Cassava Micro-Regions in Part of Eastern Paraguay

An explanation of their form and comparative study of Cassava production within some of them

Simon E. Carter
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Centro Internacional de Agricultura Tropical - CIAT
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1. INTRODUCTION

1.1 Purpose of the Study

1.1.1 Micro-region definition for Cassava

CIAT's Agroecological Studies Unit is currently defining micro-regions for Cassava. These are geographical areas which are climatically and edaphically homogeneous for cassava, and within which other, diverse, factors which influence production of the crop are similarly uniform. These factors range from topography to cropping system, and may not all be of importance in every micro-region.

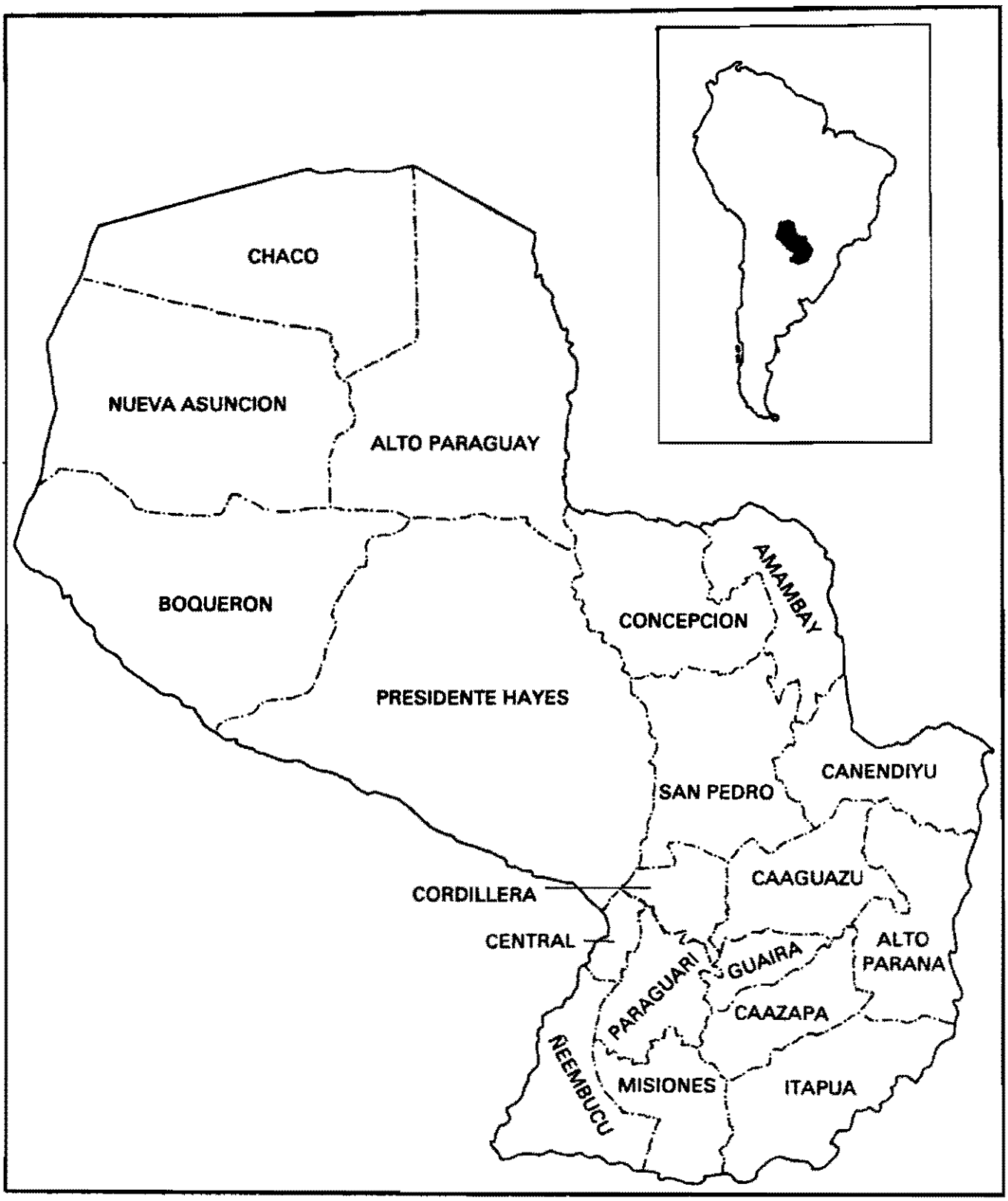
Micro-region definition consists of different levels or stages (Carter 1986). Once defined, micro-regions serve as a data-storage unit in the CIAT database. Data can be added to or referenced from this database by CIAT scientists, to aid in research orientation, project planning, or site selection for trials and surveys.

1.1.2 CIAT-SEAG-IDRC Cassava project

Micro-region definition is currently being carried out in areas of special interest to CIAT's Cassava Program.

One of these is the 'central' area of eastern Paraguay (Map 1). The Paraguayan Agricultural Extension Service (Servicio de Extension Agricola y Ganadera - SEAG) began a Cassava Project in 1986, financed by IDRC of Canada and with technical assistance from CIAT. The project's components consist of a description of the planned project areas and cassava production within them, the realization of on farm and on-station research, investigation of post-harvest technologies suitable for Paraguayan conditions, and economic analyses of current production and future potential.

Little was known previously in CIAT about cassava production, or its relationship with environmental conditions in Paraguay. In addition, agriculture in Paraguay has been undergoing dramatic changes over the last 30 years or so, as previously unpopulated regions have been colonized and deforested. In its planning stages, the project was split between an area of old established agriculture on small farms, and a more recently established colonization area of larger farms. Micro-region definition for this part of Paraguay will help scientists to understand the differences between these contrasting regions, and the way such differences affect cassava production. By defining the micro-regions at an early stage in the projects' evolution it is hoped to provide useful information for rational decision making in the planning stages of the research.



MAP 1: Paraguay: Administrative units (Departments)

1.2 The importance of Cassava in Paraguay

1.2.1 Cassava production

Paraguay is the second largest producer of cassava in Latin America, after Brazil. Average annual production is estimated on average at 2,137,000 metric tons, 7.5% of Latin American production (Lynam 1986; average figures for 1982-4). With a population of only 3,029,830 in 1982 (Dirección General de Estadística y Censos, 1985) per capita production is approximately 700 kg per year, by far the highest in Latin America.

The 1982 agricultural census recorded 178,937.25 ha. of cassava, but did not distinguish between newly sown cassava and old cassava (one year or more). Data in Lynam (1986) show cassava area to be highest in Brazil (1,987,300 ha) followed by Colombia (208,000 ha), and thirdly Paraguay (145,300 ha - lower than the census figure). If we discount Mexico and Barbados, relatively small producers, yield levels, at 14.7 kg/ha are the highest in Latin America (Lynam, 1986).

Within Paraguay production is concentrated in the eastern, wetter, half of the country (Table 1.1). The area sown to cassava is greatest in the departments of Caaguazú, Itapúa and San Pedro. These are areas of relatively recent colonization. Areas of more recent colonization, with small populations, have the smallest areas of cassava (Amambay and Canendiyú). Central department has less cassava than its

neighbours, despite its high population. The proportion of farmers growing cassava in the departments of eastern Paraguay is lowest in Central, and highest in Caazapá department. The average area of cassava sown per farm is highest in the departments with the lowest total area, Amambay and Canendiyú. Average area of cassava per farm (in eastern Paraguay) is lowest in Misiones, Central, Paraguarí, and Ñeembucú departments.

In the two departments selected for the S.E.A.G.-CIAT-IDRC projects, Caaguazú and Paraguarí, a high proportion of farms (90 and 88% respectively) grow cassava. Caaguazú has the largest number of farms (per department) in Paraguay, and Paraguarí the second largest (Table 1.1), but the difference in cassava hectareage between the two is proportionally larger than the difference in number of farms. This is due to the smaller area per farm sown in Paraguarí. Because of the recency of colonization in Caaguazú (30-50 years), soils are more fertile than those in Paraguarí, where farming is long established. More will be said later of the problems of soil fertility in both departments, however at this point it is worthwhile noting that soils are relatively more fertile in Caaguazú since yields per hectare are greater as a result. Total production of cassava in Caaguazú far exceeds that of Paraguarí.

Cassava production for urban consumption is concentrated in the departments of Caaguazú for the Asunción

TABLE 1.1 Cassava Production by Department

Department	Area Sown (Ha)	Number of farms (with land)	% Cassava Growers	Hectares per farm
Eastern Region				
Alto Paraná	11,948	13,630	78.0	1.12
Amambay	5,120	4,093	88.8	1.41
Caaguazú	30,765	35,909	90.1	0.95
Caazapá	12,716	15,449	93.2	0.88
Canendiyú	6,242	7,615	65.6	1.25
Central	5,211	13,675	52.4	0.73
Concepción	9,521	12,777	84.9	0.88
Cordillera	13,488	20,281	80.9	0.82
Guairá	12,667	16,259	91.2	0.85
Itapúa	24,736	30,264	86.5	0.94
Misiones	3,727	8,930	72.0	0.58
Neembucú	3,666	6,351	59.3	0.74
Paraguarí	16,979	26,379	87.6	0.73
San Pedro	21,597	25,365	87.9	0.97
Western Region (Chaco)				
Alto Paraguay	8	654	1.4	0.93
Baquerón	354	2,219	27.0	0.59
Chaco	9	60	56.7	0.25
Nueva Asunción	0	7	0.0	0.00
Presidente Hayes	184	1,961	15.5	0.61

Source: Resúmenes de Datos Preliminares, Censo Nacional Agropecuario 1981. Ministerio de Agricultura y Ganadería.

market, and Alto Paraná, also serving Asunción and Ciudad Presidente Stroessner. Truckloads of fresh cassava enter Asuncion's Mercado de Abasto every day from Caaguazú. Monthly data showing these amounts are given for 1982 and 1983 in Table 1.2.

1.2.2 Cassava consumption

Cassava is the staple food in the rural Paraguayan diet. Cassava consumption per capita in Paraguay is the highest in Latin America. Although some 61% of total production is used for animal feed, (Lynam and Pachico, 1982, Table 15), per capita consumption is estimated at 110.1 kg per year for the country as a whole; rural per capita consumption is estimated at 180 kg/year and urban at 35 kg/year (Lynam and Pachico, 1982, Table 3).

Cassava is eaten with every meal, beginning with breakfast, in rural areas. In urban areas it is largely replaced by bread and other wheat products such as pasta, although per capita consumption is still far higher than in any other Latin American country (Lynam and Pachico, 1982). Some rather selective data collected by the Agricultural Extension Service in Coronel Oviedo, Caaguazú, suggest even higher rural levels of cassava consumption than those cited previously. In a survey of 23 farms, weekly cassava consumption (kilos of cooked cassava) appears to be directly related to the number of adults and children on the farm (Table 1.3).

TABLE 1.2 Quantity of cassava (metric tonnes) entering Asuncion's "Mercado Abasto".

Month	Year	
	1982	1983
January	3,203	2,791
February	3,240	3,310
March	3,809	3,878
April	3,545	3,267
May	3,745	4,065
June	3,922	4,762
July	3,914	4,981
August	3,667	5,389
September	3,776	5,205
October	3,890	4,419
November	3,291	3,168
December	3,132	1,787
TOTAL	43,134	47,022

Source: Monthly records.
Mercado Abasto, Asunción.

TABLE 1.3 Consumption of cooked cassava (kg) in one week on 23 farms in Caaguazú (colonia Blas Garay, Coronel Oviedo).

Farm size (Ha)	Number of adults resident (14-+ yrs)	Number of children resident (4-13 yrs)	Kilos of cooked cassava consumed in week of survey
40.0	4	0	17.0
25.0	7	1	73.0
10.0	5	3	56.0
5.0	2	0	7.5
15.0	3	3	22.0
10.0	2	2	8.5
10.0	9	5	107.5
6.5	2	2	48.5
13.0	7	3	55.0
10.0	2	0	10.0
5.0	6	4	70.0
5.0	2	1	16.0
10.0	2	2	37.5
4.0	2	0	16.5
10.0	4	2	46.0
3.0	2	1	27.5
7.0	3	2	48.5
20.0	2	3	16.0
15.0	6	2	35.5
10.0	2	2	26.5
15.0	4	5	43.5*
6.5	2	0	20.0
5.0	3	5	46.0

Source: Unpublished survey data, S.E.A.G., Coronel Oviedo, Paraguay.

* Estimated.

Note: For some farms left-Overs were weighed and discounted from the total of cooked cassava. This information was not available for most.

A regression model fitted to this data takes the following form:

$$Y = 7.86X_1 + 4.4X_2$$

where Y = kilos cooked cassava consumed per week

X_1 = number of adults on the farm (14 + yrs)

X_2 = number of children on the farm (4–13 yrs)

The model accounts for 74.7% of the variance in Y. The estimate of the coefficient of X_1 is significant at the 0.025 level. That for X_2 is not significant at the 0.1 level.

If we ignore the fact that some cooked cassava is discarded (fed to animals) then the model predicts that weekly consumption per adult is almost 8.0 kilos, and for children 4.5 kilos. Alternatively, if adults and children are assumed to consume equal quantities, a new model predicts weekly consumption per person to be 6.5 kilos, or almost one kilo per day. This accounts for 74.1% of the variance in Y. If farm size is added to the number of adults and number of children, the model is as follows:

$$Y = 9.54X_1 + 3.98X_2 - 0.547X_3$$

where X_3 is farm size. (Y, X_1, and X_2 as above)

Note that this model predicts that cassava consumption declines as farm size increases, although the coefficient is

not significant at the 0.1 level. This model accounts for 77.5% of the variance in the observed y values.

If we use them to extrapolate consumption for a full year, the first and second models predict annual consumption of cooked cassava to be about 430 kg for adults, 230 kg for children, or 340 kg per person; this latter figure is almost twice that estimated above by Lynam and Pachico. Without data on how much was discarded we muest assume that these are overestimated, but I do not think that they are very far wrong. Most animals, such as pigs, are fed raw cassava and it is unlikely that a family would cook much more cassava then was necessary for human consumption. Whether these figures, from Caaguazú, are representative for rural eastern Paraguay as a whole is difficult to answer. The surveys were conducted almost entirely in May 1984. Variation in Cassava consumption from place to place is possible, and may depend on the available alternatives, especially bread and other wheat products (panificados). Variation in consumption over time is likely, and may depend on the availability of cassava on the farm, and the availability of cash to buy other foodstuffs. In general terms, cash income is highest from March to May (the cotton harvest) and lowest from October to February. It may be that if occupants of the farms surveyed were, in May, buying more of other foodstuffs, cassava consumption was lower than average!. Whichever way consumption levels are calculated, cassava is undoubtedly a very important subsistence crop, a staple, in rural Paraguay.

It is estimated that 61% of cassava is used as animal feed (Lynam and Pachico 1982). Most farms have a few pigs in Paraguay. Some, especially in Itapúa department, specialize in pig production and sow cassava for feed. Milk cows and sometimes oxen are fed cassava, depending on the availability of cassava on the farm. Cattle and pigs populations are given by farm-size group in the 1981 Census preliminary results (M.A.G. 1983).

1.3 The role of micro-region definition in cassava research in Paraguay.

1.3.1 Problems and opportunities in Cassava production.

The proposal for the SEAG-CIAT-IDRC Cassava Project (Brun et al. 1985) defines a number of problems of cassava production, and some alternatives for research to seek solutions to these as part of the project. Primarily the systematic loss of soil fertility in old established cassava producing regions around Asunción (Departments of Central, Cordillera and Paraguarí) is identified. Although not stated, this is partly a result of increasing pressure on the land from a growing population, and the consequent reduction in size of farms and bush-fallow periods.

Cassava production for the Asunción market has therefore shifted to more recently colonized areas, particularly Caaguazú, where soil fertility is higher and higher yields a result of this. It is admitted, however,

that the same soil problems are likely to develop there, since no change in agricultural practices has occurred. In fact, most farmers in Caaguazú have moved from the central areas which surround Asunción.

Cassava from Caaguazú is of better quality and cheaper than that from areas nearer Asunción. However, the greater distance to market means that deterioration of roots increases before they reach the consumer, and they cost more. The quality of roots varies greatly and a high proportion are rejected.

Cassava is also used for starch production in this part of Paraguay. Starch is produced on a small scale in many households, as well as in a semi-industrialized from in some places. The quality is generally poor, which limits the possibilities for sale.

Brun et al (1985) identify opportunities for improving on-farm animal feeding using cassava, and for improving starch production and starch quality. They underline the need to characterize and classify the diverse cassava germplasm which Paraguay possesses. The project's broad objective is to make available suitable technologies to increase production, productivity and the processing of cassava in Paraguay. The project will test available post-harvest technology, and include studies of actual production processes, on-farm feeding and socio-economic conditions. The project also has an important agronomic research component. Methods of improving actual production

systems using technology already developed by CIAT (such as selection of seed, planting densities and seed storage) will be tested under Paraguayan conditions. Experiments using legumes as protective cover crops, and legume rotations will attempt to address the soil fertility problem. Successful components will then be diffused over large areas.

1.3.2 How can micro-regions help?

Defining micro-regions for cassava before such a project gets underway can provide much useful information for those involved in the project, in Paraguay and in CIAT. Brun et al (1985) identify a significant difference in soil fertility affecting yields. By defining micro-regions, we can distinguish between those places where fertility is relatively high, and those where it is poor. As will be shown, not everywhere in Paraguarí department has poor infertile soils. Nor does everywhere in Caaguazú have fertile soils.

Defining micro-regions, or any sort of region, needs some point of reference, some variable which is uniform within it. These points of reference can be relatively static, for example topography or climate, or dynamic, such as soil fertility. Whilst maps and secondary data may indicate static variables, to identify dynamic variables (or processes) requires first hand knowledge of the area. Micro-regions should be maps of the distribution of both static and dynamic factors which affect cassava production.

Hence, not only is it necessary to identify climatic or topographic differences between regions, but also differences in farm size, in access to markets, in use of inputs such as fertilizers. We wish to identify problems like that of soil fertility, problems perceived by farmers, and not only problems but also opportunities such as those mentioned by Brun et al.

Micro-regions can be used as simple distribution maps, for example to identify areas of steep topography, infertile soils or small farms, to inform cassava researchers of the environmental and socio-economic conditions in that part of eastern Paraguay in question. They can be used to allow the areas immediately involved in the project to be compared with their surrounding areas. This can aid in the extension or diffusion of the results of successful research. They can be used to locate regional trials or surveys. Once the information about the micro-regions is incorporated into CIAT's data-base, further information collected either during the project or parallel to it, can be stored within a logical framework. In total, by identifying the spatial distribution of the problems and opportunities involved in cassava production, micro-regions can help researchers to answer the question 'What can we do to help cassava farmers at place X'.

2. DEFINITION OF THE MICRO-REGIONS

2.1 Method

2.1.1 Limits of the area studied

The Cassava Project described above concentrates on selected areas of Caaguazú and Paraguarí departments. As part of the process of building the micro-region data base, CIAT is interested in collecting data for a wider geographical area. In addition, these two departments are not geographically continuous, and to only examine each separately, or part of each, might hinder a fuller understanding of the differences between the two. For further research and the diffusion of successful technology after the project's completion, a wider area ought to be considered.

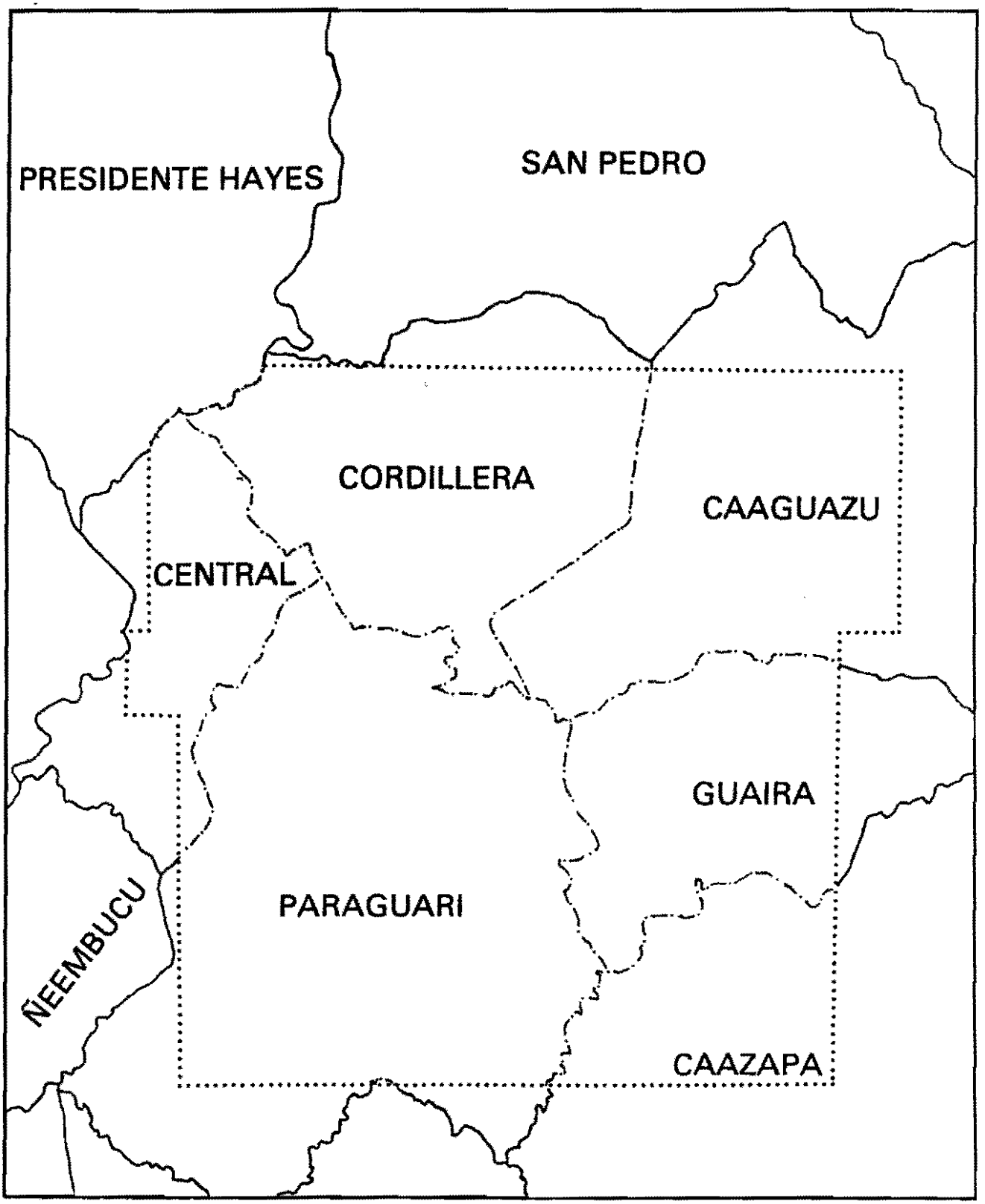
The area for which micro-regions have been defined has been made as large as possible, given the time and financial resources available. To the departments of Caaguazú and Paraguarí have been added Central, Cordillera, Guairá and part of Caazapá. The eastern boundary is located to the East of Juan Manuel Frutos in Caaguazú. That part of Caaguazú excluded is mainly a soya producing area of Mennonite and other immigrant colonies and multinational

concerns. The northern boundary is located on the limit of Cordillera department, excluding a part of northern Caaguazú which is mainly still forested. Similarly the eastern part of Caazapá which is excluded has only recently begun to be colonized. The study area forms a rectangle with two extensions on the sides (Map 2).

2.1.2 Survey design

To draw micro-regions for cassava in the part of Paraguay chosen for study requires that the same information be available or gathered in all its cassava producing areas. A complete picture for all the area cannot be pieced together using only secondary data. Furthermore, since none of the available information is primarily concerned with cassava, we cannot tell how cassava production will vary from one place to another, either its end use, or the problems and techniques of production. Whilst some questions are immediately amenable to questionnaire survey research to answer them, such as 'Do you sell cassava?' and 'Where to?', other questions are unclear. Will soil textural differences affect cassava production in the region, for example?

A two stage approach to field data collection has been adopted with the intention of identifying important factors which govern cassava production and how they vary spatially (Carter 1986a). Prior to the commencement of survey work, any available secondary data which is relevant



MAP 2: Location of the study area

to the area is examined. Informal interviews are then conducted throughout the region under study. These interviews answer initial research questions and provoke new ones. When the investigator is satisfied that he has identified all the factors of interest to him, questions are formalized and a questionnaire designed. The entire study area is divided up into a grid, and a questionnaire is completed in each grid cell at a location chosen at random.

2.1.3 The informal survey

The broad goal of this stage is to decide how cassava production is related to and dependent on other activities on the farm and external factors, such as market access. Then, to look at how these, and hence cassava production, vary from place to place. This is done by visiting as many different places in the study area as possible.

The study area was divided into a grid of nine squares. Within each, two sites were chosen at random as the locations for informal surveys. About 30 were completed over a period of one week. The framework for these is given in Appendix 1. Farmers were approached at random at each place. The interview framework was not followed in its entirety with each farmer. Rather, items were introduced for discussion and the final content of the interview depended on how much the farmer was prepared to talk about each topic. In fact, the framework (Appendix 1) proved to be too ambitious and after the first few interviews

questions were limited to those aspects which were particularly interesting or significant. It wasn't possible to investigate fully all avenues of interest for lack of time.

2.1.4 The formal survey

To complete the gaps in available data and define the distribution of those factors of interest identified in the informal survey, a questionnaire is conducted. The type of questionnaire used is designed to elicit data relating to places and groups of farms, rather than individual respondents. Generalizations rather than precise facts are sought (See Carter 1986a). The questionnaire appears in Appendix 2.

A sample of settlements (compañías) is taken from the total population of named places on available, detailed maps (1:100,000 scale). The survey area is divided into a 10 km x 10 km grid. All grid squares containing only flood-prone land or uninhabited forest are excluded, since neither are used for agriculture by campesinos. These areas can be identified from the topographic maps. Random coordinates are used to choose one settlement (usually a compañía) within each grid square.

One questionnaire is elaborated at each settlement with a group of farmers or labourers. The nature and purpose of the questionnaire is explained to them, and it is stressed that questions refer to the whole of the compañía

or colony (though this is usually evident from the way questions are phrased). Technical specialists from SEAG did this, translating the questionnaire from Spanish to Guaraní where necessary.

Initial analysis of the questionnaire involves the mapping of all survey points, and the construction of qualitative maps to illustrate the different distributions of variables of interest. This simply involves using different symbols to illustrate different facets or levels of intensity in accordance with coded question responses (for example, different categories of farm size). Many questions are precoded to speed up the mapping process.
The results of both formal and informal surveys, and the qualitative distribution maps of data from the formal survey follow in the next section.

2.2 Environment and Agriculture in the Study Area

2.2.1 Physical and human geography of the study area.

Available secondary data allows initial hypotheses to be made about the study area prior to any survey work.

Climate

The climate of Paraguay is subtropical. Rainfall decreases from 1800 mm in the Southeast to less than 400 mm in the northwestern Chaco. Because of the latitude of the country, a marked winter associated with lower daily minimum

and monthly mean temperatures is experienced. Frosts are not uncommon. In eastern Paraguay the winter months (June, July, August) are dry and the summer months, from November to March, are hot and humid. Mean Annual rainfall varies from 1400 to 1600 mm in the study area. Maximum daily temperatures in Asunción in January regularly exceed 40°C. Whilst there is a slight rainfall gradient across the study area, it is considered as climatically homogeneous in published studies using the Thornthwaite Hydric Index (MAG, 1981) and Holdridge's Life Zones (FAO, 1969). For cassava, the climate of the study area can be considered homogeneous and can be classified as Humid Subtropical (Carter 1986b);

(i) Average growing period (summer) temperatures are greater than 22°C.

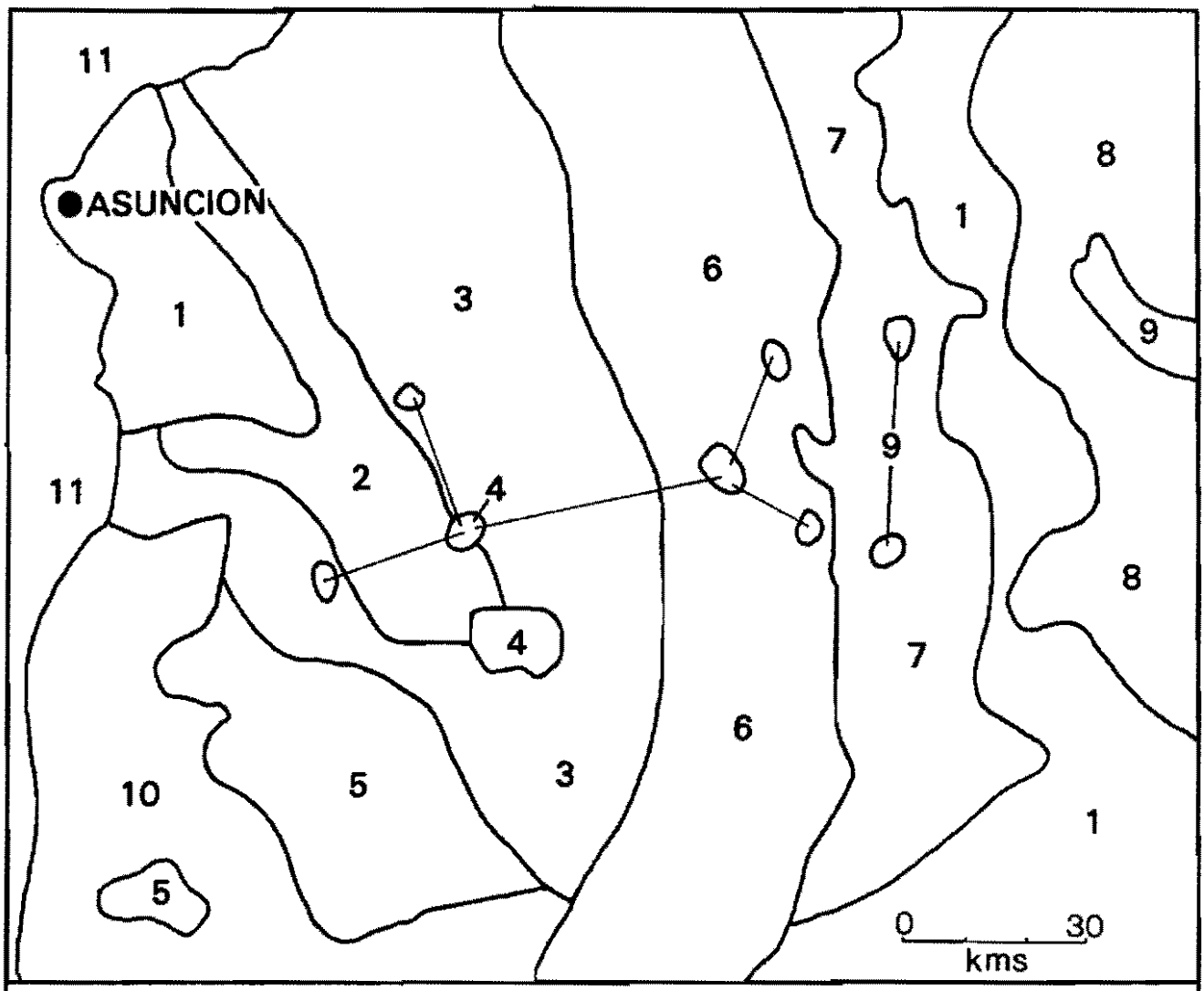
(ii) The dry season (number of months with less than 60 mm precipitation) is less than three months.

(iii) Daily temperature ranges in the growing season are greater than 10°C (favouring Cassava Bacterial Blight and other diseases).

(iv) The annual range of mean monthly temperatures is greater than 5°C, the Koppen definition of a non-isothermic (sub-tropical) climate.

Geology and Topography

The study area consists of alternating areas of raised relief, on sandstone rocks, and low-lying flood-prone areas of alluvial sediments. In the southwestern part



1.	Red continental eolian sandstone (Misiones formation).	Upper jurassic
2.	Undifferentiated quaternary sediments.	Quaternary
3.	Continental conglomerate and 'sugary' sandstones. Mudstones and kaolinitic lutite of marine origin.	Lower silurian
4.	Alkaline extrusives.	Jurassic, cretaceous
5.	Granite.	Cambrian, upper Pre-cambrian
6.	Glacial and post-glacial sediments (tillite, sandstone, limolite, conglomerate, varvite).	Upper carboniferous
7.	Quartz sandstone with inclusions of lutite.	Permo-triassic
8.	Eolian sandstone.	Upper cretaceous
9.	Basaltic extrusions with some associated red sedimentary beds and diabase intrusions (Alto Paraná formation).	Upper jurassic, Lower cretaceous
10.	Metamorphosed quartzite, filite, mica, gravels.	Upper pre-cambrian
11.	Deltaic deposits.	Quaternary

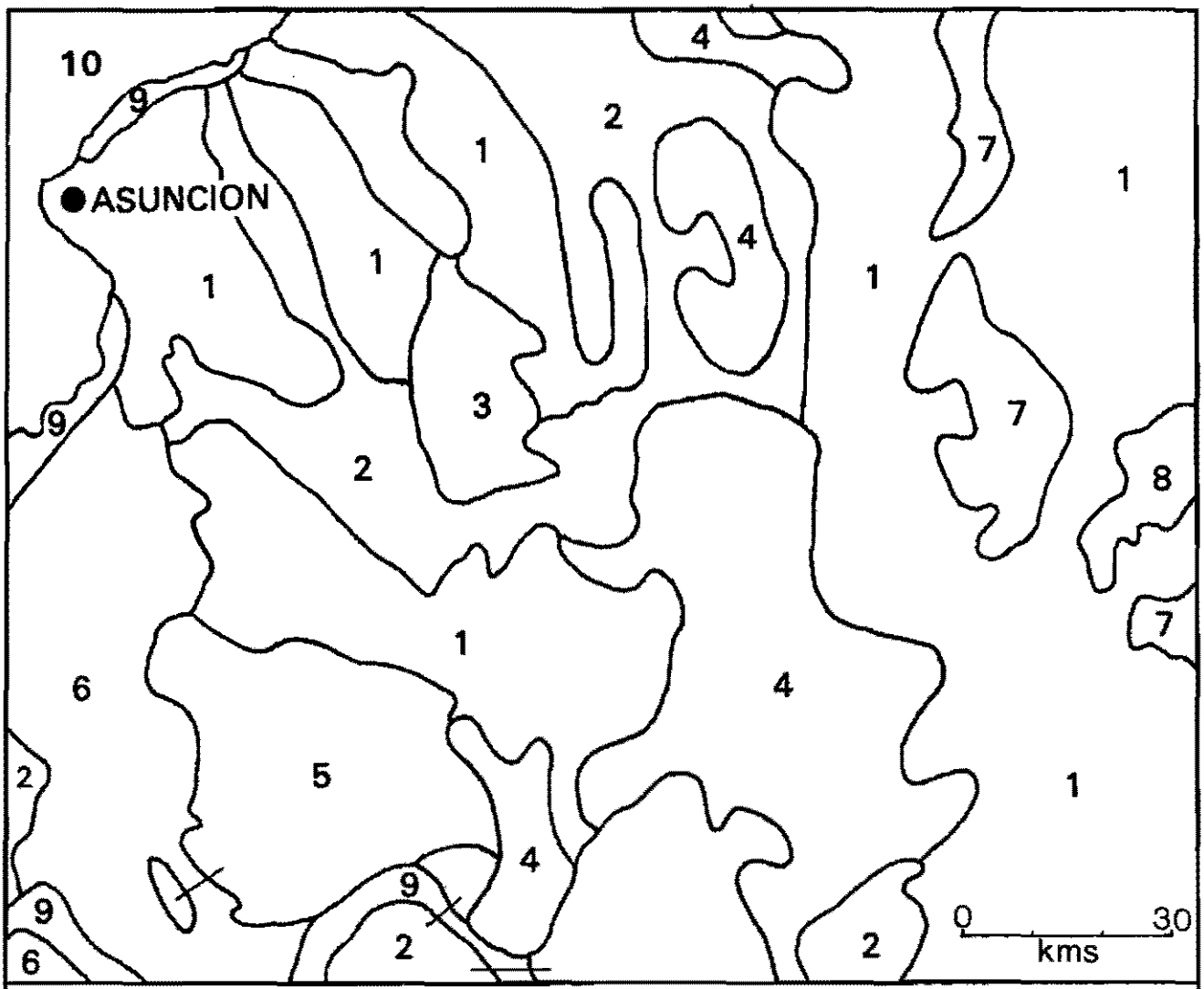
MAP 3: Geology of the study area (O.E.A., 1971)

granite outcrops give rise to raised relief and small areas of hilly relief.

