about one-sixth of the cultivated area of the country (11).

Pesticides and Herbicides

During the period from 1951 to 1967 about 10,000 tons of pesticides were used whose active ingredients were all imported, and a small portion of which were mixed in the country. About a million hectares were treated with pesticides, a figure which represents one quarter of the land area under cultivation; herbicides are an important part of the total amount of pesticides used, representing between 30 and 45 percent of the total.

Insecticides and fungicides are applied to a small number of commercial crops. In 1967, three-fifths of the insecticides were used to treat cotton and one-fifth to treat rice. Fungicides are used especially on bananas for export and on potatoes. Close to half of the herbicides employed are used on rice and sugar cane. In 1968 herbicides were used on only 4.8 percent of the farms, insecticides on 11.3 percent and fungicides on 9.3 percent (7).

Fertilizers

Consumption of fertilizers increased at an annual rate of 2.4 percent during the period from 1964 to 1968 and at an annual rate of 6.0 percent from 1968 to 1970 (8). Nevertheless, the proportion of fertilized land area is still very low, evidenced by the fact that in 1968 only 20 percent of the cultivated area was being treated with fertilizers. ICA calculated that for 1969 farmers used only 25 percent of the nitrogen, 35 percent of the phosphorous and 20 percent of the potassium needed.

More than 90 percent of the fertilized area is planted in potatoes, followed by barley, wheat, tobacco and cotton. In contrast, very little

fertilizer is used for cultivating traditional crops such as cassaba, beans and corn and for pasture lands. Organic fertilizer is important in coffee growing.

Deficiencies in the quality of the nationally produced fertilizers, as well as the unfavorable relationship between their prices and the prices for agricultural products, are mentioned by Atkinson (12) as reasons for the limited use of fertilizers.

Production Levels

Agricultural Products

Industrial crops such as cotton, sorghum, and soybeans which are typical of commercial agriculture show higher growth rates, in both land area planted and yield per hectare than those for basic food products such as corn, potatoes, and beans which are predominant in small-scale agriculture. In general, increments in production can be attributed more to increases in area cultivated than to improvements in productivity (Table V).

The average yield per hectare for the majority of crops is low compared to the potential yields which would result if more modern production techniques were employed (Table VI). It can be seen, however, that commercial crop yields are not as different from potential yields as those typical in the subsistence sector.

The importance of subsistence agriculture in producing basic foods such as corn, potatoes, beans, and peas is indicated in Table VII. More than 70 percent of the holdings where these crops are grown are under 10 hectares.

TABLE V

COLOMBIA: ANNUAL GROWTH RATES OF CULTIVATED LAND AREA, TOTAL PRODUCTION AND PER HECTARE PRODUCTION FOR PRINCIPAL CROPS 1950-1969 (FIGURES ARE IN PERCENT)

Crops	Area Under Cultivation	Production Per Hectare	Total Production
Cotton	9.4	4.4	16.0
Sugar Cane	1.1	3.8	7.8
Wheat	--	2.8	1.5
Tobacco	1.4	2.7	4.2
Cacao	1.3	2.4	3.4
Rice	3.3	2.2	5.5
Sesame	4.9	2.1	7.8
Beans	- 3.2	1.9	- 1.2
Sorghum	11.1	1.6	22.2
Coffee	0.6	1.0	1.5
Soybeans	16.1	0.8	16.3
Barley	0.2	0.3	0.6
Potatoes	3.3	0.3	3.2
Corn	0.7	0.1	0.8
Sugar Cane (brown sugar)	0.7	0.1	0.3
Bananas	- 4.6	- 9.3	

Source: World Bank. Colombia's Economic Development. Bogotá, 1972. Banco Popular.

TABLE VI

COLOMBIA: AVERAGE NATIONAL PRODUCTION AND GOALS ATTAINABLE THROUGH THE USE OF IMPROVED VARIETIES AND TECHNICAL SYSTEMS OF CULTIVATION*

Crop	National Average	Improved Varieties and New Cultivation Techniques		
		Immediate Goal	Long Term Goal	Potential Goal
Cotton (seed)	1,500	2,100	2,500	3,000
Sesame	670	700	800	1,000
Rice (irrigated	3,400	4,220	5,000	7,000
Rice (mechanized dry)	1,900	2,300	2,600	2,800
Rice (dry)	1,200	1,668	2,500	3,200
Barley	1,800	2,000	2,500	3,200
Beans	679	1,000	1,500	2,000
Corn	1,250	3,000	3,600	4,500
Corn	1,250	3,000	3,600	4,500
Potatoes	9,280	15,000	25,000	30,000
Sorghum	2,480	2,900	3,000	4,000
Soybeans	2,100	2,600	2,800	3,000
Wheat	1,016	2,000	2,500	3,500
Yuca	380	25,000	30,000	40,000
Sugar Cane	48,000	104,000	150,000	250,000
Cacao	N.A.	600	1,000	1,200
Peas	460	1,000	1,800	N.A.

*Figures are in kilograms per hectare.

Source: Instituto Colombiano Agropecuario (ICA). Oficina de Planeacion. Bogotá, 1973.

TABLE VII

COLOMBIA: PRODUCTION FROM HOLDINGS WITH LESS THAN TEN HECTARES, 1960

	Total Holdings	Area Cultivated (Has)	Holdings		Area Cultivated in Holdings	
			<10 Has	Percent of Total	<10 Has	Percent of Total
Sesame	14,851	50,719	10,292	63.3	17.952	35.2
Peas	32,266	31,643	24,818	76.9	16,920	53.4
Yarns	47,521	22,758	34,936	73.5	12,339	54.2
Sugar cane	223,076	344,480	155,612	66.7	108,766	31.5
Rice	53,283	226,792	22,583	43.3	28,961	12.7
Barley	33,414	58,304	27,021	80.8	19,885	34.1
Beans	86,662	115,927	58,774	67.8	45,213	39.0
Potatoes	108,404	123,652	88,047	81.2	62.480	50.5
Corn	539,251	871,178	389,950	72.3	359,696	41.2
Sorghum	8,202	8,694	6,110	74.4	4,505	51.8
Tobacco	19,473	23,307	15,679	80.5	15,270	65.5
Tomato	4,696	3,276	3,952	84.1	2,132	65.0
Wheat	80,919	129,675	67,148	82.9	67,876	52.3
Totals	1,252,018	2,510,405	904,949	72.2	761,995	30.2

Source: Urrego German. Los Insumos Agropecuarios en Colombia. Bogotá, Instituto Colombiano Agropecuario ICA. Centro de Comunicaciones. 1973.

Livestock Production

Cattle production is equivalent to one-third of the value of total agricultural production, and represents 10 percent of the country's GNP. Livestock exports reached U.S. $12 million in 1969 without including the illegal exports to Venezuela, estimated at 200,000 head per year. Tallow and wool for industrial use were the only livestock products imported.

The bovine population is estimated at 20 million head, of which 17 million are beef cattle. The average number of cattle fed is .6 head per hectare, indicative of the extensive kind of cattle raising that predominates.

Breeding and fattening cattle are found in the tropical zones where natural grasses of poor quality predominate. The principal bovine diseases are hoof and mouth disease, rabies, anthrax, brucelosis, septicemia, diseases transmitted by ticks, and problems caused by internal parasites. All these factors contribute to low productivity and reduce the country's capacity to satisfy internal and external demand for beef.

Dairy, for its part, increased at rates slightly higher than those for population growth in the period between 1950 and 1967. There are some dairy farms near the big cities which employ modern production techniques, but the use of feed concentrate is limited due to its high cost relative to milk prices. Natural pastures are the principal source of food for the cows, which causes severe seasonal fluctuations in production and prices.

Meat production other than beef shows little or no increase. Lamb and mutton represent only 1.0 percent of total meat consumption.

Production is carried out on family size plots using rudimentary management techniques. The output of pork has increased very slowly while poultry and egg production, which remained constant during the decade of the 1950's, doubled during the period from 1958 to 1967. Poultry farms of several thousand chickens make use of modern technology, in contrast to the rudimentary management techniques used by subsistence farmers.

Incomes

The small size of most of the production units and their low productivity are reflected in low income levels. In 1969, the net annual income for farms with one to five hectares was estimated at 4,400 pesos, and 80 percent of the economically active population in the rural sector was earning a per capita income of no more than 9,000 pesos per year (6). The minimum level of income necessary for covering a family's essential needs, 14,700 pesos in 1970,[1] was not reached by 695,000 families out of the 820,000 with holdings under 10 hectares (13).

The problem of income becomes even more acute if one considers distribution. Berry (14) stated that in 1960, 5.0 percent of the population associated with the agricultural sector received 43.0 percent of the income generated, while 50.0 percent of the population received only 14.0 percent. Urrego (15) in his study comparing rural to urban income distribution concluded that concentration of income is significantly greater in the rural sector.

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[1] During 1970, 20 Colombian pesos were equivalent to 1 U.S. dollar.

Government Programs for the Rural Sector

During the past two decades the Colombian government has proved a variety of programs to overcome obstacles for the development of the farm economy and, more specifically, to solve problems of the inequitable distribution of productive resources and services, low productivity, and underemployment more prevalent within the small farm subsector.

Programs of price supports for agricultural products and input price controls have been implemented many times without significant effects upon the small holder economy given the characteristics of its production pattern oriented, almost exclusively, to produce food for family consumption.

Traditional services of extension, technical assistance, marketing, and credit provide a limited number of services to farmers and in most cases, as result of the existing concentration of property and income, their benefits go to the economically active commercial farmers.[2]

The government's greatest effort in recent years has been directed toward implementing an agrarian reform whose main objectives and strategies are defined by laws 135 of 1961, 1 of 1968, and 4 of 1973 (16). The Colombian Land Reform Institute (INCORA) is responsible for land acquisition through direct negotiation, volumtary cession, extinction of domain or reversion to the state, and through expropriation with compensation to the landowners. It is also in charge of giving title to public domain lands, and is responsible for implementing programs of irrigation and flood control, supervised credit, commercialization, and

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[2]In 1969, 75.0 percent of the credit extended by CAJA AGRARIA was for cotton and rice, typical commercial crops, while for the corn and wheat which predominate in the subsistence sector, only 10.0 percent was allotted. The Agrarian Credit Fund, during the period from 1967 to

technical assistance.

A balance sheet of the work carried out in the field of land acquisition and subsequent distribution is presented in Table VIII. By June, 1972 almost 4 million hectares had been acquired, of which 89.3 percent were lands which had reverted to the state because possession had not been exercised over them for 10 consecutive years. Most of these lands are located far away from economic markets and lack any infrastructure. The public domain lands which have been distributed (3.5 million hectares) have similar characteristics. In most cases, it was simply a question of legalizing property titles to lands already occupied.

The principal problem for sharecroppers and tenants is the pattern of rent payment and product sharing with the landowners. Additionally, in most cases the size of the plots allotted them is not sufficient to provide acceptable income levels. The law authorizes INCORA to acquire lands for the purpose of solving this problem. It also stipulates that possible beneficiaries be registered. By 1968 nearly 72 thousand farmers had registered as tenants and sharecroppers, but by January of 1969 only 13 thousand had received certificates entitling them to preference in acquiring land.

In the field of conservation of natural resources, INCORA turned over to INDERENA (Institute for Natural Resources) the administration of national parks and preserves. However, support for colonization is creating the danger of destroying natural resources, the effects of

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1968, extended 25 percent of its loans in sums of less than $5000 pesos (subsistence sector), while only 16.0 percent of the loans made by the Banco Ganadero were for less than $30,000 pesos.

TABLE VIII

COLOMBIA: ACQUISITION AND DISTRIBUTION OF LAND BY INCORA DURING PERIOD 1962 TO JUNE 30, 1972

	Hectares	Percent of Total
Land Received		
Purchase	322,481	8.2
Expropriation	16,665	.4
Reversion *	3,511,675	89.3
Voluntary cession *	81,263	2.1
Total land received	3,932,084	
Land Distributed		
Legal title given to farmers	172,293	4.4
Legal titles given to cooperatives	3,338	.1
Housing	323	.0
Experiment Stations	600	.0
Forest Preserves	17,702	.5
Land being improved (irrigation and flood control projects)	14,828	.4
Colonization projects	1,640,434	41.7
Non-usable land	941,410	23.4
Lands to be distributed	1,137,178	29.4
Other	3,977	.1

*By December 31, 1971

Source: Instituto Colombiano de la Reforma Agraria (INCORA). Reporte de Actividades. Oficina de Informacion, 1972.

which can already be seen in areas of Caqueta and Putumayo.

Through supervised credit programs, nearly 60,000 families have received credit for a total of 1,862.4 million pesos, and during ten years of operation increments of 13.8 percent in the value of gross product sold, 9.0 percent in capitalization and 10.7 percent in the use of technical inputs have been obtained. Livestock programs have added about 800,000 hectares of pasture lands to livestock production with the majority of beneficiaries operating cattle ranches of between 5 and 50 head (17).

INCORA has also participated in the organization of agricultural cooperatives and farmers' associations whose main purpose is to bring about community participation on works of infrastructure, such as construction of roads, schools, health centers and to facilitate use of government services.

By 1969 INCORA had invested $3,600 million pesos, a figure which exceeds by more than $400 million the amount spent by the Ministry of Agriculture and by more than $800 million the amount invested in public health during the same period (13).

About 15 percent of the expenditures have been financed through credits from the Interamerican Development Bank and the Agency for International Development (AID). Projects of irrigation and flood control accounted for 85 percent of the total expenditures, while land purchases and the tenant and sharecropper programs represent only 15 percent of the total outlays.

The objectives of the agrarian reform have only been partially met, in part due to problems inherent in the law itself, a product of trade-offs among political groups of widely divergent ideologies, and in part

to a lack of planning and basic studies which would have made possible a more rational identification of priorities in programming and distribution of resources.

The small-scale agriculture sub-sector has received only marginal benefits from government programs during the last two decades. In general, such programs have contributed to strengthening the dualistic nature of Colombian Agriculture, preventing small holders from producing food at their real potential levels, and accelerating, at the same time, an out migration process which is sending to the cities more people than can be employed there. Consequently, better ways for the modernization of the subsistence agriculture, which is basic for the development of the agricultural sector and of the country, need to be found. One step in that direction seems to be the Integrated Rural development projects promoted by the Colombian government since 1972.

Integrated Rural Development Projects

Technological change has been proposed as one of the means to provide an efficient rate of growth of farm output and at the same time to lessen problems faced by small-scale farmers (18).

The Colombian Agricultural Institute, ICA,[3] began in 1968 to design production plans to promote increases in production, through adoption of improved technology for basic food crops (corn, potatoes, beans,

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[3]ICA is one of the five semiautonomous agencies of the Ministry of Agriculture. Its main responsibilities include research activities in agriculture and livestock disciplines, extension services, and educational programs. ICA manages an annual budget of around $400 million pesos ($16 million U.S.) from which it operates eleven major research centers, fourteen experiment stations, forty-six extension agencies, twenty integrated rural development projects, and employs 5,300 people, including 1,200 professionals and 1,300 subprofessional technicians.

cassaba, barley, wheat) and livestock raising. These programs were to be implemented mainly in regions characterized by the predominance of small-scale agriculture. According to ROCHIN (19) there are four types of small farms in Colombia: 1) those operating as a profitable enterprise; 2) those which can become profitable entrepreneur if access to technology, inputs and markets at real prices were available; 3) those which need special incentives, such as subsidized prices during an unspecified period of time, to become profitable enterprises; and 4) those without enough resources for a viable farm enterprise.[4]

At almost the same time, the initial results of the "Puebla Project" were made known. This project, undertaken in Mexico, applied a new strategy for increasing corn production on subsistence farms. It demonstrated the possibility of bringing the fruits of the "Green Revolution" to the traditional farmer, if he was offered, along with the technology, the resources and services necessary for its utilization (25).

The creation of "Integrated Rural Development Projects" was thus promoted and six of them were in operation by the end of 1972. During 1973, fourteen new projects were added and eight more are planned by the end of 1974 (Figure 2).

The basic characteristics of each of the twenty projects currently functioning are summarized in Table IX.

Objectives

The main objectives of the Integrated Rural Development Projects

[4]Alternative small farm classification criteria are given by Wharton (20), Miracle (21), Caroll (22), Adams (23), and Gruming (24).

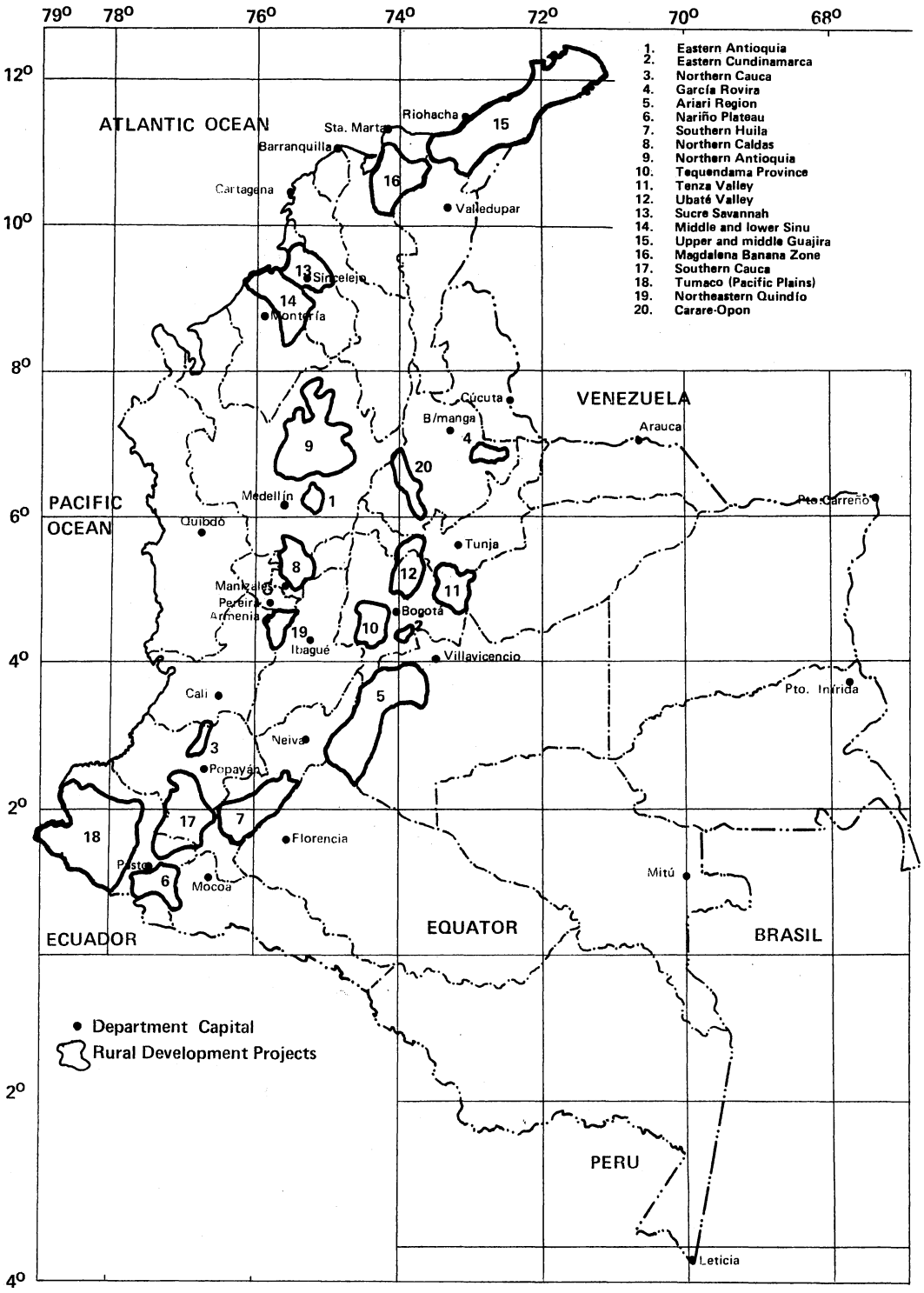

Figure 2. Map of Colombia Showing Location of the Integrated Rural Development Projects