Steep slopes are associated with discontinuities in the nature of the sandstones, and where volcanic intrusinions have formed upstanding blocks in some areas (Map 3); these are referred to as cordilleras. Elsewhere topography is flat to undulating. Available topographic maps at scales of 1:100,000 and 1:250,000 show the areas of steep topography. Flood-prone areas and swamps, which are generally used for extensive grazing, can also be identified. They are not used by campesinos for cultivation (Yates, 1981), except for rice in a few places.

Soils

Soils of the area are generally derived from the underlying rocks, and sandy, red-yellow podzolics predominate (Map 4). In areas of poor drainage or seasonal flooding, hydromorphic soils are found. Soil texture varies according to the nature of the sandstones, or where derived from granite, and some clay soils are found towards the East in Caaguazú. There appears to be no information available which describes the differences in fertility between the podzolics, however, either natural or as a result of cultivation. Nor are there any general comparisons between soils which have been recently deforested and those which have been cultivated over many years. Textural differences may be expected to influence this, but no systematic study



1. Red-yellow podzolics in association with humic gleys. Loams-sandy loams.
2. Humic gleys and acid 'pseudogleys'. (Alluvial deposits).
3. Red-yellow quartzose sands. Loamy sands-sandy loams.
4. Red-yellow podzolics in association with humic gleys. Sandy loams.
5. Red-yellow podzolics in association with humic gleys. Loams.
6. Acid pseudogleys (Alluvial deposits). Loamy clays.
7. "Terra roxa" - Red earths, associated with humic gleys. Clays.
8. Hydromorphic gleys. Clays.
9. Alluvial deposits (Hydromorphic). Texture very variable.
10. Planosols and gleyic planosols (Alluvial deposits).

MAP 4: Soils of the study area (O.E.A., 1971).

has been undertaken. The extent of existing forest can be summised from satellite imagery and published topographic maps, but deforestation is proceeding at a fast pace.

Population

The urban and rural populations for each of the six departments of the study area are given in Table 2.1. Note that over the period 1972-82 the population declined in Paraguarí, and did not change in Cordillera. The average annual rate of growth over this period for Paraguay as a whole was 2.5%. Areas of long established settlement coincide with the departmental capitals, and in general Central and Cordillera departments, and North and Central Paraguarí are old agricultural areas. As part of the government's colonization program, farmers from these regions have been encouraged to move to new areas in an attempt to expand the agricultural frontier and to solve some of the problems associated with pressure on the land in these older areas. Colonization of much of Caaguazú has taken place over the last 30 years, and for eastern Guairá over a slightly longer time scale (Yates, 1981). Again, the topographic maps indicate, by the rectangular pattern of rural roads, where some of these areas are. Farm sizes are pre-determined; usually the land is divided into 20 hectare plots in the new colonies. Over time fragmentation has begun, although farms are far larger on average than those in the old settled regions (Yates 1981).

TABLE 2.1 Urban and rural population by Department for the area studied (1982)

Department	Population			Mean Annual growth rate
	Total	Urban	Rural	1972-82 (%)
Caaguazú	299,437	57,704	241,733	3.6
Caazapá	109,452	14,002	95,450	0.6
Central	497,388	298,040	199,348	4.8
Cordillera	194,011	48,588	145,423	0.0
Guairá	143,510	40,326	103,184	1.4
Paraguarí	204,399	41,279	163,120	-0.4

Source: Dirección General de Estadística y Censos (1985).

TABLE 2.2 Relationship between age of settlement and existence of forest.

Existence of forest being cleared for agriculture	Age of settlement (yrs)		
	0-50	50-100	100+
YES	43	20	25
NO	8	23	52

$X^2 = 62.74$ (3df.) $\alpha = 0.001$

Agricultural activities and types of farm

Census material (MAG 1981) and other studies give a good picture of agriculture in the region. Yates (1981) describes and contrasts production amongst *minifundia*, Paraguayan colonists, and Austro-German immigrants in Guairá. Cassava, maize, peanuts, sweet potato, cowpea (*poroto*), squash and melons are common subsistence crops for each group. Cotton and sugarcane are the main cash crops for *minifundistas*, but on larger farms in colonization areas soya, grapes, yerba mate, and onions are found, and sugarcane is uncommon because of high relative labour costs. Census material was not available for all crops before the field work was undertaken, and a full picture of their geographical distribution could not be constructed (such as dot distribution maps). Similarly, farm size data from the 1981 census was not available, although this has since been acquired and is used in part later in this report.

Rivarola (1982) subdivides Paraguayan farms according to the proportion of their production intended for sale, and the dependence of the family on wage labour as a source of income. He distinguishes strata of 1-2 ha, producing some crops for subsistence and dependent on wage labouring as the principal source of income; of from 2-5 (and upto 7.5) ha, which destine perhaps 50% of production for sale, and for which wage labouring is of some importance; of between 7 and 10 ha to 20 or 30 ha, which destine the majority of production for sale, and on which wage labour is contracted

but rarely hired out, as all family labour can be utilized on the farm. He also distinguishes a fourth strata, with an average farm size of about 50 ha.

Studies of agricultural production in the area have been made by the Ministry of Agriculture, S.E.A.G., and other institutions concerned with agricultural development, but no complete picture exists of agricultural production across the area as a whole. Nor is there any way of assessing the relative importance of an activity in different places, apart from analysis of census data.

2.2.2 Informal and formal survey results

Soil, Soil Fertility and Erosion

Soil fertility in the area can be related in part to the length of time during which the soil has been cultivated. The initial distinction made by Brun *et al* (1985) is based upon this concept. The ages of the places surveyed have been used as a surrogate for the duration of cultivation (Map 5). The oldest settled areas Central, Cordillera, central Guairá, northern Caazapá and much of Paraguarí were generally settled over 100 years ago; in some of these areas settlement dates back to the Spanish conquest.

Many parts of Guairá and Caaguazú, and some parts of Paraguarí and Caazapá have only recently been colonized, and

there still exist uncolonized areas of forest, though these are diminishing rapidly. Many farms in the new colonies still have upto half their surface area covered by forest, but every year one or two ha. might be felled. Map 6 indicates those places where forest is still present and rozados exist (land newly cleared for agriculture).

. Amongst the places surveyed there is an inverse relationship between the existence of forest which is still being cleared for agriculture, and the age of settlement at each place, as is shown in Table 2.2.

The length of cultivation, or settlement, does not fully explain soil fertility however. Not all farms will still have forest to clear, and even if it does exist at a place fertility differences can also be attributed to differences in the nature of the soil.

Farmers distinguish different types of soil by colour, which depends on texture (especially clay content) and on organic matter content. Red earths (locally known as Yby Pytá in Guaraní) with a sandy loam texture are distinguished from sands or white earths (ybycuí and yby morotí), and from other red earths with a clayey-loam texture (yby pytá ité). Stony soils, usually associated with the steep slopes of the cordilleras are also distinguished separately (Itarayí), as are black soils whose colour is a result of the high proportion of organic matter which they contain (YbyJhú). Yellow earths (yby say yu) are also distinguished in some areas. These colour differences

and the textural differences which they imply are used to denote fertility differences, particularly amongst the red and yellow podzolics which are commonest in the area. White sands are least fertile, red sandy loams more fertile, and the red clay loams (or terra roxa as they are known in the Paraná basin) are generally considered most fertile.

Map 7 shows the most common soil type at each survey site, using this system of classification. Other soil types which can be encountered at each site are not included on this map, for clarity. However as a whole the data add some detail to Map .4, such as areas of stony soils associated with the cordilleras, and the predominance of sandy soils in the Tebicuary valley in Guairá.

Map 4 (OEA, 1971) indicates a predominance of sandy soils in Caaguazú, and the data in Map 7 generally confirm this for the area North and South of the town of Caaguazú. Further West, from the area North of Coronel Oviedo (Caaguazú department) to the South of Independencia in Guairá, the survey soil data indicate soils of higher clay content in some areas, though they are only the predominant type in one or two places. These appear to be related to a different type of sandstone (see Map 3) which forms a North-South band in this area.

If we use the farmers' textural classification to tell us something about soil fertility, then it is possible to question the assumption that the more recently colonized areas will necessarily have intrinsically fertile soils,

particularly as in quite a large part of Caaguazú (where most colonization has taken place) soils appear to be very sandy. This is particularly true for the cassava producing areas (compare Map 8 with Maps 4 and 7).

The predominance of sandy soils in the study area as a whole, coupled with the characteristically rolling topography makes soil erosion an important problem. Intense rainstorms are experienced during the summer months, and large quantities of soil are removed from fields with even quite shallow slopes. Soil conservation practices are not common, and often insufficient; some farmers plant a row of thatching straw in an attempt to reduce erosion, but these are inadequate given the intensity of rainstorms. In some places, the steep slopes of the Cordilleras are being cultivated. Erosion is likely to be even more intense on the shallow stony soils which are common on these. Areas with characteristically steep slopes are easily identified from the topographic map; for the more undulating areas which typify most of this part of Paraguay, no attempt has been made here to differentiate amongst slope classes.

Cash crops: Distribution

Almost everywhere in the departments with which this survey is concerned farmers orientate production to a greater or lesser degree towards the market. Whilst there are differences in the proportion of subsistence crops grown from one farm to the next, the same subsistence crops

mentioned above (2.2.1) are almost everywhere common. Geographic differences in the agriculture of the area are therefore concerned with the cash crops produced.

Theoretically, the existence of areas specializing in certain cash crops should depend primarily on access to markets and on the availability of credit or other sources of capital. This is not entirely the case in Paraguay, and factors such as farm size and soil fertility are shown to be important determinants of the agricultural activities of rural places.

Map 8 shows the principal cash crops cultivated at each compañía visited during the formal survey. Cotton is almost everywhere important, and in some areas is the only cash crop or one of very few. It's importance lies in its imperishability (because many places have very poor access which can be cut entirely when it rains), and in the guarranteed market for it. Farmers are assured that by growing cotton they will raise at least some cash, and in a lump sum, to pay debts and make important purchases. This makes the crop especially favoured by very small farmers who only have a tiny fraction of land to sow cash crops, and cannot afford to risk a crop with a less reliable market. Nevertheless, in recent years declining yields and fluctuating prices, often very low, have shaken this confidence somewhat, since many farmers have made losses they can ill afford.

From the Tebicuary Valley in Guairá a belt of sugarcane production extends into Caaguazú and northern Caazapá. There are also minor cane-producing areas around Quiindy in Paraguarí, and in the South of Central department. These latter areas produce syrup for rum or for sale in Asunción, whereas production in Guairá is destined for refineries, for example at Iturbe, or for the new alcohol producer at M.J. Troche. Sugar cane is probably the second most important cash crop in the area.

In much of Paraguarí cocotero fruits (from the palm, Acrocomia totai) are an important cash crop alongside cotton. Cocotero palms are semi-wild rather than cultivated, and litter the fields in the minifundia areas of Central, Cordillera, and Paraguarí. They are especially characteristic of poor, degraded soils. That they should be one of the main sources of cash in Paraguarí (there are few non-agricultural sources of income) is an indication of its poverty. Paradoxically, access to the Asunción market is good.

Horticultural production is concentrated in Central and Cordillera departments. Tomatoes, melons and watermelons, peppers and vegetables are important. Access to the Asunción market on good asfalt roads has also favoured the establishment of horticultural production in colonies served by the East-West highway in Caaguazú. A Japanese colony at La Colmena in eastern Paraguarí also specializes in horticulture (not apparent from Map 8).

Potato and onion growing have become popular in neighbouring Paraguayan colonies. This area is connected to the capital by an asfalt road. Other immigrant colonies, mainly Austro-German in eastern Guairá have good access to Villarrica and Asunción by road. Production in this region is very diversified. Sugar, cotton, yerba mate (Paraguayan tea) and fruit are amongst the most important crops, but large quantities of maize, soya and cassava are also produced.

Production of cassava as a principal cash crop is almost exclusive to Caaguazú, to those parts where either access or soils disfavour horticultural or sugar production. These cassava producing areas supply the Asunción market, starch producers in M.J. Troche in Guairá, and occasionally other rural areas where cassava is in short supply.

Other principal cash crops include tobacco, which is important to the North and North-west of Coronel Oviedo in Caaguazú, and in newly colonized areas in Caazapá. Soya is also important in this latter area, reflecting the influence of nearby Itapúa. Around Asunción, Villarrica, Coronel Oviedo and Caaguazú, dairying is found, but, according to the survey data, is not amongst the principal sources of cash.

Cash crops: Related cash flow

Cotton creates demands on cash and labour supplies from late September (land preparation and sowing) until late

March or April (harvest and disposal of crop residue). For those farmers who depend mainly or entirely on cotton as a source of cash, it therefore brings a critical period of cash shortage, and one of relative abundance during the year.

Figure 2.1 shows the months indicated by survey respondents as those of greatest cash shortage. The low point from April to June coincides with the end of the cotton harvest, when cash is relatively plentiful, and with the beginning of winter when there is little agricultural activity. The curve begins to climb in August and peaks from October to December when cash requirements to pay for labour and purchased inputs are highest.

Labour requirements for sugar cane are high at harvest time, but the main harvest period in August provides much needed cash at a critical time. In some places there is also a second harvest in December. The main disadvantage associated with sugar cane, apart from the high labour requirements, is the high cost of transport to get stripped cane from the farm to a buyer, or to a roadside winch where sugar-refinery trucks can collect it. For farmers who have a cart (carreta) and oxen team, cane is attractive (they can also hire their cart to other growers who do not possess one). For those without this facility, transport costs are prohibitive if they live more than a few kilometers from a winch or factory.

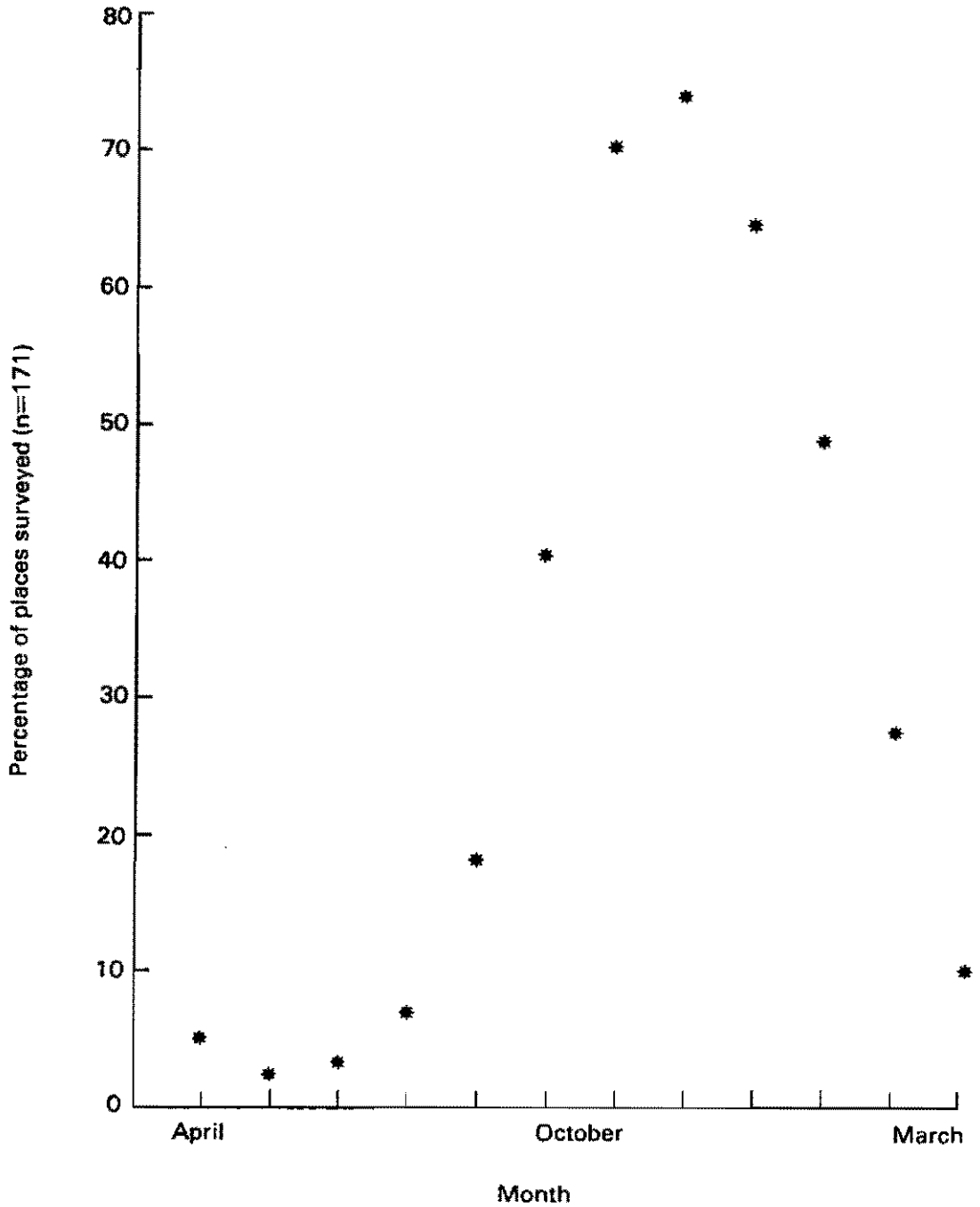


FIGURE 2.1 Percentage of places surveyed where farmers experience an acute shortage of cash in a given month.

Map 9 depicts the modal months of cash scarcity at each survey site. At most places farmers note difficult periods between September and December. In the sugar producing area in Guairá the period from December until the end of February is that of cash shortage. The income derived from the sugar harvest in August and September helps farmers to pay for weeding and other activities. The later shortage is associated with the cash needs of the cotton harvest, by which time income from sugar has run out.

Cash crops; Marketing and Access

Some cash crops such as cotton are sold to local intermediaries throughout the area. Other crops, particularly food crops, are often taken by the farmer to the large urban markets of Asunción, Coronel Oviedo or Villarrica, or to smaller local markets. Map 10 indicates places where farmers take produce to market, and the most frequent destinations; and places where farmers depend entirely on intermediaries to sell their produce (much of Caaguazú, parts of Guairá, and much of Paraguarí). In parts of Caaguazú, Cordillera and eastern Paraguarí farmers take high value crops to sell in Asunción's Mercado de Abastos, generally in hired trucks (camiones de carga).

Villarrica serves as a market centre for northern Caazapá and the new colonies of eastern Guairá, and for the minifundia areas around the city. Coronel Oviedo and Caaguazú have a similar role in the department of Caaguazú,

and in Paraguarí the town of Paraguarí has some influence as a market centre. In Guairá many sugar farmers sell direct to refineries (ingenios). Central and western Paraguarí, where farmers have little or no surplus production to market, contrasts strongly with the new colonies in Guairá and Caaguazú.

It was noted above that those parts of Paraguarí where cotton and cocoteros are the main cash crops have reasonable access to the Asunción market (about an hour and a half's drive on asfalt roads). The absence of higher value crops may be due to other factors such as a lack of capital on commonly very small farms, and poor soils. Amongst the survey sites as a whole, however, those where agriculture is most diversified (ie. where those crops which are sold most are large in number, say 6 or more) do not necessarily have good access to asphalt roads, as the Table 2.3 shows. This suggests that factors other then direct access to markets affect production in the area under study. Communications in rural areas, once off the asfalt roads, are very much dependent on the weather. Dirt roads are closed to motor vehicles when it rains, to protect them from deterioration. There is only one railway, from Asunción to Encarnación on the river Paraná, and although it passes through Paraguarí, Guairá and Caazapá it does not appear to be used for the transportation of agricultural produce.

TABLE 2.3 Relationship between number of cash crops at a place and distance to an asphalt road.

Number of Cash Crops	Distance to asphalt road (km)			
	0-5	6-20	21-45	46+
Low (5 or less)	6	61	23	11
High (6 or more)	5	46	13	6

The difference between the two groups is not significant at $\alpha = 0.1$ ($X^2=0.7$, 3 d.f.)

Agricultural credit

Credit is commodity orientated and often obtained from the buyer of a crop. Cotton especially is sold to local merchants and intermediaries who provide credit at sowing time. In turn they receive loans from the cotton gins. Farmers maintain client-patron relationships with these individuals and depend on them in times of need. Rates of interest on credit are high (typically 30 to 40% calculated on an annual basis), and buying prices for cotton which are quoted when credit is given often change when harvest time comes. Credit for sugar cane can be obtained from ingenios, particularly in Guairá.

Map 11 shows the crops for which credit is obtained. Cotton, not surprisingly, is the most common, and almost everywhere credit is available for it. Apart from Guairá and parts of Caaguazú, credit for sugar cane is only obtained at dispersed locations. Credit is available for tomatoes in parts of Central near Asunción, and here and there in Cordillera. Credit for rice is also available in localized areas in these two departments. To the North and West of Coronel Oviedo in Caaguazú tobacco is quite important and credit is available to producers. At only one location, near Coronel Oviedo in Caaguazú, is credit available for cassava.

In the South of Paraguarí, in the North of Central, in western Cordillera and around the city of Villarrica in Guairá, credit is not available for any crops, and only in a

few locations is it given to farmers who collect and sell cocotero fruits.

Official Credit Sources include the National Development Bank (Banco Nacional de Fomento; B.N.F.) and Crédito Agricola de Habilitación - C.A.H. (Banco-i; the little bank). The first has quite stringent conditions restricting lending which disfavour small farmers (especially since many lack the necessary title to their land). The CAH is specifically orientated towards small farmers. There are a few producers' organizations which provide credit, such as the Tomato Producers' Cooperative in Asunción, and occasionally farmers comités are provided with credit by the C.A.H., though these are not common. Sources of credit which are available to farmers at the places visited in the formal survey are shown in Map 12.

Farmers stress the importance of credit to them. The demands for cash to pay labourers during the period from August to April are high, as large amounts of labour are needed especially for weeding. Once a common practice in rural communities, communal labour (minga) is becoming less important as land ownership becomes more unequal. Households with fewer land resources have excess labour to sell and require cash (both wages and credit) to make vital purchases. (See Yates 1981, p219-221, for a discussion of this tendency).

Other sources of cash

In the struggle to raise cash some minor crops provide additional sources of limited income in the period from August to December. Bitter orange is cultivated in some areas, notably Cordillera and Caaguazú, and petit-grain essence is extracted from the leaves. In December cocotero fruits are collected and sold (oil extraction), and castor oil (tártago) seeds are dried and sold, especially in Caaguazú. Charcoal making is important in areas where forest still remains. The sale of cassava is also important during this period in many places, albeit in small quantities.

Use of fertilizers and other inputs

Chemical fertilizers are most commonly used in areas of horticultural or sugar production, in Central, Cordillera, Guairá and parts of Caaguazú (Map 13). In much of Paraguarí, southern Guairá and northern Caazapá they are not used. In newly deforested regions natural soil fertility may still be high enough to preclude their use, although potatoes and onions are usually grown in rozados and fertilized. Cotton sometimes receives the benefit of chemical inputs, usually foliar nitrogen and pesticides, but the amount and regularity of applications depend on the capital or credit available to the farmer. Often agrochemicals can be acquired on credit from intermediaries, but at inflated prices. Chemical fertilizers are rarely if

ever used on subsistence crops, and even when grown principally as a cash crop, cassava is not fertilized. Organic fertilizers, mainly farmyard manure, are used on high value horticultural crops in some places, and on the vegetable patch if a farm has one. Otherwise they are not collected.

At 74 (43%) places surveyed some farmers use fertilizers for one or more crops. Tomato is the most common recipient, (23% of places) followed by sugar cane (13%), peppers (10%), melon (9%) and cotton (7%). The survey data also suggest that the use of fertilizers is more common in places where a higher number of cash crops are grown (Table 2.4). Greater crop diversification not only brings more stable cash income to farmers in some parts, but also favours the production of high value crops, which in turn require relatively large quantities of purchased inputs.

Farm size and Land Tenure

Farm size and land tenure exert an influence both on the activities of the farm and on external factors such as credit, due to eligibility restrictions. Many farmers do not have titles to their land and are officially classed as occupants of state land. Others may be in the process of buying their land or acquiring legal ownership by some other means. Map 14 indicates the form of tenure most common at each survey site. This refers to the land that farmers

TABLE 2.4 Use of fertilizers amongst places with low and high numbers of cash crops.

	Chemical Fertilizers	
Number of Cash Crops	Not used	Used
Low (5 or less)	69	32
High (6 or more)	28	42

(X^2 = 13.49, 1 d.f., α = 0.01).

consider as their own, generally where their house is located. At 20% of the sites, occupancy of state land (squatting) is the main form of tenure, and is common in Paraguarí, Caazapá and parts of Cordillera. At 25% of the sites, provisional ownership is most common. There is a strong concentration of places with this kind of tenure in Guairá. Elsewhere titled ownership is most common. These proportions may not be representative for the situation as a whole; Yates (1981) and Galeano (1974) indicate that the proportion of squatters lies between 30 and 40%, though they do not state whether or not farms with provisional ownership are included in this figure. To get official credit a farmer must have titled ownership to his land as collateral (Yates, 1981 p 78).

Other forms of land tenure, although recorded in the formal survey, are not as common in Paraguay as they are in other parts of Latin America. Map 15 indicates places where these forms of tenure are found. Renting of land is less common than sharecropping. Galeano (1974 p173-4) attributes this to the rigidity of the land tenure system which lacks a method by which farmers can increase their farm size. On the other hand, subdivision of farms continues to be seen everywhere.

Farms can be subdivided according to size, even amongst the 'minifundia'. The smallest farms, many with less than one hectare and some with no land at all, generally rely on labouring as their chief source of income

(Rivarola, 1982). Information collected during the informal survey suggests that those farms upto about 3 ha in size have difficulty meeting subsistence requirements, including cassava, from production on their own farm. This is because farmers prefer to sow cash crops and buy food, and because of very poor soils.

Because land tenure statistics were not available before the formal survey was executed, part of the questionnaire sought to identify regional differences in modal farm size. For the purposes of the survey, farm size was divided into 3 strata, based on the observations from the informal survey and on Rivarola's subdivision (1982) mentioned in Section 2.2.1. Respondent's were then asked which size of farm is most common in their compañía, less than 3 ha, from 3 to 7 ha, or greater than 7 ha. Map 16 shows the distribution of farm size, according to these criteria at the places surveyed. In simple regional terms Map 16 indicates areas where farms are generally very small, and where there is a strong excess of labour according to Rivarola's criteria (1982); where farms are small but labour is less in excess; and where farms are medium to large and labour is likely to be scarce.

Obviously many other factors need to be taken into consideration, and an analysis of farm size from census data would give a more accurate picture. Nevertheless, Map 16 shows up some important differences. The smallest farms are most common in the centre and South of Paraguarí department,

in Central department, in Caazapá and the South of Guairá, and in parts of Cordillera. In eastern Guairá and almost all of Caaguazú, by contrast, farms are over 7 ha. Newly colonized areas in eastern Paraguarí and parts of Caazapá and in some old settled areas in Cordillera, are also typified by these larger farms. Farms of 3-7 ha are most common in the sugar producing area of Guairá, southern Caaguazú, in much of Cordillera and some parts of Central. Amongst the survey sites there is a strong relationship between the most common farm size and the age of the settlement, with farms smaller than 7 ha being more common at places established over 50 years ago, and vice versa (Table 2.5). This suggests that the older a place is, the more likely is the majority of farms to be small (less than 7 ha in this case), which evidences the gradual process of subdivision of farms over time.

Farm size appears to be related to the propensity to use credit and purchased inputs. Fertilizer use appears to be more common in places where 3-7 ha farms are most common (Table 2.6). This reflects not so much the greater likelihood of farms of this middle strata to use fertilizers, but rather the lower probability of the smallest farms using them, due to lower income, or of the larger farms using them since these are generally found in more recently colonized zones with somewhat more fertile soils.

TABLE 2.5 Farm size compared with settlement age.

Most common farm size	Age of settlement (yrs) 10-20	20-50	50-100	>100
<7 ha	3	16	29	64
>7 ha	5	27	14	13

(X^2 = 29.68, 3 d.f. α = 0.001)

TABLE 2.6 Fertilizer use compared with farm size classes.

Most common farm size	Fertilizers Not used	Used
a. < 3 ha	30	12
b. 3-7 ha	32	38
c. > 7 ha	35	24

X^2 = 1.57, 1 d.f., 0.3 > α > 0.2 for group a compared with group c.

X^2 = 5.86, 1 d.f., α = 0.02 for group b compared with groups a and c combined.

TABLE 2.7 Credit availability compared with most common farm size.

Most common farm size	Credit (all sources) Available	Unavailable
< 3 ha	26	16
> 3 ha	122	7

(X^2 = 29.04, 1 d.f. α= 0.001).

Credit is less likely to be available in areas of commonly very small farms, according to the survey data (Table 2.7). Why this should be is not immediately clear. In Map 11 there are four areas where credit is not available. Lack of credit may just reflect the existence of very little surplus produce for sale, including cotton. If there are other sources of employment, the inhabitants may well only be part-time farmers. In addition they may have other sources of capital to finance farming activities (in two sites near Asunción on Map 9 respondents did not recognize a cash scarcity period). In the North of Central department, agricultural production is of secondary importance compared with non-agricultural employment. Similarly, at those sites in western Cordillera where no credit is available, other forms of work are equally as important as agricultural production. In southern Paraguarí, and in the minifundia area around Villarrica there are no other forms of alternative employment. Lack of credit in these areas may just be a further indicator of their depressed state.

Cassava production: Fallowing and rotations

Cassava is rotated with cotton almost everywhere in the study area, either every year or every other year. The exact length of the rotation depends on how long the cassava crop lasts, and on how much land the farmer has available. On the smallest farms one year old cassava may well be

occupying space required to plant cotton in September or October. Where enough land is available, upto three years of fallow may be included in the rotation, although cattle are usually grazed on this. Bush fallowing is very rare, as land is in too short supply. Land is rested for a few months after the cotton is harvested, though a farmer may plant a winter crop such as peas.

On newly cleared land, in Caaguazú for example, fallowing for a full year or more is not practiced until the farmer feels that soil fertility has declined to an extent which warrants a fallow period. This may be after five or six years, or after as many as 12 or 15, depending on the soil. Cassava is often sown immediately or soon after land is cleared in Caaguazú. It may precede or follow cotton depending on the farmer's priorities and the market situation.

Elsewhere, on older land, the most fertile patches are chosen for the cotton-cassava rotation, to benefit the chief cash and consumption crop respectively. Farmers with very small farms do not fallow land, and cassava and cotton are interchanged continuously.

Cassava production: Land preparation

Weeds or vegetation associated with the fallow, or which have grown over the winter period, are generally incorporated into the soil before planting. As cattle usually graze on land in fallow, and because of the winter

period, there is insufficient vegetation to burn. Unlike many cassava growing areas in Tropical Latin America, Paraguayan farmers use ox-drawn implements for cultivation. Most farmers try to plough their land, either with their own team of oxen (yunta) and plough, or that of a neighbour hired for cash or exchange labour. This makes it easy to incorporate weeds and other residues. The sandy nature of the soils favours this type of technology. Elsewhere in Tropical America, where clay soils predominate, ploughing with an ox and plough would be more difficult (though I am not certain that this is the reason for their absence). Mechanized land preparation in this part of Paraguay is very uncommon, except in the immigrant colonies.

If he owns or can hire or borrow an ox-drawn harrow, a farmer will also harrow his land before planting. Ownership of oxen and ploughs and other implements requires extra land for grazing, and capital, so not everybody has them. Sometimes farmers with a little spare land maintain one ox, which they lend to a neighbour in the same situation, in return for the loan of his.

Cassava production: Planting, Varieties and Cropping Systems

Cassava stems for planting are cut before the winter begins and stored vertically below trees and shrubs to protect them from frost. Even without the problem of frost damage and deterioration over the winter, planting material

may be scarce for farmers who have consumed a large proportion of their cassava before winter and lost the stems of harvested plants. Generally stakes for planting are very short, less than 10 cm, because of the lack of planting material. In turn this leads to poor rates of germination, especially as rainfall is so sporadic and unreliable and the soil so sandy (larger stakes have a greater resistance to soil moisture stress; CIAT 1979 p 217-220). Sometimes the land may be furrowed from ploughing, sometimes flat, depending on the implements available to the farmer, soil texture, and the time available for preparation.

Over sixty differently named varieties of cassava have been recorded just by this survey in the study area, although some varieties have more than one name (Appendix 3). Cassava varieties are grouped by Brun et al (1985) into three types; precocious, medium and long cycle, which refer to the length of time the variety takes to reach maturity. This concept loses significance for farmers who have a limited choice of planting material and through necessity must harvest non-precocious varieties earlier than the optimum time for consumption.

Precocious or short-cycle varieties tend to mature in 6 to 8 months. Once they reach the age of a year or more their suitability for consumption declines. Medium cycle varieties take from 12 to 18 months to mature, yield better and last longer than precocious varieties, although there is a lot of variation within the broad group. Long cycle

varieties are acknowledged to take 2 or more years to mature; the most common of these, Canó, is said to improve in taste with age, and in Caaguazú 4 or 5 year old plants of this variety can be found.

For each place visited in the formal sürvey, the most important varieties cultivated are classified according to their cycle length, shown on Map 17. In many places varieties of cassava of all three types are cultivated . In Paraguarí, however, at very few places is cassava cultivated for harvesting at more than 18 months old, and most only have varieties for harvest in less than 12 months. This reflects the need to harvest cassava at an early stage for consumption amongst farmers in this department. In some parts of Paraguarí there is no seed available from later maturing varieties.

Surprisingly, in Caaguazú in the areas where cassava is produced for sale in Asunción, long cycle varieties are also uncommon. This probably reflects the greater convenience of the medium cycle varieties for sale, as it would be uneconomical to have cassava occupying land for over 18 months. Most farms in this area have some long cycle Canó, but only for consumption.

Cassava is planted during August and September. It is sown both in monoculture and as an intercrop. Most commonly it is intercropped with maize, but also with cowpea, squash, watermelon, peanuts and sweet potato. Cropping systems involving newly sown cassava are very

variable from one place to another; monoculture cassava is very common, especially in Paraguarí and in Caaguazú. In contrast, maize is usually intercropped with one year old cassava, where the crop lasts this long.

Crops such as maize which are intercropped with cassava may be planted between every row of cassava, between every other row, or only once for every 3, 4 or as many as 6 rows of cassava, depending very much on soil fertility. Cassava is usually sown in rows about one metre wide, with anything from 80 to 120 cm in between plants.

Cassava production: Weeding, inputs and production problems.

An ox-drawn carpidora (3 toothed harrow) is used by some farmers for weeding at first, but once cassava roots start to fatten this has to be done by hand. Most farmers must weed entirely by hand. In many places competition from weeds is strong, as a result of low soil fertility, and this creates a high demand for labour for weeding all crops. Some farmers maintain that cassava has a higher priority for weeding than other crops, because of its dietary importance. Where labour is in short supply (in Caaguazú particularly) cassava grown for sale is often not weeded properly. Some farmers get credit to hire labourers for weeding, apparently for the cash crops with which the credit is connected. In general labour is hired to weed cash crops, and family labour used to weed subsistence crops (Yates 1981).

Fertilizers and pesticides are not used for cassava. Stemborers (coleoptera, lepidoptera etc) and cassava hornworm (Erinnyis ello) are important pests noted by farmers (Map 18). Leaf cutting ants (ysay) are noted by Yates (1981) as a very damaging pest in Paraguay. Cassava bacterial blight causes some losses in the area, though it is largely unrecognized by farmers. After periods of intense and prolonged rainfall certain cassava varieties are susceptible to rotting, especially the more precocious ones. Because of the irregularity of rainfall, drought is another problem which may hinder germination, especially in the sandier soils. In Map 18 the areas where drought is mentioned as a problem coincide with the sandy soils of the Tebicuary valley.

Undoubtedly low soil fertility is the greatest problem for many cassava producers, not only for their cassava, which is more tolerant of poor soils, but for the other crops which form an important part in the diet, such as maize and cowpea. Farmers in the areas of poor soils acknowledge declining yields, though there are no data available which describe the rate of decline. Perhaps most importantly in the short term, organic matter is not being returned to the soil, which has a negative effect on soil moisture retention. Crops become more susceptible to the inevitable droughts which result from the irregular rainfall pattern, and crop failure results. This happened in the 1985/86 season, shortly after the survey work for this study

was completed, in much of Paraguarí and Misiones departments.

Cassava production: Harvesting, starch production and other uses

Low cassava yields are aggravated in those areas of longest settlement by the early date at which the crop is harvested (see Map 17). Farmers with least land, or who have had unexpectedly poor yields, often rely on neighbours for cassava in the last months of the year, at least until they have maize to harvest. From February onwards, when the crop is as little as five and a half months old, they begin to harvest. Yet to obtain optimum yields farmers claim it is better to wait until the crop is a year old, and begin consuming new cassava at the same time as they plant for the following year. Root quality is reported to be best when the crop is about 18 months old (medium cycle varieties). Starch content declines after winter, as new shoot growth begins, but it increases towards the end of the year. For maximum yield, and highest starch content, farmers who sell cassava never sell it before it is at least a year old, and preferably at 18 months. On the smaller farms in Paraguarí and other minifundia zones, farmers forego higher potential yield by harvesting early.

Cassava is harvested in February and March to meet another important demand, that for starch, during the Easter period. Starch is used in traditional foods, such as Chipá,

at this time. Starch is made on many farms on a very small scale to meet the requirements of the family and perhaps to sell a little. There are also some areas where starch is produced on a larger scale, near the town of Caazapá, and at M.J. Troche in Guairá, and production in these areas creates quite a large demand for cassava. Whilst local cassava is used in Caazapá, cassava is brought from quite far away to M.J. Troche, mainly from Caaguazú and eastern Guairá (See Map 19).

Starch production continues on a small scale throughout the year on many farms, but uses only small quantities of cassava. The exceptions again are the areas of larger scale production, where demand for cassava declines somewhat after Easter but is nevertheless significant throughout the year. Amongst smaller producers around Caazapá, starch production increases towards the end of the year as they attempt to raise much-needed cash. Demand and prices for starch are low at this time.

Starch production requires a certain amount of infrastructure, even for a small scale operation. A small mill or grinder, settling tanks and drying surfaces are the major pieces of equipment required. Larger fabricas (factories) consist of the same basic components and processes on a larger scale, sometimes with a motorised mill or grinder and mechanical washing and peeling of the cassava roots. The other necessity is a source of water for washing the cassava, and for the sieving and settling processes.

Cassava is fed to animals on the farm relatively constantly throughout the year, unless there is insufficient. Pigs are reared on the majority of farms as a source of cash for the difficult period at the end of the year. They consume large quantities of fresh roots, upto 15 kg per day for a large animal. Oxen and milk cows are also usually given some cassava every day, usually smaller roots, peelings and waste. The amount depends on the quantity of cassava available. No intensive animal feeding systems, such as those which are common in Itapua department and adjacent parts of Brazil, have been identified in the study area.

Sale of Cassava

Map 19 shows the markets and other destinations to which farmers sell their cassava. This confirms that Asunción is almost entirely supplied with cassava from Caaguazú. Farmers at about 20% of the survey sites sell cassava for the Asunción market. Parts of Guairá, Caazapá and Caaguazú supply the local starch industries (10% of the compañías surveyed) and in part of Cordillera farmers sell cassava to a fariña (cassava flour) factory at Piribebuy. Farmers in the rest of the area surveyed either sell cassava in the market of a local town (25% of the compañías) or just to neighbours (20%). At about 25% of the compañías surveyed cassava is not sold at all. These latter three groups are evenly distributed throughout the departments, with the exception of Caaguazú.

Cassava for the Asunción market is sold in two ways. Generally in eastern Caaguazú farmers sell cassava to an intermediary who usually owns a truck. The intermediary takes the cassava directly to the Mercado de Abasto. In western Caaguazú it is more common for farmers to hire a truck and take the harvested crop to the market themselves. Of the 33 places surveyed from which cassava is sold to Asunción, Farmers at 19 of them rely entirely on intermediaries to market the crop.

Because of the flexible harvest period, farmers who do sell significant quantities of the cassava tend to sell it when they need to raise some cash. Since intermediaries have no information about this, they have to go and look for one or more farmers who are willing to sell a quantity large enough to cover the costs of hiring a truck. Some intermediaries (camioneros) pre-arrange sales through an agent who tours the main producing zones organizing sales a few days in advance, and who hires labourers for the harvest. Post-harvest losses can thus be reduced since the intermediary can collect the cassava as soon as it is harvested and packed in sacs. Obviously, in areas where farmers have little surplus cassava, such as Paraguari, it would be too time-consuming and expensive for such a marketing system to function.

It would be a misconception to imagine that the areas where production for the Asunción market is concentrated are constantly inundated with cassava-trucks, or that sale of

cassava is constant throughout the year. Sales are better described as sporadic, and the marketing system semi-organised. One intermediary's agent explained how they work a rota of compañías or colonias throughout the year. From their point of view, then, there does exist a marketing system, which directs them to where they know they can get the quantity of cassava they require at different times of the year. The farmer will try to remain as flexible as possible, and sell when prices are highest. However, he may not be able to find a buyer. Sometimes, by necessity, he must sell at a low price.

Formal survey respondents were asked to name the months in which most cassava is sold. Their answers are summarised in Figure 2.2. From February to August sales are at a low, despite the influence of the starch market. This is probably because the supply of cassava on the farm is everywhere high at this time. 20% or less of the places report these as important months of cassava sale. From September sales increase dramatically, and peak in October, when sales are reportedly high at 50% of the places surveyed. They then decline slowly to the previous level in February. The limited data presented in Table 1.2 suggest that the quantity of cassava which enters Asunción's Mercado de Abastos declines, however, during the period from November until February. Why this should be so is explained below.

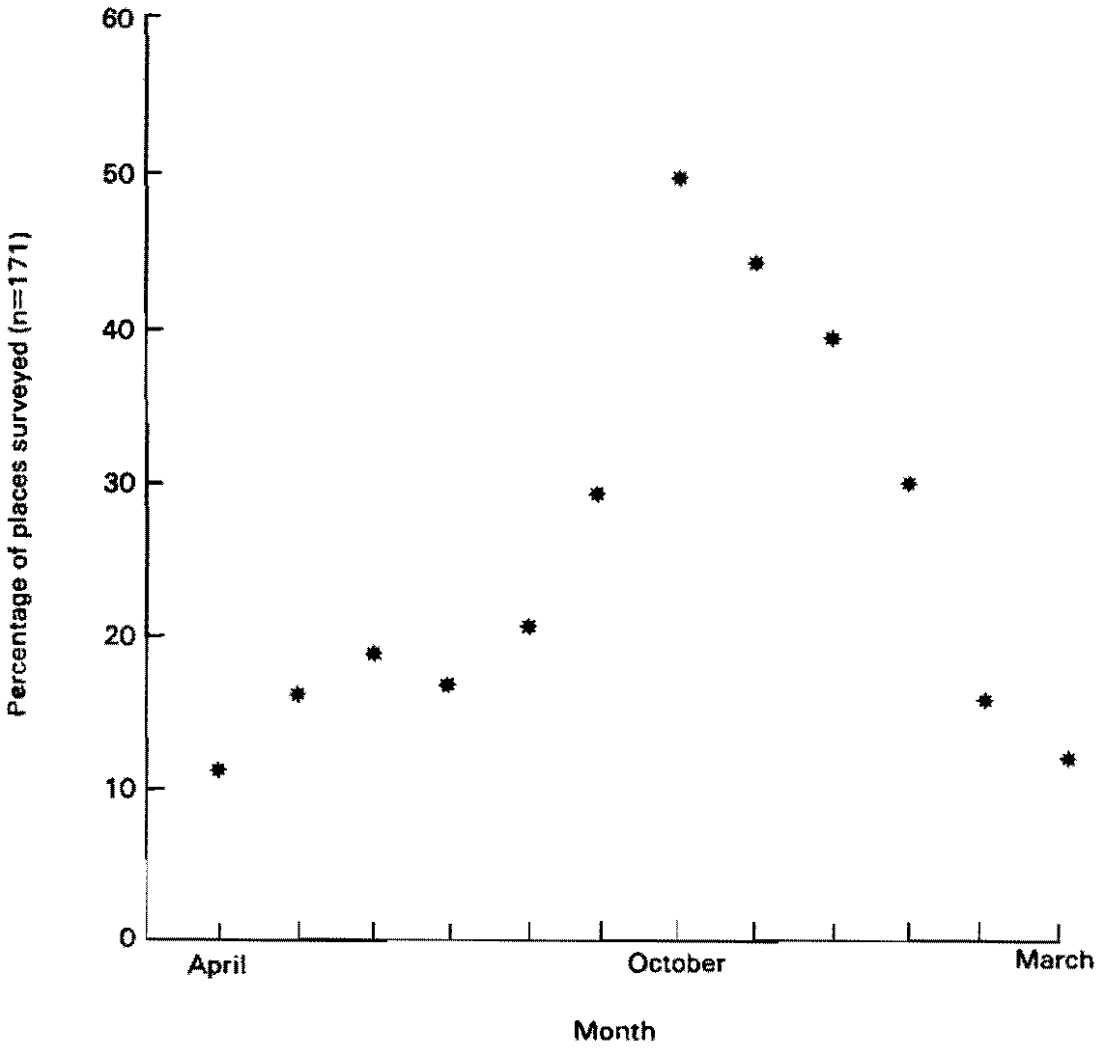


FIGURE 2.2 Percentage of places surveyed where cassava sales are important in a given month.

Supply of Cassava on the farm

The supply of cassava on many of the smallest farms reaches a low point during the months from September to February and on some runs out entirely. Farmers refer to a scarcity of cassava. Map 20 depicts areas where cassava is in short supply during this period, either for some or for the majority of the inhabitants of each compañía. Only in Caaguazú and the more recently colonized parts of Guairá and Paraguarí is this problem not experienced. If the farm size data from the survey are compared with this data, it is clear that there is an inverse relationship between farm size and the likelihood of scarcity, even using such generalized data (Table 2.8). The reasons given for this shortage of cassava in the compañías are given in Table 2.9. The three most commonly cited reasons are all related to the limited land resources which many farmers possess.

The existence of a scarcity period explains why in many places farmers report sales of cassava to neighbours. It may be that this decreased supply of cassava in rural areas affects the supply to Asunción referred to above. The months of scarcity were identified by respondents at each compañía in the formal survey. Figure 2.3 shows the percentage of places experiencing scarcity for each month of the year. The proportion peaks during the months from September to February, in the same manner as the sales curve. If we bear in mind that Figure 2.2 refers to transactions rather than the quantity of cassava sold, it

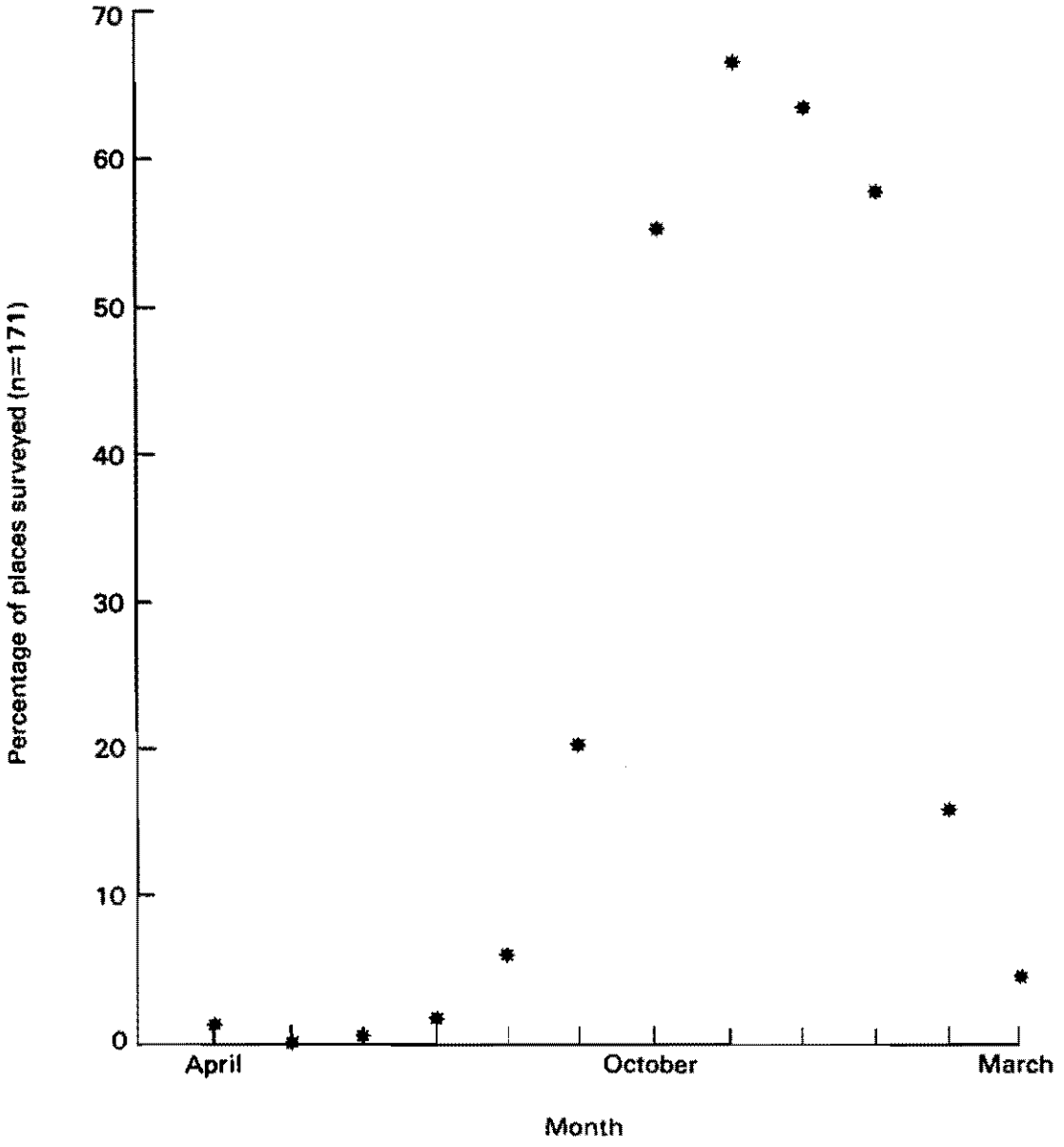


FIGURE 2.3 Percentage of places surveyed where there exists a shortage of cassava in a given month.

TABLE 2.8 Scarcity of cassava compared with most common farm size.

Cassava scarcity	Most common farm size (Ha)		
	< 3	3-7	> 7
Experienced	39	56	32
Not experienced	3	14	27

(X^2 = 21.19; 2 df, α = 0.001)

TABLE 2.9 Reasons for shortage of cassava.

Reason for scarcity	% of compañias
Lack of land	56
Harvested too early	40
Other crops preferred	22
Climatic factors etc.	6
All cassava sold previously	4

(Note that more than one answer was given in some places).

appears therefore that during the period from October to January when cassava sales are most common, most of these transactions take place between neighbours.

It is common during this period for labourers to be paid not in cash but in cassava. This is logical if one considers the subdivision of farms and remembers that the smallest farms are those which rely most on wage labour, and which are also most likely to run out of cassava. They are usually paid a number of rows of cassava per day or week's work. Theft of cassava is also common during this period, but virtually unknown for other crops.

2.3 The Form and Description of the Micro-Regions

2.3.1 Form of the micro-regions

The cassava micro-regions are shown on Map 21. Each micro-region is described in the reference table in the map pocket at the back of this report. The 1:250,000 topographic sheets for the area (Asunción, Villarrica, Pilar and Caazapá), published by the Instituto Geográfico Militar in Asunción, have been used to draw the base map. For printing, all maps have had to be reduced to 1:500,000.

2.3.2 Variables used in the definition of the micro-regions

The variables used and the role they play in defining and describing the micro-regions are shown in Table 2.10. Note that 'cultivated area' has been used at an early stage.

TABLE 2.10 Variables used in the definition and description of the micro-regions.

Variables used to define micro-regions	Variables used for definition or description	Variables used only for description
1. Climate (Homogeneous)		
2. Cultivated area		
3. Topography		
	4a. Soil texture 4b. Soil fertility	4c. Soil management (fallowing)
5. Cash Crops (number and nature)		
6a. Markets (Sale)		6b. Access
7. Cassava markets (sale)		
	8. Farm size	
		9. Land Tenure
		10. Use of fertilizers
		11. Availability of credit
		12. Length of cycle of cassava crop
		13. Cassava Cropping Systems
		14. Shortage/scarcity of cassava on farms
		15. Cassava processing
		16. Pest and other production problems

This is a necessity in much of Latin America because of the juxtaposition of minifundia and latifundia. Where possible, micro-regions should be delimited primarily according to the distribution of cultivated land. Unfortunately it is not always possible to identify this as many countries, unlike Paraguay, do not have detailed topographic (or land use) maps.

I have tried to follow a logical progression in considering the different variables which determine the form of homogeneous areas of cassava production. There are no outstanding environmental factors specific to cassava which dictate a primary subdivision of the area, (such as is the case in a similar exercise undertaken for Colombia's North Coast region). Obvious factors such as topography will effect cassava production, via soil type and the severity of erosion, but they are not specific to it. Similarly soil texture and fertility must be considered but I do not see at this stage why cassava micro-regions should be any different from, for example, maize micro-regions in the same area.

What is critical for cassava, and which does require the recognition of crop-specific areas, is the market situation. This is different for each crop found in the area, as Map 8 demonstrates. Homogeneity has been sought as far as possible (after considering climate, the location of cultivated land, topography and soils) in the number and nature of cash crops cultivated, the markets for these products, the status of cassava as a cash crop, and the markets for the crop. The pattern of cash crop production

seems to be explained well by considering access to markets, typical farm size, and soil type (texture and fertility). In some cases homogeneity of soils has been sacrificed to achieve homogeneity of the market situation and farm size within a micro-region.

The other factors described above (2.2.2) which might be considered in forming the micro-regions have been used generally as descriptors. However, once the initial form of the micro-regions has been determined using climate, topography, markets etc, these are found on the whole to be acceptably homogeneous (which is what one might expect, given causal links between the different components of the agricultural system). One or two micro-regions are nevertheless heterogeneous in almost all socio-economic factors except the cassava marketing situation (such as 23 and 24).

The significance of the form of the micro-regions, and of the factors which determine them, for cassava research and for development projects, will be discussed in Chapter 4 after a case study of cassava producers in distinctive micro- regions.

3. A CASE STUDY OF CASSAVA PRODUCING FARMS IN PARAGUARI AND CAAGUAZU

3.1 Why, Where and How?

3.1.1 Purpose of case studies

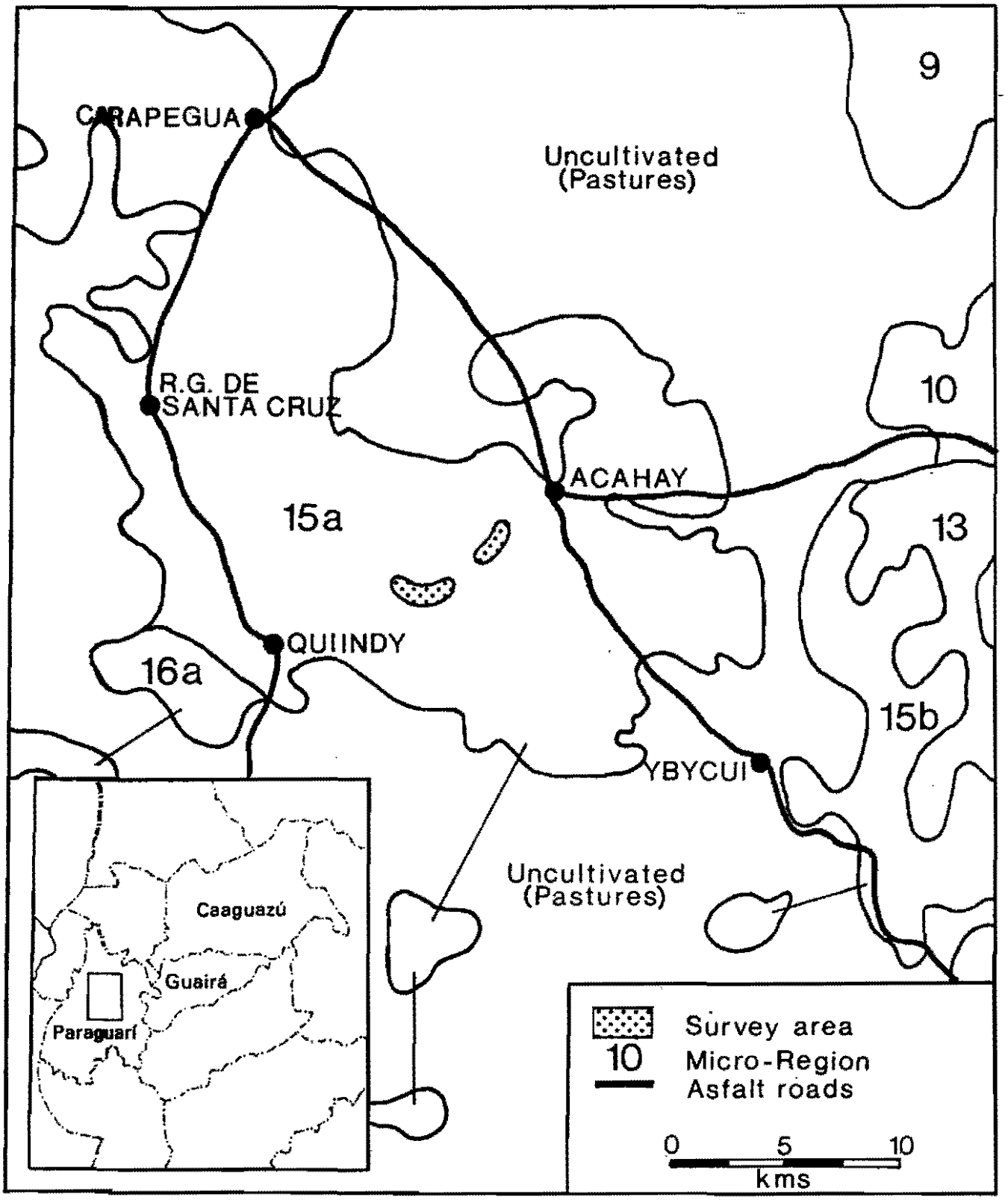
The formal survey described in Chapter 2 has identified broadly homogeneous areas of cassava production. The results of this survey and the information and questions brought to light during the informal survey pose a set of problems which need to be investigated at a more detailed level. A more probing, in-depth approach can help us to understand the differences observed between one area and another and the differences inferred between individual farms or farm types which produce cassava.

At the risk of being repetitive, the importance of cassava in the Paraguayan diet must be stressed again. Is it comprehensible that the smallest farmers in areas such as Paraguarí should forego supplies of the crop to enable them to use their limited resources of land to grow cotton and other cash crops? Does this mean that it is cheaper for them to acquire the cassava they need for subsistence from neighbours than to grow it for themselves? Why do these farmers continue to grow cash crops such as cotton, when

they get little cash profit, sometimes make losses, and feel exploited by the local cotton buying intermediaries?

How much cassava is planted on farms of different sizes, and how much is left over from one year to the next? Do there exist farms with excess land resources? What are the limitations on the amount of cassava sown on farms of different sizes? How do the answers to these questions vary between different areas such as Caaguazú and Paraguarí? In what condition are the soils on which cassava is grown, and how do these conditions vary between areas of long established cultivation and those recently deforested?

To answer these questions we need to look at how land is apportioned to different uses on different sized farms, and why this should be so. This information has been collected for a sample of farms, selected randomly, using a simple questionnaire (Appendix 4). Crop-areas have been estimated, and open-ended questions included which try to identify the rationale behind land-use decisions, and specifically the controls on the quantity of cassava on the farm (by quantity is meant the area planted to the crop, in ha. or square metres). Selected land-use data, and data on human and animal populations on each farm are given in Appendix 5. Soil samples from cassava fields have been taken to get an indication of the soil's nutrient status and texture. Information on soil management and length of time in cultivation (where applicable) has also been collected. This may explain some of the variation in fertility.

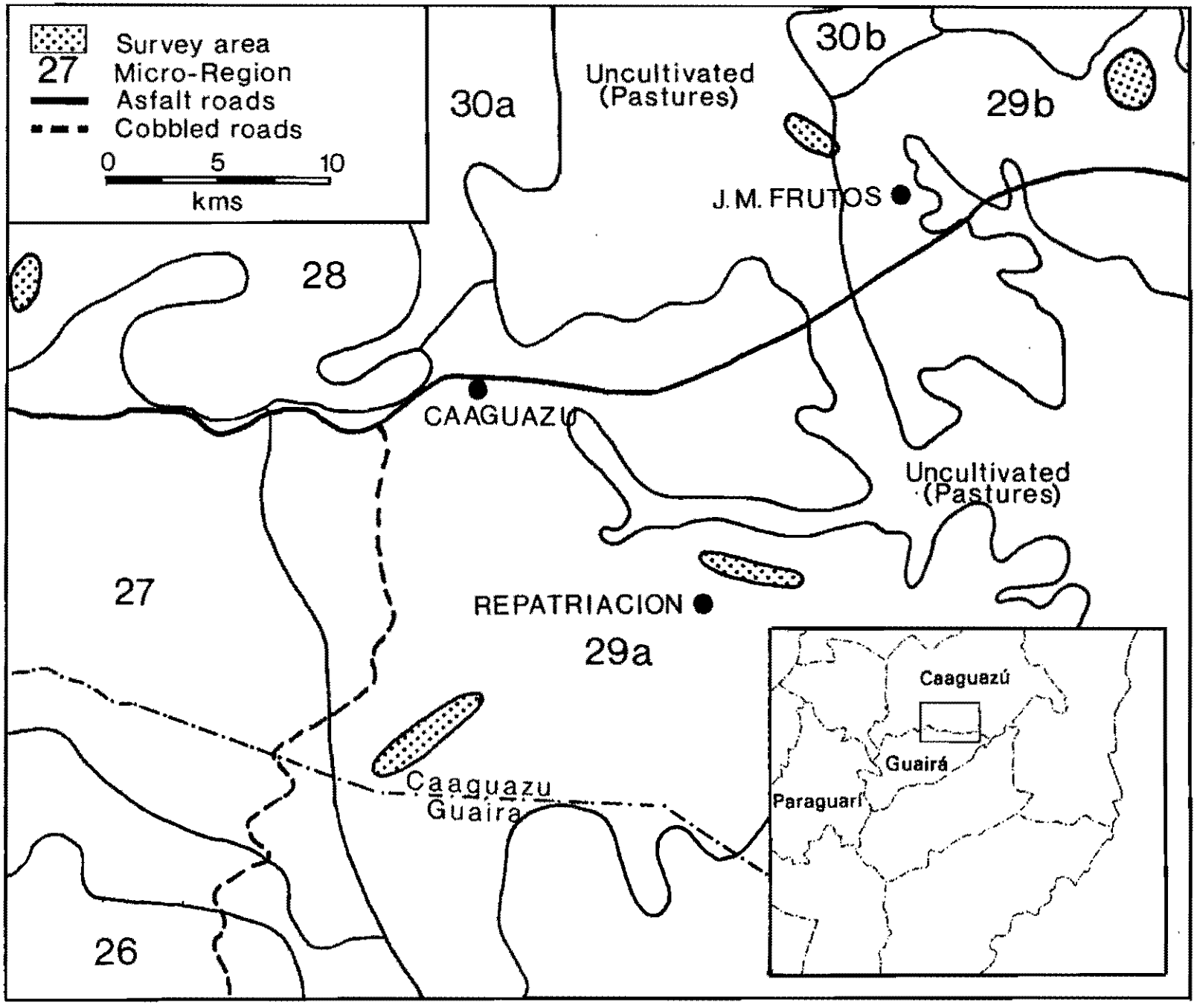


MAP 22: Survey areas, Paraguarí sample

3.1.2 Selection of case study locations and farms.

Two contrasting areas of cassava production are presented by the two departments for which the SEAG-CIAT-IDRC Cassava Project is planned, Paraguarí and Caaguazú. Within Paraguarí, an area near Acahay had been visited during the informal survey (Map 22). This area seems representative of the department as a whole, as described by Brun et al (1985). Farms are small, soils poor, and there are few alternatives to agricultural production for employment. The district of Acahay is experiencing a decline in population; from 1972 to 1982 the annual rate of decline was 0.4%, compared with an annual rate of growth of 2.5% for the nation as a whole over the same period. This decline can be attributed to rural-urban migration, and to a lesser extent to relocation of some families in new colonies, or to international migration.

In Caaguazú, the district of Repatriación was similarly chosen after being visited during the informal survey (Map 23). It consists of a number of lineas, rectilinear settlements into which the land was divided for colonization. Farms are laid out along access roads and their land extends behind for a kilometre or so; generally they have 100 or 200 m of frontage. One notable feature of Repatriación is the very sandy nature of the soils. To contrast other parts of Caaguazú with this, two other areas were chosen, one near Juan Manuel Frutos, which was considered an important cassava supplying area for the



MAP 23: Survey areas, Caaguazú sample

Asunción market, and the other nearer Coronel Oviedo, on a notably clayier soil. Whilst the choice of Repatriación was random, after the informal survey, it should be remembered that these latter two districts were purposefully chosen. Farms at these sites were of course selected randomly.

A sample of farms was selected in the field. In Acahay this was done using two methods. Firstly, farms were chosen by starting at some random point, choosing a compass bearing (from random number tables), following this for a set distance (also chosen from a random-number table), and carrying out the questionnaire at the farm where one stopped. Soon it was realized that, as all farms were visible from the access tracks, it was easier to walk along these and select the n^{th} Farmhouse, according to the random number table. In Repatriación (Caaguazú) the rectilinear settlement pattern also lent itself to this method.

Questionnaires were completed as far as possible by the author in Spanish, but often, especially in Acahay, the accompanying extension agent had to translate into Guaraní. In Caaguazú this was only necessary once or twice, or to clarify specific points.

It would have been extremely time consuming to have collected the information required about land-use by measuring the area under each crop. Nevertheless, it was possible to improve on the usual method found in Census forms and other sources, of asking how many ha. the farmer had sown of crop 'X'. Respondents were first asked how

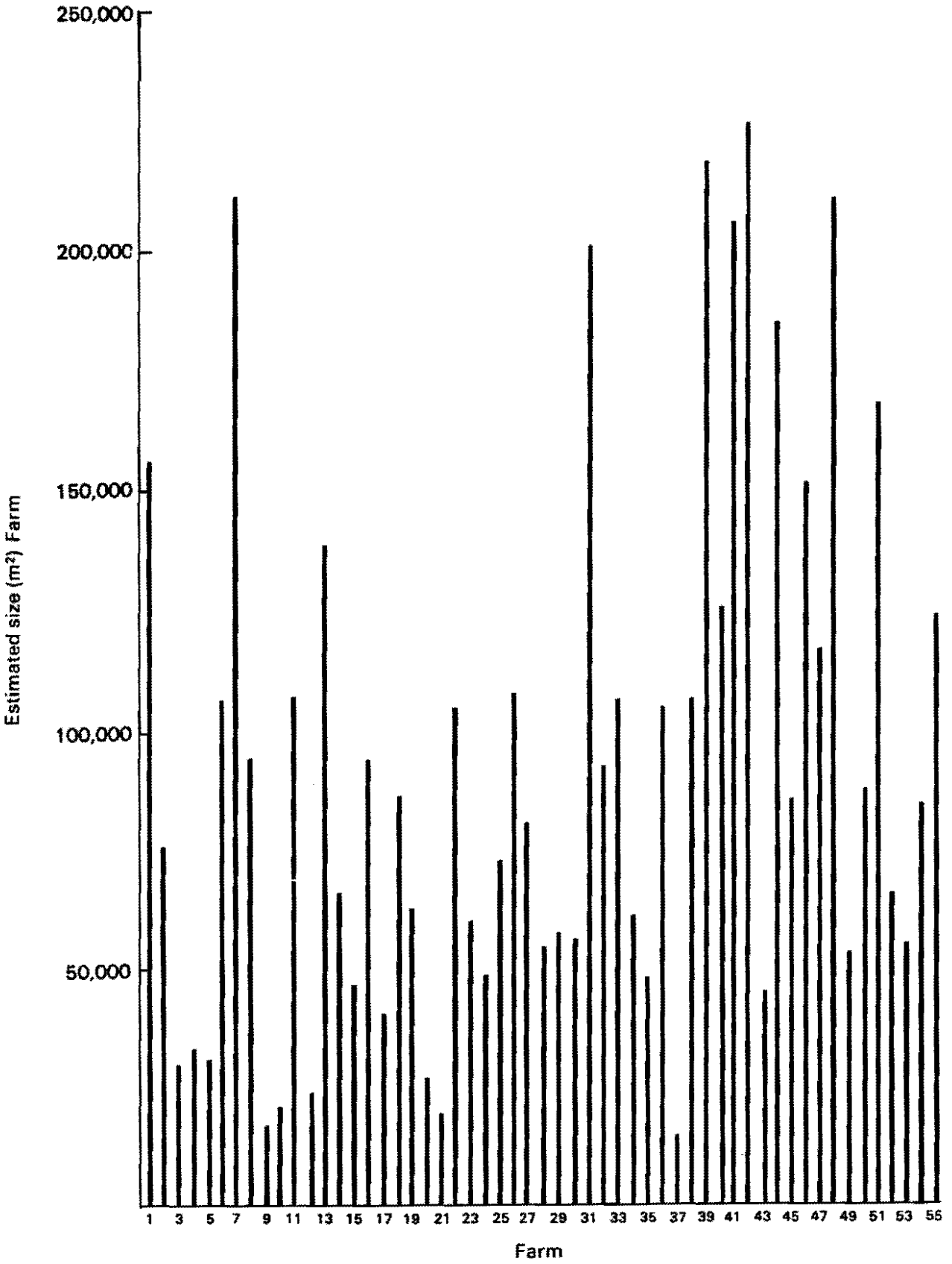


FIGURE 3.1 Estimated size of the sample of farms from Paraguarí (1-30) and Caaguazú (31-55).

large their farm was, and whether they had any other land, sharecropped, rented or borrowed from another farmer or friend. They were then asked which crops they had sown, and whether these were intercropped or in monoculture. For each crop or combination of intercrops, the area sown was calculated by asking for the number of rows sown, the approximate length of each row, and the distance between rows. Plant populations were not calculated. Where a crop was intercropped or associated with another, the number of lines per line of the other was recorded. The area of pastures (natural and sown), of forest (if any), of fallow land and the area around the house were also recorded although these were less exact. The total area was then calculated and compared to the farmers' original figure as a check. If the two were within 10% the calculation was accepted. If not, omissions were sought, or recalculations of areas made, until the discrepancy was resolved. This only had to be done on a few occasions; once or twice it appeared that the farmer's idea of the size of his farm did not accord with reality.