TABLE IX

BASIC CHARACTERISTICS OF INTEGRATED RURAL DEVELOPMENT PROJECTS IN COLOMBIA

Projects	Municipalities Per Project	Rural Population	Agricultural Land (hectares)	Total Number of Farms	Farms With Less Than 10 Hectares	Total Number of Owners	No. Owners of Farms Less Than 10 Hectares	Percentage Farms Less Than 10 Hectares	Percentage Owners of Farms Less Than 10 Hectares
Eastern Antiquia	8	91,660	106,592	13,894	12,426	7,968	7,181	89.4	90.1
Eastern Cundinamarca	9	71,307	78,712	12,917	11,706	10,294	8,427	90.6	81.9
Northern Cauca	8	79,915	159,036	12,186	10,090	8,211	6,740	82.8	82.1
Garcia Rovira	12	85,436	157,434	14,851	11,960	8,072	6,241	80.0	77.3
Ariari Region	6	11,033	1,088,170	4,664	1,160	3,460	804	24.9	23.2
Narino Plateau	11	89,846	103,151	16,944	14,967	12,181	11,028	88.3	90.5
Northern Caldas	7	106,842	220,313	11,574	8,097	6,463	4,461	69.9	69.0
Northern Antioquia	7	61,970	221,564	8,035	3,399	5,317	3,570	66.7	67.1
Tequendama Province	10	119,440	95,861	14,386	12,696	10,067	8,784	88.2	87.2
Tenza Valley	15	103,285	104,215	26,775	25,071	20,422	18,861	93.6	92.3
Ubate and Chiquinquira Valley	14	90,431	143,379	22,241	19,369	16,412	14,466	87.1	88.1
Sucre Plains	12	81,185	264,518	8,974	6,247	4,902	2,565	69.6	52.3
Middle and Lowe Sinu	9	149,691	453,237	22,361	16,848	16,320	11,529	75.3	70.6
Upper and Middle Guajira	3	210,950	241,078	4,144	1,097	2,085	275	26.5	13.2
Magdalena Banana Zone	3	143,248	277,970	3,731	1,261	2,548	680	33.8	26.7
Southern Cauca	15	212,735	257,670	30,628	26,094	23,614	10,375	85.2	86.3
Pacific Plains	6	107,894	291,468	11,786	6,232	6,884	3,748	52.9	54.4
Northeastern Quindio	7	51,551	133,903	5,338	3,414	3,948	2,623	64.0	66.4
Southern Huila Area	22	153,453	551,499	26,952	15,768	19,824	12,715	58.5	64.1
Carare Opon	1	23,610	80,627	3,948	2,370	3,134	1,184	60.0	37.8
Totals	185	2,048,482	5,030,397	276,689	212,272	192,126	136,257	76.8	70.9

Source: Colombian Agricultural Institute. ICA, Planning Office, Bogotá - 1973.

have been established as follows (26):

(1) to increase production and productivity of the agricultural subsistence sector through an efficient use of production factors, improved cultivation techniques, and the adoption of modern systems of farm management;

(2) to raise the standard of living and improve the social welfare of the community by increasing employment, income, and levels of education, and the quality of the housing and health services;

(3) to strengthen social organizations through farmer's groups and community rural development committees; and,

(4) to coordinate the public and private entities serving the agricultural sector so that they may contribute to the progress of rural people, within a framework of action adapted to the socio-economic conditions of the regions chosen for the projects. The aim is to create one integrated regional program rather than a series of parallel programs.

Strategies

To accomplish its objectives each project applies a general strategy which includes: (a) a basic regional study to describe, explain and understand the agricultural environment as a means to identify problems and constraints faced by farmers; and (b) working with the farmer within his traditional setting is strongly emphasized. The existing production systems are studied to ascertain whether or not they need to be changed; the changes introduced should be the result of the generation of technology appropriate for the social and economic conditions of its potential users.

The farmers' active role in evaluating existing technology or in creating and adopting a new one is recognized as a strategy for bringing about increases in production and productivity. The active participation of the farmers in the research phase is achieved by identifying production leaders. This group becomes disseminator within the community of results producted on their own plots and at the experimental stations. Specialized research is carried out in the nearest experimental center and their recommendations are disseminated only after a period of testing on plots ceded by farmers.

Other parts of the strategy include: (c) use of peasant organizations as a means to integrate the community, to promote relations with other social groups and to facilitate a more efficient use of public service; (d) timely provision of services such as technical assistance, credit, marketing of inputs and products, education, family improvement, health, housing and recreation; and, (e) the development of an adequate information network for dissemination of news and innovations.

Administration and Technical Structures

At the national level, ICA's Sub-Director General's office for Rural Development is in charge of policy making and coordination of program execution through a Rural Development Division. In addition, there are nine ICA regional offices to which the local development project officials are responsible.

At the project level the operational structure is composed as follows:

(a) An institutional coordinator whose principal function is to

integrate the activities of the different organizations of the agricultural sector in the project zone. This person also fills the role of Project Director.

(b) Regional and municipal committees made up of representatives of the institutions associated with the project including farmers' organizations. Their role is important in the planning and coordination of activities.

(c) A technical team made up of experts in evaluation of projects, agricultural and livestock research, communications, and home economics.

The programming and evaluation unit is responsible for preparing the basic economic study, design specific programs aimed at solving identified problems, and evaluate results of project activities.

The agricultural and livestock experts are in charge of the design and execution on the farmer's holding of research projects to study traditional production systems, and to identify possible ways to promote increases in productivity.

Projects promotion, dissemination of technology generated by the experimental process, technical assistance to farmers, appraisal and credit supervision, and family advice on matters of health, nutrition and housing are activities carried out by the communication unit personnel working mainly through farmers' community organizations.

The basic technical team is made up of a minimum of 5 experts, some trained at the Master's level, and 15 to 20 technical assistants with intermediate level training. Working with them are students carrying out studies of specific regional problems for their undergraduate and graduate degree theses, and production leaders previously identified.

Support Structures

Individuals and institutions in charge of scientific research and of production and social welfare activities made up the support structure. Basically, these are technical personnel in the ICA experimental stations, the ICA-National University Graduate Program, and the personnel of the regional institutions in charge of services of credit, marketing, conservation of natural resources, agrarian reform, local roads, health, education and housing.

International Cooperation

Technical and economic cooperation is being provided by the following international organizations:

a) International Center for the Improvement of Corn and Wheat (CIMMYT) in Mexico, especially in the Rural Development Project for Eastern Antioquia and in the training of personnel in the "Puebla Plan".

b) International Development Research Center of Canada in the Eastern Cundinamarca Project.

c) The Ford Foundation has contributed to the Garcia Rovira Project by financing the basic regional study, equipment and the training of personnel.

d) The Agency for International Development (AID) has provided funds for credit programs for farmers.

Users

Integrated Rural Development Projects are located in regions characterized by the presence of a large number of small holders of which about 80 percent are owners. Furthermore, basic infrastructure for

transportation, communication, education, and health services is available. An ICA experiment station is operating in or near the regions. In general, these research centers are outside of the domain of other organizations providing technical assistance for small holders such as the National Federation of Coffee growers, and the sugar cane, tobacco, cotton and banana producers' associations.

Families belonging to the small scale agriculture with potential commercial viability are considered as users of a rural development project services. Landless workers are excepted since it is easier to improve the lot of people who are already producers than of those who, lacking land, can only participate as labor in the production process.

That is not to ignore the importance of this latter group, to whom the grovernment should offer alternatives and programs, with which the development projects could effectively cooperate.

CHAPTER III

FARM ECONOMIC SURVEYS IN PEASANT AGRICULTURE: ALTERNATIVE ANALYTICAL MODELS

Before being able to devise agricultural policies and programs appropriate to a region's physical and human resources, its social and economic characteristics, and the aspirations of potential beneficiaries, it is necessary to describe, explain and understand the agricultural environment. At the same time the identification of the major constraints faced by farmers in raising productivity and income levels is required.

With the above information available, the policy decision making process is improved, a more rational choice of research priorities by experiment station technicians can be made, and actions of the extension agents may become more effective. However, one of the main obstacles faced by both policy makers and researchers working within a small-scale agriculture framework is the paucity of accurate data at the farm (micro) level which can be overcome using farm surveys as a source of data for basic economic studies. Analytically the data can be used in two ways:

a) A descriptive analysis including a detailed consideration of the available human and physical resources, an identification of the major agricultural and livestock activities, and a description of production techniques used and of the prevalent management systems.

This type of analysis is particularly important if one considers

that almost no knowledge of the environment exists and therefore, much less certain research hypothesis can be formulated in advance by the analyst. He will find in this information an opportunity to identify the more relevant functional relationships among economic variables.

In general, elementary statistical techniques for handling and analyzing data such as frequency and two-way classification tables, chi-square tests, correlation and simple regression models are adequate for this part of the study (27).

b) A productivity analysis of resources used. Mellor (28), and Christensen (29) consider productivity as a key development factor, nonetheless, improving its usually low levels is not easy and it is even more difficult within a small-scale agriculture characterized mainly by poverty.

As Yotopoulos (30) points out, if poverty is due to misallocation of the existing resources, a reshuffling of factors of production will be enough to foster productivity, but if the main cause is a lack of stock of factors of production then the only effective policy will be to increase available quantities to push the production possibility curve outwards forcing farmers to aim towards a new equilibrium point. It then becomes clear that a description of the current patterns of resource use will not be enough for studying regional development problems. Analyzing the causes of given levels of income and productivity is a necessary step for designing policies that would make a different and more productive use of resources profitable to individual farmers.

Many questions related to the measurement and sources of productivity changes can be answered within an explicit production function

framework that considers whole farm and individual enterprise input-output relationships.

Production Function Models

A production function is a mathematical way to express a functional relationship between resource inputs and product output. It is used mainly for economic analysis of such problems as income distribution, resource allocation and economic growth theory (31, 32).

Most of the basic information required for policy makers, for rural development planning purposes, can be provided if the relevant production function parameters have been estimated. Especially useful are those related with (a) effects of different type of inputs upon production levels, and (b) estimates of marginal products to the factors of production used.

Once planners are provided with the above information, benchmarks of how efficiently resources are being used on farms or under particular enterprises can be made, the type of underutilized resources and the bottlenecks which cause their underuse are identified, policies to foster increased production through fuller use of available resources are suggested, ways of increasing output per unit of input are found, and advice can be given to farmers about the likely advantages of altering their farm organization in a given way, providing the means for raising economic level of living (33, 34).

Problems in Estimating Production Functions

Major difficulties must be overcome to obtain useful production function estimates from farm-survey data.

First, any mathematical model can be considered only as an approximation to the complex relationships being represented and therefore chosing an adequate production function model becomes a factor that determines the usefulness of the results obtained (35). Second, the number of products and inputs that have to be considered makes it necessary to group them into a limited number of categories and the way in which the aggregation procedure is carried out might lead to a meaningless specification of the production function (36).

Johnson (37), Plaxico (36) and Parish (35) have developed several sets of rules to be followed in the process of aggregating inputs and outputs to avoid the introduction of bias into the production function estimates that can destroy their validity for policy and other recommendation purposes.[1]

Third, if the estimated production function is going to represent any real function instead of being crosses between several different functions, farms included in the sample have to be as homogenous as possible in relation with soils, production methods, quality of resources and products produced (38, 39).

Fourth, a production function may be considered part of a system of equations in which inputs and outputs are jointly determined, making a single equation approach inadequate (40, 41).

Fifth, due to lack of data, nonmeasurable variables, budget or

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[1]Inputs should be grouped in such a way that good complements or good substitutes are placed together. Input categories should be neither good substitutes nor good complements for each other. Outputs may be combined if they are affected in the same manner by each input category, separate functions may be fitted by farm or even enterprise types; or finally, mathematical functions capable of considering more than one output variable can be fitted.

computational constrains, variables that should be included in a production model are excluded creating specification errors (31).

Sixth, careful consideration has to be given to the way in which the factors entering the function are defined and measured. Due to its heterogeneous characteristics, capital is one of the most difficult inputs to define and measure. Very often a stock concept of capital has been used under the assumption that flow services and capital stock were proportional, but this will be true only if all capital assets have equal durability and yield a regular stream of service flows until they are used up. Yotoupolos (42) has shown that the use of a stock capital concept increases the coefficient of labor and makes the coefficients of land and livestock capital nonsignificant. The current service flow of capital goods is the input that should be considered in a production function model.

Differences in quality of land are normally associated with differences in quantities used of other factors, since better land tends to be farmed more intensively, resulting in productivity estimates for labor and capital that can be biased upwards showing increasing returns to scale when, in fact, they could be diminishing (35).

Disregard of quality differences in labor, due to sex, age, etc., results in an upward bias of the elasticity of capital and returns to scale (43). Also, amount of labor used should be considered instead of total quantity available, and family labor should be distinguished from hired labor.

Inputs whose quantity use depends on the volume of production, selling charges, packing, and handling costs, etc., should not be included in the model because their high correlation with output that

will result in estimated elasticities and marginal productivities values that are meaningless (31).

Finally, due to the presence of relationships between the independent variables, the multicollinearity problem needs to be considered. The precision of the estimators is affected and becomes difficult, if not impossible, to disentangle the relative influences of the various input categories upon the production levels (dependent variable). The researcher becomes uncertain as to which variables should be included in the model and the coefficient estimates are very sensitive to a particular set of data (35). Heady and Dillon (31) suggest that the correlation coefficient between independent variables should not be above .8 to avoid a high degree of multicollinearity in the model.

Production Functions for Multiple-Enterprise Farms

In regions similar to Garcia Rovira, where a subsistence type of agriculture prevails, farmers produce more than one product under a wide range of enterprise combination patterns creating special theoretical and empirical problems for production analysis.

In general, several crops are grown in either sole stands or in mixtures including intercropping, double cropping or alternate row cropping arrangements. Furthermore, one or more livestock enterprises are often present on the same farm, corresponding to what Frisch (44) has called multi-ware production or assorted products. Rao (45) uses joint production as a generic name to include both joint production and multiple-products.[2]

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[2]Joint products relates to the case where several outputs in fixed proportions are produced from a single production process, for example

As Frisch (44) argues, the main analytical problem is that some of the available production factors can be alternatively used for production of either product and therefore, the production law cannot be studied separately for each product, but must be considered simultaneously for all related products. In the past, either single or multiple-equation models have been used to overcome the problem and their adequacy in obtaining productivity estimates for multiple-enterprise farms is discussed below.

The Single Equation Approach: Whole Farm Functions. The usual approach to deal with multiple-enterprise productivity analysis, is to fit an aggregate production function[3] to data taken from a series of enterprises based on a sample of farms. This, however, is not adequate to obtain reliable productivity estimates considering that: (a) conditions for an optimum aggregation procedure are rarely present and therefore, the derived estimates of the production function parameters are biased (36), (b) the use of prices as weights to reduce different products to a single output category, gross income, results in a production function that is not always a single valued function (46, 47, 48), (c) if the individual enterprises have different types of returns to scale or if the marginal value product of a given factor is not equal

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wool-mutton, eggs-poultry meat. If each output is obtained on the same farm but under separate production process, for example corn and beans, they are called multiple-products.

[3]Gross income is aggregated regardless of the enterprise from which it was derived, and inputs are classified in broad categories regardless of the enterprise to which they were applied under the implicit assumption that individual products are obtained in fixed proportions and that they are affected in the same manner by each input category.

in the various enterprises on the farm considered, then unreasonable results could be obtained (49); (d) the aggregate production function cannot be used to give advice about how to improve farm organization because it does not provide information about the efficiency of the use of resources in the different lines of production existing on a farm; and (e) if the individual enterprises have different production functions then a function obtained by fitting data from several enterprises may cut across individual functions without representing any of the enterprise input-output relationships adequately (49, 50).

To avoid some of these restrictions, Griliches (51) proposes an aggregate production function of such functional form that allows considerable differences in output mix. Information available on the average mix of livestock and crop production is included in a Cobb-Douglas function:

$$Y = AX_1^{d_1 + b_1P} X_2^{d_2 + b_2P} X_n^{dn + bnP}$$

where P is percent of output that is accounted for by livestock and livestock products.

Obviously, the Griliches approach considers the fact that livestock inputs may have low productivity on predominantly crop-producing farms and vice versa, but does not solve the main problem of aggregation of outputs in one category.

Heady (52) classified farms by enterprise type into crop and livestock farms and then fitted a separate function for each class. The assumption is made that the level of output of livestock enterprises does not affect the productivity of resources used to produce crops and vice versa; independence between outputs is implied.

The Single Equation Approach: Multiproduct-Production Function.

El Issawy (46), and Mundlak (47, 48) present the multiproduct production function (MPF) as the appropriate way to estimate input-output relationships for multiple enterprise farms. This type of function allows consideration of two or more output categories as dependent variables, making it possible to estimate marginal productivity of a given input with respect to a given output with other inputs and outputs at various levels (36).

The general form of the MPF may be written as:

$$F(y_1, \ldots, Y_n;\ x_1, \ldots, X_n) = 0$$

where the y's represent outputs and the x's refer to total inputs. More specific algebraic forms for the MPF have been proposed as follows (46):

(a) Transcendental functions.

$$Y_1^{a_1} Y_2^{a_2} \exp(b_1Y_1 + b_2Y_2) = AX_1^{c_1}X_2^{c_2} \exp(d_1X_1 + d_2X_2)$$

(b) Constant elasticity of substitution function (CES).

$$\alpha_1 Y_1^{B_1} + \alpha_2 Y_2^{B_2} = \alpha_1 X_1^{U} + \alpha_2 X_2^{U}$$

(c) A function linear in the logarithms of some linear transformations of the input and output variables.

$$\alpha_1 B_1 \log(K_1-Y_1) + B_2 \log(K_2-Y_2) = \alpha_1 \log(X_1-K_1^*) + \alpha_2 \log(X_2-K_2^*)$$

(d) quadratic MPF.

$$a_1Y_1 + a_2Y_2 + b_1Y_1^2 + b_2Y_2^2 + c_1Y_1Y_2 = q_1X_1 + q_2X_2 + h_1X_1^2 + h_2X_2^3 + 1X_1X_2$$

The MPF should be considered as a member of a system of equations in which outputs and inputs are jointly determined; therefore, nonconventional estimating procedures such as instrumental variables,

covariance analysis, weighted regression, principal component analysis, and canonical correlation analysis have to be used to obtain unbiased and consistent estimates of the parameters (46). As a consequence, additional information not usually obtained from farm survey data is needed and outputs have to be defined in a broad sense so that all farms included in the sample will produce all products being considered (47).