3.2 The Sample of Farms

3.2.1 Farm size

Questionnaires were completed for thirty farms in the compañías of Laguna Pytá, Costa Baez and Jhuguá Poí in Acahay (farms 1-30); fifteen questionnaires were completed

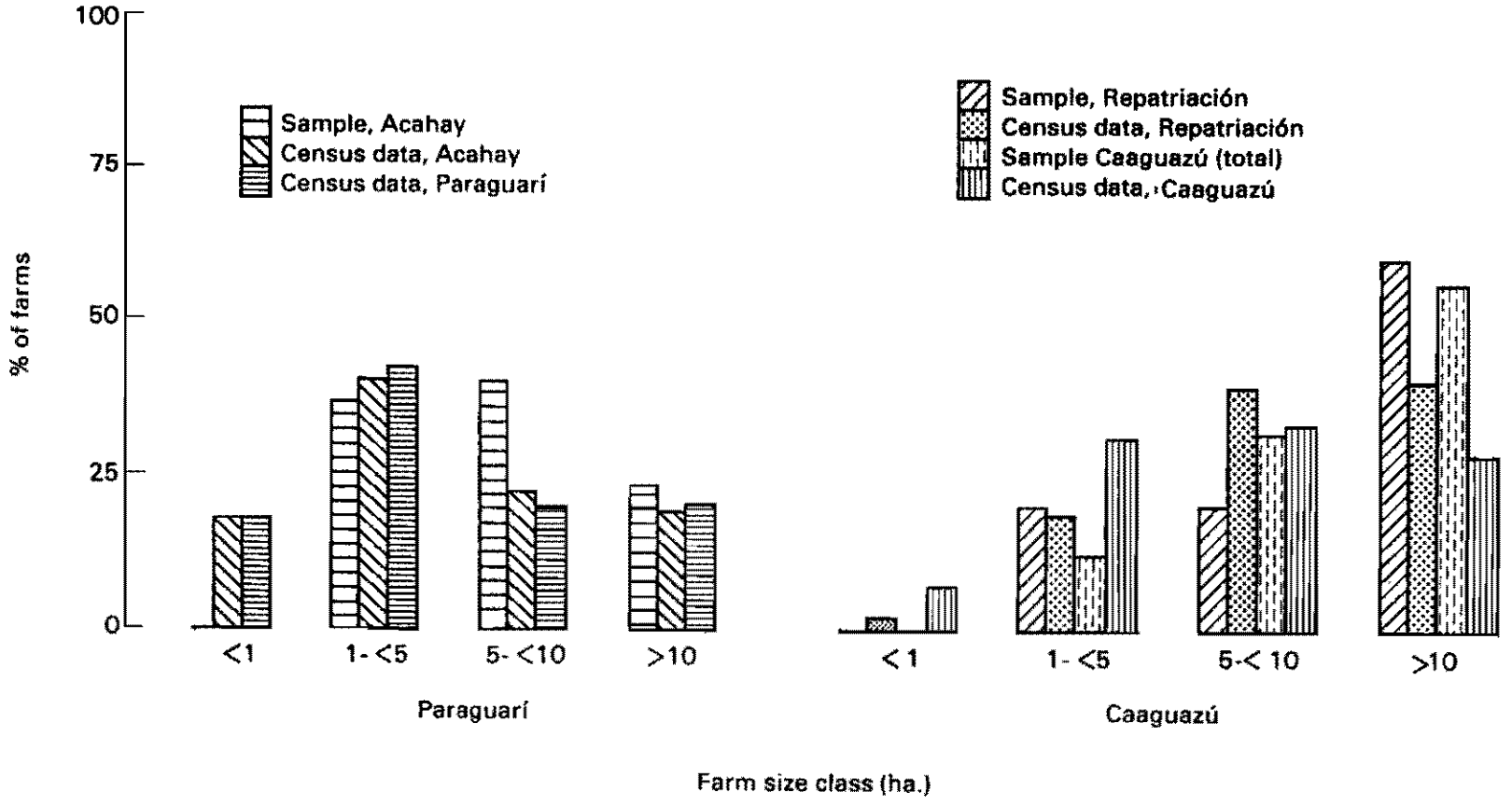


FIGURE 3.2 Distribution of sample farm size compared with census data (1981).

in Repatriación's Primera linea and Cuarta linea, seven in Juan Manuel Frutos district in Calle Santo Domingo, Calle Quinta and Ybyrá pocá, and three questionnaires in Coronel Oviedo district in Calle San Roque (questionnaires 31-45, 46-52 and 53-55 respectively).

The minimum farm size in the sample is of 1.45 ha, and the maximum of 22.7 ha. Both of these are in the Caaguazú sub-sample. The mean farm size for the sample as a whole is 9.25 ha. For the farms from Paraguarí the mean size is 7.14 ha., and for the Caaguazú farms the mean size is 11.78 ha. The size of each farm is shown in Figure 3.1.

The distribution of sample farm size is compared with the census data for the main districts from which the samples come, and for the two departments of Paraguarí and Caaguazú, in Figure 3.2. The sample data are grouped together using the same class limits used in the census. For the Paraguarí sample, the proportion of farms in the classes '1 to less than 5 ha.', and 'greater than 10 ha.', is similar to that of the census data, both for Acahay district and for Paraguarí department. The proportion of farms 'less than 1 ha.', and 'from 5 to less than 10 ha.' are under-and over-represented respectively, in comparison with the census data. The absence of farms of less than one hectare may be a result of the location of the compañías sampled. The smallest farms may be peri-urban, located around Acahay or other settlements, whereas the sample was taken from fully rural areas. Another possible explanation

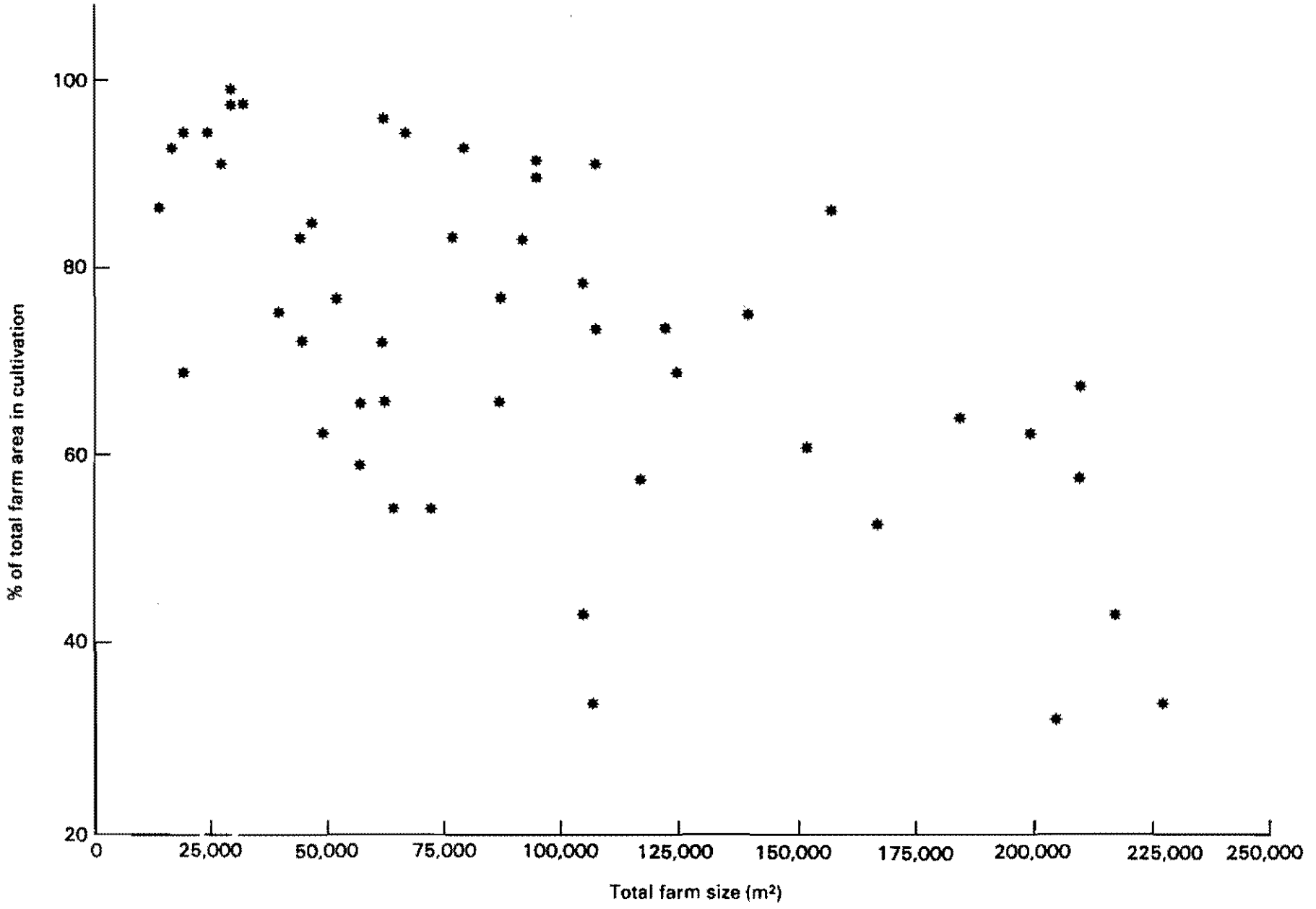


FIGURE 3.3 Proportion of farm area cultivated compared with farm size for the whole sample (55 farms).

is that the sample farm sizes refer to the total area of land worked by the farmer during the period of the survey; sharecropped, rented or borrowed land was also included in this total, whereas census data may exclude such other forms of tenure. Farms 3 and 12 (Figure 3.1) actually have less than 1 ha. which is considered the property of the owner, and either borrow or sharecrop the rest. This may also explain the greater proportion of farms in the '5 to less than 10 ha.' class, effective farm size being augmented by sharecropping or borrowing in this case as well. Unfortunately the corresponding land tenure census data to clarify this uncertainty are not available.

The Caaguazú sample is considered in two ways in Figure 3.2; the farms from Repatriación are compared with the census data for that district, and then the sample as a whole is compared with the Caaguazú census data. For Repatriación, the proportions of farms from sample and census of less than 5 ha. are about even, whereas those in the class '5 to less than 10 ha.' are under-represented, and those in the class 'greater than 10 ha.' are over-represented. This may be related to the age of the farms sampled, and the size of lot which was demarcated for colonization. Obviously in older colonized areas within the district some subdivision of farms has taken place, and in some parts original lot size is only 10 ha., whereas a third (5) of the farms sampled were still about 20 ha. The Repatriación census data show a greater proportion of farms

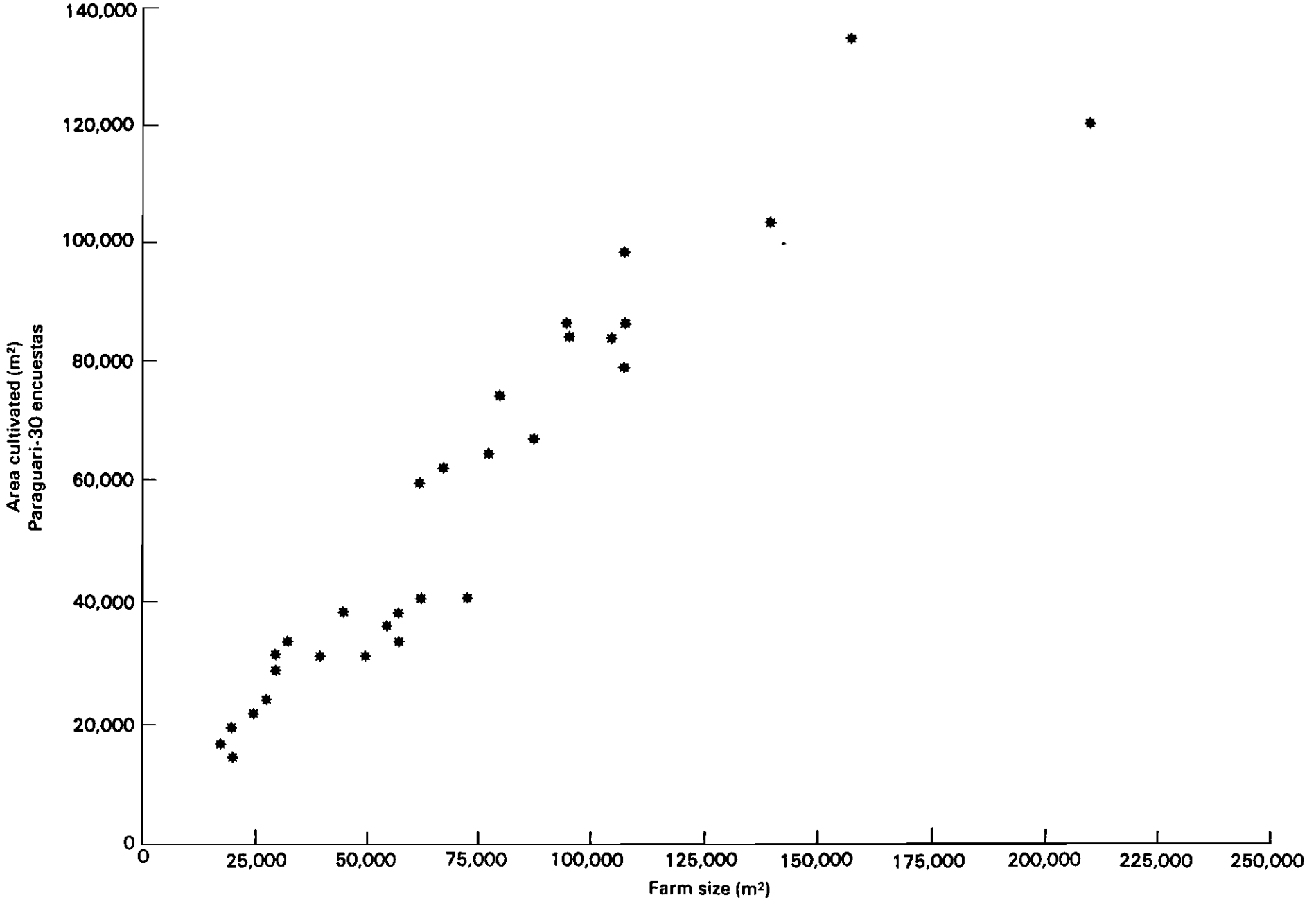


FIGURE 3.4 Area cultivated compared with farm size for the Paraguarí sample.

over 5 ha. than is found in the Department of Caaguazú as a whole. The rest of the sample data merely exaggerate further the bias towards farm greater than 5 ha in the Repatriación sample.

Figure 3.1 and the comments recorded from farmers in the Caaguazú sample are testimony to the process of farm subdivision which is now happening in Caaguazú. Farmer 35, for example, had to subdivide his land and sell to farmer 34 when his wife became ill. Farmer 37 lives on his brother's 20 ha. farm, and borrows 1 ha. or so of land. Farmer 43 is buying his lot of 5 ha. from the Instituto de Bienestar Rural (IBR), the government body responsible for colonization. The small sizes of farms 49, 52 and 53 also suggest that either the IBR is subdividing lots and creating a new minifundia outright, or that these farmers too have been forced to subdivide their land for financial reasons. The significant proportion of farms of less than 5 ha., indicated by the Caaguazú census data (nearly 40% of the total), can be expected to be found in the older colonies where the process of subdivision has had time to progress further.

3.2.2 Farm tenure

Of the thirty farms in Paraguarí, 28 (93.3%) have no title to their land, and are officially squatters. Of these, 3 (10%) augment the size of their farm by borrowing land, and 7 (23.3%) by sharecropping. One farmer has no

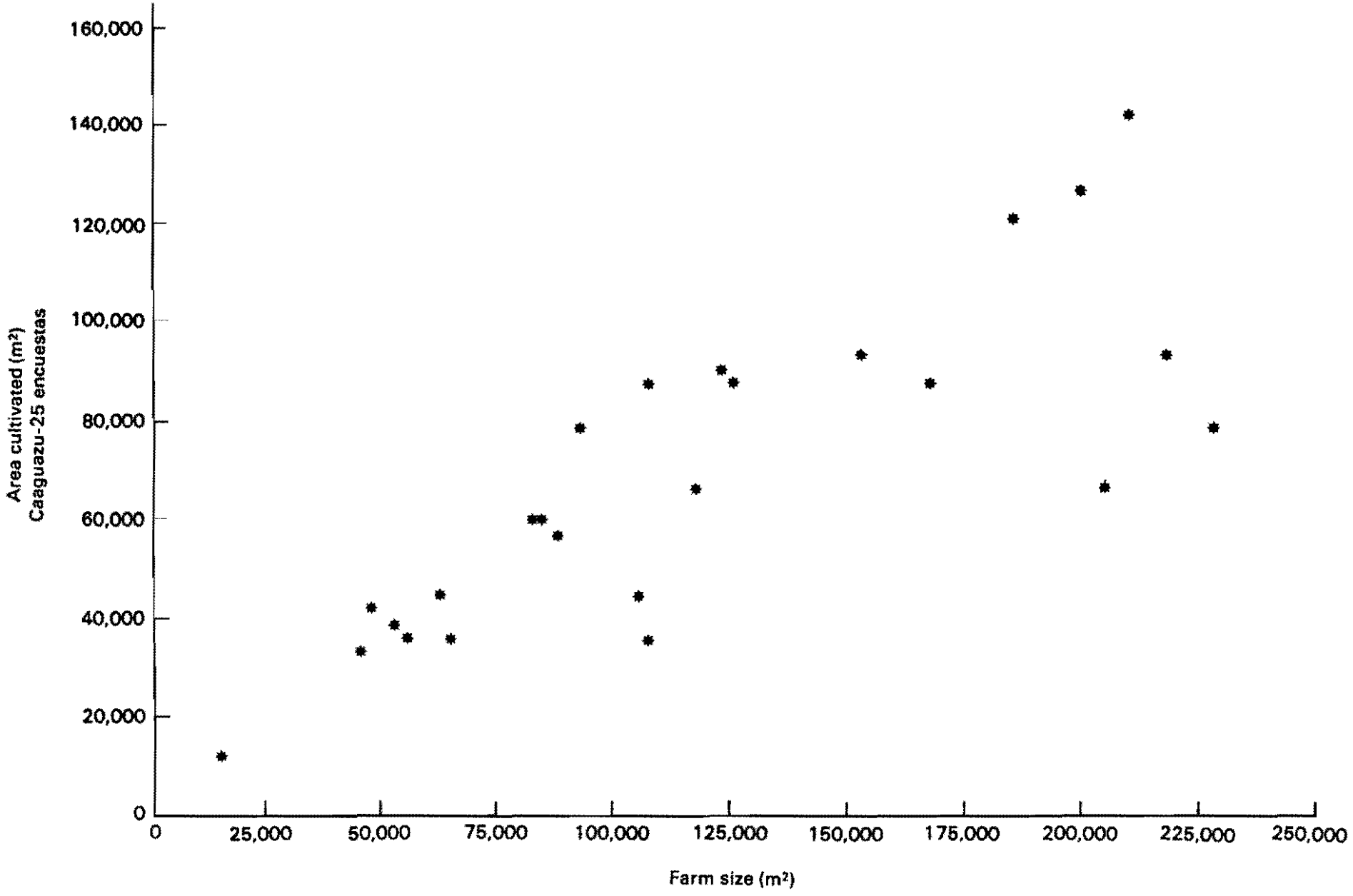


FIGURE 3.5 Area cultivated compared with farm size for the Caaguazú sample.

land and is looking after a neighbour's land; in return for this loan half of his cash crops go to the owner (in other words, he is entirely sharecropping). Only one farmer (3.3%) had a title, and only for part of his land. Although the compañías visited for this survey were not visited during the formal survey described in Chapter 2, the predominance of title-less squatters around Quiindy and Acahay is apparent from Map 14.

The farms in the Caaguazú sample show a greater variety of types of tenure. 14 farmers (56%) have a title to their land. In addition, 2 of these have more land which they have acquired by sharecropping or renting, and in one case part of the land used by the farmer was untitled. 8 farmers (32%) are currently paying for their land, one of whom also sharecrops another piece of land, and one who borrows land to increase his farm size. 1 farmer borrowed all the land he used from a relation. Tenure was not recorded at two farms. Most farmers in this sample therefore have or are in the process of acquiring title to their land.

3.2.3 Land use apportionment amongst cash crops and other uses.

Cultivated area

Figure 3.3 shows the proportion of farm area cultivated and the size of each farm. This varies from

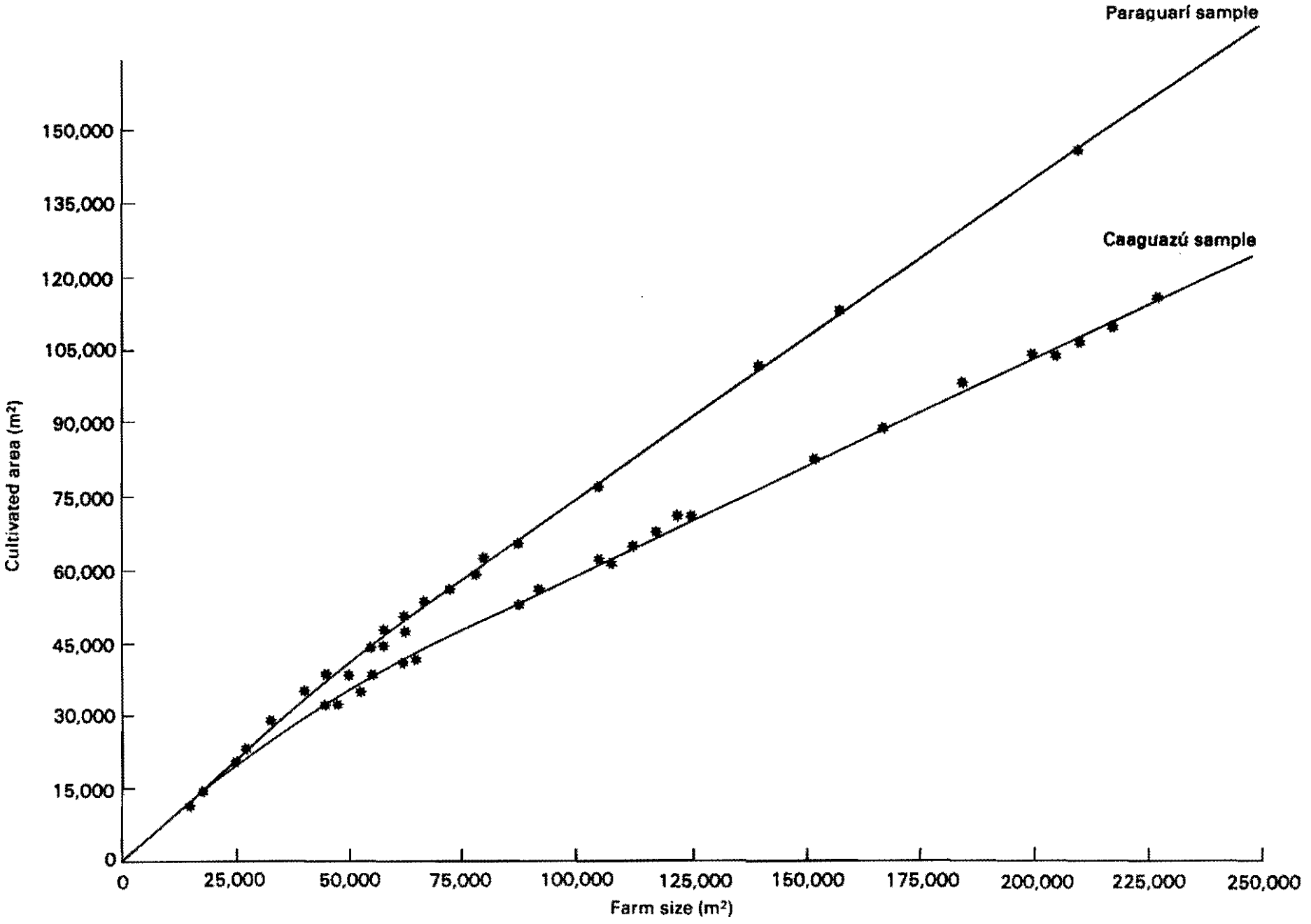


FIGURE 3.6 Fitted curves for cultivated area compared with farm size for the Paraguarí and Caaguazú samples.

32.8% to 99.0%. There is a tendency for the proportion of cultivated area to decrease as farm size increases, but there is a great deal of variation within the data set. Within the Paraguarí sample, the proportion of farm area cultivated ranges from 54.7% to 99.0%, with a mean of 81.1%; and from 32.8% to 86.1% in the Caaguazú sample, with a mean of 62.9%.

Figures 3.4 and 3.5 show the area cultivated and farm size for the Paraguarí and Caaguazú samples respectively. In the former, cultivated area increases linearly with farm size, with a slight tendency to flatten out on farms larger than 12 ha. The mean area cultivated is 5.6 ha, and the maximum 13.5 ha. In Figure 3.5 the relationship between cultivated area and farm size (the Caaguazú sample) is much more curvilinear, and there is far more variation in the data. The mean value of the cultivated area is 6.8 ha and the maximum 14 ha, figures which only narrowly exceed those of the Paraguarí sample.

By fitting a log transform to the Paraguarí and Caaguazú sample data the cultivated area can be described by the following equations:

$$y = x_1^{(0.8888)} . 0.9792645 \qquad 1$$

$$y = x_2^{(0.7899)} . 0.9792645 \qquad 2$$

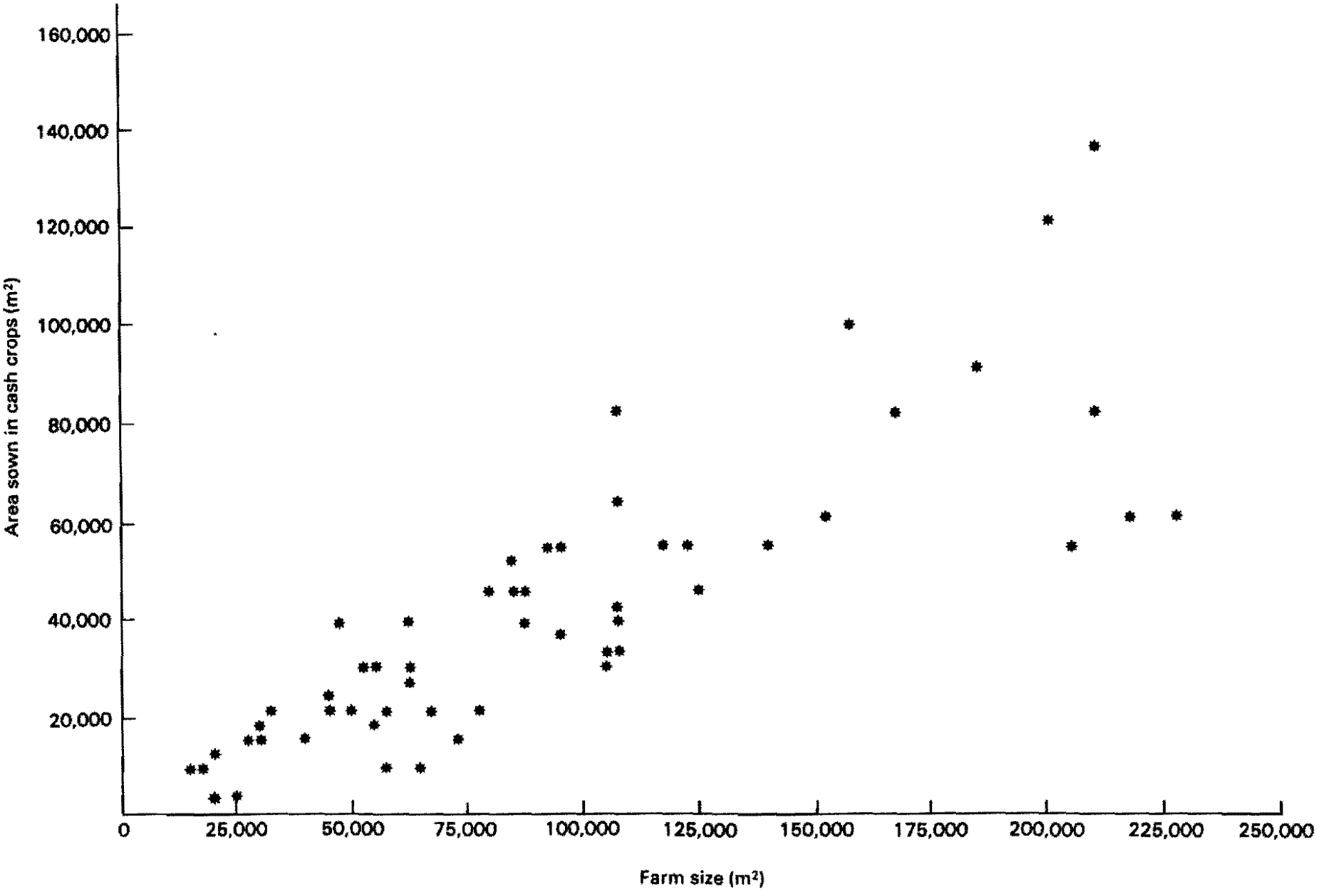


FIGURE 3.7 Area sown in cash crops compared with farm size for the whole sample (55 farms).

where y = area cultivated (ha)

x_1 = farm size, Paraguarí sample (ha)

x_2 = farm size, Caaguazú sample (ha)

The retransformed fitted values for the sample data points are shown in Figure 3.6. The two curves are significantly different (α = 0.1). Together they account for 95.78 percent of the variance in y (for the data set as a whole). As well as showing that there is very little difference between mean and total cultivated area between the two samples, the data also imply, by way of these separate curves, that a farmer in the Caaguazú sample is significantly less likely to cultivate as much of his land as a farmer with the same size of farm from the Paraguarí sample.

Proportion of the farm in cash crops

The area sown in cash crops (those designated as primarily for sale) tends to increase with farm size (Figure 3.7). The mean area in the Paraguarí sample is 3.0 ha, and in the Caaguazú sample 5.3 ha. However, the proportion of total farm area sown in cash crops is not dependent on farm size (r = 0.0745, not significant at the α =0.1 level). The proportion of farm area in cash crops varies greatly amongst farms of similar sizes (Figure 3.8). Figures 3.7 and 3.8 suggest that there are groups of farms of similar size and with a similar proportion of their total area

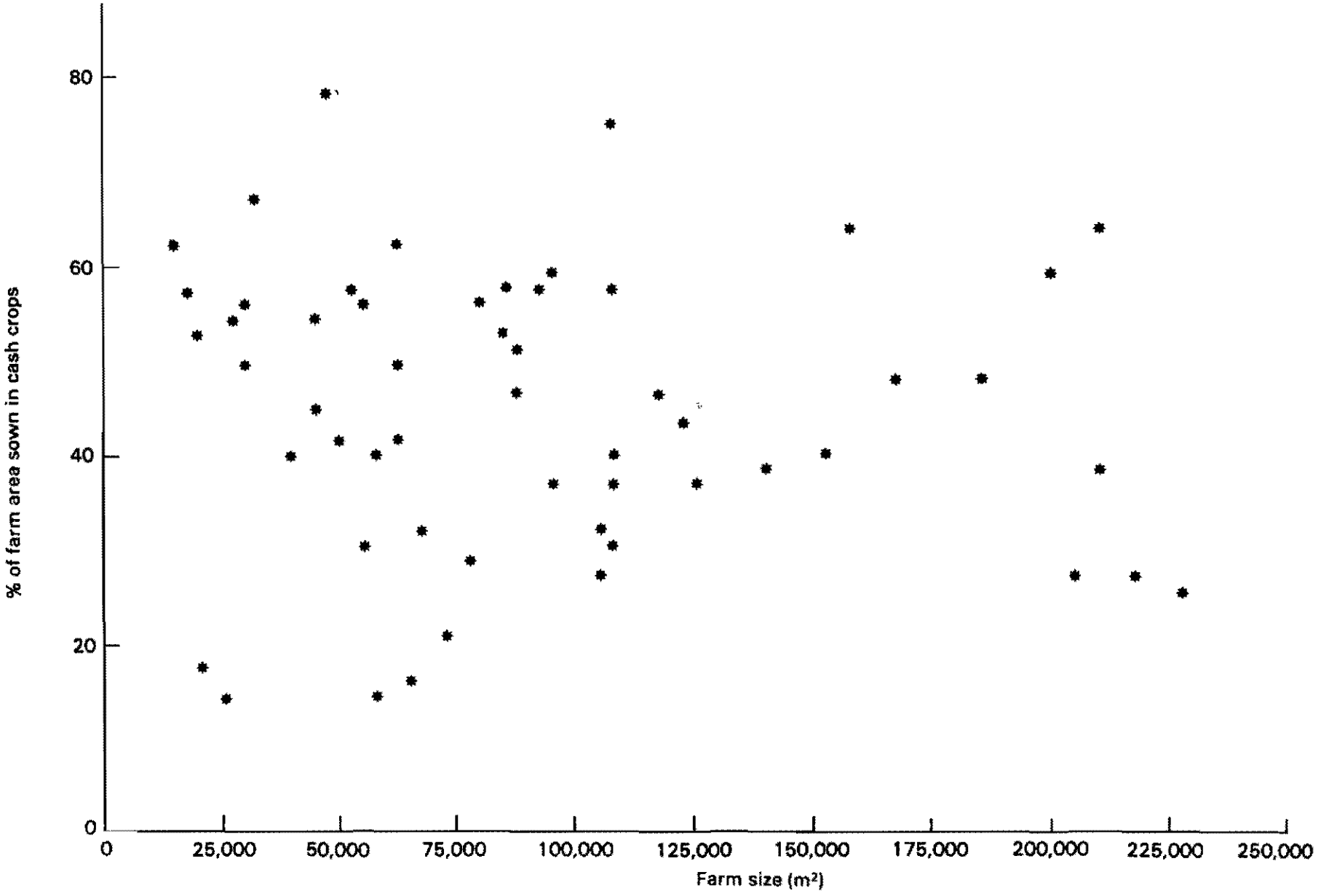


FIGURE 3.8 Percentage of farm area sown in cash crops compared with farm size for the whole sample (55 farms).

devoted to cash crops, which can be distinguished from other groups with similar size characteristics and different proportions of cash crops, or vice versa. These groups have been identified by Cluster analysis (Hierarchical Centroid; Lawes Agricultural Trust, 1984). 5 groups can be clearly distinguished at the 75% level using this technique (Figures 3.9 and 3.10). Figure 3.9 shows the range of values within each Cluster for the two variables in question.

The clustering process subdivides the farms in the following way: for farm size, whether greater or less than 15.5 ha; for proportion occupied by cash crops, whether less than 23.0%, between 23.0 and 47.5%, or greater than 47.5%. Cluster 1 consists of 5 farms, ranging in size from 15.7 to 21 ha, and with between 47.7 and 63.7% of the farm occupied by cash crops. 4 of these are from the Caaguazú sample. Cluster 2 consists of 4 farms, 3 from Caaguazú, which range in size from 20.4 to 22.7 ha, and have between 26.4 and 37.9% of their area occupied by cash crops. Cluster 3 consists of 20 farms, 14 from Paraguarí and 6 from Caaguazú, ranging in size from 4.1 to 15.2 ha, and with between 27.5 and 47.2% of their area occupied by cash crops. Cluster 4 consists of 21 farms, 11 from Caaguazú and 10 from Paraguarí. These range in size from 1.4 to 10.8 ha, with a high proportion of their areas occupied by cash crops (between 49.6 and 77.8%). Cluster 5 comprises 5 farms, 4 from Paraguarí, from 2.1 to 7.3 ha in size, and with from 14.9 to 20.6% of their area occupied by cash crops.