Using the MPF it is possible to estimate the profit maximizing list of outputs of the different products and the inputs of the various factors, given the price situation, but it is not possible to determine the total use of each factor within each enterprise and therefore it is not possible to judge the efficiency of resource use in different enterprises,[4] and advice cannot be offered to farmers in regard to allocation of inputs between individual enterprises to achieve economic efficiency.

Multi-equational Approach. Another way to look at the multi-product farm production process is to represent it by more than one functional relationship. Some of the alternative models available are presented by El-Issawy (46) as follows:

(a) A model with m equations in which each equation represents the output of a given product as a function of the quantities of the factors used in its production.

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[4] The $\breve{MPF}$ allows estimation of $\frac{\partial Y_i}{\partial X_j}$, but does not give any information about $\frac{\partial Y_i}{\partial X_{ji}}$ where X_{ji} refers to the input of X_j allocated to the i^{th} enterprise.

$$Y_1 = f_1 (X_{11}, X_{12}, \ldots, X_{1n})$$

.

.

.

$$Y_m = f_m (X_{m1}, X_{m2} \ldots, X_{mn})$$

where Y_i = output of the i^{th} product; i = i . . . m

X_{ij} = quantity of the j^{th} factor used to produce output of the i^{th} product; j = 1 . . . n

The total amount of each major input has to be partitioned between the individual enterprises, which for many inputs, is very difficult to accomplish in an objective way.

(b) Each of the m equations represents the output of one product as a function of the total quantities of the individual inputs used on the farm.

$$Y_1 = G_1 (X_1, \ldots, X_n)$$

.

.

.

$$Y_m = G_m (X_1, \ldots, X_n)$$

where $X_j = \sum_{i=1}^{m} X_{ij}$ j = 1 . . . n

This model implies that when the total factor quantities are given, the output of all products are determined which is true in the case of joint products but not acceptable for the more general production schemes, prevalent on multiproduct-farms.

(c) Each product can be considered as a function of some specific factors as well as generally applicable inputs.

$$Y_1 = f_1 (X_{11} \cdots X_{1k}; X_{k+1} \cdots X_n)$$

.

.

.

$$Y_m = f_m (X_{m1} \cdots X_{nk}; X_{k+1} \cdots X_n)$$

where the X_{ik} are specific factors used to produce the i^{th} output; K = 1 ... K, and X_n are general inputs which total quantities used cannot be partitioned between the individual enterprises; $X_n = X_{k+1}, \ldots, X_n$. This is a more satisfactory model both from the theoretical and empirical point of view especially if it is implemented using data from written records and accounts that justify the assumption about independence among individual enterprises.

Estimation Procedures for Multi-Equational Models. After a decision to use a multi-equational approach is made, an appropriate estimation procedure has to be chosen to obtain the desired parameter estimates. The statistical method to be followed depends on the type of relationships which individual enterprises may bear to one another on a multiple enterprise farm.

If the individual enterprise production functions integrating the multi-equational model are independent, a least squares procedure can be applied to estimate each equation corresponding to each major enterprise.[5] On the other hand, if the production functions of the different

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[5]Production functions can be considered independent of one another if input or output changes in one enterprise do not affect the parameters of the production function of the other enterprises. If that is the case, a shift of inputs from one enterprise to another will result in a movement along the individual enterprise production functions without the production functions themselves being changed.

enterprises are interdependent, then one of the statistical methods of solving simultaneous equation systems must be applied.[6]

After both technical and economic sources of dependency between individual enterprise production function for multiple-enterprise farms were considered, Beringer (49), and El-Issawy (46), conclude that the apparent dependencies were due to "pricing in terms of on farm opportunity costs and/or neglecting to charge and credit by products in a proper way." If factors are measured either in physical or in constant monetary terms, independence among individual enterprise production function prevails and consequently, fitting each equation of the multi-equational model independently to data from multiple-enterprise farms is an adequate approach to take.

Vinod (53) argues that ordinary least squares, when applied to estimate production coefficients for multiple-enterprise farms, will yield inconsistent estimates, and suggests use of canonical correlation analysis as the adequate statistical procedure to estimate all equations simultaneously taking account of the jointness in production. However, Chetty (54), Rao (45), and Dhrymes (55) have shown that Vinod's method only provides a round about procedure for computing least square estimates and therefore, canonical estimates are not consistent unless ordinary least squares are as well.

On the other hand, Mundlak (48) argues, that estimating each equation separately does not consider the dependence that may exist between the disturbance terms in the various individual enterprise production functions and therefore, the generalized least squares estimators

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[6]Two stage least squares, limited information system, etc.

proposed by Zellner (56) are judged as more efficient than those obtained by the application of ordinary least squares to each equation.

The basic operational difficulty with this procedure is the estimation of the variance-covariance matrix required to apply a generalized least square routine.[7] Zellner proposes that ordinary least squares be applied to each equation of the multi-equation model and the computed residuals used to estimate the variance-covariance matrix Σ. The assumption of equal sample sizes for each equation is implicitly made and therefore, only those farms with similar production structure can be considered for analyses.

When Zellner's approach is applied to data obtained from multi-product farms of the type prevalent in regions with wide variations in ecological and climate conditions, the assumption about equal sample sizes becomes so restrictive that the possible gains in efficiency may be overcome by either the product aggregation procedure necessary to obtain equal sample sizes or by the amount of bias introduced in the equations if other alternative ways to avoid such requirement were applied.[8]

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[7] The generalized least squares estimator is of the form: $\hat{B} = (X^{1}\Sigma^{-1})^{-1} X^{1}\Sigma^{-1}Y$ where Σ represents the variance-covariance matrix.

[8] Some alternative ways to handle the equal sample size requirement are: (a) to consider a subset of farms from the main sample such that all farms included produce the same products; (b) to aggregate products until a similar production structure is obtained for all farms; (c) to assume zero covariance for products not produced on a given farm; (d) to match individual observations (residuals) without considering to which farm do they belong.

Considering the kind of data available, and the restrictions imposed by inequal sample sizes at the activity level, the multi-equational model with each of the individual equations estimated by fitting data through an ordinary least squares procedure appears, in spite of its potential limitations, as the best alternative available for a production analyses in the Garcia Rovira region.

Alternate Functional Forms. Several forms of equations that are theoretically appropriate and empirically feasible to estimate each of the individual enterprise production functions of the multi-equational model, are available (31).

The widely used equation is the power function, generally known as Cobb-Douglas (57), of the general form:

$$Y_i = \alpha X_1^{b_1} X_2^{b_2} \ldots X_n^{b_n}$$

where Y represents total output obtained, and the X's indicate amounts of inputs used to produce Y.[9]

The main properties of the Cobb-Douglas function are presented by Heady (31, 32), and Parish (35) as follows:

(a) Its logarithmic transformation is linear in the parameters allowing its estimation by least square procedures

(b) The regression coefficients, b_i, derived from the logarithm forms of the equation are the production elasticities of the individual

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[9]For a review of research done using Cobb-Douglas functions see Heady and Dillon (37) and Walters (58). Some results obtained after 1960 are presented in Hooper (59), Mazundar (60), Cozens (61), Johnson (62), Strivastava (63), Massell (64), Schwartz (65), Rojas (66), Bostwick (67), and Norman (68).

resources.[10]

(c) It is homogeneous of degree Σb_i.[11]

(d) The elasticity of factor substitution is unitary.[12]

(e) Partial elasticities b_i and total production elasticities Σb_i do not change over the entire range of the function.

(f) The isoquants become asymptotic to the input axes.

(g) The isoclines are straight lines through the origin.

(h) The function cannot describe any two stages of production simultaneously.

(i) The productivity level of a given resource depends on the magnitude of the others.

Properties a, b, and c together with the fact that it requires fewer number of parameters to be estimated than any other alternative form are factors explaining its wide use but on the other hand, properties d, e, and f are quite restrictive.[13]

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[10] Percentage change in output that results from a one percent change in the input of the factor.

[11] $\Sigma b_i > 1$ increasing returns to scale
$\Sigma b_i = 1$ constant returns to scale
$\Sigma b_i < 1$ decreasing returns to scale

[12] The elasticity of factor substitution, σ, is a measure of easy at which the varying factors can be substituted for others. It is the proportional change in the factor ratio in response to a proportional change in the marginal rate of substitution between two factors.

[13] A uniform degree of substitutability in different types of production is unlikely considering the wide range of technological alternatives that exist to carry out production. Constant elasticities of production are not likely to occur, given that production can be obtained using variable factor proportions which results in partial production elasticities and returns to scale that differ among different production techniques. Finally, the symmetry assumption implies no limit to the range in which the proportions of any two inputs can be varied to produce a given level of output.

Efforts to overcome the above restrictions can be divided into two categories: (1) To eliminate the unitary elasticity of factor substitution: The CES production function, (69), the class of homothetic isoquant production functions (70), and the variable elasticity of substitution function (71), have been developed.

(2) The transcendental function (72), the Cobb-Douglas with variable returns to scale (73), and the generalized power production function (74, 75) were developed to overcome the constant elasticity of production assumption of the original Cobb-Douglas model.

None of the modified Cobb-Douglas functions have been used in estimating farm production functions mainly because they are difficult to generalize in order to consider more than two input categories. Furthermore, some of them are not linear in their parameters which makes the estimation procedures very complex, leaving the unrestricted specification of the function as the form to be applied in this case.

Chapter IV describes the procedures used to gather the basic data for the study and, based on its analysis, a discussion of the technological levels and the main characteristics of the production factors for the Garcia Rovira agriculture are presented.

The numerical results obtained from both single and multi-equational models for production analysis on multiproduct subsistence farms, as well as the causes of poverty in the region, are discussed in Chapter IV.

CHAPTER IV

RESOURCES AVAILABLE, PRODUCTION SYSTEMS, AND TECHNOLOGICAL LEVELS OF AGRICULTURE IN GARCIA ROVIRA

The discussion in this chapter focuses on the methodology used in gathering socioeconomic data from farmers, with a brief description of the data collected in order to provide an idea of its accuracy and limitations. Resources available for production, as well as technical practices, and management systems prevalent in Garcia Rovira agriculture are analyzed.

Data Development

The Sample

All production units[1] located in the rural development project area, estimated at 15,411 in the 1970 national agricultural census (9), were considered as population. Then, using standard sampling procedures (76) a stratified random sample of the producers was obtained.

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[1]The total amount of land located in one municipality which is held by one producer constitutes a production unit. This concept is independent of the size of the holding and the number of parcels as long as the land of which it is comprised is located in only one municipality. It is also independent of the tenure form under which it is held. Therefore, a producer may own one parcel and rent another; however, the two constitute the production unit belonging to that producer. For this study, the production unit is considered as the unit of observation and analysis.

Prior knowledge of the prevalence of particular sizes of farms and land tenure forms permitted stratifying the population into 12 strata. Each farm listed in the agricultural census was then classified into one of the strata according to its size and predominant form of tenure.[2] A sample size of 1263 farms was determined with the corresponding sub-sample sizes for each of the 12 strata considered (Table X).

Eight hundred and fifteen holdings were selected at random as substitutes for cases where it would be impossible to locate the one chosen as a first option, or where the producers refused to provide information. Producers to be interviewed were selected at random and identified by their locations and names.

During the field work inaccuracies in census data related to farm size and tenancy were detected. Many farms belonged to a different strata than the one originally assigned and had to be reclassified using the information given by farmers during the interviews. This post-classification procedure resulted in oversampling for some strata and undersampling for others. Fortunately, as shown in Table X, the most important groups in relation to the development project objectives[3] are those with a number of completed interviews above the estimated sample size. In general, the sample included 8.2 percent of the holdings and 11.8 percent of the project area.

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[2]If the land holding was made up of a number of parcels under different types of tenure, the holding was classified according to the form of tenure which predominated, that is, the type under which the greatest surface area was held.

[3]Owners and sharecroppers with holdings less than 50 hectares.

TABLE X

GARCIA ROVIRA ECONOMIC SURVEY
THE SAMPLE, 1972

Stratum		Total Number of Farms	Estimated Sample Size	Percent Farm Sampled	Number of Interviews Completed	Percent of Interviews Completed
Farm Size (Hectares)	Tenancy					
< 4.00	Owner	4,552	123	2.7	201	163.4
< 4.00	Sharecropper	2,814	98	3.5	150	153.1
< 4.00	Other	1,082	165	15.3	55	33.3
4.00 - 9.99	Owner	2,647	135	5.1	292	216.3
4.00 - 9.99	Sharecropper	837	95	1.1	95	100.0
4.00 - 9.99	Other	485	172	35.5	78	45.3
10.00 - 49.99	Owner	1,367	113	8.3	200	177.0
10.00 - 49.99	Sharecropper	612	50	8.2	67	134.0
10.00 - 49.99	Other	578	48	8.3	25	52.1
≥50.0	Owner	234	100	42.7	55	55.0
≥50.0	Sharecropper	104	72	69.2	18	25.0
≥50.0	Other	99	92	92.9	7	7.6
Total		15,411	1,263	8.2	1,243	98.4

Data Collection

The field work, undertaken between March and June 1972, was carried out in two phases. The municipalities of Macaravita, San Miguel, Capitanejo, Enciso and San José de Miranda were surveyed first and 418 questionnaires were completed in a period of 20 days during March-April 1972. In the remaining seven municipalities, 815 questionnaires were administered in 25 days in May-June 1972. Thirty interviewers and five supervisors were employed to complete 1243 of the 1263 anticipated interviews.

Data Collected

Using a questionnaire designed in accordance with the study's objectives and through interviews with farmers selected in the sample, information was gathered on the following economic variables for the year 1971.

1) Available labor force: family structure, sex, age, education level and principal occupation of family members.

2) Utilization of labor force: labor force employed in different agricultural activities according to the seasons and the work accomplished. Both family, and contracted labor were considered by ages and sex groups.

3) Land Tenure: Land tenure pattern by field; labor and other inputs provided by sharecroppers; output sharing provisions.

4) Land Use. Distribution of the area of the holdings according to use: crops, pasture lands, woodlands, fallowland and unuseable areas.

5) Farm inventory; inventory of the number and estimated value of

capital goods.[4]

6) Credit: Sources of credit; interest rates and terms.

7) Costs of production for agricultural enterprises.

8) Outputs: quantity produced, quantity sold, family consumption; value of production sold; expected production; production losses.

9) Other sources of income: work on other holdings; non-agricultural activities.

10) Agricultural technology: soil preparation; planting methods; kinds of seeds used; pest and disease control; weeding practices; harvesting.

11) Livestock Technology: Vaccinations; vermifuge techniques; management practices for sheep, cattle, poultry, and swine.

12) General information on marketing of products, and inputs.

13) Exposure to means of communication: visits to urban centers; magazine and newspaper reading; radio programs.

14) Migration: period of residence in the region; family members who have migrated; causes of migration.

15) Attitude toward change: degree of participation in farmers' associations; communal use of resources; decision-making processes.

16) Housing: kinds of construction and type of materials used for housing; water, light and sewer services.

Obviously, the information obtained is subject to the usual sources of measurement errors in the collection of primary input-output data from illiterate farmers. Efforts were made to minimize those errors by

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[4]Includes buildings, products or inputs in storage, machinery and equipment, tools, draft power animals, livestock, and poultry.

recruiting interviewers familiar with the region and with previous experience in interviewing farmers. Adequate training and a close supervision of enumerators were provided, and frequent cross checking of the interview forms was performed. The cooperation of both local authorities and farmers was sought through meetings in which the objectives of the study were explained in detail and the usefulness of the results emphasized.

Resources Available

Population Characteristics

Garcia Rovira has a young population. 56 percent of the sampled population is younger than 19 and 74 percent have not yet reached thirty years of age (Table XI).

Following the labor legislation definition the productive age group, persons between 15 and 55 years of age, comprise 47.5 percent of the population.[5]

On average, there are 107 men to every 100 women, but the proportion varies according to age groups. Males predominate in the 15 to 29, 45 to 59, and over 60 age categories. The proportion is lower for the age group between 30 and 44 years of age.

For every thousand women of reproductive age there are 296 children. These figures are low compared to national standards which indicate a proportion of 840 children per 1000 women.

The typical Garcia Rovira family is composed of 9 persons of whom

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[5]Actually, the labor force is underestimated considering that normally persons under 15 years of age are taking part in agricultural activities.

TABLE XI

GARCIA ROVIRA POPULATION BY SEX AND AGE, 1972

Age Group	Male	Female	Total
	Percentage		
1 - 4	11.3	12.5	11.9
5 - 9	17.4	17.0	17.2
10 - 14	15.8	14.7	15.3
15 - 19	11.5	10.8	11.2
20 - 24	7.9	7.4	7.6
25 - 29	6.1	5.9	6.0
30 - 34	4.8	5.6	5.2
35 - 39	4.9	5.9	5.4
40 - 44	4.4	5.1	4.7
45 - 49	3.8	3.8	3.8
50 - 54	3.5	3.7	3.6
55 - 59	3.0	2.5	2.8
60 - 64	2.4	2.1	2.2
65 - 69	1.0	1.1	1.1
70 - 74	1.2	1.1	1.2
75 - 79	.6	.4	.5
80 - 84	.2	.3	.2
$\geq$ 85	.2	.1	.1
Total	100.0	100.0	100.0
Percentage	51.7	48.3	

4 are men, and 5 are classified as dependents: children, elderly people, and women. The average number of families per farm is 1.1.

Families are most commonly nuclear and organized along partriarchal lines; only occasionally does one find persons living in the household aside from parents and children.[6]

Heads of families are young; 19.8 percent are between 15 and 34 years old, 51.3 percent between 35 and 54 years of age, while those over 54 years comprise 28.9 percent of the total.

The mothers are younger than the fathers with 38 percent of mothers between 14 and 29 years of age and only 11.7 percent over 55 years. The high incidence of young heads of households indicate potential benefits from family improvement programs.

Educational Level. During 1971, 47 percent of the school age population was enrolled in school. Of the heads of household interviewed, 30.2 percent are illiterate, 40.0 percent have completed 1 to 2 years of elementary school and 28.0 percent have finished the elementary school program. The remaining family members are classified as follows: illiterates, 10.2 percent; with 1 or 2 years of elementary school 46.1 percent; 7.2 percent have completed elementary school; 1.0 percent have a partial high school course, and .1 percent have some advanced education.

However, if one takes into account the quality of education in rural schools, those persons with 1 or 2 years of elementary education

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[6]In 85.9 percent of the families interviewed the father is head of the household and only 9.2 percent of the members are not considered part of the basic nuclear family.

may be considered as functional illiterates.[7] This raises the illiteracy rate to 70.2 percent for heads of families and to 56.3 percent for other members.

The high incidence of illiteracy is the immediate reason why 72.7 percent of those interviewed do not read any kind of book or magazine. Of those who are literate, 27.3 percent preferred to read material on agriculture.

The most effective mass communication medium is radio; 82.7 percent of those surveyed listen to radio programs.[8] News and programs on agricultural topics are the afvorite broadcasts. However, 49.2 percent of persons who listen to programs pertaining to agriculture reported that they did not put into practice the technical advice they have heard.[9]

Migration. Migration within the municipalities of Garcia Rovira has always existed, but migration to Garcia Rovira from other parts of the country is practically unknown. About seventy percent of those interviewed are natives of the area where they presently live and 33.3 come from other Garcia Rovira municipalities.