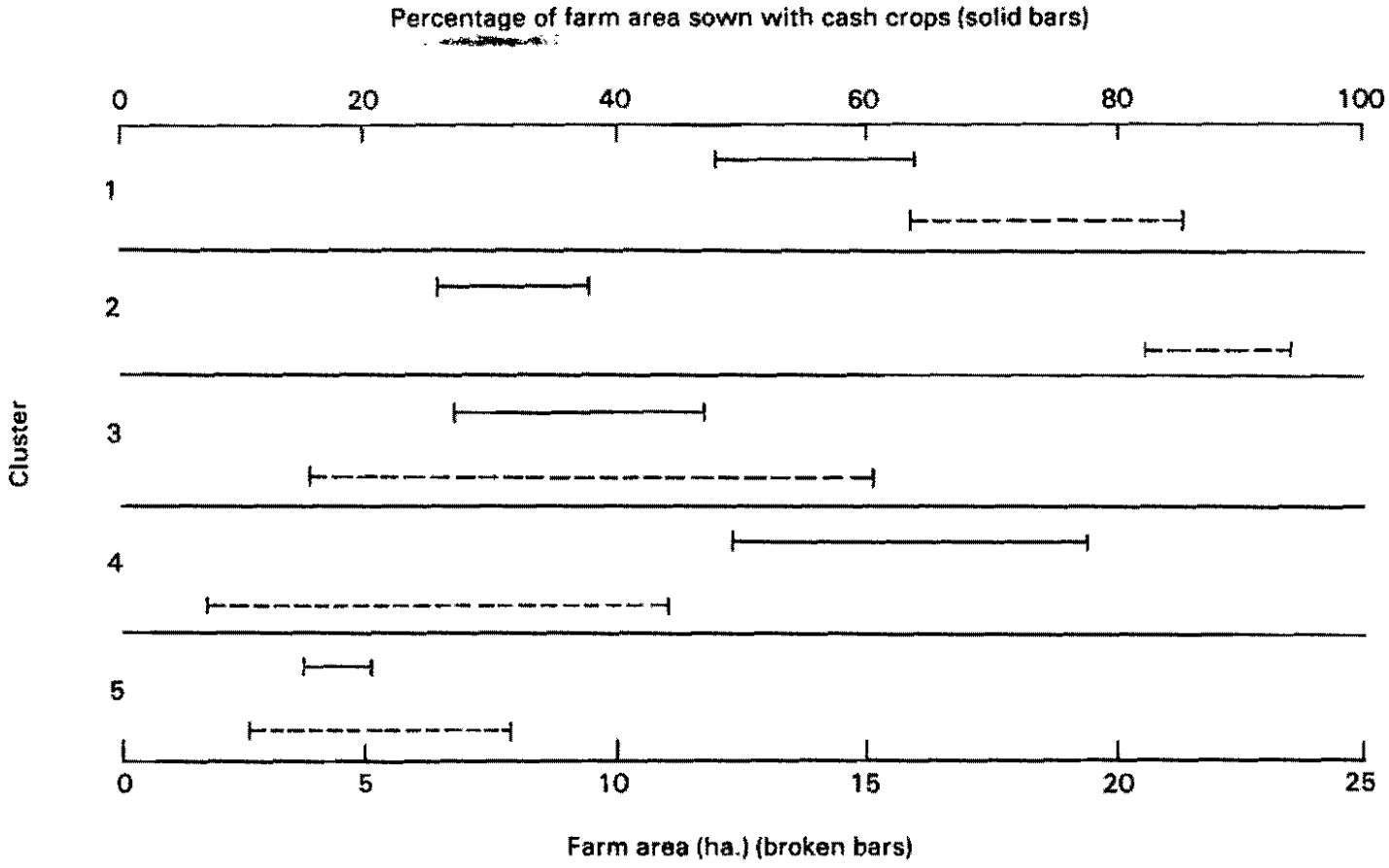


FIGURE 3.9 Range of values for the two variables "Percentage of farm area sown with cash crops" and "Farm size" within each cluster

Clusters 1 and 2 basically represent the largest farms in the sample, and consist largely (77%) of farms from Caaguazú. However, the proportion of the farm devoted to cash crops differs markedly between the two. Clusters 3, 4 and 5 contain smaller farms of similar sizes, with marked differences between each group in terms of the proportion of the farm devoted to cash crops.

Relative importance of cash crops in the two samples

Cotton is by far the most important cash crop on the farms of both samples, being present on all of those in the Paraguarí sample and 24 (96%) of the Caaguazú sample (Table 3.1). Sugar is the second most common cash crop on the Paraguarí farms (present on 50%), but in Caaguazú is replaced by cassava (grown specifically for sale on 64% of the farms). Only one farmer from the Paraguarí sample plants cassava for sale, but this is grown on sharecropped land in Caaguazú (Farm 24; ironically this farmer had none for subistence in Paraguarí). Castor oil is grown on a greater proportion of farms (32%) in the Caaguazú sample than sugar cane (grown for sale on only 16%). Castor oil is only grown for sale on 2 farms (7%) in the Paraguarí sample, although a few plants are generally scattered around most farmhouses. Other cash crops grown in the Paraguarí sample are Tomato (1 farm), Cowpea (2 farms), Peppers (1 farm) and Maize (1 farm), 17% of the total number of farms. In the Caaguazú sample 3 farms grow tomato, 2 grow onions, 2 grow

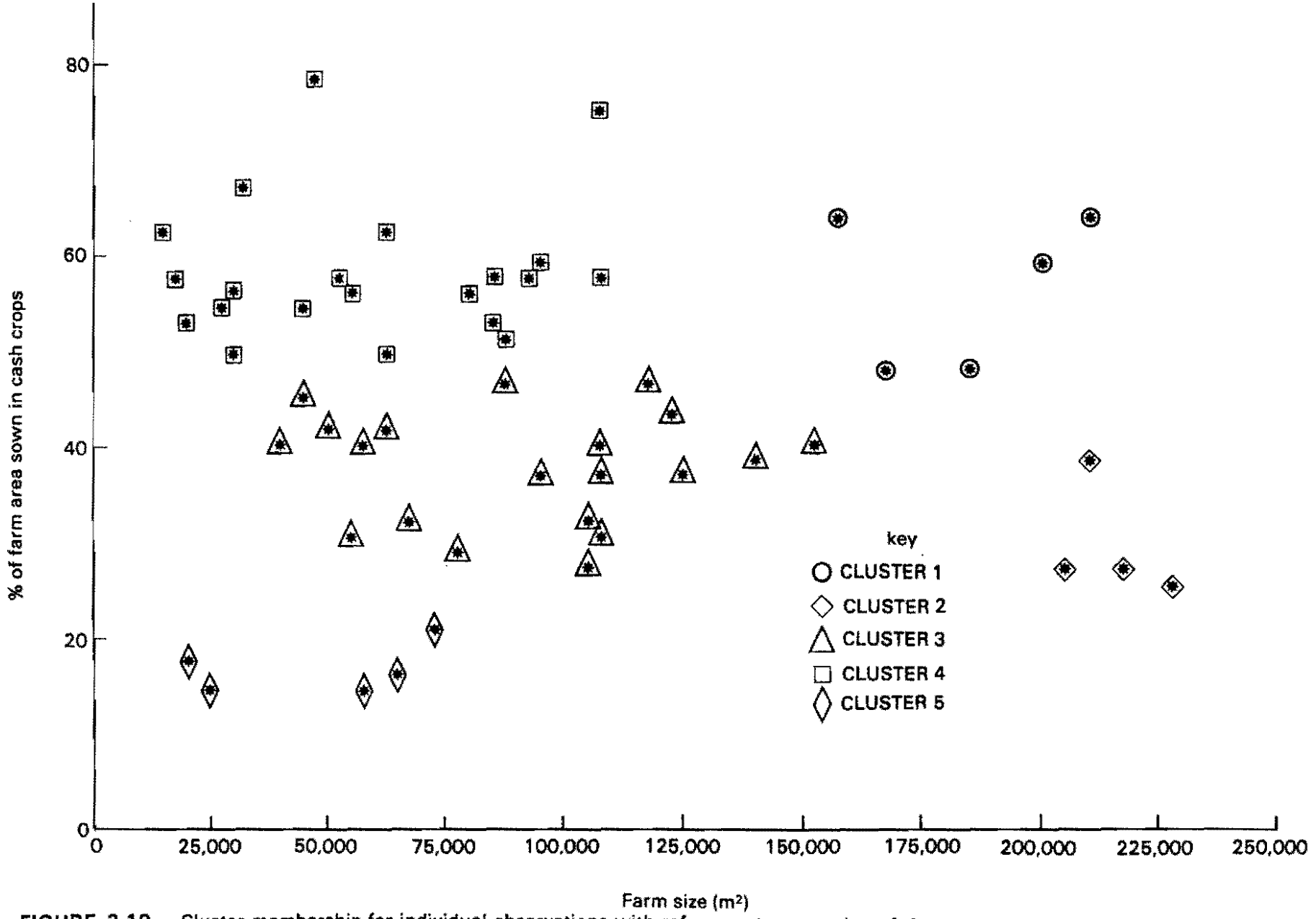


FIGURE 3.10 Cluster membership for individual observations with reference to proportion of farm area in cash crops and farm size.

TABLE 3.1 Crops grown primarily for sale (cash crops).

C R O P	PARAGUARI SAMPLE		CANGUAZU SAMPLE	
	No. of farms	%	No. of farms	%
Cotton	30	100	24	96
Sugar cane	15	50	4	16
Cassava	1	3	16	64
Castor oil	2	7	8	32
Tomato	1	3	3	12
Onions	-	-	2	8
Other horticultural crops	1	3	2	8
Maize	1	3	1	4
Cowpea	2	7	-	-
Fruits (Banana, orange, grapes)	-	-	2	8

(Note that many farms have more than one cash crop).

other horticultural crops and fruits (peppers, squash, banana, oranges) and one grows maize. Maize is generally grown only for subsistence in both areas.

Twelve farms (40%) in the Paraguarí sample have only one cash crop, cotton. 15 farms (50%) have 2 cash crops, and 3 farms (10%) have 3 cash crops. In addition, mention should be made of the abundance of cocotero trees in the fields of the farmers of this sample. Many collect and sell cocotero fruits when they ripen in December. Of the farms in the Caaguazú sample, only 4 (16%) have one cash crop, ten (40%) have 2 cash crops, six (24%) have 3, and five (20%) have 4 or more.

Reasons for preference for the different cash crops

Farmers were asked to name their preferred cash crops, and give their reasons (Table 3.2). 19 farmers (63.3%) in the Paraguarí sample prefer cotton to other crops, 5 prefer sugar cane (16.7%), and the remaining 6 farmers (20%) indicated that both crops offered them advantages. Of the farmers in the Caaguazú sample, 9 (36%) prefer cotton to all else, 7 (28%) prefer cassava, and 3 farmers (12%) see advantages in both these crops. 2 farmers prefer cassava and maize or castor oil, and 2 prefer cotton with sugar cane, banana, or onions.

The reasons for preference for these crops are given in Table 3.3. Within the Paraguarí sample, the importance of cotton to the farmers questioned hinges on the fact that

TABLE 3.2 Cash crops preferred by farmers in the two sample areas. Paraguarí. n = 30. Caaguazú n = 25.

C R O P	PARAGUARI SAMPLE		CAAGUAZU SAMPLE	
	No. of farmers	%	No. of farmers	%
Cotton only	19	63.3	9	36
Sugar-cane only	5	16.7	-	-
Cotton and sugar-cane	6	20.0	-	-
Cotton, sugar cane and banana	-	-	1	4
Cotton and onion	-	-	1	4
Cassava only	-	-	7	28
Cassava and cotton	-	-	3	12
Cassava and maize	-	-	1	4
Cassava and castor oil	-	-	1	4
Horticultural crops	-	-	2	8

TABLE 3.3 Reasons given for preference for chosen cash crops: % of farmers questioned (Paraguarí n = 30, Caaguazú n = 25).

Reason given for Preference	SAMPLE AREA PARAGUARI		CAAGUAZU			
	CROP					
	Cotton	Sugar Cane	Cotton	Sugar Cane	Cassava	Others
Credit available	43.3	6.7	8.0			
Guaranteed market	16.7	16.7	16.8		4.0	
Higher prices/income	20.0		12.0		4.0	4.0
Short harvest cycle	10.0					8.0
Gives a large return all at once, to pay off debts			24.0			
Fewer input costs and lower labour requirements (than cotton)		13.3		4.0	36.0	12.0
Soils too poor for other crops					4.0	

Note that some farmers grow more than one cash crop, and some give more than one reason for preference.

they can get credit for inputs and more importantly to meet cash expenses (and amongst the poorest, buy food) at the critical period in their agricultural calendar. Relatively high prices compared with the few alternatives they have, a guarranteed market, and the short harvest cycle which allows them to replant the following spring or sow some winter vegetables, are other advantages the crop offers. Credit availability appears to be less important for sugar-growing farmers, although a guarranteed market (local sugar-syrup factories) is important. Significantly, some farmers (with farms of from 5.6 to 10.8 ha) find the lower input and lower overall labour requirements of sugar to be an advantage over cotton. Cotton, rather than sugar, tends to be favoured by the smallest farmers; only one of the 14 farmers with less than 5.0 ha grows sugar as a cash crop, although some have small quantities for animal feed.

Returns per hectare are theoretically larger for cotton than sugar, but the prices paid by local middlemen are usually set when credit is taken, and often are lower than the official prices at harvest (if higher, the buyer may lower it). Credit rates offered by intermediaries or other money lenders, quoted by farmers during interviews, lie around 30-40% annually, and seed prices, as well as those of chemical products via intermediaries are well above official or retail levels. Few farmers expect to make money on their cotton crop, unless they have enough land to sow 2 or 3 ha. The real reason for the preponderance of cotton is

the fact that credit can be acquired, which is necessary for survival for the smallest farmers (8 out of 13 that quoted credit availability as the reason for their preference have less than 5 ha of land) and to pay for the hire of labour for the larger farmers. On the smallest farms there is no alternative source of cash.

Both credit and fertilizer use within the Paraguarí sample are associated with cotton production; without some form of credit many farmers would not be able to cultivate the crop. 26 (86.7%) of the farmers in the sample had received some form of credit at the time of the survey, 8 from official sources ('Credito Agricola de Habilitación), 14 from intermediaries and 4 from other private sources or family. 24 of these used it to buy cotton seed for planting, as well as for other household needs. Only 3 farmers in the Paraguarí sample used any kind of chemical fertilizers, all having bought foliar nitrogen for cotton. One had bought this with credit.

Within the Caaguazú sample, of the reasons given for preference for cotton as a cash crop, the nature of the cash flow associated with that crop is the most important reason for the farmers who grow it. 6 farmers, all in the same area of Repatriación district had outstanding debts with the Instituto de Bienestar Rural (IBR) for their land, and the large sums of dinero junto (money all at once) that they receive from cotton allow them to pay off portions of their debts. As in Paraguarí some farmers see the guarranteed

market as an advantage, but credit availability was only considered an advantage by two farmers. 19 farmers (76%) received credit, 3 from official sources (CAH, Ministry of Agriculture, and Farmers' Cooperatives), 8 from intermediaries, and 8 from money lenders or family. All 19 used part of this money to buy cotton seed, but a higher proportion than in Paraguari, 16 farmers (64%), also bought insecticides or foliar nitrogen for the cotton crop. The significance of this is that, whilst cotton is grown by almost all the Caaguazú farmers, they do not depend on it as a source of credit at a critical time as do many of the farmers in the Paraguari sample. Instead they perceive other advantages, as suggested in Table 3.3.

The main reasons favouring cassava (and some of the other crops, such as onions) as a cash crop quoted by the Caaguazú farmers are the lower inputs required to cultivate it (chemical fertilizers and insecticides) and its lower labour requirements, in comparison with cotton. Nevertheless, on 16 of the farms (64%) of the Caaguazú sample, there is more land planted to cotton than to cassava. This suggests that the higher incomes which can be derived from cotton make it the first choice as long as labour is not limiting. Cassava, hence, becomes important to a farmer when he does not have enough labour at his disposal, or cannot purchase more, to plant more cotton. Obviously by growing cassava as well as cotton, farmers can spread their risks more.

An added advantage of cassava, though not one mentioned by any of the farmers, is the fact that it can be sold during periods of cash scarcity. The results from the survey described in Chapter 2 indicate that in Caaguazú, as elsewhere, cassava sales (events, rather than absolute quantities) are more numerous during the months of September to February. In both the Paraguarí and the Caaguazú samples farmers were asked whether they had sold cassava within the last year, and if so, how much, at what price and what the destination of the cassava was. Only one farmer in the Paraguari sample had done so (800 kg). 12 farmers in the Caaguazú sample had sold cassava within 12 months of the survey (October/November 1985). These sales are detailed in Table 3.4. Of 24 transactions, 50% took place between August and October. 3 other farmers indicated that they were about to sell cassava. It appears that the ability to sell cassava at this time reduces farmers' dependence on the availability of credit for cotton, and accounts in part for the lack of importance attested to it by the farmers from Caaguazú in comparison with the farmers from Paraguari.

The reasons given by farmers in the Caaguazú sample for preference for cassava indicate that these farmers do not have the cash or labour resources to cultivate all of their land in the intensive way required for cotton. Cassava requires less weeding once the canopy closes, and no purchased inputs. The other way of looking at this problem is that there is a ceiling to the the amount of land a

TABLE 3.4 Sales of Cassava amongst farmers of the Caaguazú sample

Farm	Date	Quantity (kg)	Price (gs/kg)	Destination
38	12-84	5,000	7.0	Starch Producer, M.J.Troche
51	02-85	6,800	10.0	Mercado de Abasto, Asunción
35	03-85	2,000	12.0	Mercado de Abasto, Asunción
51	03-85(x2)	16,900	9.0	Mercado de Abasto, Asunción
47	04-85	60,000	12.0	Mercado de Abasto, Asunción
35	06-85	2,000	5.0	Mercado de Abasto, Asunción
44	06-85	2,000	4.0	Mercado de Abasto, Asunción
50	06-85(x2)	20,000	10.0	Mercado de Abasto, Asunción
47	07-85	8,000	8.5	Starch Producer, M.J.Troche
50	07-85	10,000	6.0	Mercado de Abasto, Asunción
33	08-85(x3)	30,000	6.0	Mercado de Abasto, Asunción
34	08-85	11,000	6.0	Mercado de Abasto, Asunción
34	08-85	10,000	7.0	Mercado de Abasto, Asunción
48	08-85	28,000	5.0	Mercado de Abasto, Asunción
31	09-85(x3)	24,000	5.0	Mercado de Abasto, Asunción
37	09-85	2,000	5.0	Mercado de Abasto, Asunción
43	09-85	12,000	5.0	Starch Producer, M.J.Troche
31	10-85	12,000	7.0	Mercado de Abasto, Asunción

farmer can cultivate using family labour, limited cash resources (limited amounts of hired labour) and a plough and oxen. The largest cultivated area on the farms of the Caaguazú sample is 14.0 ha. If we refer back to Figure 3.6, and the fitted curves for cultivated area and farm size, then given that agricultural technology is the same in the two areas, it would appear that labour is more costly in the Caaguazú area. That is not to say that seasonal labour shortages do not occur in Paraguarí. Rather, labour is relatively more abundant there than in Caaguazú because of differences in average farm size, and in spite of high rates of emigration.

The differences in farm area cultivated between the samples, shown in Figures 3.4 and 3.5, are therefore reflections of the differences in labour scarcity or cost. Whilst soil fertility is obviously greater and a determinant of higher productivity on the Caaguazú farms, there is no reason why this should influence the area cultivated given that the basic crop mix and agricultural technologies of the two areas are the same.

Underutilisation of land

Each farmer was asked whether or not he utilised all the land comprising his farm, and if not, why. Of the farms in the Paraguarí sample, only 7 (21%) have any land in fallow, and the maximum area is only 2.0 ha. Only four farms (13%) have secondary forest, all less than 1.0 ha.,

which provide firewood. 19 farms (62.7%) have either natural or planted pasture, but only 2 have more than 2.0 ha.; of these one has 9 ha. but cattle raising is considered as an important part of the farm's activities. None of the 30 farmers felt that he had unutilised land.

Of the farmers in the Caaguazú sample, 13 (52%) do not feel that they have unutilised land. 9 of these have less than 10 ha; the largest is of 15.2 ha. Two of these 13 farms have 2.0 ha. of fallow, and one has 1.0 ha. Six have either natural or sown pastures, three of which have 3.0-4.0 ha, the others 1.0 ha. or less. None have more than 1.0 ha. of forest, which is used for firewood, and none have more than 2.0 ha. of forest and fallow land combined. Referring back to the clusters (Figure 3.8), three of the largest four of these farms (farms 36, 46 and 55) belong to cluster 3, nine belong to cluster 4 (Farms 32, 33, 34, 35, 37, 43, 45, 49, 50) and one to cluster 5 (Farm 52).

The remaining 12 farms vary in size from 5.6 ha. to 22.7 ha. Their owners all feel that they have underutilised land, and that they cannot use it because of a lack of economic resources, in other words cash to hire labourers. These farms have variable quantities of uncleared forest within their boundaries, and some also have significant amounts of land which has been cleared and left in fallow (Table 3.5). When totalled, the quantity of unused land varies according to farm size, as is apparent from

TABLE 3.5 Land not used for crop production on farms whose owners feel they have underutilised land (Caaguazú)

Farm	Cluster	Total Size (Ha)	Area in Fallow (Ha)	Area in Forest (Ha)	Total Unused (Ha)	Total Unused %
42	2	22.7	2.0	8.0	10.0	44.1
39	2	21.8	0.0	8.0	8.0	36.7
41	2	20.4	13.0	0.8	13.8	67.6
48	1	21.0	0.0	6.0	6.0	28.5
31	1	20.0	1.0	4.5	5.5	27.5
44	1	18.5	4.0	2.0	6.0	32.4
51	1	16.7	0.0	6.0	6.0	35.9
40	3	12.6	2.0	2.0	4.0	31.7
47	3	11.6	3.0	0.0	3.0	25.8
38	3	10.6	2.5	1.5	4.0	37.7
54	4	8.5	0.0	2.0	2.0	23.5
53	4	5.6	0.3	1.5	1.8	32.1

Table 3.5. Since the total of unused land is dependent on the total of cultivated land, these data mirror the cluster groupings, but in doing so highlight the relative unimportance of pastures on these farms. Only two have more than 2.0 ha, and four have no area in pastures.

With the exception of farms 53 and 54, these farms are all larger than 10 ha. Only two farms (farms 46 and 55) of the previous group, where no land is unutilised, are larger than the smallest farm in this group (Farm 38 with 10.6 ha) if 53 and 54 are excluded. Given that farms 53 and 54 have 2.0 ha or less of unutilised land, they cannot be distinguished from farms of the first group and the exclusion appears to be valid. There is, then, little overlap between the two groups, and the boundary between them lies around 10 to 11 ha.

Lack of labour, or lack of capital to hire labour or acquire a tractor, instigates an unintensive production system on many of these larger farms. Soil fertility is not managed to maintain or increase yields, and when these begin to decline more forest is cut down and the cultivated land left in fallow for a year or two. Purchased inputs are used only for cotton and in some vegetable producing areas. On the sandy soils of Repatriación, foliar nitrogen is often used so that the plants can develop quickly enough to resist periods of water-stress. Otherwise the only inputs are man and animal power.

3.2.4 Inhabitants and population of Cassava-consuming animals.

On each farm the number of inhabitants was recorded, and farmers were asked to indicate how many animals and of which kinds consume cassava on the farm. These data are given in Appendix 5, and are used in the next section to explain the area occupied by cassava.

The average number of adults and children per farm are 2.9 and 4.1 for the Paraguarí sample, and 4.2 and 3.4 for the Caaguazú sample. In the latter case, there were higher than average numbers of adults on almost all of the farms whose owners do not cultivate all their land because of shortage of labour (Table 3.5). The difference distinguished between adults and children may not be significant in terms of the amount of work each does on the farm. Nevertheless, the higher average number of persons (or adults) per farm in the Caaguazú sample contradicts the differences in cultivated area between the two samples which were described above. The only obvious resolution to this contradiction is to suggest that the hypothesised differences in hired labour costs between the two areas are great and more significant than was first thought.

Milk cows, pigs, oxen and horses are fed cassava on the two samples of farms. Farmers were only asked to indicate the number of each regularly fed with cassava (poultry were excluded). They distinguished between adult and young pigs. In the Paraguarí sample 77.7 percent of

farmers feed cassava to 1 or more milk cows, the maximum being 4 on one farm. The average number that are fed cassava per farm is 1.3 cows. In Caaguazú 84 per cent feed cassava to 1 or more milk cows, the maximum being 5 with an average number of 2.0 cows per farm.

70 per cent of farmers in the Paraguarí sample feed adult pigs with cassava. Most of these have 1 to 3 animals, but one farmer has 12. The average number per farm is 20. 26.7 per cent had 1 to 3 young pigs fed with cassava. In the Caaguazú sample, 64 per cent feed adult pigs cassava, and have from 1 to 7. The average per farm is 2.0 animals. 44 per cent had young pigs fed with cassava.

In the Paraguarí sample 30 per cent of farmers feed a pair of oxen cassava, and 10 per cent feed two pairs cassava. 3 farmers (10 per cent) have horses which are fed cassava. In Caaguazú 72 per cent have from 1 to 3 oxen which are fed cassava. No farmer in this sample feeds cassava to horses. Because of the sensitive nature of information on animals to some farmers, questions were limited to cassava consumption, and data on animals which are only grazed were not recorded.

3.3 Area in Cassava

3.3.1 Area by age of the crop.

The area on each farm occupied by cassava was recorded according to the age of the crop. Figure 3.11

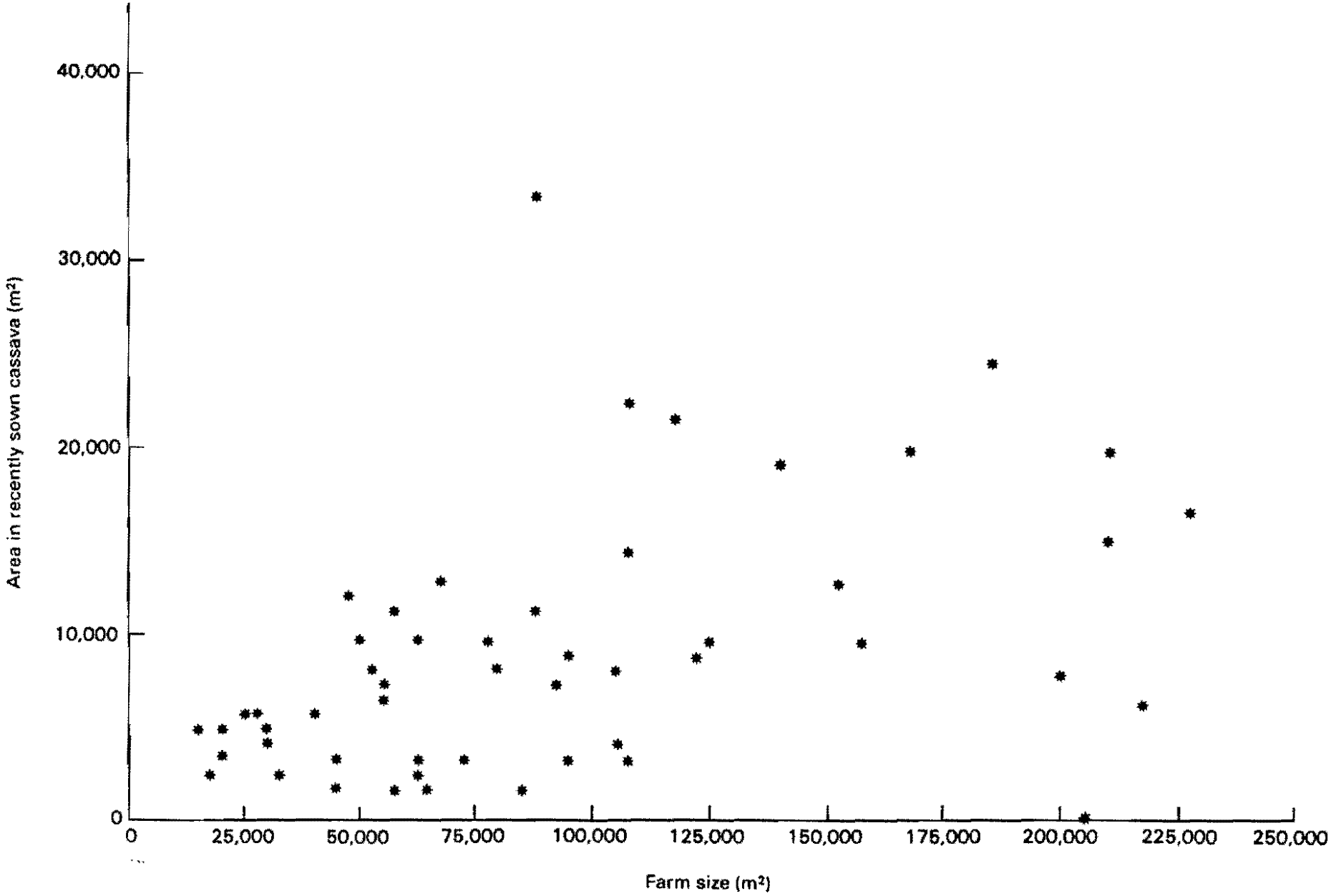


FIGURE 3.11 Area occupied by recently sown cassava compared with farm size for the whole sample (55 farms)

shows the area of recently sown cassava (2-3 months old) for the sample as a whole. The amount varies from 0.0 ha to 3.35 ha with a mean of 0.87 ha. For the Paraguarí farms, the minimum is 0.13 ha, and the maximum 1.95 ha, with a mean of 0.69 ha. For the Caaguazú farms the mean is 1.09 ha, whilst the maximum and minimum correspond to those of the entire sample given above. In the Paraguarí sample, on 23 of the 30 farms (77%) recently sown cassava is left in monoculture. On the rest it is intercropped with maize or watermelon. In the Caaguazú sample the reverse is true. On 20 out of 25 farms (80%) this cassava is intercropped (mainly with maize but on some farms also with peanuts, watermelon or phaseolus beans).

At the time of the survey, most farms were utilising one year old cassava for subsistence or sale. The area in cassava of this age is shown with farm size in Figure 3.12, and varies from a minimum of 0.0 to 2.0 ha, with a mean of 0.35 ha. Of the Paraguarí farms, four have no cassava of this age; the mean value amongst this sample of farms is 0.26 ha, and the maximum 0.80 ha. There are two farms in the Caaguazú sample with no '1 year old' cassava; the mean value is 0.46 ha, and the maximum 2.0 ha.

Seven farms have cassava which is 2 years old, and one farm has 3 and 4 year old cassava. No farm in the Paraguarí sample has cassava more than 1 year old. The area occupied by cassava which is 2 or more years old is compared with farm size in Figure 3.13. The maximum area is 0.50 ha,

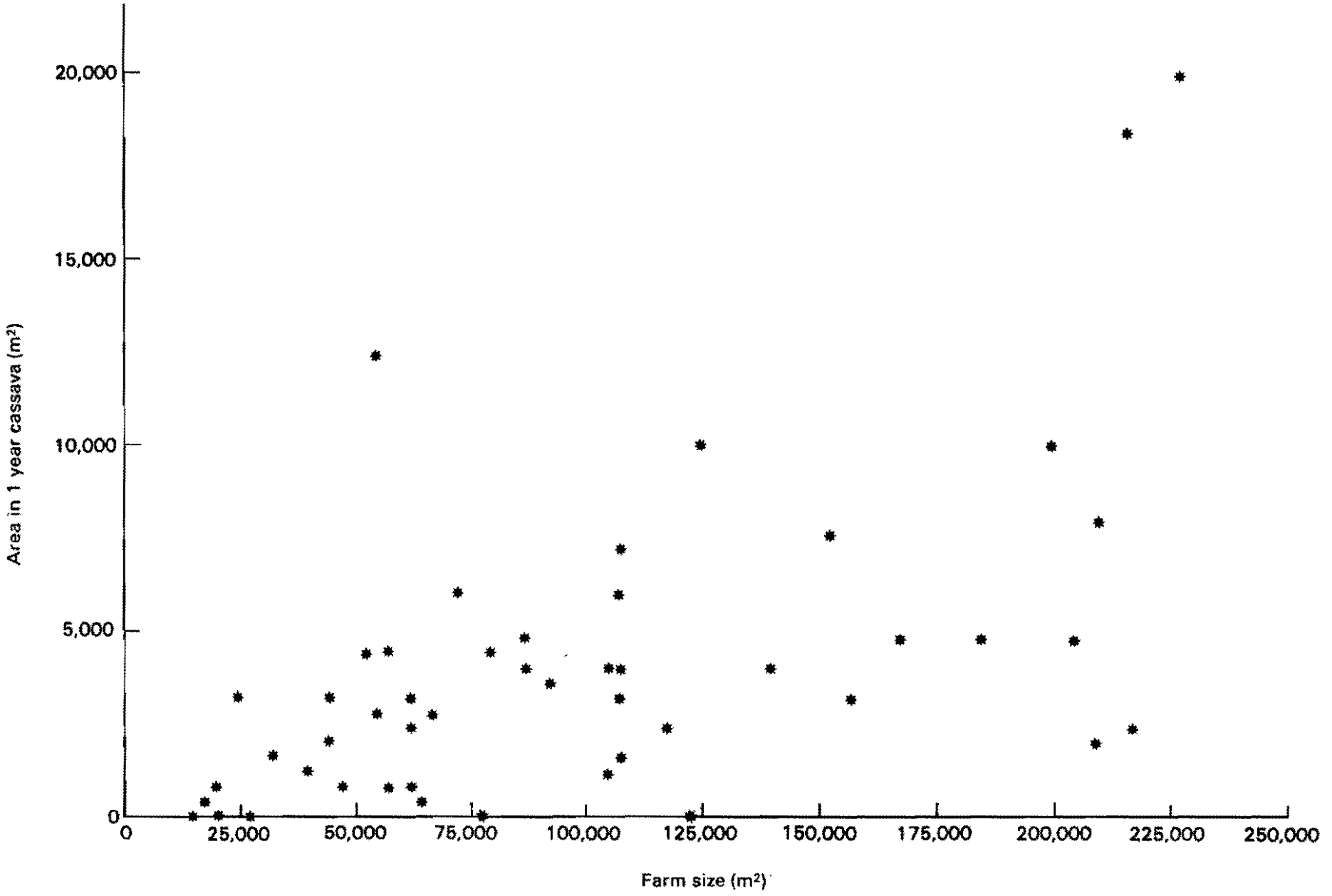


FIGURE 3.12 Area occupied by one year old cassava compared with farm size for the whole sample (55 farms).

and the mean for the Caaguazú sample is 0.07 ha. Of the farms in the Paraguarí sample only 3 (10%) have cassava of one year or older which is intercropped (with maize and in one case cowpea). In the Caaguazú sample 10 farms (40%) have intercropped cassava of one year or older, all with maize.

The total area occupied by cassava of all ages on each farm varies from a minimum of 0.21 ha. to a maximum of 6.0 ha., with a mean of 1.61 ha. (Figure 3.14). For the Paraguarí sample the minimum, maximum and mean values are 0.21 ha., 2.35 ha. and 1.03 ha., respectively. For the Caaguazú sample these are 0.5 ha., 6.0 ha. and 2.27 ha. respectively, the mean being more than double that of the Paraguarí sample. From Figure 3.14 it appears that there is a tendency for the total area in cassava to increase with farm size, although the variance increases simultaneously.

In Chapter 2 (Section 2.2.2) it has been suggested that the duration of a particular year's crop depends upon harvest period and end-use, on farm size, and on the need for some farmers to harvest earlier than might be considered appropriate for optimum yields. A farmer's cassava will be considered here as two different crops, at least while some is still too young to be consumed. Four farms (2,20,21 and 24) in the Paraguarí sample, and one (37) in the Caaguazú sample had no consumable (1 year old, or older) cassava at the time of the survey and four months before they could realistically hope to begin to harvest the newly sown crop

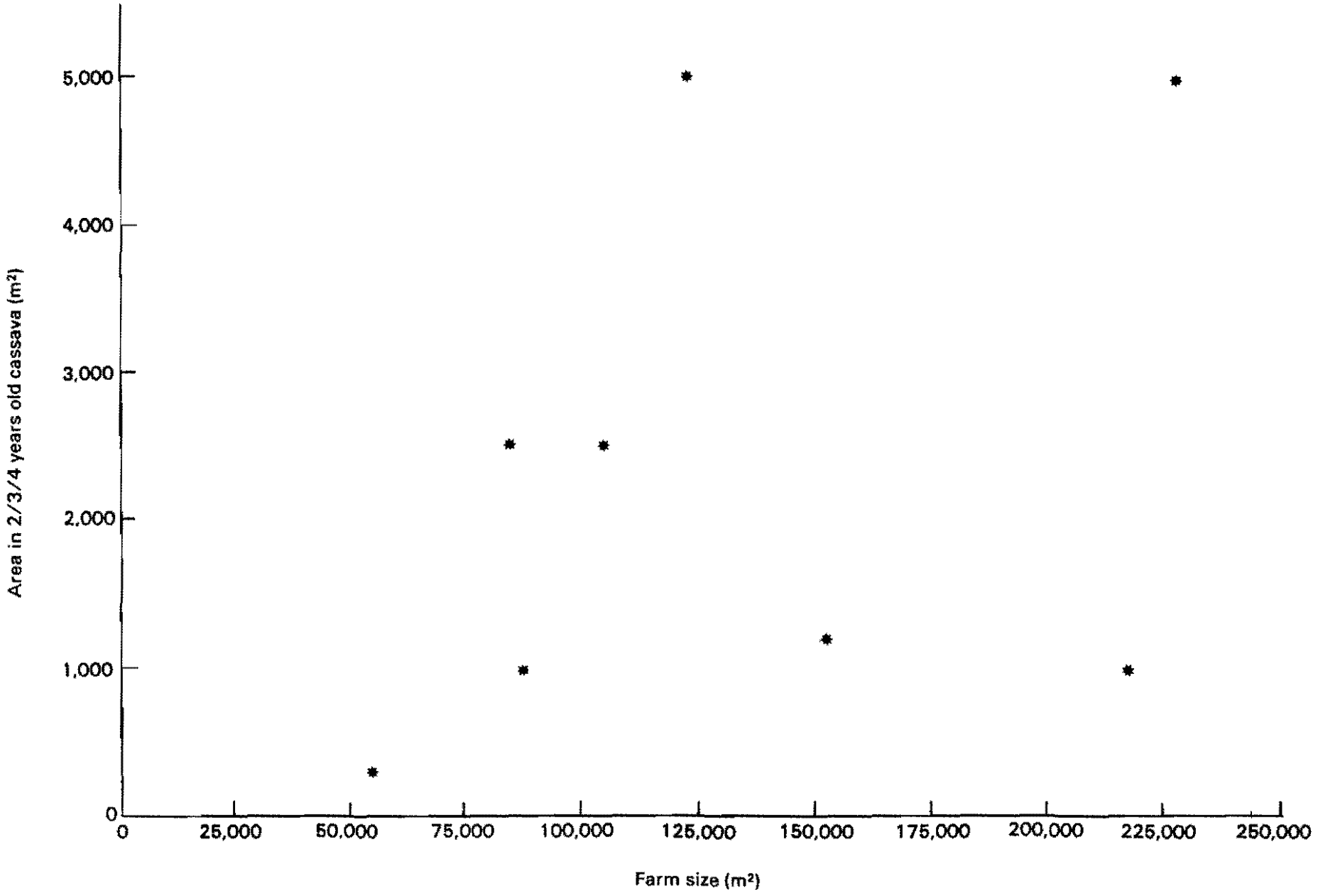


FIGURE 3.13 Area occupied by two, three and four year old cassava compared with farm size (8 farms only, all in Caguazú)

(Figure 3.15). A further five farms (4,5,9,10,52) had less than 0.15 ha., and the farmers considered that they would not have enough to last until the new harvest began. Another farmer with 0.12 ha. of cassava (farm 3) thought that he had enough to last until the new harvest, but had run short the previous year.

Of the nine farms which had run short of cassava or would soon do so, all but 1 (Farm 2) have effectively less than 3.5 ha. of land. One farmer in Paraguarí (Farm 24) has share-cropped land in Caaguazú with recently planted cassava for sale. 1.5 ha. of his farm in Paraguarí are flood-prone land and only suitable for grazing; as a result, his 5.5 ha. on paper are effectively less than 2 ha. In another case (Farm 52), a farmer in Caaguazú with 6.5 ha. maintains 3 ha. in pasture for his cattle, and at the time of the survey had only 0.04 ha. of cassava remaining for consumption. The exception (Farm 2), a farmer with 7.6 ha. in Paraguarí, had only recently bought the farm, and planted too little cassava to compensate for the low soil fertility. He had none left at the time of the survey.

Only one farm with less than 3.5 ha. did appear to have enough cassava to last until the recently planted crop could be harvested (Farm 12). Significantly, the farmer here has a second source of income (butchering), which probably explains the low emphasis he places on cash crops.

Of a total of 10 farms that had no cassava for consumption, or were likely to run out soon, and had no

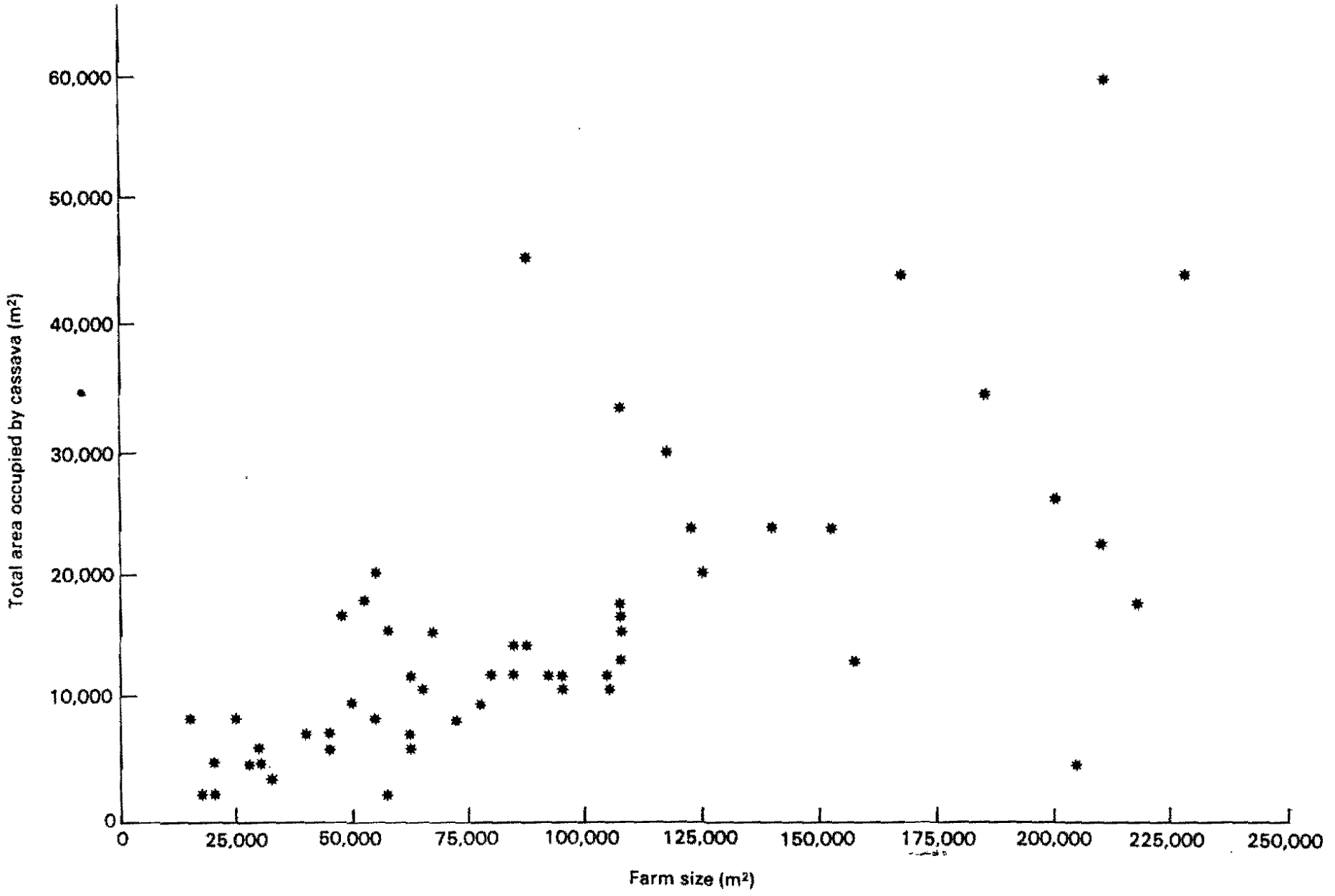


FIGURE 3.14 Total area occupied by cassava of all ages compared with farm size for the whole sample (farms).

evidence of exceptional circumstances such as that of farm 2, seven belong to Cluster 4 described above (Farms 3, 4, 5, 9, 20, 21, 37), six coming from the Paraguarí sample. One farm (24) belongs to Cluster 3 (probably because of the importance of non-cultivable pasture-land it does not belong to Cluster 4) and is also from Paraguarí. Two farms (10,52) belong to Cluster 5, one each from Paraguarí and Caaguazú. Both of these have larger than average numbers of milk cows on the farm, which require pasture and consume important quantities of cassava. The only farm with less than 3.5 ha. that appeared to have enough cassava to meet subsistence requirements also belongs to Cluster 5 (Farm 12). Little emphasis is given to cash crops on this farm, but the owner has another source of income, probably more important to him than agriculture.

3.3.2 Analysis of the area of recently sown cassava.

If we wish to explain the area occupied by cassava, it is necessary to consider a set of factors which govern the amount of cassava sown by a farmer and a set of factors which govern the amount of cassava actually being consumed which remains at any one period of time. It would not be possible here to attempt to model all the factors that determine either of these quantities, such as soil fertility, yield potential of different varieties, or variable consumption patterns. Nevertheless, using the information which was collected during the survey on family

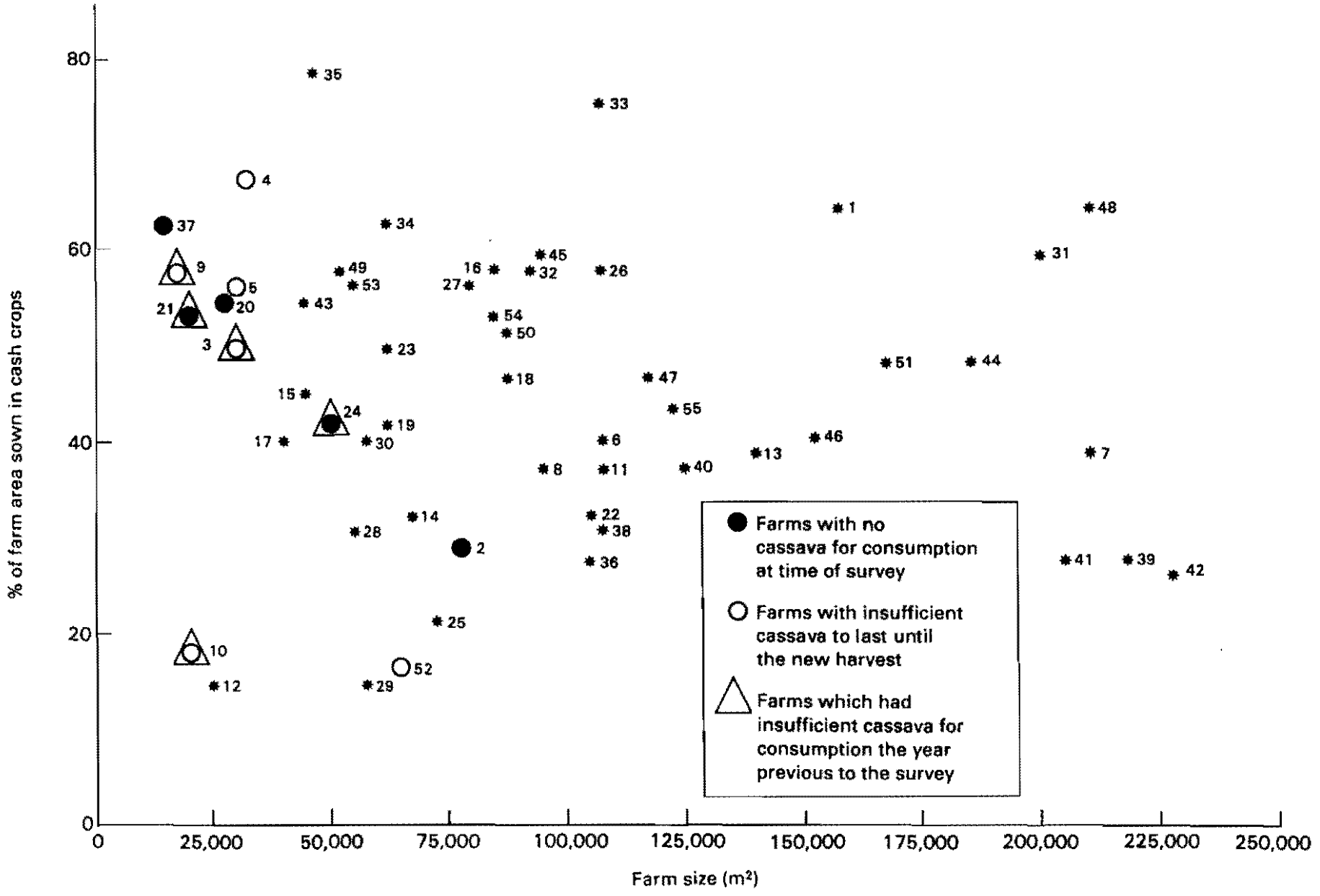


FIGURE 3.15 Farms experiencing shortage of cassava for subsistence amongst the whole sample (55 farms).

size, the number of animals which consume cassava, the land-use data, some degree of explanation can be sought for the variation in the amount of cassava on the farms sampled.

For simplicity of analysis the area of cassava has been divided into that which is recently sown, and that which is being consumed. Planting distances are assumed to be 1.0 m x 1.0 m, based on the usual density found in both samples. It is assumed that farm size will be the strongest determinant of the area occupied by cassava, of either age group. The amount of recently sown cassava on all the 55 farms of both the Paraguarí and Caaguazú samples is described by the equation:

$$Y = 3668 + 0.0539X$$

where: Y = Area of recently sown cassava (in square metres)

X = Farm size (in square metres)

The equation does not describe the data very well, however. Neither the X coefficient nor the intercept are significant, and only 18.6 percent of the variance is explained. This is because some of the farmers in the Caaguazú sample plant cassava for sale, as well as for subsistence, regardless of farm size, whilst in the Paraguarí sample cassava is planted for subsistence only. To fully explain the quantities sown on the Caaguazú farms would require a more careful analysis of the factors which favour cassava as a cash crop.

The area of recently sown cassava on the 30 farms of the Paraguari sample (Figure 3.16) is described by the equation:

$$Y = 2354 + 0.0636X$$

where:

Y = area of recently sown cassava (in square metres)

X = farm size (in square metres).

Neither of the coefficients are statistically significant, although the equation accounts for 37.6 percent of the variance in Y, indicating a clearer relationship between farm size and the area sown for this half of the sample then for the whole. None of the farms smaller than 5 ha. have more than 0.6 ha. of newly sown cassava. Of the farms greater than 5 ha. in comparison, 65% (13 from 20) have more than 0.6 ha. Some explanation can be added to this by taking into account the proportion of farm area which the farmer devotes to cash crops and assuming that this will control the area of land left for subsistence crops, cassava amongst them. In addition, the number of people and cassava-consuming animals (pigs and milk-cows) on the farm should also exert some influence on the amount of cassava sown. The equation explaining the amount of cassava sown for these farms is as follows:

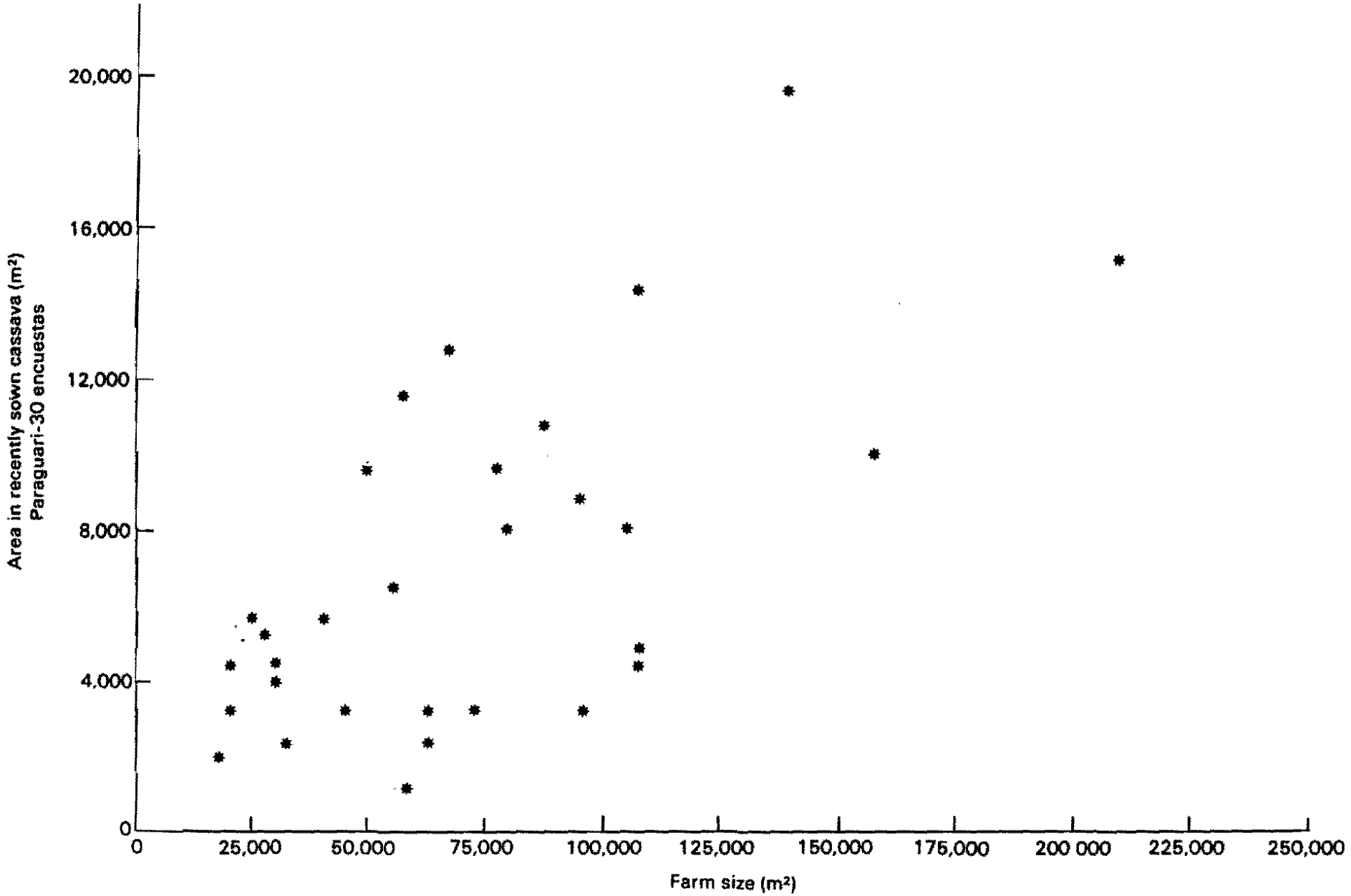


FIGURE 3.16 Area occupied by recently sown cassava compared with farm size for the Paraguarí sample.

$$y = 7453 + 0.058x_1 - 112.7x_2 + 32.6x_3 - 906x_4$$

where:

y = area of recently sown cassava (in square metres)

x_1 = farm size (in square metres)

x_2 = percent of farm area occupied by cash crops

x_3 = number of pigs on the farm (young animal = 0.25 fully grown animal)

x_4 = number of milk cows on the farm

The equation explains 52.2 percent of the variance in y; the coefficients for x_3 and x_4 are not statistically significant however. Adding extra variables to describe the number of people on the farm does not improve the explanation offered by the model. The variance unaccounted for may be a result of other priorities of the farmer, particularly his pasture requirements, or it may be a result of differences in soil fertility perceived by the farmer and which control the amount of cassava he sows.

3.3.3 Analysis of the area of cassava used for consumption at the time of the survey.

It is assumed that the area of cassava which is being consumed depends firstly on farm size. It has been shown above that this exerts some influence on the area of recently sown cassava. It would have been difficult to

measure the area sown in cassava the previous year with the same accuracy.

On examining the amount of cassava being consumed on the farms studied, it is apparent that the sample has again to be subdivided.

The following equation describes the relationship between farm size and the area occupied by cassava of one year of older, for the whole sample:

$$y = 230 + 0.03929x$$

where: y = area of 'old' cassava (currently being consumed; in square metres)

x = farm size (in square metres)

The equation only explains 30.7 percent of the variance in y, and neither coefficient is statistically significant. If the Caaguazú farms are examined separately, it can be seen that there is even less relationship between farm size and the area occupied by 'old' cassava amongst that group of farms. The equation:

$$y = 990 + 0.0373x$$

where: y = area occupied by 'old' cassava (1 year or older; in square metres)

x = farm size (in square metres)

only accounts for 16.6 percent of the variance in y, and neither coefficient is statistically significant. The problem with the data for these farms is that it cannot be split up into area planted for subsistence and area planted for sale. If yields are higher for the Caaguazú farms than for those from Paraguarí, as one would expect, then farmers in the former area would devote less area to cassava for subsistence needs. Furthermore, the importance of cassava as a cash crop differs from place to place in Caaguazú. The farms surveyed were from three different locations, amongst which cassava's role as a cash crop varies according to soil type.

There appear to be clearer relationships between the amount of 'old' cassava present (at the time of the survey) and the farm size and consumption-related variables for the Paraguarí farms. The four farms described above with no cassava for subsistence use must be excluded, since it is not possible to calculate a negative value corresponding to the area of cassava consumed after the farmers' own cassava terminated. Farm number 7 has also been excluded from the following because of its extreme size, both farm area and area in 'old' cassava; it appears to influence the form of the regression very strongly. The amount of one year old cassava on the remaining 25 farms is described by the following equation:

$$y = 0.0972x_1 - 0.00000457x_2 + 11.325x_3 - 264x_4 + 255.7x_5 - 1771$$

where:

y = area of 1 year old cassava (in square metres)

x_1 = farm size (in square metres)

x_2 = (farm size)^2 (in square metres)

x_3 = number of pigs (young animal = 0.25 fully grown animal)

x_4 = number of adults (>14) living permanently on the farm.

x_5 = number of children (<14) living permanently on the farm.

This explains 52.1 percent of the variance in y. The coefficients for the intercept, x_3 and x_4 are not statistically significant. Note that the equation is a better fit with a quadratic term included; from Figure 3.17 it is apparent that the relationship between the area in cassava and farm size is not linear. This suggests an upper limit to the amount of one year old cassava on the largest farms of 0.5 - 0.6 ha. at the time of the survey.

Further variance in y can be explained by excluding those farms which indicated that they had given away significant amounts of cassava to pay labourers, or had suffered some catastrophe or unexpectedly low yields (such as farm 2 described above). Unfortunately no measure of the

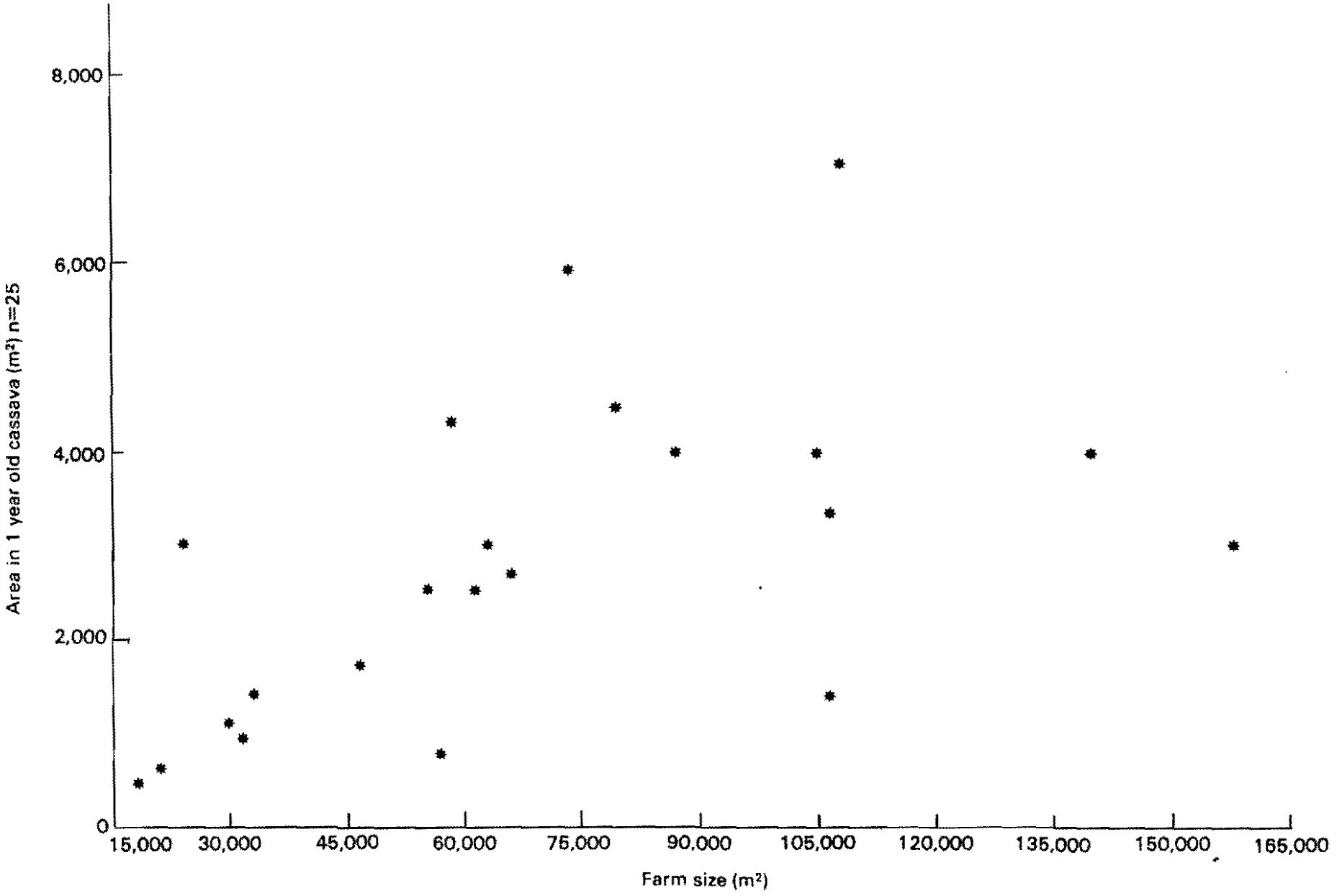


FIGURE 3.17 Area occupied by cassava for consumption compared with farm size for the Paraguarí sample (excluding farms with no cassava).

quantity of cassava disposed of in these forms is possible. Therefore, five farms must be excluded on these grounds. All of these farms are larger than 7.0 ha.

For the remaining 20 farms (Figure 3.18), the area occupied by one year old cassava is described by the equation:

$$y = .0.0532x_1 - 0.0000002091x_2 - 21.81x_3 + 156.1x_4$$

where: y = area occupied by one year old cassava (in square metres)

x_1 = farm size (in square metres)

x_2 = (farm size)^2 (in square metres)

x_3 = percentage of farm area in cash crops

x_4 = number of persons (adults and children) living permanently on the farm.

This explains 76.4 percent of the variance in y. The coefficients are all statistically significant (α = 0.05). (It is apparent from Figure 3.18 that the relationship between the area occupied by cassava and farm size is also quadratic).

Of the 20 farms in this last group, 9 farmers reported having disposed of small amounts of cassava, either through sale or gifts to neighbours. These farms are all larger than 5 ha. It appears that on the very smallest farms, less than approximately 5 ha., cassava is not used to pay labourers, nor can enough be spared to help neighbours

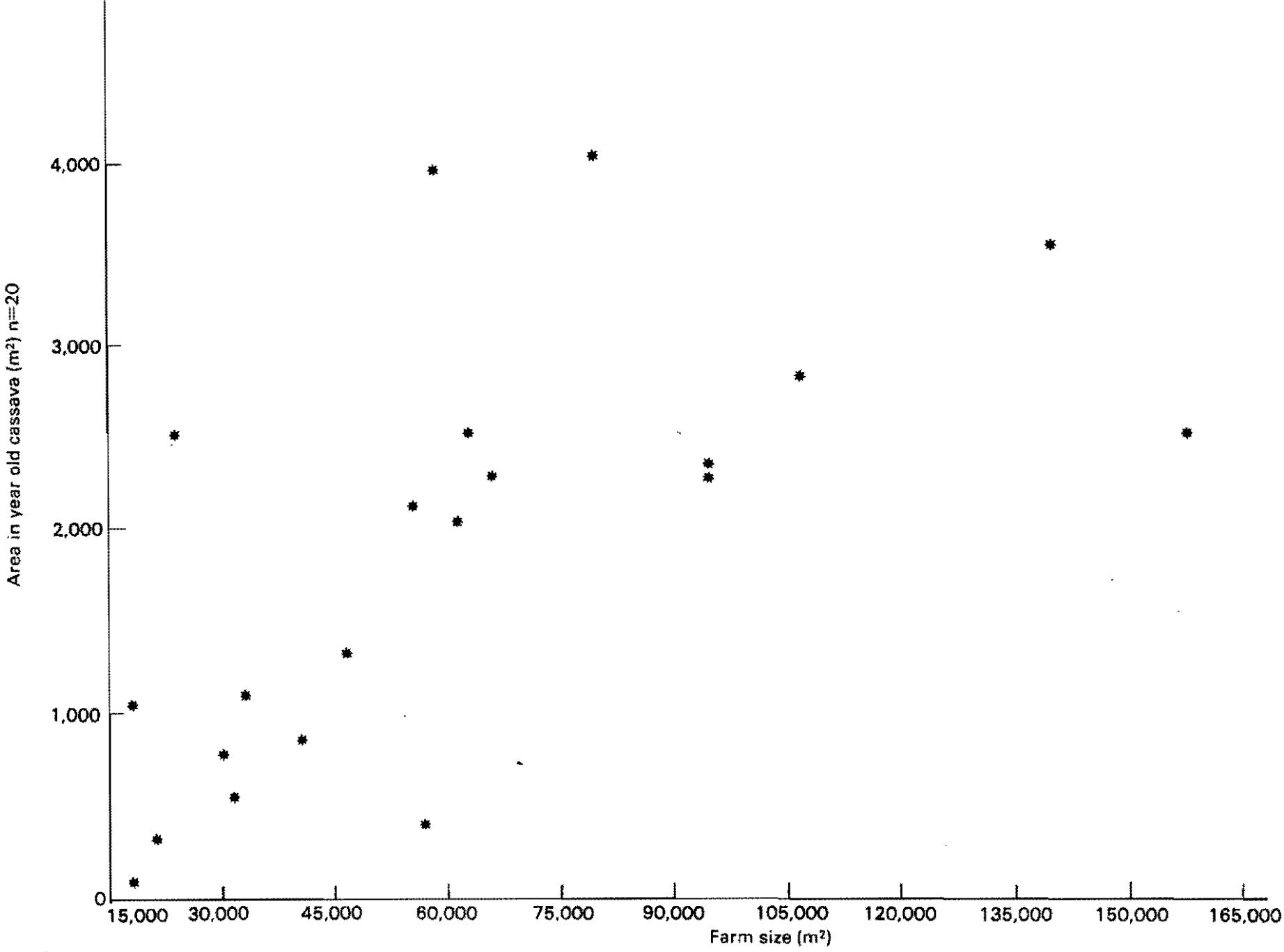


FIGURE 3.18 Area occupied by cassava for consumption compared with farm size for the Paraguarí sample (excluding farms where large quantities were disposed of off the farm).

who have none. The area of one year old cassava on the farm and farm size are shown for the 11 remaining farms from which no cassava has been disposed of off the farm in Figure 3.19. The data are described by the following equation:

$$y = 0.05021x_1 - 0.0000001035x_2 - 31.77x_3 - 13.4x_4 + 472x_5 + 144.2x_6$$

where: y = area occupied by one year cassava (in square metres)

x_1 = farm size (in square metres)

x_2 = (farm size)^2 (in square metres)

x_3 = percent of farm area in cash crops

x_4 = number of pigs on the farm (small animal = 0.25 large animal)

x_5 = number of adults living on the farm

x_6 = number of children (<14) living on the farm.

The equation accounts for 93.5 percent of the variance in y. All coefficients except that for x_2 are statistically significant; the equation nevertheless is a better fit with the quadratic term included than if it is discarded.

Farm size, by influencing the amount of cassava planted, is undoubtedly the strongest determinant of the area of one year old cassava at a point in time on the farms sampled. The positive coefficients for the numbers of adults and children on the farm suggest a conscious decision

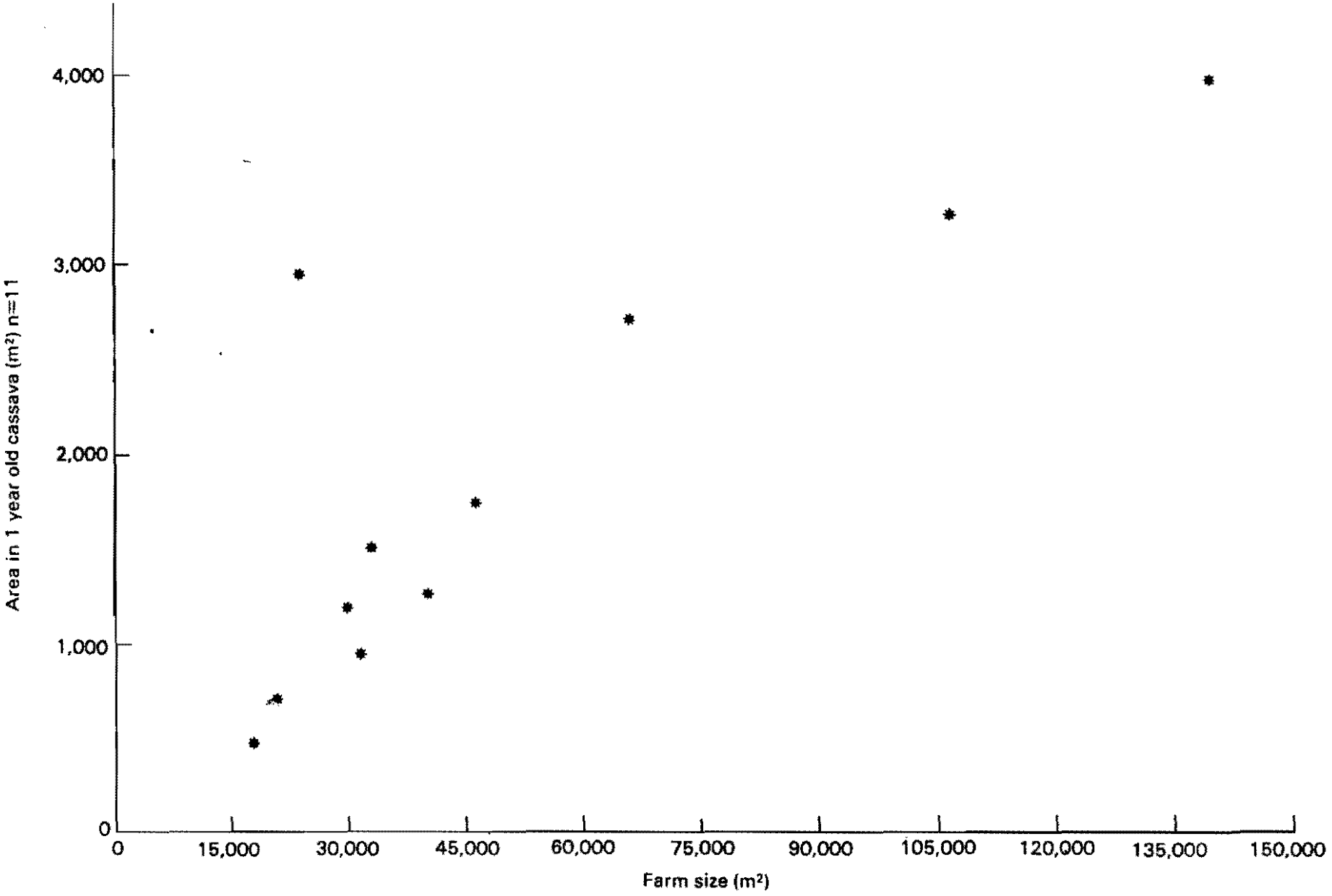


FIGURE 3.19 Area occupied by Cassava for consumption compared with farm size for the Paraguarí sample (excluding farms on which any cassava was disposed of off the farm).

to plant more cassava as family size increases, rather than a decrease in the amount of cassava due to increased consumption, which is associated with the number of pigs on the farm. Often pigs are only bought on a year to year basis for fattening, and sold towards the end of the year; they may not have much influence on the amount of cassava planted, only on the rate of consumption.

As was hypothesized, the percentage of farm area on the Paraguarí farms which is sown in cash crops exerts quite a strong negative influence on the remaining area in cassava, probably also by limiting the area planted (assuming that the proportion of farm area planted in cash crops remained relatively constant from the year of planting to the year of consumption). Some farmers gave away or payed labourers with important quantities of cassava. It may well be that farmers with more than 5 or 6 ha. plant significantly more cassava than they will consume, to pay labourers, and for security in the event of poor yields or climatic perturbances (Figure 3.16 shows that 6 farmers in Paraguarí planted more than one hectare of cassava).