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[7]During 1972 more than 40 percent of the rural schools did not offer more than three of the five years of elementary school due to a lack of students caused by economic pressures that obligate children to work in agriculture or domestic activities before they have the opportunity to complete primary education.

[8]A radio station located in San José de Miranda broadcast to the greater part of the province and broadcasts from the major national radio networks are also heard.

[9]27.8 percent give lack of technical assistance as their reason for not implementing the technical advice; 24.6 percent claim they do not understand it; 11.6 percent cite a lack of funds; 4.5 percent mention the scarcity of land; and 3.2 percent cite the risk implicit in the recommendations.

Among heads of families, 88 percent have lived in the region for longer than 20 years, and only 3.7 percent have lived in the present location for less than 10 years. Only 29 percent show any interest in leaving the area. Those who did want to leave blame their disatisfaction principally on job and land scarcity, problems in educating their children, and, in some cases, on political violence.

Migration in Garcia Rovira, though small in volume, is selective with regard to age and sex of the migrants. Young people are more likely to migrate than adults and men migrate more frequently than women.[10]

About 73.0 percent of the emigrants have received an elementary school education, 17.8 percent have some high school and/or college, while only 9.5 percent are illiterate. Thus, emigration has also been selective with regard to educational level and has tended to take away some of the better trained people from the region.

Lack of work and land scarcity are cited as the primary reasons for leaving the region in 73 percent of the cases. For 11.3 percent, the lack of opportunities for education was the reason to emigrate.

A high percentage of emigration is seasonal, occurring during periods when the demand for labor decreases, and it is directed toward Venezuela where high salaries for agricultural labor are paid. Those emigrating tend to return during planting and harvesting times.

Land

Land Use. Patterns of land use in Garcia Rovira during the second

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[10] 60.1 percent of the migrants are younger than 30 years of age whereas 57.8 percent are men.

semester of 1971 are summarized in Table XII.

TABLE XII

LAND USE PATTERNS IN GARCIA ROVIRA, 1972

Use	Area (Has)	Percentage
Cropping land	4,573	24.5
Fallow land	1,327	7.1
Grazing land	7,177	38.4
Woodland	1,041	5.6
Unusable	4,544	24.4
Totals	18,662	100.0

The region's topographic characteristics are well reflected in land use patterns. Most of the area, 38.4 percent, is devoted to livestock raising with cropping and unusable land accounting for equal percentages of the total area. The intensive type of agriculture that prevails is also shown by the small percentage of area reported as fallow land.

San José de Miranda, Macaravita, San Miguel, Capitanejo and Enciso have the largest percentages of cropping land; grazing land predominates in Cerrito, San Andrés and Guaca and the largest percentages of unusable land is found in Macaravita and San Miguel where 14.0 and 12.5 percent

of the soils are severely eroded.

Greater percentages of grazing and unusable land are reported for those holdings comprised of more than 50 hectares, whereas on small farms cropping land is predominant.

To compare actual against potential land use patterns, a subsample of 418 production units, for which agrological classification is available, was taken from the main sample.[11] As indicated in Table XIII, current land use is inadequate with regard to its productive potential; 28.5 percent of the area is being sown despite the fact that only 16.1 percent possesses characteristics suited to the intensive use implied by current cultivation schemes. Most of the land, 65.1 percent, would be better employed in reforestation programs to stop the process of soil erosion resulting from inappropriate land uses.

TABLE XIII

CURRENT AND POTENTIAL LAND USES IN GARCIA ROVIRA, 1972

	Current		Potential*	
Use	Has	Percentage	Has	Percentage
Cropping & Fallow	2,174.9	28.5	1,232.1	16.1
Grazing	2,898.0	37.9	1,433.8	18.8
Woods & Unusable	2,564.1	33.6	4,971.1	65.1
Totals	7,637.0	100.0	7,637.0	100.0

*Based on a subsample of 418 production units.

[11] Agrologic classifications were made by the Agustin Codazzi Geographic Institute (77), based on physical and chemical soil properties, and are used to recommend potential uses of land.

Farm Size. Production units under 10 hectares constitute 70 percent of the total and cover 18.9 percent of the sample area whereas holdings larger than 50 hectares account for 52.7 percent of the area and 6.4 percent of farms (Table XIV).

This situation, although similar to that throughout the country, is, nevertheless, more critical in Garcia Rovira if one considers the low quality soils prevalent which makes the redistribution of larger units a very partial solution to the problems of low productivity and low income. More than 70 percent of the area occupied by farms of more than 50 hectares belong to agrological classes VII and VIII unsuitable for agriculture (Table XV). Subdivision of this land into smaller units implies a more intensive use which would aggravate the already advanced process of soil erosion.

Over 50 percent of the land held by farms less than four hectares in size is unsuitable for crop or livestock production. Farms within the range of 4 to 10 hectares have more productive land than any other group.

Land Tenure. Ownership, accounting for 60.2 percent of the farms and 81.8 percent of the total area, is clearly the predominant land tenure system. Sharecropping with 26.5 percent of the holdings and 12.4 percent of the area follows in importance. On average owners hold 20.8 hectares, sharecroppers have 7.2 hectares, and 6.7 hectares are under other tenure arrangements (Table XIV).

In general, sharecroppers receive from the landlord land, and up to 75 percent of the value of seed and fertilizers. Output sharing provisions varies widely with sharecroppers receiving from 35 to 50 percent of the value of production.

TABLE XIV

FARM SIZE AND LAND TENURE SYSTEMS IN GARCIA ROVIRA, 1972

Farm Size (Hectares)	Land Tenure			Total	Percentage	Average Farm Size
	Owner	Sharecropping	Other			
Less than 4.0						
Farms	201	150	55	406	32.7	
Hectares	703.7	106.7	49.5	860.3	4.5	2.1
4.0 < 10.0						
Farms	292	95	78	465	37.4	
Hectares	2,243.6	340.1	159.0	2,742.7	14.4	5.9
10.0 < 50.0						
Farms	200	67	25	292	23.5	
Hectares	4,423.1	670.5	313.7	5,407.3	28.4	18.5
≥ 50.0						
Farms	55	18	7	80	6.4	
Hectares	8,220.7	1,246.1	582.8	10,049.6	52.7	125.6
Totals						
Farms	748	330	165	1,243		
Hectares	15,590.5	2,363.4	1,105.4	19,059.9		
Percentages						
Farms	60.2	26.5	13.3		100.0	
Hectares	81.8	12.4	5.8		100.0	
Average Farm Size	20.8	7.2	6.7	15.3		

TABLE XV

DISTRIBUTION OF LAND BY SOIL QUALITY AND FARM SIZE IN GARCIA ROVIRA, 1972*

Farm Size Hectares \ Percentage of Land Suitable for	Crop[a/] Production	Livestock[b/] Production	Forest[c/]	Waste[d/]	Total
< 4	17.1	32.1	47.1	3.7	100.0
4 < 10	25.5	29.6	44.2	.7	100.0
10 < 50	16.8	18.0	58.4	6.7	100.0
≥ 50	13.8	16.0	59.0	11.2	100.0

*Based on a subsample of 418 farms for which agrologic soil classifications (in Roman numerals) were available.

[a/] II, III Moderately sloping land between, 1,000 - 3,000 meters above sea level non-eroded soil, drained, low to medium fertility suitable for crop production.

[b/] IV Lands with steeper slope (25-50%), surface soils affected by erosion, primarily suited for extensive livestock raising.

[c/] VII Very steep hilly land in cold climates or paramo, low fertility; land that is best left with natural vegetation to maintain the watershed.

[d/] VIII Extremely steep land with rocks and guillies that is unproductive (waste).

Nearly 38 percent of the holdings less than four hectares in size are under sharecropping arrangements and are located mainly in the municipalities of Capitanejo, Enciso, San José de Miranda, and Molagavita.[12] Most of the land assigned to sharecroppers is suited for crop or livestock production in contrast with land under ownership for which more than 70 percent is classified as only adequate for forest or unusable. The highest share of good land appears under the "other" tenancy category made up mainly of cash rented farms located on the flatest land available in the region (Table XVI).

As indicated in Tabel XVII, sharecroppers and renters are at the forefront in the use of improved seed, but all other inputs appear to be used euqally by all types of farms.

Capital

In an agricultural subsistance economy, capital is represented, mainly, by land improvements, livestock, and basic tools and equipment. During the interviews information about quantities and values of the exciting capital goods as of December 31, 1971, were obtained for each farm.

For purpose of this study, capital consists of the value of buildings and improvements on the land, tools and implements, machinery, draft power animals, and livestock.[13] Capital goods were appraised at

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[12] Independence among farm size and land tenure systems was tested using Chi-square test. The null hypothesis of independence was rejected at .01 probability level.

[13] Values for land, perennial crops, and non-durable capital goods were not considered. Land was analyzed as a separate production factor, perennial crops were not economically important in the region, and for the non durable capital goods it was assumed that they were used in the same production period that they were purchased.

TABLE XVI

DISTRIBUTION OF LAND BY SOIL QUALITY AND TENANCY IN GARCIA ROVIRA, 1972*

Area Suitable for \ Tenancy	Owner	Share-Cropper	Other	Total Area
	Percentages of Farm Area			
Crops	10.0	25.1	42.3	16.1
Livestock	19.7	24.4	11.3	18.8
Forest	60.0	45.1	45.5	56.7
Unusable	10.3	5.4	.9	8.4
Total	100.0	100.0	100.0	100.0

*Soil classifications corresponding to those in Table XIX.

TABLE XVII

TENANCY AND THE USE OF IMPROVED INPUTS IN CROP PRODUCTION IN GARCIA ROVIRA, 1972

Improved Inputs \ Tenancy	Owner	Share-Cropper	Renters	Other
	Users (Percentage)			
Improved Seeds	15.0	25.3	28.4	17.6
Fertilizer	42.5	21.7	40.9	37.9
Insecticides	55.7	59.8	59.0	52.4
Herbicides	4.7	.4	9.0	3.7
No. of Farmers Reporting	717	249	88	187

their replacement value.

Uses of Capital. About 48 percent of the capital is represented by fixed investments in buildings and land improvements whereas only 6.2 percent corresponds to working capital (tools and equipment). Dairy and beef cattle comprise the largest investment in livestock followed by horses and draft power animals used for transportation and land tillage (Table XVIII). Available capital is estimated at $23,778 pesos per production unit and at $2,413 pesos per hectare underlining the scarcity of a key element to apply more modern production systems which are, generally, more intensive in the use of capital.

Tables XIX and XX relate capital per holding and capital per hectare, to farm size respectively. About 17.0 percent of holdings have between $10,000 pesos and $15,000 pesos worth of capital, 33.0 percent have less than $10,000 pesos, and only 3.1 percent have over $100,000 pesos. Farms of less than 10 hectares in size fall primarily into the categories of less than $15,000 pesos of capital with those of more than 10 hectares are concentrated in the larger capital categories. Independence between size of holding and capital available is rejected by a Chi-square test.[14]

On a per hectare basis, 53 percent of the holdings reported a capital of less than $2,500 pesos with only 1.3 percent of farms belonging to the category of more than $15,000 pesos. In this case, 94 percent of the holdings of more than 50 hectares are concentrated in the category of less than $2,500 pesos per hectare while 56.8 percent of

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[14]Chi-square calculated = 100; Chi-square .01(27) = 46.96.

TABLE XVIII

USE OF CAPITAL IN GARCIA ROVIRA, 1972

Investment Categories	Percent of Total Capital Invested
Buildings and land improvements	48.2
Fixed equipment	2.2
Non fixed equipment	2.4
Tools	1.2
Dairy equipment	.3
Horse equipment	.2
Poultry equipment	.0
Sub Total	54.5
Dairy and beef cattle	34.8
Horses and draft power animals	5.2
Sheep	2.9
Poultry	1.1
Swine	.5
Goats	.0
Sub Total	45.5
Total	100.0

TABLE XIX

CAPITAL PER FARM BY SIZE OF HOLDING
IN GARCIA ROVIRA, 1972

Capital Per Farm (Thousands of Pesos) \ Farm Size (Has)	< 4	4 < 10	10 < 50	≥ 50	Total
	Percentage*				
< 2.5	4.4	1.0	.2	.1	5.7
2.5 < 5.0	4.6	3.1	.4	.1	8.2
5.0 < 7.5	5.8	3.5	.6	.1	10.2
7.5 < 10.0	3.6	4.5	.9	.1	9.1
10.0 < 15.0	6.0	8.0	2.5	.3	16.8
15.0 < 20.0	3.0	6.2	3.1	.1	12.4
20.0 < 30.0	2.7	6.6	4.8	.7	14.9
30.0 < 50.0	.9	3.6	5.9	1.2	11.6
50.0 <100.0	.2	1.2	4.5	2.3	8.3
≥100.0	.2	.2	1.0	1.7	3.1

*Percentages are of N = 1239

TABLE XX

CAPITAL PER HECTARE BY SIZE OF HOLDINGS
IN GARCIA ROVIRA, 1972

Capital Per Farm (Thousands of Pesos) \ Farm Size (Has)	<4.0	4.0 < 10.0	10.0 < 50.0	≥50.0	Total
	Percentage*				
< 2.5	11.2	18.8	16.7	6.3	52.9
2.5 < 5.0	9.6	14.0	5.6	.1	29.3
5.0 < 7.5	5.7	3.6	1.2	.1	10.6
7.5 < 10.0	1.9	.5	.3	.1	2.8
10.0 < 15.0	2.2	.8	.1	.1	3.2
≥ 15.0	.8	.3	.1	.1	1.3

*Percentages are of N = 1239

the holdings of less than 10 hectares have a capital greater than $5,000 pesos per hectare. These figures reflect a production structure which is intensive in holdings of less than 4 hectares and extensive in farms of more than 50 hectares. The capital invested per hectare shows an inverse relationship with the size of the holding.[15]

Capital per farm is directly related to land tenure, but on a per hectare basis it is independent of tenancy.[16] With the exception of the category corresponding to holdings with capital of less than $2,500 pesos per farm, the incidence of privately owned holdings is equal to or greater than that for sharecropping (Table XXI). On a per hectare basis, more than 50 percent of landowners as well as sharecroppers invest less than $2,500 pesos (Table XXII). Furthermore, the percentage corresponding to the category of more than $10,000 pesos per hectare is also similar, 5.0 percent, for both systems of tenure.

Agricultural Credit. Credit, as a source of capital, have been used by 53.0 percent of those interviewed; 28.2 percent have requested credit without having obtained it, and 18.5 percent have never solicited it. About 38.0 percent of the credit is granted by particulars at rates of interest from 15.7 to 30.3 percent per year. Private and official banks charge an average interest rate of 18 percent a year.

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[15] A Chi-square test under the null hypothesis of independence between capital invested per hectare and the size of the holding led to the rejection of the null hypothesis at .01 percent probability level.

[16] The appropriate Chi-square tests were applied with the following results: χ^2 calculated = 108.89; χ^2 .01(18) = 36.19
χ^2 calculated = 14.12; χ^2 .01(10) = 23.21

TABLE XXI

CAPITAL PER FARM BY TENURE CLASS
IN GARCIA ROVIRA, 1972

Capital Per Farm (Thousands of Pesos) \ Tenancy	Owner	Share-Cropper	Others	Total
	Percentage*			
< 2.5	1.9	2.3	1.4	5.6
2.5 < 5.0	2.8	2.8	2.4	8.0
5.0 < 7.5	4.8	3.0	2.3	10.1
7.5 < 10.0	4.6	2.7	1.9	9.2
10.0 < 15.0	9.8	3.2	3.7	16.7
15.0 < 20.0	7.1	2.3	3.1	12.5
20.0 < 30.0	9.1	2.4	3.3	14.8
30.0 < 50.0	8.9	.9	1.9	11.7
50.0 <100.0	6.3	.5	1.5	8.3
≥100.0	2.5	.1	.6	3.2

*Percentages are of N = 1239

TABLE XXII

CAPITAL PER HECTARE BY TENURE CLASS
IN GARCIA ROVIRA, 1972

Capital Per Hectare (Thousands of Pesos) \ Tenancy	Owner	Share-Cropper	Other	Total
	Percentage*			
< 2.5	29.2	11.8	12.0	53.0
2.5 < 5.0	17.6	5.2	6.6	29.4
5.0 < 7.5	6.7	1.6	2.2	10.5
7.5 < 10.0	1.4	.5	.8	2.7
10.0 < 15.0	1.9	.9	.3	3.1
≥ 15.0	1.0	.1	.1	1.2

*Percentages are of N = 1239

Credit is demanded, mainly, to cover cost of production and for the purchase of family consumption items. About 60 percent of credit private sources is short term with medium and long term credits being handled almost exclusively by government and private banks.

The average loan is estimated at $4,750 pesos per farm and $478 pesos per hectare . The amounts are clearly insufficient to apply technologically advanced methods of agriculture. The problem is even more acute considering that loans are granted based on the applicant's financial capacity, a practice which tends to concentrate credit services among those farmers with more resources leaving subsistence holders without almost any assistance.

Production Systems and Technological Practices

Agricultural Enterprises

Technology. The kinds of crops grown in a region and the technologies used to produce them are determined by such physical factors as water, temperature and soil quality; social factors, such as traditions and preferences, and economic factors, mainly product and input prices.

The sample of farms in the Garcia Rovira area grow a total of 29 different crops, some of which are grown in mixtures rather than in sole stands.[17] These varieties of agricultural enterprise allow for the use of wide range of production techniques from the most rudimentary

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[17]The practice of growing two or more crops together at the same time is termed intercropping. Different spatial arrangements of plants in each crop mixture are found but the practice of growing several crops in a random mixture is more popular than growing crops in alternate rows. Intercropping should be distinguished from double cropping which refers to the practice of planting a crop shortly after the previous one has been harvested.

to the modern methods recommended by the experimental stations.

For descriptive purposes, a production process can be divided into stages which take place either simultaneously or successively and together make up a production system. For crops, these stages are: soil preparation and seed selection, planting, weed control and fertilization, insect and disease control, and harvesting.

In Garcia Rovira, most farms depend on manual labor or animal power for field preparation: 52.2 percent of the farms use oxen and metal tipped wooden plows, 9.8 percent use only hoes, and 31.5 percent use combinations of oxen and hoes. The use of machinery to prepare soils is concentrated in the municipality of Capitanejo which has the flatest land in the region and some large farms appropriate for mechanization.[18]

Biological research at the experiment stations has produced improved seeds which have high yields and are pest and disease resistant. However, only 22 percent of the producers reported they have used this type of seed. Improved seeds are used primarily for tobacco, corn, and potato crops. Their use is concentrated in the municipalities of Capitanejo, Enciso and San José de Miranda where 31.1, 26.8 and 14.5 percent of the producers are using them.

Seeds are more frequently produced on the farm than bought at the market. About 87 percent of the corn seed and 73 percent of the potato seed comes from a field previously harvested making it advisable to offer farmers improved varieties rather than hybrids.

Average quantities of seed planted per surface unit, for main

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[18] 28.5 percent of the farms in this municipality reported the use of machinery.

crops, with rates of seeding recommended by experiment stations are presented in Table XXIII. Higher rates are prevalent for corn, and peas; lower seed quantities are planted for potatoes and beans whereas in the cases of wheat and barley actual and desired densities of planting are not very far apart. Planting is done, in all cases, by hand using hoes and other such elementary tools as digging sticks.