It is important to note that the regression models only represent the period of time over which the survey was conducted. Without including data on rates of consumption it is not possible to predict how much longer the cassava will last on each farm. For the same reason the farms without one year old cassava could not be included in the model, which makes it difficult to predict the conditions

under which a farm would have just run out of cassava at the time the survey was conducted. Those which had run out of cassava, or were about to run out, have been indicated above (Figure 3.15). The assumption made at the time of planning the formal survey, that farms of less than 3 ha. could not grow enough cassava for subsistence requirements, seems to be borne out by these data, at least in minifundia areas like Paraguarí.

The regression models described above go some way towards explaining why this should be so. Farm size and the proportion of farm area planted in cash crops exert a strong influence on the amount of cassava sown on these farms. In Caaguazú, where cassava is a cash crop for many farmers, the relationships described do not function; their purpose was only to explain the small quantities of cassava on the smallest farms in the whole sample.

3.3.4 Reasons given for not planting more Cassava

Given the importance of cassava in the diet, why do the farmers in the Paraguarí sample with least land not plant more cassava? Similarly, given the lower labour requirements and fewer purchased inputs for cassava, why do farmers in the Caaguazú sample not plant more cassava? By now, the answers farmers give to these questions should seem fairly obvious (Table 3.6).

18 farmers (60%) from the Paraguarí sample simply gave the lack of a market as the principal reason for not

TABLE 3.6: Reasons given for not planting more cassava.

REASON GIVEN	FARM	TOTAL
Not enough land to sow more cassava; other crops (cotton) take preference.	3,4,5,9,20,21,24 35,37,49	Paraguarí 7 Caaguazú 3
Prefer to sow other crops for sale, rather than more cassava (sell some cassava).	31,32,33,34,36,38, 39,40,41,42,43,44, 45,47,48,50,51,52	Caaguazú 18
Have enough for subsistence needs (cassava not one of their cash crops).	46,53,54,55	Caaguazú 4
Have enough for subsistence needs (no market for cassava).	1,6,7,8,11,12,14, 17,18,19,22,23,25, 26,27,28,29,30.	Paraguarí 18
Increased quantity sown this year.	2,10,13,15	Paraguarí 4
Lack of resources (cash) to be able to sow more.	16	Paraguarí 1

growing more cassava. One farmer summed up the situation thus; "I can't sell cassava if I plant more ... nobody around here has the money to buy it, and only occasionally can you sell any in Acahay market." However, another farmer pointed out that if he wanted to sow more cotton he had to sow more cassava to feed and pay for the extra-wage labour he used; in actual fact, since the cassava which is used to feed and pay labourers is a year old at the time the labour is used, then if the farmer has little or no cash, the amount of cassava he has left over from subsistence requirements may exert an important influence on the amount of extra labour he can hire, hence on the area he can sow in cash crops. Another farmer said he would prefer to cultivate more cassava, rather than cotton, if there were a market, because it involved less inputs and labour; this echoes the sentiments of some of the farmers in Caaguazú.

18 farmers (72%) from the Caaguazú sample grow cassava as a cash crop, but prefer to grow other crops rather than increase the area sown to cassava. Cotton and other high value crops bring higher returns per hectare; therefore a farmer will not decrease the area in such crops to increase the amount of cassava he sows. Because of shortage of labour, or of resources to hire labour, none of these farmers could consider increasing the total area they cultivated as a way of increasing the area in cassava. Two farmers stated this explicitly as their reason for not cutivating more cassava. Only one farmer in the Paraguarí

sample gave lack of resources to be able to sow more as his reason for not growing more cassava.

4 farmers in the Paraguarí sample had increased the area they sow with cassava at the time of the survey. One (farm 2) has been explained above; the farmer was new to the farm and the previous year had sown what he thought was a sufficient quantity, only to get very poor yields. Another (Farm 10) had also increased the area sown to try and prevent the shortages experienced for the previous two years, although the new total (0.45 ha. of recently sown cassava) does not seem adequate for his requirements. The other two farms have not experienced shortage of cassava; one was deliberately increasing his crop for pig food, and the other wanted to increase yield per plant by delaying the harvest of part of the crop. None of these farmers devotes more than 50% of his farm area to cash crops.

7 farmers in Paraguarí (23.3%) and 3 in Caaguazú (12%) can not increase the area they sow in cassava because they do not have enough land. All (except farmer 24 whose situation has been explained previously) devote at least 50% of their farm area to cash crops (figures 3.10 and 3.15). None have more than 5.5 ha. of land. Those from Paraguarí do not grow sufficient cassava for subsistence because they would rather sow cash crops on a large part of their land and rely on neighbours to give them cassava, or work in exchange for it. As one farmer explained, "You can always get cassava from somebody else who has more land and sows

more ... you need the money from cotton." Another problem mentioned by two farmers who cultivate land as sharecroppers is that the landowners feel that cassava occupies land for too long, and there are few that will let a sharecropper plant cassava. Land is usually sharecropped for cotton, which only occupies the land for five or six months; since the sharecropper usually supplies the labour, the land owner can also increase the area he has in cotton without increasing his labour requirements greatly.

At first it appears that cassava shortage is not so critical to these farmers; examples have been given of farmers who assume that they can meet their needs from neighbours or by working for cassava. Other comments and personal remarks lead one to believe otherwise. Many of those who have enough cassava mention the occurrence of theft of cassava, something which was recorded widely in the formal survey. If the social environment is as benevolent as some farmers make out why is theft so common? Whilst the incidence of gift-giving of cassava is quite common between neighbours, some farmers have to buy cassava, which means that they have less cash available for other purchases which might broaden the diet or increase protein intake. One farmer recounted how he had recently had to sell his milk cow to buy cassava, depriving his children of an important part of their daily diet. Because of the importance of cassava in the diet, unreliability of supply increases the vulnerability of the farmer and his family in situations in

which even the small amounts of cash used to buy cassava could be critical for short-term 'survival'.

This situation only eases for the poorest farmers in Paraguarí in December, when they can sell cocotero fruits, and harvest maize (choclo). The need for cassava continues however; 7 of the 9 farmers in the Paraguarí sample with farms smaller than 4 ha. (those who lacked cassava or were going to experience shortage later in the year) began to harvest their 1984 cassava crop at the beginning of February 1985 (5 months old). The one farmer in the Caaguazú sample who was to run out of cassava later in the year (farm 37) began harvesting his 1984 crop at the beginning of January 1985, at less than 5 months old. For the other farmers in the Paraguarí sample, the average date when they began to harvest in 1985 was about the middle of March, a month or so later than the smallest farmers. Those larger farmers in Paraguarí, and more commonly in Caaguazú, who began to harvest in February did so because of preferences for the better culinary characteristics of new cassava, whereas the smallest farmers were forced to harvest because they had none of their previous crop left. Part of the problem faced by the smallest farmers is that by having to harvest so early they forego higher yields which the crop could attain if it were left in the ground longer. Unfortunately they do not have a choice.

3.4 Soil Conditions in Cassava Fields of the Sample of Farms

3.4.1 Objectives

Regional differences in soil conditions have been estimated for the purpose of defining micro-regions, using surrogate variables to subdivide the study area in terms of soil fertility and soil texture. Yield differences in cassava are attributed to these regional differences in soil characteristics by Brun et al (1985). Nevertheless, the same authors suggest that the differences in soil fertility, and hence in yields will decrease. This is because agricultural practices which might maintain soil fertility have not been adopted in areas of recent colonisation where fertility is currently higher.

To the observer who visits Caaguazú directly after visiting Paraguarí, the differences in soil fertility are very obvious; they are manifest by the healthier appearance, larger size and better germination rate of crops in the former area, compared with the latter. However, it is not possible to say how much more fertile they are merely by observation. How do their nutrient contents differ? It would not be within the scope of the Cassava Project to attempt to answer this question systematically for the two departments of immediate concern. Soil samples have been taken on the farms of the respondents to the second questionnaire, to give an initial guide to soil fertility

differences (which are not obvious from existing maps), and to relate the data thereby obtained to the defined micro-regions. Soil textural analyses can also be compared to the farmers' classification to gain a better understanding of how they differentiate between soils, and to try and verify the assumptions used to define the micro-regions.

3.4.2 Sampling and analysis

Samples were taken from fields of recently sown cassava on each farm visited in the second survey, using an auger or spade, to a depth of 30 cm. (auger) and 30-40 cm. (spade). Samples were generally combined from 3 separate cores or pits. Analyses were carried out at the Instituto Agronómico Nacional in Caacupé, Paraguay, for pH, percentage of organic matter, calcium, magnesium, potassium, phosphorous, and sand, silt and clay fractions. Note that the location (general) of the last three farms of the Caaguazú sample was chosen to allow the collection of samples of a different soil type (<u>yby pytá ité</u>, or <u>Terra Roxa</u>) to that which is most common in that part of Caaguazú (sandy soils).

3.4.3 Soil fertility and texture

The maximum, minimum and mean values of the variables analised are given for the two areas, Paraguarí and Caaguazú, in Table 3.7. The last three individual samples

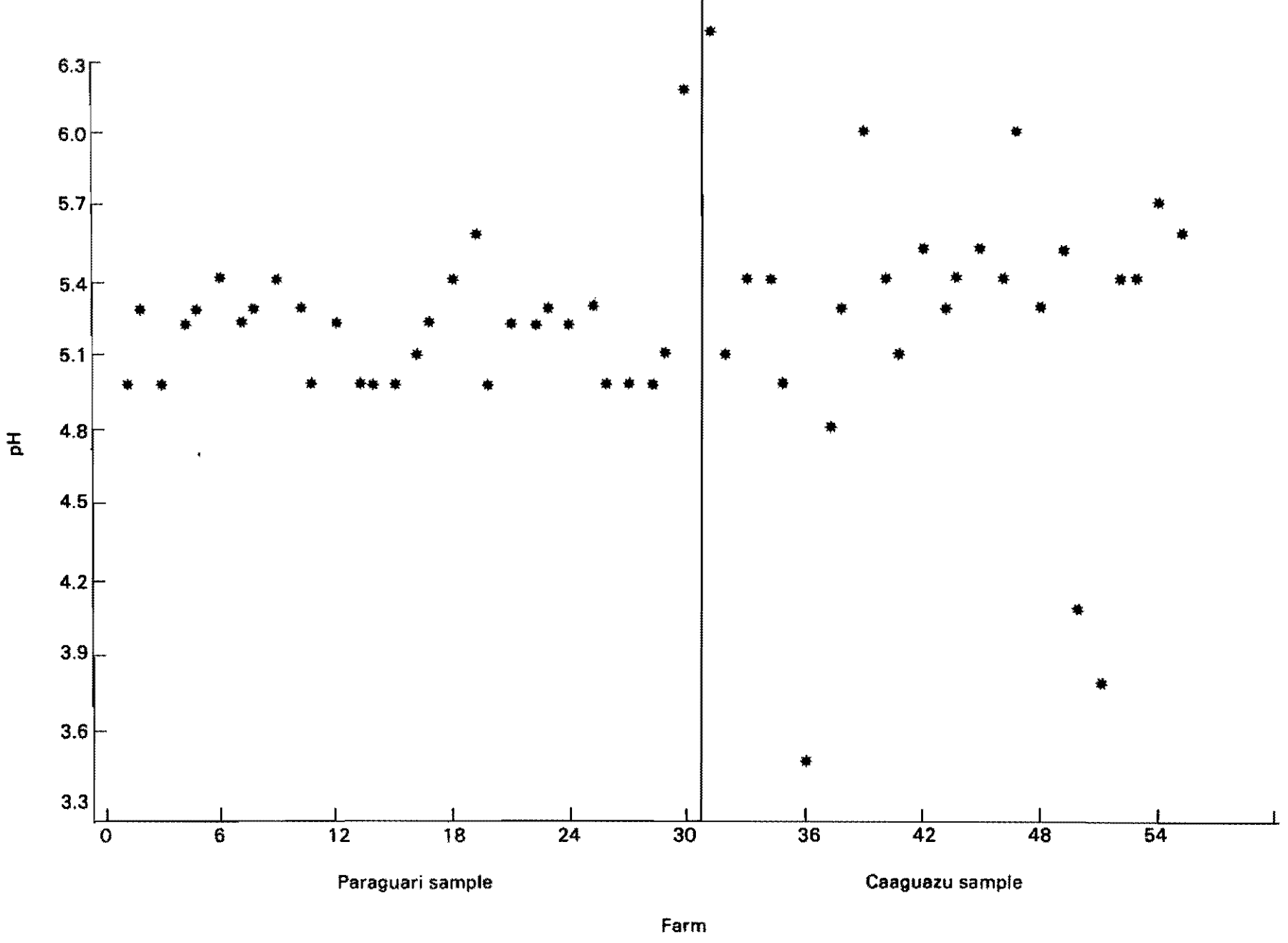


FIGURE 3.20 Soil pH in cassava fields of the whole sample.

from Caaguazú all have over 13% clay content, whilst none of the others in that sample have more than 6.5% (Figure 3.24). Silt content is also highest in these three individual and sand content (all less than 75%) is lower than that of any other from Caaguazú or Paraguarí. These characteristics derive from the geologically different parent material, basalt, compared with the sandstone from which the other soils in the sample are derived.

One other rather extreme individual was collected in Caaguazú by chance, a black soil (yby Jhú). The organic matter content, 6.5%, was the highest of all the samples collected in Caaguazú and Paraguarí, whilst the pH, 3.4, was the lowest of all. The phosphorous content, 19.0 ppm, was also highest of all (none of the others from Caaguazú exceed 6 ppm), as was the potassium content, 0.14 meq/100g.

T-tests on the different soil variables do not show significant differences between the two samples, for any variable (Table 3.8). Even when the members of the Caaguazú sample with extreme values are removed, there are still no significant differences in texture, or in chemical properties.

Figures 3.20-3.24 show pH, % organic matter, and sand, silt and clay contents of the two samples. The variance of the pH values of the Caaguazú sample appears to be greater than that for the Paraguarí data; for organic matter content the reverse is apparent. If farms 53-55 (the extreme values) are removed then the variance of the

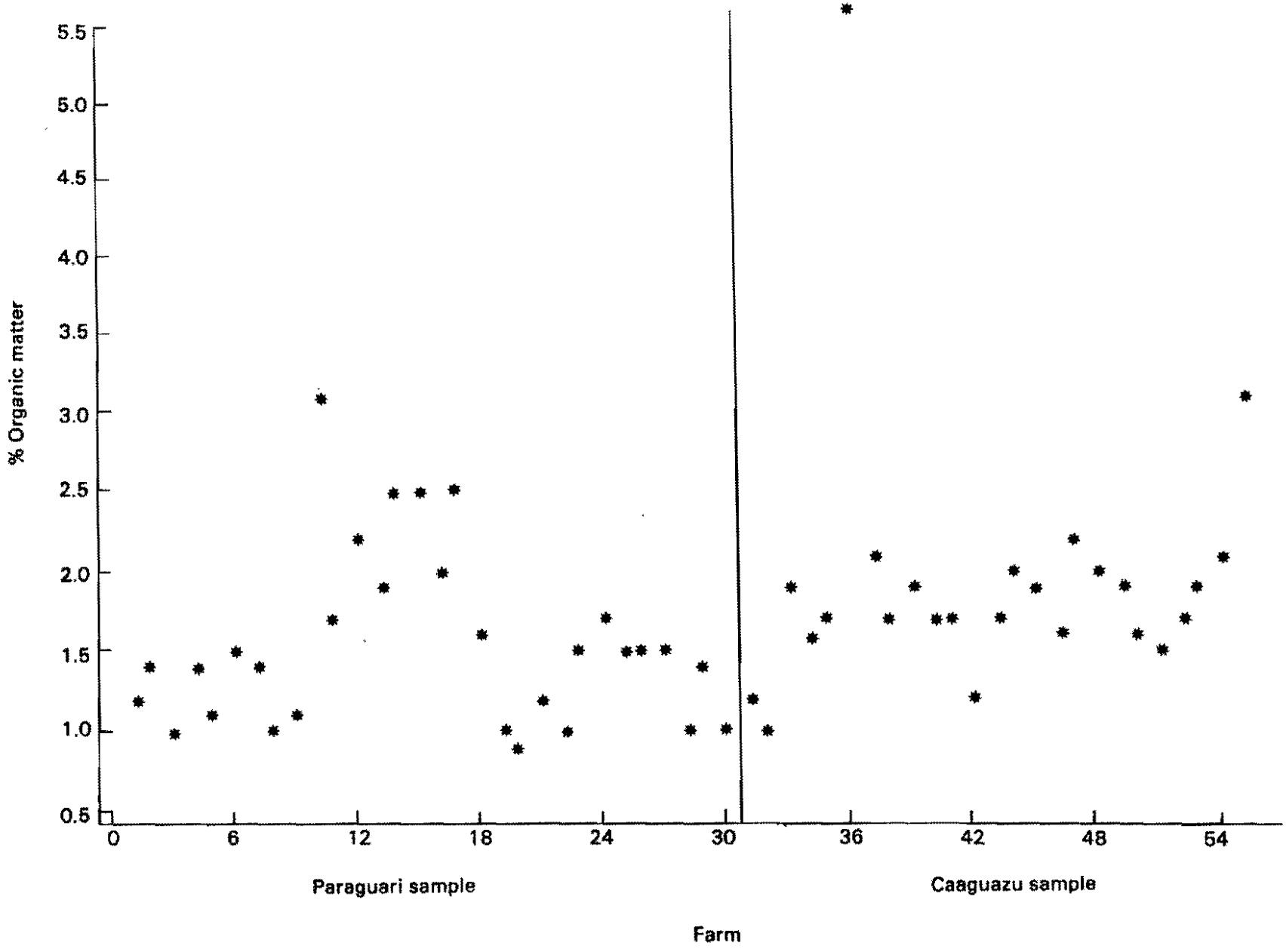


FIGURE 3.21 Soil organic matter content (%) in cassava fields of the whole sample.

TABLE 3.7 Maximum, minimum and mean values for 9 soil characteristics of the two samples.

VARIABLE	---PARAGUARI SAMPLE---			---CAAGUAZU SAMPLE---		
	Max.	Min.	Mean	Max.	Min.	Mean
pH	6.2	5.0	5.21	6.4	3.5	5.25
% Organic Matter	3.1	0.9	1.54	5.6	1.0	1.94
Calcium (meq/100g)	3.6	2.4	2.87	3.6	2.4	2.85
Magnesium (meq/100g)	1.26	0.69	0.89	1.26	0.66	0.92
Potassium (meq/100g)	0.12	0.06	0.084	0.14	0.06	0.088
Phosphorous (ppm)	13.0	0.0	3.30	19.0	0.0	3.44
% sand	92.46	76.90	83.96	95.00	70.46	88.54
% silt	16.22	3.98	9.47	14.00	1.89	6.32
% clay	12.0	2.8	6.57	15.54	1.54	4.95

TABLE 3.8 T-values and Smirnov T1 values between the Paraguari and Caaguazú samples.

SOIL VARIABLE	Student's T.	Smirnov T1
pH	-0.056	0.4333*
% Organic Matter	0.388	0.5067**
Calcium (meq/100g)	0.035	-0.2200
Magnesium (meq/100g)	-0.119	0.1800
Potassium (meq/100g)	-0.147	-0.1867
Phosphorous (ppm)	-0.029	-0.2733
% sand	-0.594	0.5933**
% silt	0.632	-0.4267*
% clay	0.342	-0.5267**

* = Significant at $\alpha = 0.02$ (Two-tailed test)
** = Significant at $\alpha = 0.01$ (Two-tailed test).
For Smirnov's T1, m=30, n=25. T1 approximated (Conover, 1980).

textural variables is also lower amongst the Caaguazú data. Taking these differences into account, there do appear to be differences between the two samples for these variables (not the case for calcium, magnesium, potassium or phosphorous contents). T-tests are not powerful enough to pick up the differences in variance.

Smirnov's Ti statistic has been calculated for all nine soil variables. The results are given in Table 3.8. This test seeks differences between the cumulative probability distributions of the two samples. Even without excluding those members of the Caaguazú sample with extreme values, significant differences are found for pH, % organic matter, and sand, silt and clay contents. Whilst silt and clay contents are higher amongst the Paraguarí sample, pH, % organic matter and sand content are higher in the Caaguazú sample. No significant differences are observed for calcium, magnesium, potassium or phosphorous contents.

Whilst only representing small areas in the Departments of Paraguarí and Caaguazú, these data do give some indication of the magnitude of differences in soil fertility between the two areas. Chemically there are few differences between the two samples. pH is slightly higher, and the difference significant, in the Caaguazú soils. Organic matter content is also significantly higher in the Caaguazú sample. Higher organic matter content can be attributed to the shorter length of time for which the Caaguazú soils have been cultivated. The fields which have

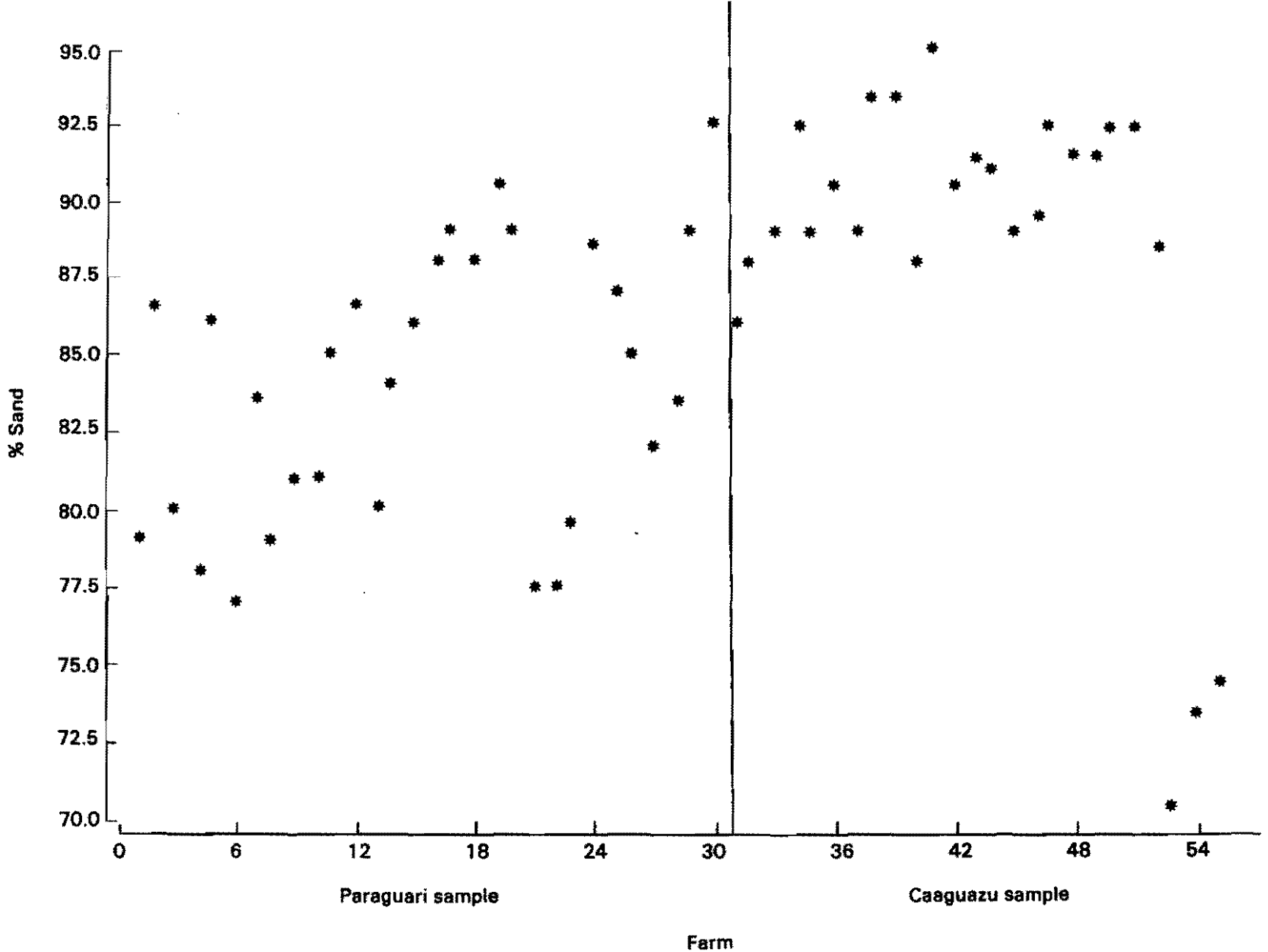


FIGURE 3.22 Soil sand content (%) in cassava fields of the whole sample.

been cultivated for the longest time in the Caaguazú sample were only deforested about 25 years ago, and amongst this sample as a whole, the average length of time since deforestation for the fields sampled is 10 years. The Paraguarí soils, on the other hand, had mostly been in constant cultivation for as long as the farmers could remember. Taking this into account, the differences in organic matter content are not very great.

Only four of the fields in the Paraguarí sample (13.3%), and five in the Caaguazú sample (20%) had been fallowed ever, according to the respondents. Those in the latter sample had all been for periods of one year, whilst those in Paraguarí included one field that had only recently been taken out of use as rough pasture (rastrojo); two had been fallowed for one year each and another for two years. Generally, fallowing is not a common part of the agriculture practised by farmers in Paraguarí due to shortage of land. In Caaguazú some farmers spoke of fallowing as a necessity especially on the sandier soils. As has been shown (Section 3.2.3), lack of labour is another reason why land is left uncultivated in this area. No significant relationships were found between the length of time since deforestation, the occurrence and duration of fallowing and the organic matter content of the Caaguazú soils.

Of the cassava fields in the Paraguarí sample only 5 had ever received some application of either chemical or organic fertilisers as far as the farmers could remember.

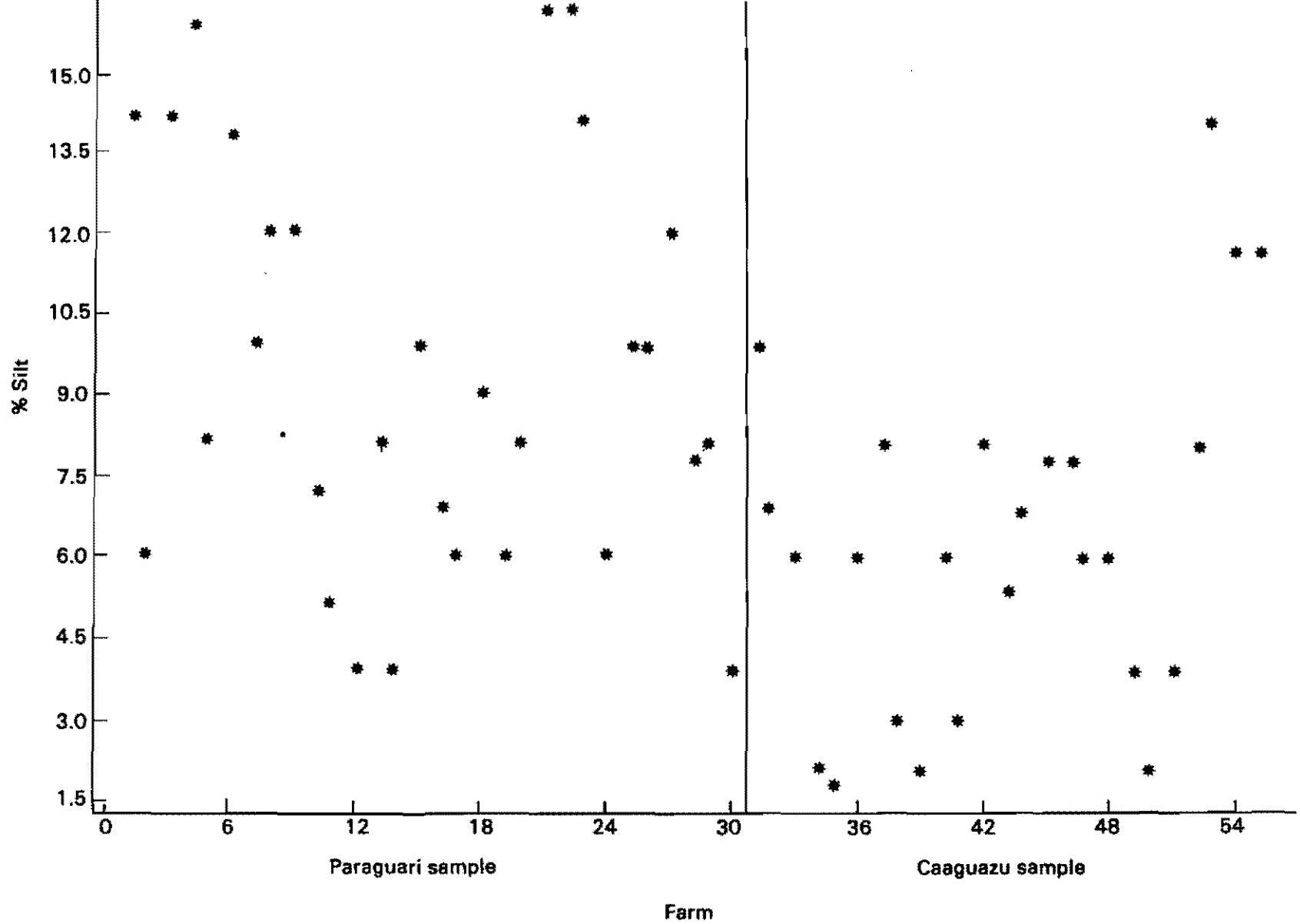


FIGURE 3.23 Soil silt content (%) in cassava fields of the whole sample.

One farmer had applied organic matter when the cassava crop was planted in 1985. Only one farmer had applied any form of chemical fertiliser, three years prior to the survey. In the Caaguazú sample only one farmer had applied any sort of fertiliser, foliar nitrogen, to a cotton crop the year previous to the survey.

The sandier nature of most of the Caaguazú soils must favour stronger leaching, which may account for the absence of differences in nutrient content between the two samples. Cation exchange capacity, not analised, is likely to be higher for the Paraguarí soils because of their higher clay content. Organic matter content and pH are both likely to continue to decrease with further cultivation and leaching in the Caaguazú soils.

3.4.4 Soil textural differences between the soil classes identified by farmers.

Farmers were asked to name the type of soil which was sampled on their farm. 23 were of the yby pytá type, 11 of the ybycuí type, 2 each of the yby pytá ité and yby say yú types. 13 farmers said that the soil type fell in between yby pytá and ybicuí. No name was given for this soil. 3 farmers did not know the soil type sampled. Because of the size of each group, comparisons can only be made between yby pytá, ybicuí, and the soil which falls between the two.

The mean values of sand, silt and clay contents for the sample data according to the soil type named by the

TABLE 3.9 Mean values of sand, silt and clay contents for soil types identified by farmers.

SOIL TYPE	SAND (%)	SILT (%)	CLAY (%)
Yby pytá	83.69	9.83	6.92
Median type	88.56	7.84	3.75
Ybycui	90.66	5.63	3.81

TABLE 3.10 Smirnov T1 statistic comparing sand, silt and clay contents of three different soil types identified by farmers.

SOIL TYPE COMPARISON	Sand Content	Silt Content	Clay Content
Yby pytá - Median type	0.576*	0.358	0.710*
Median type - Ybicui	0.481	0.431	0.270
Yby pytá - Ybicui	0.691*	0.468	0.605*

* Significant at $\alpha = 0.01$
Others not significant at $\alpha = 0.1$.

farmer is given in Table 3.9. The yby pytá soils would appear to be different from the others in terms of sand, silt and clay contents. The median type, in between yby pytá and ybicuí, has less sand and more silt than ybicuí whereas clay contents are similar in both. To test for statistical differences between the different soil types for sand, silt and clay contents, Smirnov's T1 Statistic has been calculated, and is given in Table 3.10.

The soil type yby pytá has significantly different sand and clay contents to those of both of the other soils. No significant differences exist between the silt contents of any of the soils, nor between sand and clay contents of the ybicuí and median types. It can be concluded that differences recognised between the two soils named by farmers correspond to significant differences in clay and sand contents. However, significant differences in these variables do not exist between the named sandy soil, ybicuí, and the intermediate soil distinguished separately but not named by farmers. The difference between these two types of soil which is distinguished by farmers may not therefore be based on texture, but on some other characteristics. Nor is this likely to be chemical; student's T_1 was calculated for the same soil types for each of the nutrients analised. The only significant difference found was between the organic matter content of the yby pytá soils and the median type, which may just be a reflection of the predominant occurrence of the former in the Paraguarí sample and the latter in the Caaguazú sample.

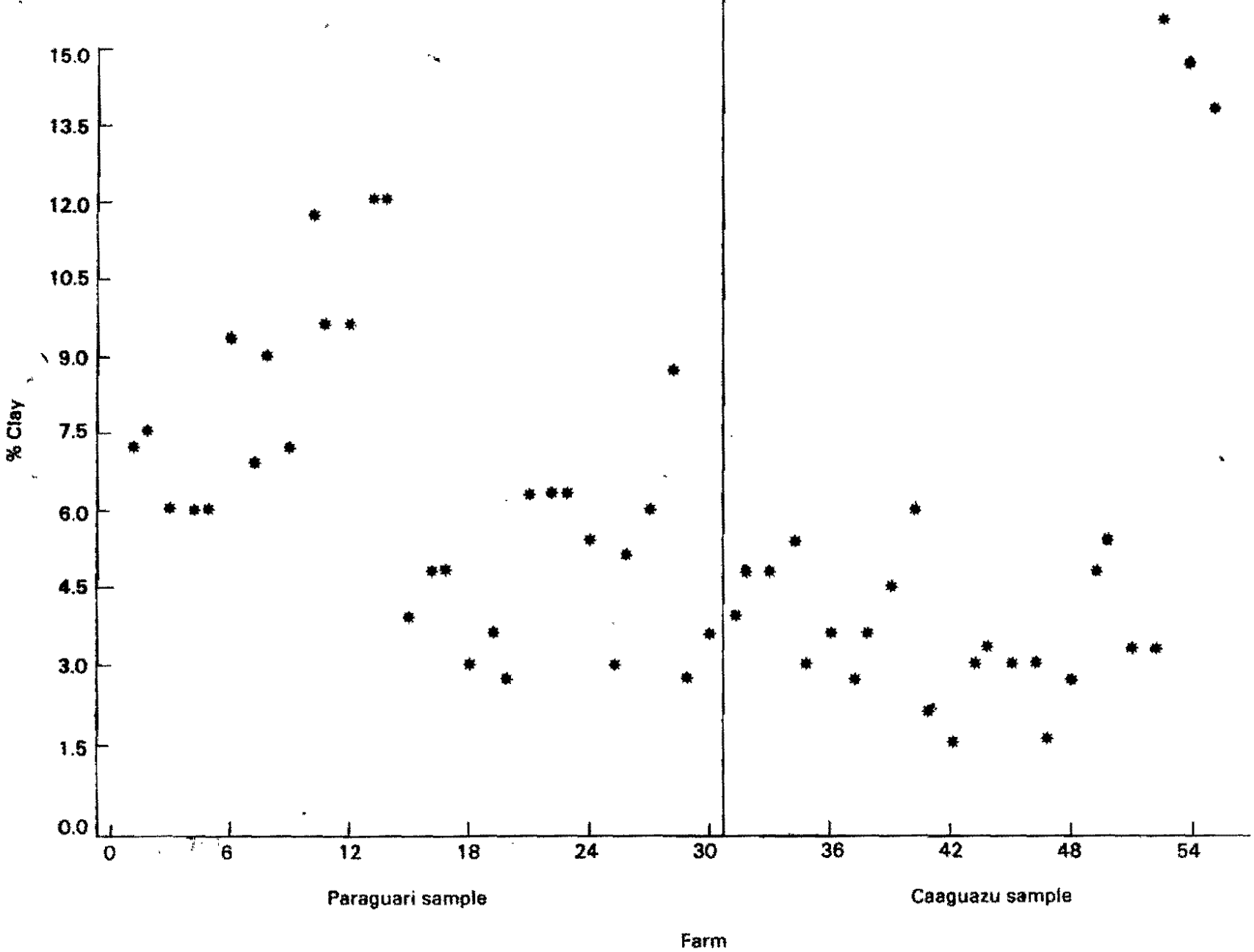


FIGURE 3.24 Soil clay content (%) in cassava fields of the whole sample.

4. CONCLUSIONS

4.1. Method for Defining the Micro-Regions

4.1.1 Method used, costs of fieldwork and time required.

The micro-regions (see Table 2.9 and Map 21) have been defined using a combination of secondary data and field survey. Existing methods of informal survey have been used to gain a better understanding of the processes which affect cassava production in different parts of central Paraguay. To draw the micro-regions data have been collected throughout the study area from a random sample of settlements (compañías). A deeper insight has been gained through a more detailed case-study of two cassava-producing areas.