TABLE XXIII

GARCIA ROVIRA ECONOMIC SURVEY: SEEDING RATES FOR MAJOR CROPS (KILOS/HECTARE), 1972

Crop	Seeding Rates	
	Actual	Recommended
Corn	15.9	14.0
Potatoes	738.6	2,000.0
Beans	31.6	50.0
Peas	75.1	60.0
Wheat	96.0	110.0
Barley	76.3	85.0

The use of non-traditional agricultural inputs in Garcia Rovira is indicated in Table XXIV. Fertilizer use is reported by 40.9 percent of the farms with its application widespread within potato and tobacco producers whereas only a small proportion of farms producing peas, beans

TABLE XXIV

USE OF NON TRADITIONAL AGRICULTURAL INPUTS
IN GARCIA ROVIRA, 1972

Crop	Total Number of Farms	Percentage of Farms Using:		
		Fertilizer	Insecticides	Herbicides
Corn	586	7.8	13.3	.3
Tobacco	165	78.8	84.8	--
Beans	221	7.7	41.6	.4
Potatoes	348	86.2	91.9	.6
Peas	406	6.4	6.6	.5
Wheat	141	12.8	13.5	27.6
Barley	78	12.8	11.5	29.5

and corn are applying it.[19] The high input cost is the main reason given by farmers to explain low rates of fertilizer application.

In a majority of cases, 63,0 percent, weed control is done using a hoe, 12.0 percent of the farmers weed by hand, and only 4.3 percent use chemical products.[20] Some 17.0 percent of those interviewed do not report any form of weed control.

[19]Furthermore, even when fertilizer is used, quantities applied per hectare are low in relation to what experiment stations are recommending.

[20]Use of chemical products as a method of weed control is concentrated on wheat and barley crops.

Disease and insect control products are used by 56.7 percent of the farmers. Their use is mainly in tobacco and potato production.

Harvesting is done by hand, and only 10.0 percent of the farmers indicated that they have stored their products. Of those, 60 percent store for later consumption purposes, 32 percent to have seeds available and 7 percent to get a better price for the product. The type of storage is primitive and consists of no more than improvised structures or even in the room where the family lives.

Principal Crops. Six crops: corn, potatoes, peas, corn beans, beans, and tobacco occupy 83.3 percent of the planted area. Corn, peas, and potatoes are part of the enterprise combination scheme on 47.8, 32.9 and 28.1 percent of the farms, respectively. Intercropping accounts for 12.9 percent of the area sown, with the corn-bean mixture being the most important within this cropping system (Table XXV).

Corn and kidney bean production is localized for the most part in San Andres and San José de Miranda, peas in Cerrito and Málaga, and potatoes in Guaca and Cerrito. Tobacco is concentrated in Capitanejo and San José de Miranda, while the few hectares of wheat and barley are found in Cerrito. Of the associated crops, corn-beans is mainly produced in San José de Miranda, San Andrés and Molagavita.

Crop yields are extremely low by national standards. The average production per hectare of corn, beans, and peas is only about one-third the national average. Wheat and barley yields are only 25 percent of the national figure, and even tobacco, which yields the most per hectare, is only 58.5 percent of the national estimated average (Table XXVI).

During 1971 crops were affected by a severe rainy season, which caused losses of more than 50 percent in the potato, pea, and wheat

TABLE XXV

PRINCIPAL CROPS OF GARCIA ROVIRA, 1972

	Farm Units with Crop		Area Sown (Hectares)		Average Area Sown
	No.	Percentage*	No.	Percentage	
Corn	594	47.8	1,070.45	23.5	1.80
Potatoes	349	28.1	900.57	19.8	2.58
Peas	409	32.9	714.70	15.7	1.75
Corn-beans	176	14.2	399.87	8.8	2.27
Beans	222	17.9	355.34	7.8	1.60
Tobacco	165	13.3	349.58	7.7	2.12
Wheat	141	11.3	184.25	4.0	1.31
Barley	78	6.3	171.40	3.8	2.20
Agave-fiver	26	2.1	99.00	2.2	3.81
Sugar Cane	39	3.1	77.13	1.7	1.98
Corn - peas	16	1.3	72.00	1.6	4.50
Corn - string beans	33	2.6	51.00	1.1	1.54
Tomatoes	36	2.9	34.66	0.8	0.95
Corn - potatoes	13	1.0	24.00	0.5	1.85
Corn - beans - string beans	13	1.0	23.00	0.5	1.77
Corn - potatoes - string beans	5	.4	8.00	0.2	1.60
Corm - millo	3	.2	4.50	0.1	1.50
Corn - peas - beans	2	.2	2.00	--	1.00
Beans - string beans	1	.1	2.50	--	2.50
Corn - potatoes - beans	1	.1	2.00	--	2.00
Peas - millo	1	.1	1.00	--	1.00
Corn - sorghum	1	.1	1.00	--	1.00
Totals			4,547.95	100.00	1.96

*Percentages are of N = 1,243

TABLE XXVI

AVERAGE PRODUCTION PER HECTARE OF MAJOR CROPS IN GARCIA ROVIRA, 1972

Crop	National Average (Kgr/ha)	Garcia Rovira		Percentage of National Production	
		Average Production (Kgr/ha) 1971	Average Normal Yield (Kgr/ha)	1971 Production	Normal Yield
Corn	1260	371	734	29.4	58.2
Peas	650	245	443	37.7	68.1
Tobacco	1700	994	1466	58.5	86.2
Beans	679	237	434	34.9	63.9
Potatoes	6900	2868	5798	41.6	84.0
Wheat	1130	281	668	24.9	59.1
Barley	1800	464	770	25.8	42.8

harvests.[21] To obtain an idea of the consequent underestimation of yields, farmers were asked to give an estimate of expected yields under normal climatic conditions. The anticipated per hectare yields are also low compared to national averages, especially for corn and barley, while tobacco and potatoes yields do approach the national averages.

If one considers the fact that national yield averages for crops

[21] Losses were estimated at 53.3, 49.5, 39.7, 45.5, 28.9, 50.5 and 58.0 percent for peas, corn, barley, beans, tobacco, potatoes and wheat, respectively.

are also low compared to goals obtainable through the use of improved varieties and modern systems of cultivation,[22] it is clear that improving productivity is one way to lessen the subsistance farmer's problems.

Considering as subsistence crops those of which more than 50 percent of the product is for family comsumption or saved for seed, corn and potatoes fall into that category. Tobacco, agave fiber and barley are commercially oriented crops (Table XXVII).

TABLE XXVII

PRINCIPAL CROPS IN GARCIA ROVIRA AND THE PERCENTAGE SAVED FOR HOME CONSUMPTION, SEED, AND FOR COMMERCIAL SALES, 1972

	Percentages of Principal Crops for		
Crop	Home Consumption	Seed	Commercial Sales
Corn	72.1	5.6	22.3
Potatoes	31.4	23.4	45.2
Peas	23.5	19.2	57.3
Tobacco	--	--	100.0
Barley	14.5	9.8	75.7
Wheat	32.3	25.0	51.7
Agave fiber	8.2	1.8	90.0
Sugar cane	30.0	10.0	60.0
Tomato	39.0	.8	60.2
Kidney Beans	12.7	10.3	77.0

[22] See Table VI - Chapter II.

Livestock Enterprises

Thirty-eight percent of the project area is grazing land covered by natural grasses mixed with red and white clovers. Alfalfa (Medicago sativa), elephant (Pennisetum purpureum), imperial (Oxonopus scoparius), and gordura (Melinis minutiflora) grasses are also found, but none of them account for more than 8.0 percent of the grazing area.

Seventy-six percent of the capital invested in livestock is accounted for by dairy and beef herds. Draft power animals, sheep, goats, poultry, and hogs follow in importance. More than 90 percent of the production units have cattle, nearly all families keep chickens for eggs, meat and as source of cash, and 35.5 percent of the farms have either swine or sheep.

The major share of Garcia Rovira's herd is found in the municipalities of San Andrés, Cerrito, Concepción, Guaca, and San José de Miranda. San Andrés is the principal dairy production center while sheep and goats are concentrated in Cerrito and Concepción. San José Miranda, Guaca and Molagavita are the chief producers of hogs and poultry.

Technology. Seventy-five percent of the farms use no special field preparation or seed pasture planting practices. When they are applied, farmers depend on manual labor or animal force. Fertilization of pasture land is almost unknown as demonstrated by the fact that only 1.4 and 3.5 percent of farmers apply chemical or organic fertilizers. Pasture rotation, as a soil conservation practice, is reported by one-fourth of farms, with continuous grazing being the prevalent feed cattle system.

Mixed and native breeds account for more than 85 percent of the

livestock population. Normandy and Holstein improved breeds represent 14.0 percent of the cattle; Rommey Marsch and Corriedale are 12.0 percent of the sheep population, and Duroc represents 5.9 percent of the hogs.

Milking is done in the pasture in nearly all cases, a rather inefficient and unsanitary process.[23] The interval period between calves is 423 days on average, compared to a lactation period of about 282 days. In 76.0 percent of the farms, young heifers begin their reproductive life at 30 months, at 24 months in 19.0 percent of the production units and up to 36 months in 1.0 percent of the cases. Artificial insemination is not used and the male-female ratio is as low as 1:8.

None of those interviewed indicate that they fed concentrates as nutritional supplements to their animals. However, 25 percent did report the use of mineral mixes.

Diseases and parasites are mentioned by 45.3 percent of the producers as the principal cause of low production. Thirty-two percent of farms are using chemical products to control external parasites, whereas 45 percent report the use of vermifuges to control internal parasites.

The principal cattle diseases are: hoof and mouth disease, brucellosis, and hemorrhage septicemia. Preventive vaccination is the primary means of control, but its use is quite limited.[24]

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[23]Only 1.1 percent of the production units have any kind of stable or stall for milking.

[24]38.0 percent of farmers vaccinate against hoof and mouth disease, 22.0 percent against hemorrhage septicemia, and 2.2 percent against brucellosis. Only one percent of sheep raisers use vaccination; for hogs and poultry vaccination is unknown.

Records which would allow production control, cost estimates or animal selection are not kept.

Production Levels. The elementary type of technology and management practices are reflected in the levels of production obtained. Milk production is less than 4 liters per day per cow, wool production is 1.8 kilograms of virgin wool/sheep/year, and egg production is .7 units/hen/day on average. The number of head per hectare of grazing land varies from .3 to 1.2 indicating an extensive rather than intensive land use.

Eighty percent of the milk and its derivatives produced is sold, leaving the remanent for family consumption. The greater proportion of the products and by-products derived from sheep, and hogs, 75 and 95 percent respectively, is placed on the market, while 65 percent of egg production is consumed by the family. Almost all labor, 88 percent, utilized in livestock operations is family and exchanged labor.

Summary

This chapter has dealt with a descriptive analyses of the economic survey data gathered from subsistence agricultural farmers in the Garcia Rovira rural development project area. A stratified random sample of 1,243 farms was drawn and the data collected, through interviews, was used for a detail description of the kind of resources available, production systems, and management practices applied by Garcia Rovira farmers.

Six crops: corn, potatoes, peas, beans, cornbeans, and tobacco, out of a total of 29 different crops grown, are identified as the most important in reference to area sown, and number of farms including at

least one of them as part of their production schemes. Corn and potatoes are the main products for family consumption while tobacco, agave fiber and barley are more commercially oriented.

Soil tillage is done in the most part using oxen wooden plows and human force. The use of fertilizer, improved seeds, herbicides, and insecticides is confined to few crops and farms. Crop yields are low even in reference to national standards that are low by themselves.

Grazing land, 38 percent of the total regional area, is used for raising dairy and beef cattle, as the principal livestock enterprise, under poor management systems which are also reflected in low productivity levels.

The patterns of land use are characterized by a divergency in regard to the land productivity potential accelerating a soil erosion process that has already claimed an important share of the natural resources available.

Holdings under 10 hectares represent 70 percent of the total farms and control only 18.9 percent of the land. However, a greater proportion of good soils is under the control of this group than under farms with more than 50 hectares for which most of their soils are classified as non-usable.

Ownership and sharecropping are the predominant land tenure arrangements. Sharecroppers and renters have the greatest proportion of good land and are also shown at the forefront in the use of improved seed.

Almost 50 percent of the capital resources are invested in buildings and land improvements with very low percentages devoted to working capital. Capital invested per farm is directly related to farm size,

even excluding land value, but on a per hectare basis the relationship is reversed reflecting the intensive type of agriculture existing on small holdings.

Owners have more capital invested per farm but there is no significant differences among capital invested per hectare and the three types of land tenure considered. Credit is used more as a short term resource to cover production expenses and family consumption needs, and is obtained mainly through non-institutional channels at high rates of interest. When credit is granted by banking institutions, the established side conditions prevent subsistence farmers from obtaining it.

The population in Garcia Rovira is very young. Employment source is almost exclusively in agriculture activities. A high rate of illiteracy prevails and an outmigration process, selective in relation to age, sex, and education is taking away the better trained people from the region.

CHAPTER V

SOURCES OF INCOME, INPUT PRODUCTIVITIES AND THE CAUSES OF POVERTY IN THE STUDY REGION

The main sources of income received by farmers during the survey year are considered initially. This is followed by a section on the distribution of income and its relation to farm size, land tenure and production patterns. Thirdly, input-output coefficients are estimated from both whole farm and individual enterprise production function models and the contributions of each category of resources to production are analyzed.

Finally, the economic variables, identified as income determinants are further analyzed to trace the causes of poverty in the region and suggest priorities for efforts to alleviate it.

Sources of Income

Farming is the major occupation and the principle source of income for Garcia Rovira families. Eighty six percent of the family heads are employed as laborers on their own plots; 3.9 percent work as day laborers on someone else's land,[1] and the remaining 9.9 percent are women whose chief activities relate to their household duties.

Of the remaining family members, 21.0 percent are employed in

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[1] Exchange of labor among neighbors to provide manpower for their farming needs is a very common practice in the region.

farming and 77.6 percent are dependents: students, children, elderly or disabled people. Only 1.4 percent of the people included in the productive age bracket is employed in non agricultural pursuits.

As indicated in Table XXVIII, 91.7 percent of the total farmers' gross income comes from the value of agricultural and livestock products. Income from off-farm work is next in importance with 3.5 percent; other agricultural activities account for 2.6 percent, and non agricultural income is only 2.1 percent of the total gross income. If farm size is considered, it is apparent that the importance of income generated by agriculture increases with the farm size. Also off farm work and non agricultural activities decrease in importance as size of farm increases.

Dairy, potatoes, tobacco, beans, and corn products generate about 75 percent of total production value. All crops and livestock enterprises yield positive net income, without considering returns to land, labor and management. If wages for both family and hired labor are considered, then potatoes, poultry and wheat show negative net income figures.[2] Tobacco, beans and peas stand out as the most profitable crops but area expansion for tobacco is restricted mainly by ecological requirements. Dairy and swine are the most profitable livestock enterprises but are sources of employment for only 6.9 and 1.4 percent of the labor force respectively compared to the 88.1 percent of the productive population dedicated to crop production. On a per hectare basis, tobacco, potatoes, and peas employ the most labor with corn also accounting for an important share of employment considering their wide-

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[2]Most of the labor is classified as family and "exchanged" labor for which no alternative employment opportunities exist.

TABLE XXVIII

SOURCES OF INCOME BY FARM SIZE, GARCIA ROVIRA, 1972

Farm Size (Hectares)	Total Gross Income Per Farm (Pesos)	Gross Value of Production*	Wages as Off-Farm Laborer**	Other Agricultural Related Activities***	Nonagricultural Activities****
		Percent of Total Gross Income			
< 4.0	7,567.46	75.3	16.1	3.6	5.0
4.0 < 10.0	11,236.05	81.3	9.6	4.7	4.4
10.0 < 50.0	19,023.60	82.2	4.2	8.5	5.1
≥ 50.0	83,643.95	94.4	1.1	2.6	1.9
Averages	29,824.18	91.7	3.5	2.6	2.2

*Gross value of production includes both products sold and consumed but excludes changes in inventory.

**Refers to work on other than own farm.

***Includes value of livestock byproducts and horticulture crops.

****Mainly small businesses.

spread cultivation (Table XXIX).

Distribution of Income

Farm Size and Income Distribution

Larger farms earn absolutely more than small ones. On average, farms of less than four hectares in size produce about $5,696 pesos worth of goods. Farms of larger than 10 hectares produce considerably more, up to $79,000 pesos. On a per hectare basis, however, the relationship is reversed. Farms less than 10 hectares produce more per hectare than do farms of over more than 50 hectares. The intensive production structure prevalent on small farms compared to the extensive schemes of the larger farms is clearly reflected by figures in Table XXX.

The annual gross value of production is divided by income categories and the percentage of farms of a given size belonging to each income category was estimated (Table XXXI). About 72.0 percent of the farms earn less than $10,000 pesos for their annual production with a proportionally greater concentration of farms of less than 10 hectares in the lower than $10,000 pesos categories. A direct relationship between farm size and gross value of production per farm is suggested and confirmed by a χ^2 test at .01 percent probability level.

On a per hectare basis, the relationship between gross income and farm size is presented in Table XXXII. Seventy percent of the farms produce less than $2,500 pesos per hectare, Nearly 70 percent of the farms of less than 10 hectares belong to the low income strata whereas almost all farms in other size categories receive less than $2,500 pesos per hectare. A χ^2 test confirmed the dependency between the two

TABLE XXIX

SOURCES OF INCOME, NET INCOME, AND LABOR DEMAND FOR MAIN CROP AND LIVESTOCK ENTERPRISES, GARCIA ROVIRA, 1972

	Percent of Gross Value of Production From	Net Income per Hectare (Pesos)*		Labor Employed**	
		Not Including Labor	Including Labor	Man-Days Per Unit	Percent of Total Labor
Dairy & Beef	20.6	766.0	628.0	5.5	6.9
Potatoes	18.5	955.9	- 432.8	111.1	47.4
Tobacco	15.6	3,561.0	1,987.2	125.9	20.9
Beans	9.0	2,070.0	1,960.0	8.8	1.5
Corn	8.7	709.8	599.8	8.8	4.4
Peas	7.1	1,098.0	804.2	23.5	7.9
Poultry	5.7	6.6	- 7.1	.5	2.2
Sheep	2.5	185.5	16.8	.7	1.4
Barley	1.2	947.0	589.5	28.6	2.3
Swine	1.2	497.0	357.5	5.6	1.4
Wheat	.9	299.0	- 229.7	42.3	3.7
Others	9.0	--	--	--	--

*Included are cost for seed, fertilizer and weed control. Not included is an inputed value for land.

**Days worked by women, children and men over 55 years of age were multiplied by .75 to convert them to man-days of labor equivalents. The daily wage, during 1971, the year on which these figures are based, was $12.80 pesos without food and $8.20 pesos with food, on the average.

TABLE XXX

FARM SIZE AND GROSS VALUE OF PRODUCTION
GARCIA ROVIRA, 1972

Farm Size Categories Has	Farms	Land Has	Gross Value of Production Per Farm	Gross Value of Production Per Hectare
< 4	388	860.3	5,696.8	2,569.29
4 < 10	470	2,742.4	9,137.4	1,565.83
10 < 50	297	5,407.2	15,635.1	859.34
≥ 50	83	10,049.0	78,991.3	652.43
Totals	1,238	19,058.9	27,365.1	1,411.72

TABLE XXXI

GROSS VALUE OF PRODUCTION PER FARM RELATED TO FARM SIZE IN GARCIA, ROVIRA, 1972

1,000 Pesos \ Farm Size Has	Figures in Percent*				
	< 4.0	4.0 < 10.0	10.0 < 50.0	≥ 50.0	Totals
< 2.5	8.0	10.2	4.6	1.6	24.4
2.5 < 5.0	6.8	8.2	5.2	1.0	21.2
5.0 < 7.5	5.6	6.8	3.8	.6	16.8
7.5 < 10.0	2.4	4.5	2.1	.3	9.3
10.0 < 15.0	3.8	3.6	2.4	1.4	11.2
15.0 < 20.0	2.4	1.7	1.9	.5	6.5
20.0 < 30.0	1.4	1.0	1.8	.3	4.5
30.0 < 50.0	.6	1.0	1.0	.6	3.2
≥ 50.0	.3	1.0	1.2	.4	2.9
Total Number of Farms	388	470	297	83	1238
Percentage	31.3	38.0	24.0	6.70	100.0

*Percentages are of N = 1238

TABLE XXXII

GROSS PRODUCTION VALUE PER HECTARE AND FARM SIZE
GARCIA ROVIRA, 1972

1,000 Pesos \ Farm Size Has	< 2.5	2.5 < 5.0	5.0 < 7.5	7.5 < 10.0	≥ 10.0	Total Number of Farms	Percentages
	Figures in Percent*						
< 4.0	15.4	7.3	3.5	1.3	3.8	388	31.3
4.0 < 10.0	32.8	3.3	.6	.6	.6	470	38.0
10.0 < 50.0	22.5	.7	.3	.1	.3	297	24.0
≥ 50.0	6.3	.2	.1	.1	.1	83	6.7
Totals	77.0	11.5	4.6	2.1	4.8	1238	100.0

*Percentages are of N = 1238

variables with smaller farms yielding a higher production per unit of surface.

Data in gross value of production per hectare, at crop level, is related to farm size in Table XXXIII. Corn, tobacco, potatoes, wheat and barley output per unit of land decreases as size of holding increases. For beans, and peas, the relationship is inverse with value of production increasing with farm size.

A major part of the farmer's income is derived from wages received in kind, cash or as implicit compensation for work on his own plot. Demand for labor decreases with farm size, and well over 50 percent of labor employed by farms of less than 10 hectares is "exchanged labor" (Table XXXIV).[3] Disguisedunemployment is underlined by the fact that, on average, a farm of less than 4.0 hectares size demands about 338 man-days of labor per year with the productive family members supplying over 800 hundred.

Land Tenure and Income Distribution

The relationships between land tenure and gross value of production are examined in Tables XXXV and XXXVI. A greater concentration of owners on each of the individual income categories suggest a direct relationship between the two variables, a hypothesis that was confirmed by an χ^2 test.[4] This relationship, however, can be explained by the fact that there is more land available under ownership than under any

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[3]"Exchanged labor", given its characteristics, could be considered as family labor but in the questionnaire used for interviews it was placed together with hired labor.

[4]Chi-square 16(.01) = 32.0; Chi-square calculated = 33.5.

TABLE XXXIII

GROSS VALUE OF PRODUCTION PER HECTARE BY CROP AND SIZE OF FARM IN GARCIA ROVIRA, 1972

Crop	Farm Size and Value of Production (Hectares)			
	< 4	4 < 10	10 < 50	≥ 50
	Pesos			
Corn	2,099.9	848.1	787.1	685.7
Potatoes	4,311.0	3,256.9	2,333.0	1,440.1
Kidney Beans	2,142.1	1,950.6	2,025.9	2,846.3
Peas	1,784.2	1,261.8	2,108.9	3,613.5
Wheat	708.5	628.1	1,267.1	307.5
Barley	1,626.0	1,386.9	1,428.0	867.5
Broad Beans	342.4	269.8	521.3	1,603.0
Tobacco	6,281.1	4,466.6	3,573.1	3,384.4

TABLE XXXIV

MAN-DAYS OF LABOR PER HECTARE BY FARM SIZE AND TYPE OF LABOR IN GARCIA ROVIRA, 1972

Farm Size (Hectares)	Equivalent Man-Days of Labor/Hectare		
	Family	Contracted and Exchanged Labor	Total
< 4.0	70.1	83.4	153.5
4.0 < 10.0	20.7	56.0	76.7
10.0 < 50.0	22.4	8.7	31.1
≥ 50.00	2.4	2.9	5.3
Totals	63.0	67.5	180.5

TABLE XXXV

GROSS VALUE OF PRODUCTION PER FARM AND LAND TENURE SYSTEM IN GARCIA ROVIRA, 1972

Land Tenure / 1,000 Pesos	Owner	Sharecropper	Others	Totals
	Percent*			
< 2.5	15.3	4.1	5.0	24.4
2.5 < 5.0	11.0	4.9	5.3	21.2
5.0 < 7.5	9.6	3.1	4.1	16.8
7.5 < 10.0	5.6	1.8	1.9	9.3
10.0 < 15.0	5.9	2.5	2.8	11.2
15.0 < 20.0	4.0	1.5	1.0	6.5
20.0 < 30.0	2.8	.6	1.1	4.5
30.0 < 50.0	2.1	.8	.3	3.2
≥ 50.0	1.6	.7	.6	2.9
Total number of farms	717	248	273	1,238
Percentages	57.9	20.0	22.1	100.0

*Percentages are of N - 1238

TABLE XXXVI

GROSS VALUE OF PRODUCTION PER HECTARE AND LAND TENURE SYSTEM IN GARCIA ROVIRA, 1972

1,000 Pesos \ Land Tenure	Owner	Sharecropper	Others	Totals
	Percent*			
< 2.5	46.9	13.1	17.0	77.0
2.5 < 5.0	5.3	3.5	2.7	11.5
5.0 < 7.5	1.9	1.2	1.4	4.6
7.5 < 10.0	1.0	.6	.5	2.1
10.0 < 15.0	1.8	.7	.1	2.6
15.0 < 20.0	.5	.3	.1	.9
20.0 < 30.0	.3	.2	.1	.6
≥ 30.0	.2	.4	.1	.7
Total number of farms	717	248	273	1,238
Percentages	75.9	20.0	22.1	100.0

*Percentages are of N - 1238

of the other land tenure systems and not due to a greater productivity by owners.

If the relationship is analyzed on a per hectare basis, data in Table XXVI indicate that 81 percent of the owners produce less than $2500 pesos per hectare, whereas 65 percent of the sharecroppers belong to that income category. At the other extreme, 1.7 percent of the farms under private ownership produce $15,000 or more per hectare and 4.5 percent of the farms assigned to that income strata are under sharecropper arrangements. Sharecroppers seem to be producing more per unit of land than those farmers working under a different land tenure system.[5] Nevertheless, a more detailed analysis of production structures for each group have to be made before a more definite conclusion is drawn on this hypothesis. The apparent superior productivity may be explained by the following factors: a) a more commercially oriented production by sharecroppers whose main crop is tobacco; b) as indicated early, sharecroppers have a greater percentage of good quality soils available; c) sharecroppers are leading the use of improved seeds; d) there is a surplus of sharecroppers and as a result they are easily replaced by others if their productivity level does not satisfy the landlord's expectations; e) the input-output sharing provisions are such that sharecroppers have to achieve fairly high levels of productivity just to obtain enough income for their subsistence needs.

Input Productivities

Both single and multiequational approaches to productivity analyses

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[5] A χ^2 test led to the acceptance of the alternate hypothesis of dependence between the two variables $\chi^2_{14\ (.01)} = 29.14$; χ^2 calculated = 44.25

for multi-product farms, as discussed in Chapter III, are used to derive appropriate coefficients to determine whether development efforts should be directed towards changing parameters of the existing production function, mainly through technological change generated by introducing new kinds of inputs, or to improve the efficiency with which the available inputs are allocated.

Based on unrestricted Cobb-Douglas functions computed by least squares multiple regression, production function estimates are obtained at three levels of input-output aggregation:

a) Whole farm function

b) Crops and livestock functions

c) Separate functions for individual crops and livestock activities

Several production function specifications and various grouping of resources were tried. Of the sets of estimated functions, those presented here are logically and statistically most acceptable.

The Production Models

Whole Farm Function. A single aggregative function is estimated as a first step to the identification of problems related with resource allocation and as a broad guide in formulating over-all regional development policies.

In a logarithmic form the function is written as:

$$Y = \alpha_o + \Sigma B_i X_i + e$$

where: Y = log of output

X_i = log of the i^{th} input

B_i = elasticity of production of the i^{th} input

α_o = a constant

e = an error term of zero mean and finite variance

Gross value of agricultural production is chosen as a measurement of total output and used as the dependent variable (Y). The farm inputs are grouped into five categories: land, labor, fixed capital, working capital, and total biological inputs. In addition, five qualitative variables are included in all function specifications: weather and diseases, climate, land tenure, education, and location.

The dependent variable, gross value of production, includes value of crop and livestock products sold or consumed during 1971. Land is measured in hectares of productive land (cropping and pasture land) and also as total land available (cropping, pasture, unusable land). A labor variable, including family as well as hired labor employed during the year, is measured in actual manday-equivalents. Work performed by women, children, and men over 55 years of age, is multiplied by .75 to obtain homogeneous man work day equivalents.

Capital inputs are expressed on a service flow basis and divided into three variables:

a) Fixed capital including houses, barns, fences and major land improvements. An annual interest of 18 percent is charged to the corresponding inventory values to obtain the flow concept measurement of the variable.

b) Working capital. A proxy for value of capital services was obtained by asking farmers about the cost of productive services (cash operating expenses) from equipment and draft animals (wooden plow, preparation and sowing implements, bullocks services, etc.). For live capital assets (cattle, poultry, hogs, sheep) an annual interest of 18

percent is charged to the reported inventory values. The values obtained were then added to represent the annual flow of services for equipment and live capital asset for a given farm.

c) The value of seeds, fertilizer, insecticides, drugs, and supplements are combined to represent a package of biological inputs.

Education enters all models expressed either as the sum of the years of education of the head of the family or as an average of school years attended by all family household members in the age bracket 15 to 55 years which constitute the most likely people to participate directly in farm activities.

The ratio between obtained (Y) and expected value of production (Y*) is included as a measurement of bad weather and animal disease, negative effects.

The following group of variables are considered as dummy variables and therefore, are not logged:

a) Climate is represented by three dummy variables corresponding to hot, temperate, and cold climates. A value of 1 is assigned to a farm if it belongs to a given climate and zero if not.

b) Land tenure is divided into three categories: ownership, sharecropper and others (includes renters, squaters, etc.). A value of 1 is assigned to a farm belonging to a given tenure system.

c) One dummy variable is included to represent each of the 12 counties in the project. A farm receives a value of 1 for the dummy variable representing the county where the farm is located and zeros for the remaining 11 location dummies.

Crop and Livestock Aggregate Functions. Two production functions, one for livestock and one for crops are also estimated. The objective

here is to evaluate resource productivity differences in primary (crop) and secondary (livestock) production.

Both functions have the same Cobb-Douglas form presented for the whole farm function.

The annual value of crop production including the value of all crops sold, stored or used on the farm is defined as dependent variable for the crop function. Land, labor, capital services, seed, insecticides, fertilizers, and fixed capital together with the same group of qualitative variables considered for the whole farm function constitute the set of independent variables.[6]

Annual value of livestock products including sales, and home used products but excluding inventory changes is taken as dependent variable for the livestock function. Pasture land, labor, working capital, drugs and vaccines, feed and supplements, fixed capital, and the qualitative group of variables are defined as regressors.[7]

Functions for Individual Crops and Livestock Activities. To analyze actual allocation of resources the farmers make among their production alternatives a set of equations, each one corresponding to a main

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[6]Land is measured as hectares of cropping land. Labor corresponds to total manwork day equivalents used on crops including family and hired workers. Capital services estimated by cash operating expenses for equipment and draft animals used on crops.

[7]Pasture land measured in hectares. Labor measured in total manwork day equivalents used on livestock including hired and family workers. Working capital measured as annual interest on live capital assets inventory value. Fixed capital has the same value in both functions since it was considered as an input jointly available for use in crop and livestock activities. It is measured as annual interest on corresponding inventory values.

crop or livestock activity, is estimated.

Each equation represents the output of a given product as a function of the quantities of the factors specifically used for its production as well as of jointly available resources. A set of qualitative variables affecting all production activities is also included.

The estimated set of equations is represented as:

$$Y_1 = f(X_{11}, X_{12}, \ldots, X_{1k}; X_{k+1}, \ldots, X_n; X_{n+1}, \ldots, X_q)$$

$$Y_2 = f(X_{21}, X_{22}, \ldots, X_{2k}; X_{k+1}, \ldots, X_n; X_{n+1}, \ldots, X_q)$$

$$\vdots$$

$$Y_m = F(X_{m1}, X_{m2}, \ldots, X_{mk}; X_{k+1}, \ldots, X_n; X_{n+1}, \ldots, X_q)$$

where

Y_i = output from the i^{th} activity $i = 1 \ldots m$

X_{il} = the l^{th} production factors specifically used to produce the i^{th} output

X_j = resources jointly available for production which quantity cannot be partitioned among individual activities in a nonarbitrary way. $j = k + 1, \ldots, n$.

X_n = qualitative variables, $h = n + 1, \ldots, q$

The dependent variable, total output obtained from a given crop or livestock activity, is expressed in physical units (kilograms) regarding output as an homogeneous variable, or in monetary terms (pesos) when two or more non-homogeneous outputs are aggregated.

Cropland, labor, seed, fertilizer, insecticides, and capital services are considered as specific production factors for a given crop activity. Pasture land, labor, drugs and vaccines, and working capital are specific resources for livestock production activities.

Fixed capital is the only resource included as a joint input

available for all activities. The same set of qualitative variables, as defined before, is included in each activity function. Each independent variable is expressed in the same units of measurement applied for the aggregate functions but obviously, at a lower level of aggregation.[8]

Each function is estimated by least square procedures under the assumption that a firm chooses inputs to maximize anticipated rather than realized output. If such assumption holds, simultaneous estimation is unnecessary (36).

Empirical Results

Regressions coefficients together with their standard errors, estimated by fitting production function models described previously to the data from the sample of Garcia Rovira farms are presented in Tables XXXVII to XXXIX.

All regressions are significant at the 0.1 percent probability level. A major part of the interfarm variation in crop output is explained by the observed inputs with coefficients of multiple determination ranging from .54 for the corn function to .84 for the potato model. However, the proportion of the variance in livestock output which is explained by the independent variables is smaller due to the same nature of the livestock production process which requires a considerable period of time to be completed and, as consequence, is only partially reflected by a single year survey data. Fifty-seven percent of the variation in output is explained by the variables included in the whole farm aggregate model.

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[8]Individual functions for corn, tobacco, potatoes, peas, small grains (wheat and barley), major species (dairy cattle and sheep), and minor species (poultry and swine) are estimated.

TABLE XXXVII

PRODUCTION COEFFICIENTS FOR AGGREGATE FUNCTIONS, GARCIA ROVIRA, 1972

Variables	Whole Farm Function 1	Whole Farm Function 2	All Crops	All Livestock
Farm Size	.09247***(.02769)			
Productive Land		.16917***(.03145)		
Crop Land			.25866***(.04105)	
Pasture Land				.09697***(.03176)
Labor	.23756***(.02681)	.23456***(.02661)	.29995***(.04525)	.00302 (.02511)
Fixed Capital	.14941***(.02389)	.13451***(.02389)	.09297***(.02471)	.08229** (.03300)
Working Capital	.27049***(.02248)	.24405***(.02909)	.03723 (.03328)	.47724***(.03579)
Total Biological Inputs	.16772***(.01826)	.16771***(.01815)		
Seed			.28891***(.02964)	
Insecticides			.01514***(.00487)	
Fertilizer			.00834* (.00462)	
Feed-Supplements				.03683***(.01016)
Drugs - Vaccines				.00695 (.00515)
Weather - Diseases	.51527***(.04173)	.51343***(.04176)	.73527***(.03550)	.33700***(.08528)
Hot Climate	.49733***(.08423	.47589***(.08270)	.73676***(.09939)	
Temperate Climate	.24486***(.05195)	.22355***(.05059)	.40280***(.05982)	
Location 1				-.51103** (.22242)
Location 3				-.59727***(.17870)
Location 5				-.47474***(.13749)
Location 6				-.22578* (.13552)
Location 8	-.15075** (.08670)	-.17115** (.08598)		-.31003***(.12047)
Location 9	-.14122** (.06460)	-.18510***(.06389)	-.20985***(.07883)	-.20147***(.09515)
Location 10				-.26813***(.10267)
Location 12				-.48750***(.11532)
Sharecropping	.16220***(.05704)	.16097***(.05669)		
Returns to Scale	.92	.95	1.00	.70
R^2	.5732	.5752	.7083	.4664
Sample Size	1185	1175	925	733

***Significant at .01 probability level
**Significant at .05 probability level
*Significant at .1 probability level

Numbers in parentheses are the calculated standard errors of the respective coefficients.

TABLE XXXVIII

PRODUCTION COEFFICIENTS FOR MAIN CROPS IN GARCIA ROVIRA, 1972

Variable	Corn	Pea	Potato	Tobacco	Small Grains[1]
Land	.33991***(.09154)	.35028***(.06829)	.00279 (.07029)	.47398***(.11583)	.20214* (.11720)
Labor	.24708***(.07154)	.25587***(.05379)	.51023***(.06924)	.10218 (.07349)	.25652** (.10898)
Fixed Capital	.08789***(.03406)	.05626* (0.3083)	.07034* (.03928)	.13221***(.04651)	.26683***(.05494)
Working Capital	.09313** (.04063)	.09006** (.03833)	.11053***(.04223)	.02893 (.05582)	.11382** (.05373)
Seed[2]	.20294** (.08636)	.21368***(.05868)	.49386***(.07173)	.23252***(.08865)	.42205***(.29863)
Insecticides			.03892***(.01030)	.02844* (.01517)	
Fertilizer			.01793** (.00830)	.03586***(.01242)	
Climate: Temperate	.27204***(.07174)				
Weather	.69892***(.04669)	.7177***(.03808)	.78028***(.04819)	.54420***(.12382)	.53738***(.06409)
Location 2		-.40547** (.17313)			
Location 3	-.38429***(.12638)	-.32607***(.10323)			
Location 4		-.36981** (.14606)	-.85239** (.33554)		
Location 5		-.22106* (.11551)			
Location 6			-.55118***(.13083)		
Location 10			-.30913***(.09237)		
Location 12					
Returns to Scale	.97	.97	1.24	1.03	1.26
R^2	.5369	.7437	.8372	.6613	.6395
Sample Size	499	359	293	155	179

***Significant at .01 probability level
**Significant at .05 probability level
*Significant at .1 probability level

Numbers in parenthesis are the calculated standard errors of the respective coefficients

[1]Includes wheat and barley

[2]Tobacco and small grains seed are given in pesos. All others are expressed in kilograms.

TABLE XXXIX

PRODUCTION COEFFICIENTS FOR MAJOR AND MINOR LIVESTOCK SPECIES IN GARCIA ROVIRA, 1972

Variable	Major Species[1]	Minor Species[2]
Pasture Land	.11075***(.03882)	
Labor	.00518 (.02899)	.02223 (.02892)
Working Capital	.56560***(.04700)	.47808***(.03517)
Fixed Capital	.06934* (.04007)	.11972***(.03168)
Feed-Supplements	.03334***(.01061)	.01552***(.00777)
Drugs-Vaccines	.00922 (.00589)	.01056* (.00554)
Diseases	.06436 (.10321)	.74280***(.09597)
Location 1	-.68988***(.25283)	
Location 3	-.75594***(.27357)	
Location 5	-.41786** (.16914)	
Location 10		-.28908***(.09618)
Location 12	-.46456***(.11387)	-.37093***(.10819)
Returns to Scale	.79	.65
R^2	.45445	.40653
Sample Size	630	637

***Significant at .01 probability level
**Significant at .05 probability level
*Significant at .1 probability level

Numbers in parentheses are the calculated standard errors of the respective coefficients.

[1]Includes dairy and sheep

[2]Includes swine and poultry

As the correlation matrices presented in the appendix indicate, the multicollinearity problems among explanatory variables are not beyond the bounds usually accepted in production function analyses based on cross-section data.

Education is the only variable that was included in all models without showing enough statistical strength to be considered as significant, even at .5 percent probability level. The high levels of illiteracy and the need for more agricultural related training programs, in contrast with formal and urban oriented courses being offered by rural schools can be given as main reasons in explaining this result.

Most of the regression coefficients are significant at probability levels equal to or greater than .1 percent. Exceptions are the coefficients for labor, working capital, drugs and vaccines, and land in one or more models, but their estimated values are reported for practical reasons.

Assuming that no relevant input factors have been excluded, the sum of the regression coefficients corresponding to controllable factors provide an indication of economic returns to scale. A two tailed test was used to test the null hypothesis that the elasticities sums to unity for each function. The results indicate that with the exception of the minor species case none of the sums is significantly different from one and therefore the data are compatable with constant returns to scale in all branches of farming.[9]

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[9]The t test applied is delineated as follows (assuming two inputs only, X_1 and X_2):

$$t = \frac{(b_1 + b_2) - 1}{\sqrt{\text{var}\,(b_1) + \text{var}\,(b_2) + \text{cov}\,(b_1 b_2)}}$$

Production Elasticities

Regression coefficients, in Cobb-Douglas functions, are interpreted as elasticities of production indicating the strength of the relation between the dependent variable output and the set of regressors considered in each model.

Since the sample standard deviations for the tested independent variables are not equal, the standard partial regression coefficients are estimated and used to identify those factors that are most important in explaining variations in output[10] (Tables XL, XLI).

Considering the whole farm functions, the factors of production in the order of the magnitude of their elasticities are: working capital, biological inputs, and labor. Comparing coefficients for the two main branches of farming, labor, seed, and land are the main crop output determinants with working capital, pasture land, and feed accounting for most of the livestock output. Working capital does not appear to bear a strong statistical relationship to crop yeild and neither does labor for livestock production.

At the individual crop or livestock activity level, the shares of the factors of production are, in most cases, consistent with prior expectations.[11] The elasticity with respect to land has the highest value for all crops with the exception of potatoes and small grains. Next are the coefficients of labor and biological inputs, with output

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[10] Standard partial regression coefficient is equal to the original b value multiplied by the standard deviation of the associated independent variable and divided by the standard deviation of the dependent variable.

[11] No apparent reason can be given to explain the low coefficients obtained for land in potato and labor in tobacco.

TABLE XL

STANDARD PARTIAL REGRESSION COEFFICIENTS FOR AGGREGATE PRODUCTION FUNCTIONS IN GARCIA ROVIRA, 1972

Variables	Whole Farm Function 1	Whole Farm Function 2	All Crops	All Livestock
Farm Size	.09056			
Productive Land		.14889	.16296	.11109
Labor	.22255	.21910	.38889	.00356
Fixed Capital	.14189	.12809	.07622	.07677
Working Capital	.27301	.24607	.03328	.49925
Total Biological Inputs	.22147	.22180		
Seed			.27416	
Insecticides			.07753	
Fertilizer			.04784	
Feed - Supplements				.10477
Drugs - Vaccines				.04046
Weather - Diseases	.23799	.23735	.38889	.11029
Hot Climate	.12433	.11967	.15722	
Temperature Climate	.09954	.09109	.14160	
Sharecropping	.05746	.05724		
Location 1				-.06644
Location 3				-.10010
Location 5				-.10649
Location 6				-.05158
Location 8	-.03407	-.03891		-.08108
Location 9	-.04395	-.05768	-.05029	-.07438
Location 10				-.08827
Location 12				-.13888

TABLE XLI

STANDARD PARTIAL REGRESSION COEFFICIENTS FOR INDIVIDUAL CROP AND LIVESTOCK ACTIVITIES IN GARCIA ROVIRA, 1972

Variables	Corn	Pea	Potato	Tobacco	Small Grains	Major Species	Minor Species
Crop Land	.21722	.23885	.00182	.35347	.11808		
Pasture Land						.11489	
Labor	.15589	.17607	.34255	.09005	.14059	.00591	.02448
Working Capital	.08447	.07456	.08119	.03016	.11476	.49252	.46719
Fixed Capital	.08671	.05423	.04737	.15563	.23879	.05856	.12035
Seed	.13566	.15969	.33795	.19243	.29863		
Insecticides			.10382	.09589			
Fertilizer			.06694	.15364			
Feed - Supplements						.09630	.06305
Drugs - Vaccines						.04901	.06234
Weather - Diseases	.47318	.53256	.40731	.21607	.38821	.01892	.23942
Temperate Climate	.11845						
Location 1						-.08305	
Location 2		-.06609					
Location 3	-.09525	-.09049				-.08439	
Location 4		-.07042	-.06363				
Location 5		-.05338				-.07603	
Location 6			-.10589				
Location 10			-.08927				-.09725
Location 12						-.12766	-.11024

being highly responsible to seed in all crop activities. Fertilizers and insecticides appear to be significant in both crops where they were included as variables. Working capital does not seem to have much influence on tobacco output.

Working capital is clearly the most important factor for both major and minor species production. Pasture land and fixed capital are next with feed and supplements showing strong statistical significance but small size coefficients.

The effects of an unfavorable rainy season are reflected by the size of the coefficients for the variable weather. Tobacco and small grains appear as weather resistant crops in contrast to pea and corn which seem to be highly susceptable to bad weather. On the livestock side, diseases have a greater negative effect on minor than on major species, a fact also reflected by the size and significant levels of the corresponding coefficients for drugs and vaccines.

Land tenure becomes a significant variable for the whole farm function only with a coefficient indicating that sharecroppers' output is about six percent higher than that obtained by farmers under any other tenure pattern.

Farms located in hot climate obtain 12 percent higher outputs than those in cold climate and 3.0 percent above those in temperate zones. These higher levels of output are due to higher levels of crop production rather than to livestock output which do not appear to be affected by climate conditions.

Coefficients of location dummy variables[12] are useful in identify-

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[12]The following code is used to identify locations: Macaravita (01), Capitanejo (02), San Miguel (03), Enciso (04), San Jose de Miranda (05),

ing those zones within the development project area with levels of output lower than regional averages where technical assistance is needed the most. In general, based on aggregate output, the region is quite homogeneous with only those farms located in San Andrés, and Molagavita producing from 3.0 to 4.0 percent less output than the average.

San Andrés has the lowest level of crop output in the region, whereas Capitanejo, Enciso, Malaga, and Concepcion are leaders in livestock production.

Location is not an important factor in determining tobacco and small grains output levels. Even in those cases where it is a statistically significant variable, the size of the standard partial regression coefficients lead to the conclusion that from a policy point of view the region may be considered as homogeneous.

Marginal Productivities

From the estimated elasticities a set of estimated marginal productivities is obtained. The marginal productivity of factor X_k in producing activity Y_i is denoted by M_{ki} and is given by:

$$M_{ki} = E_{ki} \frac{\gamma_i}{\lambda_{ki}}$$

where E_{ki} = Elasticity of factor K in producing output i^{th}

γ_i = Geometric mean of Y_i

λ_{ki} = Geometric mean of X_{ki}

Carcasí (06), Málaga (07), Molagavita (08), San Andrés (09), Guaca (10), Concepcion (11), and Cerrito (12).

The estimated marginal productivities, then, refer to the "average farm". The geometric mean of the variables and the marginal productivities of the inputs are presented in Tables XLII - XLIII.

Differences between marginal products and input opportunity costs, as well as significant differences among marginal productivities of each factor in different uses is judged by appropriate t and F tests.[13] Marginal productivities for each factor of production and the corresponding allocative efficiencies are further discussed below.

Land. Marginal productivity of land range from $66 to $2097 pesos per hectare depending on the level of input-output aggregation being considered. Data on annual rent per hectare of land is not available in most cases but a reasonable estimate of the market opportunity cost of land in the region is obtained by charging 18 percent annual interest

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[13] The appropriate t test is of the form:

$$t = \frac{b_{ij}\ \frac{Y_i}{X_{ij}} \quad \text{opportunity cost of } X_i}{\left(\frac{\Lambda}{\frac{Y_i}{X_{ij}}}\right)\ \sqrt{\text{variance } b_{ij}}}$$

An estimate of the variance of a marginal productivity estimated from a Cobb-Douglas function is given by:

$$\text{Var MPP}_{xij} = \text{Var}\ b_{ij}\left(\frac{\Lambda}{\frac{Y_i}{X_{ij}}}\right) = \left(\frac{\Lambda}{\frac{Y_i}{X_{ij}}}\right)^2 \left[\text{Var } b_{ij}\right]$$

A more precise formula has been derived by Carter and Hartley (77). Nonetheless, for estimates of the marginal products with the inputs of their geometric means the above equation leads to negligible errors in the variance estimate (31). The F test is of the form:

$$F = \frac{\text{Var}\left(\text{MPP}_{x_{ij}}\right)}{\text{Var}\left(\text{MPP}_{x_{kj}}\right)}, \quad i \neq k$$

TABLE XLII

SAMPLE GEOMETRIC MEANS AND STANDARD ERRORS FOR PRODUCTION FUNCTION VARIABLES IN GARCIA ROVIRA, 1972[1]

Variable	Unit of Measurement	All Crops	All Livestock	Corn	Pea	Potato	Tobacco	Small Grains	Major Species	Minor Species
Farm Size	Ha	6.63 (3.19)	--	--	--	--	--	--	--	--
Productive Land	Ha	4.99 (2.83)	--	--	--	--	--	--	--	--
Crop Land	Ha	--	2.73 (2.39)	--	1.38 (2.08)	1.30 (2.19)	150.0 (2.16)	1.20 (2.13)	--	--
Pasture Land	Ha	--	--	3.18 (3.63)	--	--	--	--	3.55 (3.57)	--
Labor	Man-Days	141.40 (3.03)	143.73 (2.57)	23.23 (3.77)	59.10 (2.06)	31.36 (2.20)	174.38 (2.48)	45.05 (2.03)	16.84 (4.04)	8.98 (3.21)
Fixed Capital	Pesos	1243.46 (3.08)	1232.86 (3.11)	1454.59 (2.85)	1154.71 (3.09	1231.31 (3.02)	1417.42 (3.37)	1158.59 (3.18)	1231.4 (2.91)	1314.80 (2.90)
Working Capital	Pesos	1305.10 (3.31)	544.58 (3.44)	1124.5 (3.24)	222.31 (2.82)	352.17 (2.59)	286.95 (2.93)	375.84 (3.68)	1517.5 (2.81)	64.48 (2.82)
Seed	Kgr	--	715.18*(3.71)	--	22.04 (2.15)	95.00 (2.36)	374.50*(2.35)	271.31*(2.49)	--	--
Insecticides	Pesos	--	--	--	--	86.31 (63.63)	26.65 (32.52)	--	--	--
Fertilizers	Pesos	--	--	--	--	85.00(334.76)	118.42 (83.48)	--	--	--
Feed Supplements	Pesos	--	--	--	--	--	--	--	73.58 (34.43)	162.60 (74.03)
Drugs - Vaccines	Pesos	--	--	--	--	--	--	--	464.01 (5.10)	36.04 (5.21)
Output	Pesos	4737.51 (3.27)	2922.46 (3.98)	2263.82 (3.08)	362.5**(3.15)	2660.00**(4.74)	1229.00**(2.81)	633.90 (3.64)	1888.84 (3.41)	574.27 (2.88)

*Seed expressed in pesos

**Output expressed in kilograms per farm

[1]Standard errors in parenthesis

TABLE XLIII

MARGINAL PRODUCTIVITIES[1] FOR SELECTED INPUTS IN GARCIA ROVIRA, 1972

Function \ Input	Land	Labor	Fixed Capital	Working Capital	Seed	Insecticides	Fertilizer	Feed Supplements	Drugs - Vaccines
Whole Farm 1	66.07	7.96	.57	.98	--	--	--	--	--
Whole Farm 2	160.61	7.86	.51	.89	--	--	--	--	--
All Crops	276.69	6.10	.22	--	--	--	--	--	--
All Livestock	69.03	--	.13	.96	--	--	--	--	--
Corn	196.45	3.33	.06	.33	7.34	--	--	--	--
Pea	317.95	9.63	.05	.30	2.65	--	--	--	--
Potato	--	9.20	.14	.75	1.33	1.31	.62	--	--
Tobacco	2097.10	--	.62	--	4.12	7.08	2.00	--	--
Small Grains	106.78	3.61	.15	.19	.99	--	--	--	--
Major Species	58.93	--	.09	.87	--	--	--	.86	.04
Minor Species	--	--	.05	4.26	--	--	--	.05	.17

[1] Expressed in the following dimensions: Land in pesos per hectare; labor in pesos per man work-day equivalent; all other inputs in pesos per peso invested. Marginal productivities estimated at the geometric value of input and output.

to the reported values per hectare of crop, pasture, and waste land.[14]

Marginal products and the opportunity cost of land do not differ significantly from each other when the appropriate t test is applied. However, if F tests are used the differences are significant at the .01 percent probability level, providing evidence that marginal product of land differs among alternative uses. The market value of output would be raised by shifting land from pasture to crop, from corn to tobacco, and from small grains to pea production.

The above statistical result should be interpreted with caution considering the potential increase in soil erosion that will result from transfering pasture land to crop production. Furthermore, the ecological conditions required for an optimum tobacco production place a considerable constraint on its expansion, and a reduction in corn production will have a negative effect upon the already low levels of nutrition.

Labor. All estimated marginal productivities, with the exception of the one corresponding to the pea function, are significantly lower than the average wage rate reported for hired labor, $12.80 pesos per man work day.

Although the positive marginal products imply that output could be raised by using more labor, the expected return is too low to justify the additional effort. However, we should keep in mind that the true opportunity cost of family labor is lower than the wage rate for hired labor, given the almost nonexistent employment alternatives, and there-

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[14]Following this criteria, opportunity cost of land is estimated at $546 pesos per hectare-semester for cropland, and $656 pesos per hectare-year for pasture land. Land dedicated to tobacco production has an opportunity cost as high as $3500 per hectare-semester.

fore the ratios of marginal product of labor to opportunity cost are not far from the efficiency index of 1.0 required for an adequate resource allocation.

Since marginal productivity of labor is different among the alternative uses, reallocating labor from corn, and small grains to pea and potato production will increase total output.

Capital. A low return to investments in fixed capital is suggested by the uniformly low marginal productivities obtained.

As for the working capital, marginal products corresponding to the whole farm function as well as those estimated for all livestock, potato, tobacco, and major species models are consistent with optimal resource allocation. Whereas, marginal products lower than opportunity cost, indicating overinvestment in this type of capital, correspond to the estimated functions for all crops, corn, pea, and small grains. The high marginal product for working capital in minor species indicates that additional investments should be made in this activity.

Biological Inputs. Use of improved biological inputs seems to be one of the most promising ways to increase agricultural output in the region.

The marginal value product per peso of cost from additional seed at the geometric mean was more than 2 in corn, pea, and tobacco crops indicating that additional seed use may be profitable. Potato and small grains are used in line with profit maximization goals. These results together with the data presented in Table XIII, point out the need for an intensive research program that allow experiment stations to define more precisely the advisable rates of seeding for

the more important crops in the region.

Possible gains from using more fertilizer and or insecticides may be small considering that marginal products are not different from opportunity cost. On an individual farm basis, however, those farms not using any fertilizer or applying small quantities would benefit from fertilizer as indicated by the corresponding elasticity coefficients.[15]

Biological inputs do not appear as profitable for livestock production with the exception of feed and supplements for major species where marginal value product is not significantly different from opportunity cost.

The reason for this low return lies in the nature of the subsistence production under which animals are fed on household scraps, crops residuals and small amounts of purchased concentrate, and where drug and vaccines are either not used or applied without following technical directions adequately.

Causes of Poverty

As indicated before, 83 percent of the farm units in Garcia Rovira receive less than $15,000 pesos of gross annual income. If we base

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[15]The effects of these inputs could be exaggerated due to the use of a small value, .0001 to represent no users when the corresponding production functions were estimated. This smaller value increases the spread between the zero and nonzero observations.

poverty on the number of farms with incomes under the $15,000 pesos level,[16] poverty appears as the main regional problem.

It is of interest to examine the characteristics of the more "wealthy" farms, and in particular the tendency for better than average farms to use more or less of any of the productive inputs identified previously as income determinants.

Respondents of the Garcia Rovira survey were divided into two subgroups: farms with a reported gross value of production more than $15,000 pesos annually, and farms with less than the established income level of poverty.

The mean values of all variables considered for productivity analysis, as well as other socioeconomic variables (family size, age, soil quality), were estimated for each subsample and compared for significant differences at .01 probability level.[17]

The subset of significant variables finally selected as having a major influence on the incidence of poverty are presented in Table XLIV.

Poor farm families can be depicted as having fewer members in the productive age bracket and a lower level of education. Sample means for age are not different considering either all family members or the household heads only.[18]

The low income farm is smaller, in absolute terms, but a similar proportion of productive land (cropping and pasture land) is available

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[16] See Chapter II, page 23.

[17] A test for comparing two sample means with impaired observations and unequal variances was applied.

[18] Sample means for age were estimated at 36.9, and 41.0 years for productive family members, and 47.2 and 46.3 years for the head of the family respectively.

TABLE XLIV

CAUSES OF POVERTY IN GARCIA ROVIRA, 1972

Variable \ Income Level (Pesos)	Sample Means	
	≥ 15,000 (N = 161)	< 15,000 (N = 1023)
Family characteristics		
Number of productive members	3.6	2.9
Level of education: productive members	3.2	2.3
Level of education: head of family	2.3	1.8
Land Tenure		
Hectares under ownership	40.6	7.1
Hectares under sharecropping	2.7	1.7
Farm Size (Hectares)	48.4	10.7
Cropping land	9.2	2.9
Pasture land	19.6	3.9
Production Structure - Hectares dedicated to:		
Tobacco	1.0	.2
Potato	2.5	.4
Capital invested (Pesos)		
Dairy	18,472.0	5,167.7
Sheep	2,558.0	407.0
Total Inventory Value (Pesos)	25,950.7	10,028.8
Biological input expenses (pesos) per hectare of:		
Tobacco	1,248.2	681.5
Potato	2,200.9	1,220.0
All crops	823.4	465.5
Biological input expenses (pesos) for:		
Dairy	1,495.7	633.7
All livestock	2,617.2	1,340.3
Gross Value of Production (pesos) from:		
All activities	36,744.5	5,058.8
All crops	26,214.9	3,073.3
All livestock	10,529.4	1,985.4
Tobacco	8,420.3	558.0
Potato	9,802.1	672.0
Dairy	8,006.1	177.9

goals are going to be achieved.

Summary

The purpose of this chapter was to analyze patterns of resource allocation and the associated productivity and income levels obtained by farmers in the study region.

Dairy, potato, tobacco, bean, and corn production generate about 75 percent of the farmers' income. The importance of farming as a source of income decreased with farm size since small farm dwellers have to complement the meager level of income obtained from farming their own plots with off-farm work on somebody else's land or even in non-agricultural related activities.

On a per hectare basis, smaller farms and sharecroppers obtain higher gross incomes than larger farmers and owners did, but the absolute value of their incomes is in 85 percent of the cases well below the level of $15,000 pesos per annum considered as the poverty income threshold.

To evaluate levels of productivity and to identify those variables having a more significant effect upon production, production function estimates were obtained at both aggregate and activity levels. All models were based on Cobb-Douglas functions and estimated by least square multiple regression procedures.

All regressions are significant at the 0.1 percent probability level, with a major part of the variation in crop output explained by the observed variables. However, the coefficients of multiple determination for the estimated livestock functions are low.

Constant returns to scale prevail for all branches of farming.

to both groups. Land ownership predominates in the high income strata, but on the other hand, while the mean values for land under ownership and sharecropping arrangements appear as non-significantly different, the proportion of land held under this land tenure system in relation with farm size is clearly higher for the low income farms.

A high proportion of the resources available to the low income farms is dedicated to corn, bean, pea, wheat, and poultry production in contrast with a greater percentage allocated to tobacco, potato, and dairy activities within the farms with higher income levels.

Expenses for biological inputs are consistently higher within the high income farm group at both aggregate and activity levels.

The different resource allocation patterns followed by farmers within each group are clearly reflected by the corresponding structure of the gross value of production figures. Farmers within the above poverty group obtain most of their income, 71 percent, from crop production with potato and tobacco outputs accounting for 27 and 23 percent of the total receipts; dairy production, with 22 percent, is the third source of income. For the low income group dairy is the most important activity generating 35 percent of their incomes; peas, tobacco; corn, and poultry are next with 13, 11, and 10 percent, respectively.

A more diversified and subsistence oriented production results in levels of income for the poor farm families well below those obtained by more successful farmers.

Differences in stock and type of resources available, as well as differences in both resource allocation patterns and technological practices emerge as the main causes of poverty in the region suggesting the kind of programs that need to be implemented if the rural development

Working capital, biological inputs, and labor appear to be the most important controllable factors explaining output at the whole farm level, whereas labor, seeds, and land account for most of the variation in crop output. Working capital appears to be the key factor in livestock production followed by pasture land and biological inputs. Working capital, however, does not have strong statistical relationship with crop yields, and neither does labor for livestock production.

Education is not a significant variable in any of the models tested. Weather has the greatest effect on production of all the non-controllable factors (land tenure, climate, location).

Most of the estimated factor marginal products are significantly different among alternative uses, and some of them diverge from the corresponding opportunity costs suggesting that there is a certain degree of resource misallocation.

The potential gains in output achievable from reallocation of inputs need to be determined, but given the kind of resources available and the existing levels of technology there is no reason to expect them to be large. Furthermore, part of those gains can be explained by measurement errors or by factors specific to the particular sample year.

In consequence, rural development programs for the region should be directed more to affect those variables causing poverty: the size of the family, education, land tenure, stock of factors of production, the use of profit-increasing innovations, than to focus on creating changes in product mix on farms.

CHAPTER VI

SUMMARY AND CONCLUSIONS

The Colombian Agricultural sector is largely characterized by the existence of a dual economy made up of commercial sector and a great number of small farms within which low levels of technology and income are widespread.

A variety of government programs implemented to alleviate some of the problems stemming from the sector's inadequate structure have not achieved the hoped for success. In part due to a lack of sufficient resources and limited interinstitutional coordination and even more to the ignorance of the socioeconomic environment under which the subsistence farmer works. Early in 1972, based on the experience obtained in the Plan Puebla Project in Mexico, the Colombian Agricultural Institute (ICA) launched new programs aimed to lessen problems faced by small-scale farmers. Integrated Rural Development Projects were then established for selected areas of the country. This thesis undertakes a basic economic study for one of these projects, the Garcia Rovira Project.

This chapter is divided into three parts: objectives and procedures, findings and conclusions, and implications. In the first part, the objectives of the study are restated, and the procedures used to fulfill the objectives are described. The second section summarizes important findings and draws some conclusions based on these results.

The last part is a discussion of the implications of the study.

Objectives and Procedures

The major objectives of this study were to: (1) describe the main agricultural and livestock activities carried out by Garcia Rovira farmers, the types of technology being used, and the prevailing management systems; (2) delineate the resources available for production; (3) analyze patterns of resource allocation and the associated productivity and income levels obtained by farmers; (4) identify factors related to poverty to suggest ways to alleviate it; and (5) propose strategies leading to the achievement of the goals established for the regional development project.

The data were collected by detailed personal interviews with the heads of a random sample of farm households drawn from the National Agricultural Census. A questionnaire designed to gather socioeconomic data was administered to 1243 farmers by 35 interviewers between March and June 1972.

The economic analysis of the data was carried out in two stages. First, a descriptive analyses of the human and physical resources available, the main agricultural and livestock activities, and of the production techniques used under prevalent management systems. Single functional relationships among economic variables were presented through frequency and two-way classification tables. Appropriate statistical tests were applied to judge the validity of advanced hypothesis. Second, output coefficients were estimated by least squares multiple regression procedures from three aggregate and seven individual enterprise Cobb-Douglas production function models.

The estimated coefficients were used to evaluate the contribution of each category of resources to production and whether or not the existing mix of enterprises on farms, as well as the intrafarm allocation of resources, was consistent with economic principles.

Those variables identified as income determinants were evaluated for possible differences in the corresponding mean sample values between the group of more successful farmers and those below the poverty level.

Findings and Conclusions

Garcia Rovira's population may be characterized as young, illiterate, and having agriculture as its almost exclusive source of employment. High levels of disguised unemployment were found.

Regional population growth has been practically zero during the last 50 years, nonetheless, an excess of population exists in relation to the available land resources. Migration then, seems to be unavoidable, but needs to be controlled or otherwise most of the better trained people will be taken away from the region.

Education, even though the data do not show strong statistical evidence to accept its hypothesized direct relationship with output, is in fact a priority factor to consider for development purposes. An adequate education program would train young people that decide to stay in farming, to adopt the kind of new technology required to change the production function parameters and therefore increase marginal products for all inputs. On the other hand, those who choose to leave the region would have the required skills to find profitable jobs in other sectors of the economy.

A process of soil erosion that has already claimed a major part of

the crop land available is accelerated by inadequate patterns of soil use in regard to its productive potentials. Simultaneously with the introduction of new farming techniques, most of which are intensive in land use, soil conservation programs need to be implemented to protect the natural resource base.

Holdings under 10 hectares represent 10 percent of total farms, and control 18.9 percent of the land. However, more than 70 percent of the area occupied by farms of more than 50 hectares is classified as unsuitable for agriculture, making the redistribution of larger units into small farms not advisable. The feasibility of some kind of cooperative arrangement for land exploitation, as a way to overcome the small farm size problem, needs to be determined.

Individual ownership and sharecropping are the predominanat land tenure systems. Owners have more land in absolute terms, but the proportion of good soils held by sharecropper is greater.

Sharecroppers and small farms produce more output per unit of land but most of them belong to the poverty group of farmers. The apparent discrepancy between these two findings is explained by output sharing provisions unfavorable to the sharecropper in most cases. Sharecropping under fair input-output sharing conditions may be one way of increasing output and incomes in Garcia Rovira.

More than 50 percent of the invested capital is represented in fixed assets with the proportion dedicated to working capital being particularly low in livestock activities. Credit, as a source of capital, is oriented more to cope with consumption needs than to increase production, and the side conditions under which it is granted prevent small farm holders from using it adequately.

Production methods are typical of a subsistence agriculture with soil tillage done, in most parts, using oxen, wooden plows, and human force. Improved seeds, fertilizer, herbicide, and insecticide use are confined to few crops and farms. Livestock production is also carried under traditional management and technical practice with yields extremely low even by national standards.

Dairy, potato, tobacco, bean, and corn production generate about 75 percent of the farmer's income. Farmers above the poverty income level are tobacco and potato producers in contrast with those in the low income bracket whose main lines of production are dairy and subsistence crops.

From the regression analyses of the data it is concluded that constant returns to scale prevail for all branches of farming with the exception of poultry where diminishing returns to scale are indicated. Working capital is identified as the main factor in livestock production with variations in crop output explained mainly by land, labor, and biological inputs.

The estimated marginal products suggest that in some cases either a reallocation of resources and/or changes in the product mix on farms would result in output gains. The size of such gains are not expected to be large, however. The hypothesis is advanced in the sense that a greater development effect would be obtained by acting upon those variables identified as causing poverty instead of focusing on programs in promoting optimal use of the current set of resources.

Implications

The urgent need to proceed with programs which will provide the

solutions to the problems inherent in subsistence agriculture is widely recognized among economists. This is not an easy undertaking, however, and the resources available for effective actions are limited. Given the complexity of the problem, the Integrated Rural Development Projects constitute an improvement over the traditional approaches used to meet the needs of this sector in Colombia. Their final success however, depends a great deal on whether or not measures to minimize the potential negative effects of the induced technological change are simultaneously applied. Otherwise, the integrated rural development projects would only be contributing to maintain the status quo of poverty and the minifundia system.

Limitations

This study and the analyses contained in it is subject to limitations due to: a) possible biases introduced by measurement errors from the data used, gathered by a survey of farmers which main source of information was their memories; b) the usual difficulties related with obtaining useful production function estimates by using Cobb-Douglas functional forms in addition to the complexities associated with the multiproduct schemes of the Garcia Rovira farms.

The analysis refers to average farm performance in the sample and does not explore the scope for changes on individual farms. This would be better done by using budgeting or other programming techniques for which some of the parameters estimated in this study may be used.

The study is also limited by its static nature that does not consider year-to-year variabilities and its more positivistic rather than normative approach to the problems.

Need for Further Research

Studies of this kind need to be followed by further work to clarify or confirm some results. Research projects about the nature of the sharecropping tenure arrangements and to evaluate the size of the potential gains from reallocating inputs are needed before more definite policy recommendations can be made.

More work is urgently needed on developing an analytic framework more in line with the nature of the subsistence agriculture. Farm oriented production economic research to evaluate the profitability of the technological package being offered to small-scale farmers would be helpful in speeding acceptance of the innovations. Budgeting and linear programming studies may prove to be rewarding.

Research to identify more precisely those variables related with poverty and the effects obtained by manipulating them need to be done if more normative-policy type of recommendations for regional development are going to be given. Simulation studies appear as highly recommendable in this case.

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APPENDIX

TABLE XLV

SIMPLE CORRELATION COEFFICIENTS BETWEEN INDEPENDENT VARIABLES (EXCLUDING DUMMY VARIABLES)
WHOLE FARM FUNCTION IN GARCIA ROVIRA, 1972

	Farm Size	Labor	Fixed Capital	Working Capital	Biological Inputs	Weather-Diseases
Farm Size	1.000000	.476713	.443524	.643016	.451334	-.036758
Labor		1.000000	.263901	.494079	.474302	-.089209
Fixed Capital			1.000000	.443947	.305838	-.067100
Working Capital				1.000000	.537364	-.009597
Biological Inputs					1.000000	-.031080
Weather-Diseases						1.000000

TABLE XLVI

SIMPLE CORRELATION COEFFICIENTS BETWEEN INDEPENDENT VARIABLES (EXCLUDING DUMMY VARIABLES)
WHOLE FARM FUNCTION 2 GARCIA ROVIRA, 1972

	Productive Land	Labor	Working Capital	Fixed Capital	Biological Inputs	Weather-Diseases
Productive Land	1.000000	.469470	.670948	.477651	.459390	-.017596
Labor		1.000000	.489062	.264752	.469417	-.093350
Working Capital			1.000000	.444212	.536234	-.005382
Fixed Capital				1.000000	.305546	.069856
Biological Inputs					1.000000	-.034622
Weather-Diseases						1.000000

TABLE XLVII

SIMPLE CORRELATION COEFFICIENTS BETWEEN INDEPENDENT VARIABLES
(EXCLUDING DUMMY VARIABLES) - AGGREGATE CROP FUNCTION
GARCIA ROVIRA, 1972

	Crop Land	Labor	Fixed Capital	Capital Services	Seed	Fertilizer	Insecticides	Weather
Crop Land	1.000000	.612550	.392460	.558305	.554827	.167126	.170834	.039695
Labor		1.000000	.354145	.653014	.679511	.502182	.461130	.104348
Fixed Capital			1.000000	.344495	.337625	.207567	.211458	.062051
Capital Services				1.000000	.620208	.277086	.286597	.044466
Seed					1.000000	.403040	.409935	-.004282
Fertilizer						1.000000	.668897	.146826
Insecticides							1.000000	.111175
Weather								1.000000

TABLE XLVIII

SIMPLE CORRELATION COEFFICIENTS BETWEEN INDEPENDENT VARIABLES (EXCLUDING DUMMY VARIABLES)
AGGREGATE LIVESTOCK FUNCTION GARCIA ROVIRA, 1972

	Pasture Land	Labor	Fixed Capital	Working Capital	Feed-Supplements	Drugs-Vaccines	Diseases
Pasture Land	1.000000	.211156	.391498	.600332	.084694	.179631	.005612
Labor		1.000000	.053232	.302456	.124543	.165754	-.088895
Fixed Capital			1.000000	.382269	.055000	.114567	.012843
Working Capital				1.000000	.077193	.332665	.053028
Feed-Supplements					1.000000	.192789	-.004174
Drugs-Vaccines						1.000000	.070189
Diseases							1.000000

TABLE XLIX

SIMPLE CORRELATION COEFFICIENTS BETWEEN INDEPENDENT VARIABLES
(EXCLUDING DUMMY VARIABLES) MAJOR SPECIES FUNCTION
GARCIA ROVIRA, 1972

	Pasture Land	Labor	Fixed Capital	Working Capital	Feed-Supplements	Drugs-Vaccines	Diseases
Pasture Land	1.000000	.260008	.363899	.611400	.149518	.137659	-.046873
Labor		1.000000	.088508	.342601	.002294	.144579	-.089772
Fixed Capital			1.000000	.400709	.038956	.086418	.011733
Working Capital				1.000000	.146764	.217471	.038442
Feed-Supplements					1.000000	.132075	.015362
Drugs-Vaccines						1.000000	.102466
Diseases							1.000000

TABLE L

SIMPLE CORRELATION COEFFICIENTS BETWEEN INDEPENDENT VARIABLES
(EXCLUDING DUMMY VARIABLES) MINOR SPECIES FUNCTION
GARCIA ROVIRA, 1972

	Labor	Fixed Capital	Working Capital	Feed-Supplements	Drugs-Vaccines	Diseases
Labor	1.000000	.009123	.278200	.168596	.167398	-.040807
Fixed Capital		1.000000	.243748	-.008990	.062769	.051938
Working Capital			1.000000	.065737	.274767	.033983
Feed-Supplements				1.000000	.071993	-.043618
Drugs-Vaccines					1.000000	-.025931
Diseases						1.000000

TABLE LI

SIMPLE CORRELATION COEFFICIENTS BETWEEN INDEPENDENT VARIABLES (EXCLUDING DUMMY VARIABLES)
CORN FUNCTION GARCIA ROVIRA, 1972

	Hectares	Labor	Fixed Capital	Capital Services	Seed	Weather
Hectares	1.000000	.693093	.297192	.508177	.820835	-.065779
Labor		1.000000	.244440	.393171	.699725	-.090903
Fixed Capital			1.000000	.340372	.309085	.073644
Capital Services				1.000000	.444629	.019955
Seed					1.000000	-.116281
Weather						1.000000

TABLE LII

SIMPLE CORRELATION COEFFICIENTS BETWEEN INDEPENDENT VARIABLES (EXCLUDING DUMMY VARIABLES)
PEA FUNCTION GARCIA ROVIRA, 1972

	Hectares	Labor	Fixed Capital	Capital Services	Seed	Weather
Hectares	1.000000	.645928	.271106	.434936	.753831	.075505
Labor		1.000000	.221746	.308789	.563763	.189928
Fixed Capital			1.000000	.328712	.309775	.065916
Capital Services				1.000000	.410899	.010668
Seed					1.000000	.005190
Weather						1.000000

TABLE LIII

SIMPLE CORRELATION COEFFICIENTS BETWEEN INDEPENDENT VARIABLES (EXCLUDING DUMMY VARIABLES)
TOBACCO FUNCTION GARCIA ROVIRA, 1972

	Hectares	Labor	Fixed Capital	Capital Services	Seed	Fertilizer	Insecticides	Weather
Hectares	1.000000	.608696	.4454]0	.443456	.743722	.358090	.258636	.023405
Labor		1.000000	.270573	.501165	.448538	.262347	.207568	.058673
Fixed Capital			1.000000	.288568	.332939	.246155	.053364	.026849
Capital Services				1.000000	.404056	.188744	.151294	-.054883
Seed					1.000000	.283892	.202668	.094603
Fertilizer						1.000000	.261609	.091506
Insecticides							1.000000	-.026737
Weather								1.000000

TABLE LIV

SIMPLE CORRELATION COEFFICIENTS BETWEEN INDEPENDENT VARIABLES (EXCLUDING DUMMY VARIABLES)
POTATO FUNCTION GARCIA ROVIRA, 1972

	Hectares	Labor	Fixed Capital	Capital Services	Seed	Fertilizer	Insecticides	Weather
Hectares	1.000000	.774148	.212668	.514010	.825450	.366093	.18671	-.001327
Labor		1.000000	.230232	.532101	.792725	.498391	.280443	.018659
Fixed Capital			1.000000	.357977	.220872	.076874	.171029	.161187
Capital Services				1.000000	.515274	.292721	.220548	.046957
Seed					1.000000	.433511	.144008	
Fertilizer						1.000000	.433511	.144008
Insecticides							1.000000	.155637
Weather								1.000000

TABLE LV

SIMPLE CORRELATION COEFFICIENTS BETWEEN INDEPENDENT VARIABLES (EXCLUDING DUMMY VARIABLES)
SMALL GRAINS FUNCTION GARCIA ROVIRA, 1972

	Hectares	Labor	Fixed Capital	Capital Services	Seed	Weather
Hectares	1.000000	.592007	.306421	.4442344	.689901	.070328
Labor		1.000000	.297802	.378280	.554186	.114338
Fixed Capital			1.000000	.266415	.249113	-.006375
Capital Services					1.000000	.039628
Weather						1.000000

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