The field-work was all completed in a period of ten weeks. The total cost for this stage was about $6,000 US. The formal survey data were initially processed and the micro-regions defined in a period of about 3 months. A further 3 months' work was required for analysis of the case-study data and production of this document.

4.1.2 Results of informal and formal surveys.

The informal and formal survey work have allowed the identification of broad characteristics of the cassava producing areas and the differences between them. Maps of the distribution of qualitative variables for a sample of compañías have been combined with maps of environmental characteristics to delimit the micro-regions.

Analysis of secondary and formal survey data has permitted the identification of regional differences in population change rates and farm fragmentation over time. Differences in farm size are reflected by variability in things such as use of fertilizers, access to credit and seasonal shortages of cassava. Regional differences in agricultural activities are identified based on the importance of the crop to the farmers interviewed (that is, how much they rely on it as a source of cash) rather than simply on the area sown. Seasonal dimensions of cash shortage, cassava sales and cassava shortage have been identified for the survey area as a whole from this data.

The descriptive information for each micro-region (Table 2.9) comprises the initial input to CIAT's data-base. The mapped micro-regions, topographic information, roads and place locations will be added to this as digitized geographic information, and climatic data will be linked to each micro-region according to the meteorological stations which fall within each. Each micro-region can be used as a data-storage unit for other survey and trials data which

arise either from the SEAG-CIAT-IDRC Cassava Project or independently. Data from the 1981 agricultural census could be incorporated into this base if the geographic boundaries of the districts to which the data pertain could be identified. This would probably also require the production of a series of dot-distribution maps in collaboration with SEAG to apportion the data correctly to the micro-regions, since their boundaries will not coincide with those of the administrative units of the census.

4.1.3 Case-Study Results.

The more detailed case-study survey has yielded important information on land-use in minifundia and newly colonised areas, and on the way this affects cassava production. A sample of farms has been classified by a clustering technique based on size and the proportion of land devoted to cash crops. Amongst the smallest farms, a generally strong orientation towards cash crops reduces the area available for subsistence production to a very small quantity. Farmers in Paraguarí cultivate a greater proportion of their farm than those in Caaguazú, and it is hypothesized that this is because of differences in the cost of hired labour. Many of the largest farms in Caaguazú have significant amounts of unused land. This tends to favour cassava production in Caaguazú, since it requires less labour and purchased inputs than the alternative cash crop, cotton (although cotton is still the principal cash crop on

most farms). In Paraguarí cotton is the preferred cash crop because credit is available to cultivate it.

For the Paraguari sample of farms, the areas in recently sown and one year old cassava have been modelled, and explained in terms of (principally) farm size, but the best models include the proportion of farm area in cash crops and the number of humans and animals consuming cassava on the farm. This modelling can only be done on a simple basis for the smallest farms. On larger farms cassava is disposed of in a number of ways including payment of labourers; some farmers plant extra cassava specifically for this. In Caaguazú cassava is sown as a cash crop, and modelling of the area in cassava was not possible.

Finally some information has been obtained about soils in the two areas which suggests that there are differences in soil texture and fertility (based on pH and organic matter content) between the two areas. These are not great, however, probably due to rapid fertility decline in the sandy soils of the Caaguazú sample.

4.2. Cassava Production within an Agro-Socioeconomic System

The survey information and other descriptive material which has been used to define cassava micro-regions and the case-study material indicate the operation of interrelated sets of processes. These affect the cassava production

situation in a number of ways.

All of these processes ought to be considered in research planning and in project design, since the cassava production situation in each micro-region is a result of their interactions. Figure 4.1 attempts to illustrate these interactions.

4.2.1 Commercial cassava production and marketing

'Commercial' cassava production is concentrated in certain areas, generally in those of more recent colonisation (Map 19). Farmers in micro-regions 4, 5, 6, 11, 19, 20, 26, 27, 28, 29, 30 and 33 sell cassava to Asunción's Mercado de Abasto. In addition, farmers in micro-regions 26, 27, 29 and 30 sell cassava to starch producers in M.J. Troche (Guairá). Farmers in micro-region 23 sell cassava to local small-scale starch producers. In almost all the other micro-regions cassava is sold in limited quantities, to small urban markets or within the rural community itself. In micro-regions 10, 14, 17 and 24 no cassava is sold at all.

The concentration of commercial cassava production in recently colonised zones is a result of the relative abundance of land, and the low production costs in these areas. In Chapter 3 farmers' reasons for preferring different cash crops are described. The most commonly cited reason for growing cassava is the low labour requirements of the crop compared with cotton. Farmers are therefore able

to cultivate more of their land if they sow cassava than if they sow more labour-intensive crops. Cassava yields are higher in these areas than in the minifundia areas. (Brun et al, 1985). Production costs are therefore lower, and the volume of production so great that cassava prices in the entire region are affected. Cassava is therefore simply not a viable cash crop in the minifundia areas, even for farmers who have enough land to make them less dependent on cotton as a cash crop.

A further point in cassava's favour manifest in Repatriación, Caaguazú is its greater tolerance to drought in the very sandy soils of that area (micro-region 28), again compared to that of cotton.

The marketing situation for cassava in Paraguay is currently quite limited compared with the magnitude of production. Most cassava is undoubtedly consumed in rural areas. After Asunción, starch producers in M.J. Troche, and in Caazapá, are the second largest market (no data are available to the author to allow a comparison). Commercial starch production is therefore very centralised, and the limited markets for starch (mainly for traditional foods) restrict demand for cassava for starch. Other small-scale processing industries (mainly farina production) have limited demand for cassava.

Access to the Asunción market is reasonably good for most of the newly colonised areas in Guairá, Paraguarí and Caaguazú. The principal cassava producing micro-regions

(27, 28, 29 and 30) lie approximately 150 kms from Asunción, but producing areas in that department range from 100 to over 200 kms distant. Cassava producing areas to the North of Caaguazú, around Yhu and San Joaquín (micro-region 30) are particularly remote. Nearer Asunción, where access is improved by a denser road network, horticultural and other high value crops become more important. Only in one or two of the compañías surveyed in Cordillera, for example, are there farmers who market cassava in Asunción.

The poor quality of most rural roads and the practice of closing them to traffic when it rains create problems in the process of marketing cassava in many producing areas. Through delays, this must also add to post-harvest losses.

Cassava's flexible harvest period allows farmers who produce the crop for sale and who can find a buyer to augment their income during periods of cash scarcity. In areas such as Caaguazú this can be a major source of income at this time. In the minifundia areas farmers who have more cassava than they require for subsistence sometimes sell the crop in small quantities in local towns, similarly to increase income when cash is scarce. This takes place in micro-regions 1-3, 8, 9 , 15, 16, 18, 22, 31 and 32. Sale of cassava to neighbours who do not have sufficient for subsistence also occurs in some communities. Nevertheless, in the minifundia areas of Paraguari earnings from cassava are very limited.

4.2.2 Cash flow

Income and expenditures demonstrate marked peaks in the year for most farmers. There are few alternatives to cotton as a cash crop in the area studied, and the main ones, cassava and sugar cane have limited spatial distributions. For many farmers the most crucial period of the year is that of cultivation of cotton, and the least troubled period is that which follows the cotton harvest. In any case the existence of a winter season in which agricultural activities cease tends to create a peak demand for labour for planting in the months immediately following it. Insofar as this demand must be met by hiring labour it becomes a period of peak cash demand.

Were credit freely available to those farmers that needed it the shortage of cash would not be a problem. Official restrictions prevent farmers with no title to their land from getting loans from the B.N.F., which is by far the most widespread official source of credit (see Map 12). Instead most farmers rely on unofficial sources of credit, and pay high interest rates. In practice this prevents capital accumulation amongst the smallest farmers, since by the time cotton is harvested they owe the majority of their earnings to whoever gave them credit. The limited land resources of many farmers are perhaps the real cause behind this inability to raise enough cash from one year's harvest so that some remain during the following year's lean period. Low prices for cotton, and agricultural commodities in

general accentuate the problem (Yates 1981, p 107).

Cash flow problems are most acute, then, in minifundia areas with little diversity of cash crops. In areas such as central Guairá where there exists a market for sugar cane with some credit availability, the situation is less grave but only marginally so (since labour requirements for sugar cane are greatest for the harvest, traditionally in August and in September and December). In Caaguazú cassava sales help to even out the cash-flow on the farm in some areas, especially where land is not in short supply.

4.2.3 Cassava production for subsistence

Cassava is an extremely important part of the Paraguayan campesino's daily diet, probably more so on the smallest farms (Section 1.2.2).

A number of processes operate to create a scarcity of cassava for subsistence on these farms (Figure 4.1). Because of their scarce land resources, many farmers must choose between cultivating enough cassava to meet their needs, and cultivating enough of a cash crop to be able to earn sufficient cash to pay for schooling of their children, services and foodstuffs such as meat and oil. Informal credit is therefore a vital necessity for them; many farmers in the area studied cultivate cotton for this reason.

Survey data suggest that in at least 25 of the 33 micro-regions some farmers experience a shortage of cassava

for subsistence for part of the year, and in 2 (micro-regions 15 and 16) that a majority of farmers are in this situation. Only in 5 micro-regions, 4 of which are in Caaguazú and one Guairá, is there little or no shortage (micro-regions 21, 26, 27, 29 and 30) and only in three of these (21, 26 and 30) is there no hint of any scarcity.

Just how many farms are there that are likely to experience a shortage of cassava? In Chapter 3 (Figure 3.15) the hypothesis that farms of less than 3 ha. are not capable of meeting subsistence requirements seems to have been substantiated. Figure 3.15 suggests that farms of upto 4 ha. may in fact be included in this category. Preliminary data from the 1981 Agricultural Census (Appendix 6) do not allow the number of farms of less than 3 or 4 hectares to be calculated directly. As a surrogate the number of farms of less than or equal to 5 ha. can be calculated. This is given for each 'district' which falls within the area for which micro-regions have been defined, in Appendix 6. The data can not be accurately subdivided between the defined micro-regions since the limits of micro-regions and administrative units for which the data is recorded are unlikely to coincide (and in any case the administrative units' boundaries are not marked on available maps and often are unknown).

In the departments of Central, Cordillera, Caaguazú, Guairá, Caazapá and Paraguari there were 71,979 farms (54.6% of the total) smaller than 5 ha. in 1981. (This includes

farms classed as 'landless'. It is assumed here that this term refers to agricultural exploitations which are composed entirely of rented or sharecropped land). As a very conservative estimate, at least 60% of these must be smaller than or equal to 3 ha., since almost all of the individual districts have farm-size distribution curves which are skewed left of the 5 ha. class interval (Appendix 6). In other words, there are at least 42,000 farms of 3 ha. or less in size in these six departments. Can we assume that on all of these, farmers will not grow enough cassava to meet subsistence requirements?

As was demonstrated in Figure 3.15, some farmers may devote more of their land to producing subsistence crops rather than cash crops. The case-study data suggest that these are a small minority. The extrapolation of the case-study conditions to other areas will not be everywhere valid. In areas where more lucrative cash crops are grown, around Asunción for example, shortage of cassava (resulting from decisions to devote most of the farm to cash crops) can be offset by purchase of other foodstuffs, or indeed of cassava. Or it may be that farmers do not need to devote as much of their land to cash crops if remunerations are higher, and therefore produce more cassava. This may be the case in parts of micro-regions 1, 2, 4, 11, and 12 in the minifundia areas, in which alternative cash crops to cotton are grown and where credit may be available for small, title-less farmers to grow them. In the newly colonised

areas parts of micro-regions 27, 31, 32 and 33 have similar conditions although farms are generally larger here. Elsewhere the smallest farmers are almost entirely dependent on cotton to raise cash (sugar-growing areas are excluded since the crop has special labour and transport requirements which disfavour very small farmers). In general, then, this estimate, of the number of farmers likely to experience shortage of cassava for subsistence (from their own farm), is acceptable. It suggests that approximately one third of all farms in the six departments studied could benefit from increases in cassava production purely for subsistence purposes.

Paraguayan farmers are buying more food now than previously. This not only includes meat, oil and other essentials, but also pasta, bread and other wheat products, and rice, that is, sources of carbohydrates. Traditional maize and cassava-based foods are now less important. This may be due to the greater convenience of purchased foodstuffs, or even to lower energy requirements for preparation. But on the smallest farms, where cash is almost constantly in short supply, it can only be because the farmers cannot produce enough food. Yates (1981, p 109) makes similar observations. At times of greatest cash scarcity purchase of food on these smallest farms must cease. During the period from September to December we have seen how cassava sales within rural areas, as well as theft, increase dramatically. Because of the timing of the crop's

growing cycle, the early harvest, and small amounts planted, cassava becomes scarce on the smallest farms at precisely the time when the farmer has least alternative foodstuffs (through purchase).

Excess cassava production on farms which exceed the above minimum can be seen to play a critical role in rural society at this time. The data from the Paraguarí case study indicate that farmers with more than about 7 ha. of land dispose of significant amounts of cassava, either as gifts or to pay labourers. Labourer-farmers can meet their cassava requirements by receiving cassava in payment for work (which assists their employers who are also relatively short of cash). Sale of cassava, far cheaper than other foodstuffs, and as a last resort theft, are other means of distributing the excess of cassava between those who do not have enough. The author has no idea of how successful this process of redistribution is. Certainly the situation is worsening with respect to food consumption (production) in general (Yates, 1981, p 108-9) and malnutrition has a strong seasonal tendency. In cases of crop failure, such as that of 1985/6, the situation becomes far more grave. It is most likely that excess cassava production on un-affected farms is not enough to satisfy demand.

4.2.4 Labour shortages

Labour shortages are experienced in both newly settled areas, and in old established areas, but for

different reasons. One of the main reasons, it seems, why cassava is favoured by farmers in Caaguazú is because it has lower labour requirements than the principal alternative, cotton. Farmers perceive a labour shortage because, given the technology available to them and the amount of family labour they have, they are not able to cultivate all their land. One must assume that the remuneration from the available crops does not permit them to hire much labour. Low prices for agricultural produce are one aspect of government policy which disfavours them; the other is the high cost of imported technology such as tractors and chemical fertilizers which might allow them to increase productivity (Yates 1981 p107). The relative shortage of labour can not therefore be offset by either labour-replacing technology or by yield-increasing technology. As a result cultivation is extensive on many farms.

In the minifundia areas there is an absolute excess of labour, so much so that national and especially international migration from departments like Paraguari and Cordillera has reduced population growth-rates to a standstill, or put them in decline (Table 2.1). Lack of cash on many farms prevents hiring of this labour during periods of peak need. Labourers are faced with the choice of migration or working for payment in kind (for example cassava, as has been explained). This situation has developed as a result of differentiation in farm-size and the development of a semi-landless class. Reciprocal labour

(*minga*) is disappearing in many places as a result of this.

4.2.5 Soil fertility

The interaction of a number of factors is causing soil fertility decline. The natural conditions which favour erosion and fertility decline are accentuated by the abandonment of traditional fallowing practices (partly the result of the subdivision of land) and by the lack of an adequate technology to maintain soil fertility.

Sample data from a newly colonised area of Caaguazú and a *minifundia* area of Paraguari show few differences between soil fertility of the two areas, though the data cannot claim to be representative for the two Departments as a whole. If we accept the tentative conclusion that soil fertility differences are based on the residual effects of natural fertility under forest, then the recently colonised areas (Micro-regions 5, 9, 10, 11, 13, 14, 17, 20, 25-33) can be considered at present to have somewhat more fertile soils. There is little evidence from available soil data to suggest that there are other significant differences in soil fertility (based for example on mineral content).

Soil management does not differ between the newly colonised and older settled areas. With the exception of some horticultural producing areas (parts of micro-regions 1, 2, 4, 11 and 27) cultivation is relatively extensive. Farmers in Caaguazú and other recently colonised areas who obtain higher than average yields are entirely dependent on

the fertility of the soil for their success. How long will they continue to have such success without a change in cultivation practices? It cannot go on much longer than the time it takes to fell the remaining forest that they hold in reserve.

4.2.6 Land holding

Large numbers of farmers in the area studied do not have enough land to allow them to simultaneously produce enough cash crops to meet cash requirements and enough cassava to meet subsistence requirements. Insecure tenure aggravates the situation faced by some of them. Despite government efforts to relocate farmers from the *minifundia* areas few choose to go to new colonisation zones, for a variety of reasons (Yates, 1981). Speculation and the existence of very large *latifundios* have prevented younger *campesinos* acquiring their own land in the *minifundia* areas (Rivarola, 1982), and hence have contributed to the process of fragmentation. The small size of the majority of farms in these areas is the greatest hindrance to farmers achieving a reasonable standard of living.

Yet in Caaguazú and other areas of recent colonisation the fragmentation process is already beginning (Chapter 3, Section 3.2.1) because some farmers cannot pay off the debts they incurred on buying their land, and are selling land to clear these debts. Given the available technology, they cannot make a large enough profit from

their 10 to 20 ha. farms. Obviously some have either had bad luck or mismanaged their debts, nevetheless the tendency is worrying. Ballantyne (1985) goes as far as to argue that 50 ha. is the minimum farm size required to achieve an annual income of US$1050 (p 150) in these areas, which may partly explain this tendency.

One must also ask what the children of these farmers will do for land. Large areas in Caaguazú, Alto Paraná and other colonisation zones have been bought by speculators or sold to foreign companies (Rivarola, 1982). For how long will colonisation still provide an option in attempting to solve the land distribution problem? Whiout a solution to the problem of low prices, or the development of more appropriate technology, a repetition of what has occurred in the minifundia areas is to be expected. The social conditions which brought about the existence of a minifundia and the decline in soil fertility near the capital have merely been transferred to a different location.

4.3 Towards some Solutions

4.3.1 Which farmers?

Any attempt to provide technical and other assistance to cassava farmers in central Paraguay must begin by recognising, at the very simplest level, the existence of two types of farmers. They have some common problems, such as declining soil fertility, hence yields, and labour

shortages (albeit to different degrees). On the whole they use similar technologies to produce cassava and other crops. They have one fundamental difference: one group meets its subsistence requirements for cassava, and can commercialise the excess. The other does not meet its subsistence requirements from the cassava produced on its own farm, and must meet them from other sources. The principal cause of this difference is the difference in the amount of land to which each has access; both are equally integrated into the market economy. This simple dichotomy ought to be broadened, because not all farmers in minifundia areas have very small farms, nor is the opposite true in the areas of more recent colonisation. Some farmers who do satisfy their cassava requirements will not be interested in producing for the market, because they can grow more profitable crops.

The problems and processes going on in the region which are outlined in the previous section suggest a number of directions in which research can proceed.

4.3.2 Subsistence production

At certain times of the year, principally from September until the new harvest begins in February, there is a shortage of cassava, probably absolute at the community level (that is, even assuming redistribution of cassava between farmers who have and haven't got enough to satisfy their requirements). In few micro-regions is there no scarcity but it is particularly acute in micro-regions 15

and 16 (where work in the SEAG/CIAT/IDRC Cassava Project has already begun). Therefore, yield increasing technology, such as higher-yielding varieties, improved cropping practices or soil management should be readily accepted by even the smallest farmers as long as they do not incur higher costs (labour or cash). By increasing yields a positive contribution can be made towards nutrition, and, by decreasing the labour or cash a farmer expends to get more cassava, towards income.

Components of such a yield-increasing technology might include:

- Changes in planting periods. If continuous planting of cassava is possible (except during the winter), farmers could extend the average length of time to harvest and hence increase yields. The feasibility of this would depend on the effect of frost on young plants, planted after February for example, and on the effect of drought particularly between November and February. Two other unanswered questions are: Would there be enough labour available to permit this? and Would it be feasible within the cotton-cassava rotation? Replanting after the cotton harvest, in March and April may be the most feasible option, but then young plants would be subjected to the risk of frost damage.

- Soil fertility maintenance through the use of cover crops, leguminous intercrops and green manure. Some of this work is already planned as part of the Cassava Project (Brun

et al, 1985). Again, costs must be minimal.

Successful technology which can increase cassava production for subsistence will need massive diffusion, to at least 40,000 farmers (if the estimate made in 4.1.4 is accurate). Achieving anything near that figure is probably the greatest challenge if one takes into account the limited resources of Paraguay's extension service. Nevertheless, the agents which it has know their areas of respnsibility well, and despite problems of access due to road quality, the distances between SEAG's regional centres and even the most remote communities are not unduly large. To attempt to reach such a large quantity of farmers would require contact with groups, for example farmers cooperatives, rather than meeting farmers on an individual basis. Such organisations have not traditionally been favoured in Paraguay, and their organisation would be costly and time consuming for SEAG. Illiteracy and infrequent use of radios would prevent methods of massive information diffusion from having much success, and so the onus must really be on greater organisation despite the political and financial problems involved.

4.3.3 Production of cassava for the market

Farmers in areas such as micro-regions 5, 6, 11, 19, 20, 26-30 and 33 could benefit in a number of ways from increased cassava marketing opportunities. Decreases in losses and the increase in storage time which result from

treatment of fresh cassava with 'Mertect' can increase farmers' income (Janssen and Wheatley, 1985). Whether this technology will be successful under Paraguayan conditions still remains to be seen. Were it successful this may encourage farmers to grow more cassava, since it requires less labour than cotton, their main alternative. Relative earnings and security of the cassava market would be the decisive factors. Because of access problems it can be assumed that post-harvest losses are currently high, especially when rains cause closure of rural roads. Introduction of fresh storage technology could therefore have a tremendous impact by eliminating most of these problems.

Provision of a market for cassava or processed by-products during periods of relative scarcity of cash, mainly from September until March, will help farmers to more easily pay for labourers and meet other cash requirements. At present the principal market, for starch, has a demand curve which peaks in March and April, and prices are at a low in the final quarter of the year. Greatest benefit would be derived from increased demand during this period.

Expansion of cassava production on farms in Caaguazú and other recently colonised areas would require the introduction of labour-saving technology and of a cassava-specific credit programme. Despite the fact that cassava seems to require less labour than cotton, it is unlikely that the area in the former would be extended at

the expense of the latter, unless there was a drastic change in prices. To increase cassava production would require more intensive cultivation, new varieties, or an extension of area. The latter option is unlikely; farmers have neither the money to hire more labour or buy a tractor. As it is, labour shortages create problems for cultivating more than about 12 ha. with the aid of plough and oxen. Research is required to identify whether or not cropping system changes can reduce labour requirements, or alternatively increase yields so that the farmer needn't cultivate as much of his land. This latter option would have the additional advantage of helping maintain soil fertility, by permitting the rotation of land and fallowing or the production of green manures on unused land.

Credit for cassava producers is a necessary requirement both in areas of current commercial production and in areas where commercial production might be encouraged in the future. The need for credit has been outlined in chapters 3 and 4. (See Figure 4.1). Where farmers have titles to their land they can get credit from the B.N.F. Otherwise they must depend on unofficial credit from intermediaries, usually only if the produce cotton, or, in some places from the C.A.H. (micro-regions 1, 2, 4, 15, 17, 18, 23, 27, 28, 31 and 33). Credit is usually commodity orientated, and unofficial rates of repayment high. It is likely that the CAH would be the best source of credit for cassava growers, despite the fact that it does not reach

farmers everywhere.

The problem of soil fertility maintenance will increasingly affect farmers in recently colonised zones. Larger farmers, both here and in the minifundia areas, are more able to adopt measures to combat fertility decline, such as rotations, green manuring and intercropping with legumes than are those with least resources. Higher-yielding cassava varieties which are adapted to poor acid soils may provide a short term solution, but without the adoption of improved management techniques yields will decline eventually. As with the smallest farmers, the greatest problem is probably that of getting a solution to the farmer, once a low cost labour-unintensive package is available. In areas of commercial cassava production larger farmers, those with at least 10 ha. of land, should be willing and able to bear higher costs to maintain soil fertility if market opportunities are improved.

Some areas are unlikely to benefit from the development of cassava markets at present, because of the existence of good access and markets for high value crops in Asunción, particularly horticultural produce. These areas consist of micro-regions 1, 2, 4 and parts of 27.

Increasing the market for cassava and cassava by-products, if it proves possible in Paraguay, can bring direct advantages to many farmers. If processing is developed, then the creation of increased demand for labour can help the poorest. There exists, however, one danger

with such a programme, especially in the minifundia areas. Increasing marketing opportunities, that is, the price of cassava in these areas could have two negative effects for the poorest farmers.

Firstly, they rely on neighbours who have more land to provide them with cassava in times of shortage. If those 'better-off' farmers could sell that cassava at a higher price, then the availability of surplus cassava would decline, with serious effects for the poorest sectors.

Secondly, depending on the timing of demand for cassava, the poor would be likely to sell cassava themselves when they needed to raise cash, for example in some emergency. Without an increase in productivity they would therefore see their cassava 'consumed' even more rapidly, and would have even greater difficulty meeting their requirements at the end of the year.

Only by concentrating on production increases for subsistence on these smallest farms before the development of markets for the crop could such a situation be averted. Were a stable situation reached, the creation of markets for cassava could benefit both the poorest and those who are better off, particularly during the cash scarcity period at the end of the year.

S U M M A R Y

Cassava plays an extremely important part in urban and rural diets and as an animal feed in Paraguay. Available data suggest that per capita urban and rural consumption in Paraguay are the highest in Latin America. CIAT is encouraging research on the crop in Paraguay via a joint project with the agricultural extension service (S.E.A.G.) and IDRC of Canada. CIAT's Agroecological Studies Unit has undertaken to characterise the project area by defining cassava-specific micro-regions.

As an introduction, census data are presented which show that cassava production is concentrated in the departments of (in order of importance) Caaguazú, Itapúa, San Pedro, Paraguarí, Cordillera, Caazapá, Guairá and Alto Paraná. Data from a S.E.A.G. survey suggest that rural per capital cassava consumption is higher than previous estimates, and may be as high as 340 kilograms per annum. Despite the enormity of production, S.E.A.G. identifies a number of problems, including low soil fertility and large distances to market from the principal producing areas, which constrain production and limit the use of the crop somewhat outside of rural areas.

The micro-region definition work has been carried out in the departments of Central, Cordillera, Guairá, Paraguarí and in part of Caaguazú and Caazapá. The method used draws on secondary data and on informal and formal field survey data. Field data are collected using a systematic-random sample of agricultural settlements.

The whole study area is considered to be climatically homogeneous. Topography is on the whole undulating, but there are some steep cordilleras for which separate micro-regions are derived. Soils can be subdivided into red and yellow podzolics (acrisols) and hydromorphic soils (planosols and gleysols). The latter are not used for campesino agriculture. Within the podzolics some important textural differences are identified from existing maps and by conferring with farmers, and some of these provide the basis for defining separate micro-regions. The limits of the micro-regions correspond to those of the areas of cultivated land. These are identified by excluding low-lying pasture, forest and large cattle ranches, all identifiable from available maps.

Agricultural production is differentiated on the basis of the principal cash crops grown. Differences in modal farm size are found to exist, depending on whether settlements are old or newly colonised. Farm size, marketing opportunities and the principal cash crops affect factors such as cash flow, credit availability and the use of fertilizers, and are used in the process of micro-region definition.

Cassava production in both old established settlements and newer colonies relies on traditional methods of land preparation with plough and ox, rotation and, if land is available, fallowing. Varieties are classified according to optimum age at harvest, but in some areas this classification becomes redundant and cassava is harvested as soon as possible when needed for subsistence. Cassava is produced for sale to Asunción and to starch producers in Guairá department, principally in Caaguazú and eastern Guairá. In many areas cassava shortages occur amongst the smallest farms, and particularly in central Paraguarí.

The variables and information used to define and describe the micro-regions are presented as a series of qualitative maps. The micro-regions are derived and mapped by overlaying these and comparing them manually. They are then described in a quick-reference table.

To gain a deeper insight into some of the processes affecting cassava production, a small farm-level survey has been carried out on a random sample of farms in Paraguarí and Caaguazú departments. Size of farms in the sample is described, and sample size distribution compared with census data. Fragmentation of farms in Caaguazú is noted. Land tenure, cultivated area, proportion of the farm in cash crops, farmers' preferences amongst cash crops and the reasons for their preferences are compared for the two halves of the sample. The existence of unutilised land is

examined. Because of shortages of labour, many farmers in Caaguazú do not cultivate all of their land, and farmers in Paraguarí tend to cultivate a higher proportion of their farm area. In Caaguazú this favours the cultivation of cassava as a cash crop, since it requires less labour and other purchased inputs than the main alternative, cotton.

The area in recently sown, one year, and older cassava is described for the whole sample. Farms are identified which do not have sufficient cassava to meet subsistence needs. Shortages of cassava are related to the cultivation of a large proportion of their area in cash crops.

The area recently sown in cassava is described for the Paraguarí sample by a model which takes into account farm size, proportion of farm area in cash crops and the number of animals on the farm. This is not possible for the Caaguazú sample because some farmers sow cassava for sale.

A further model is presented which accounts for the area of one year old cassava (for consumption) on the Paraguarí farms, utilising farm size. the proportion of farm area devoted to cash crops, and the number of people and cassava consuming animals. Those farms from which some cassava was disposed of off the farm are excluded from the model.

Farmers who sell cassava in Caaguazú do not sow more of the crop because other crops are more profitable. In Paraguarí those who can meet subsistence needs do not produce the crop commercially because of low prices (lack of

a market). Those who do not meet their subsistence requirements cannot sow more for lack of land, and must trust that they will be able to get cassava from neighbours or buy it.

On each farm, a sample of soils has been collected from cassava fields (recently sown). Soils from Paraguarí are compared with those from Caaguazú. Significant differences in pH, organic matter content and sand, silt and clay contents exist between the two samples. Considering the short period of cultivation of the Caaguazú soils, organic matter content is nevertheless low, and it is concluded that the differences in fertility between the two are based on the residual effects of natural fertility from forest clearance. Soil management (fallowing and use of purchased inputs) does not differ between the two areas, and is most notable for its absence. Three soil types recognised by farmers and used to define the micro-regions are compared using the same soil data. Significant differences in texture exist between some of them.

In conclusion, the survey methods and principal findings are reviewed, and the results from both the micro-region definition and the case-study are integrated. The interaction of a set of processes is stressed. The juxtaposition within the study area of areas of commercial cassava production and areas where the crop is in short supply for subsistence are caused by and dependent upon

varying market opportunities, problems of cash supply, labour shortages, soil fertility differences and, most profoundly, variable access to land.

Researchers need to recognise the distinction between farmers that produce the crop commercially and those that cannot meet subsistence requirements. Possible ways of increasing cassava production for subsistence, such as the introduction of new varieties and improved soil management will be acceptable to most of the poorest farmers if they do not involve increased costs. The advantages of increased market opportunities for some farmers are outlined. It is stressed that in minifundia areas there may be negative effects on the poorest if market opportunities are improved before the problems of subsistence production are solved.

References

BALLANTYNE, A. O. 1985. Subsistence production - What comes next? Agricultural Administration, 20 (1985) 139-152.

CARTER, S.E. 1986a. A method for collecting and organising data on the agro-socioeconomic environment for a crop commodity programme (cassava). Paper presented at the Workshop on Agroecological Characterisation, Classification and Mapping. FAO, Rome, 14-18 April 1986.

CARTER, S.E. 1986b. Climatic and Edaphic Classification at a Continental Scale (1:5,000,000) for Cassava in South America. Internal document, Agro-ecological Studies Unit, Centro Internacional de Agricultura Tropical (CIAT). Cali, Colombia.

CENTRO INTERNACIONAL DE AGRICULTURA TROPICAL (CIAT). 1979. Yuca: Investigación, producción y utilización. CIAT/UNDP. Cali, Colombia.

CENTRO INTERNACIONAL DE AGRICULTURA TROPICAL (CIAT). 1985. Annual Report 1984. Cassava Program. CIAT. Cali Colombia.

CONOVER, W.J. 1980. Practical non-parametric statistics. Second edition. John Wiley and sons, New York.

DIRECCION GENERAL DE ESTADISTICA Y CENSOS. 1985. Censo Nacional de Población y Viviendas, 1982(1). Dirección General de Estadística y Censos, Asunción, Paraguay.

FOOD AND AGRICULTURE ORGANISATION OF THE UNITED NATIONS (FAO). 1969. Estudio ecológico de los bosques de la región oriental del Paraguay. Documento de Trabajo No.1, Proyecto de Desarrollo Forestal y de Industrias Forestales. FAO: SF/Paris. Asunción, Paraguay 1969.

GALEANO, L.A. 1974. Las explotaciones agrícolas en el Paraguay. Hacia una interpretación sociológica de las características regionales. Revista Paraguaya de Sociología, 31(1974).

INSTITUTO GEOGRAFICO MILITAR. Mapa Nacional 1:250,000. Asunción, Paraguay. (Various dates of publication).

INSTITUTO GEOGRAFICO MILITAR. Carta Nacional 1:100,000. Asunción, Paraguay. (Various dates of publication).

JANSEN, W. and WHEATLEY, C. 1985. Urban Cassava Markets. The impact of fresh root storage. Food Policy, August 1985.

LAWES AGRICULTURAL TRUST; 1983. GENSTAT (General Statistical Package) Users' guide. Version 4.04. N.A.G. Ltd., Oxford.

LYNAM, J.K. 1986. Trends in Cassava. 1985. In: Trends in CIAT Commodities. Internal Document - Economics 1.11. April 1986. Centro Internacional de Agricultura Tropical, Cali, Colombia. p 111-121.

LYNAM, J.K. and PACHICO, D. 1982. Cassava in Latin America: Current status and future prospects. Centro Internacional de Agricultura Tropical, Cali, Colombia.

MINISTERIO DE AGRICULTURA Y GANADERIA (MAG). 1976. Proyecto de diversificación agrícola en el departamento de Paraguarí (Distritos de Ybycuí, Acahay y La Colmena). MAG-BID-IICA. Asunción, Paraguay.

MINISTERIO DE AGRICULTURA Y GANADERIA (MAG). 1981. Zonificación esquemática e indicación de especies de crecimiento rápido para experimentación y reforestación en Paraguay. Documento de Trabajo No.25; Proyecto PNUD/FAO/SFN Par 76/005. M.A.G. Asunción, Paraguay.

MINISTERIO DE AGRICULTURA Y GANADERIA (M.A.G.). 1983. Preliminary results (unpublished) Censo Nacional Agropecuario 1981. M.A.G. Asunción, Paraguay

ORGANIZACION DE LOS ESTADOS AMERICANOS (O.E.A.). 1971. Cuenca del Rio de la Plata. Estudio para su planificación y desarrollo. Inventario y análisis de la información básica sobre recursos naturales. Secretaría de la Organización de los Estados Americanos, Washington, D.C.

RIVAROLA, D.M. 1982. Estado, modernización agrícola y diferenciación campesina en el Paraguay. In: Estado, campesinos y modernización agrícola. Centro Paraguayo de Estudios Sociológicos (CPES). Asunción, Paraguay. p 21-95.

YATES, M.J. 1981. Colonists and 'campesinos': Small-scale agricultural production and rural life in eastern Paraguay. Unpublished Ph.D. thesis. University Microfilms International, Ann Arbor, Michigan.

APPENDIX 1: Semi-structured Framework for Informal Interview, Cassava Production, Paraguay.

1. CROPS

1.1 What crops are cultivated?

1.2 Which of these are most important i) for subsistence (including animal feeding) ii) for sale? Which is the most important and why?

1.3 What animals are bred i) for on-farm consumption ii) for sale? How many typically?

1.4 What are the main expenses which farmers have to make during the year? How is this money acquired and how do the solutions vary amongst different farms?

1.5 Which crops or products (including animals) are most reliable for meeting cash needs? Which crops or products have unreliable markets and/or low prices?

2. CULTIVATION

2.1 How long do farmers cultivate a field with the same crop? Are crops rotated? Which and over what time period?

2.2 Do any farmers leave land in fallow? Which, how often and for how long?

2.3 Do any farmers use fertilizers or manure on their crops? What, for which crops? How much is applied and when? Which farmers?

2.4 How is land prepared for cultivation and with what implements?

2.5 Do any farmers use insecticides or herbicides? Which farmers? For which crops? What products, when are they used, how often and to combat what?

3. LAND

3.1 How much land do farmers sow in subsistence crops? How much do they think is necessary to satisfy their requirements, according to the size of their family?

3.2 How much land is used for pasture, and how many animals does it support? How much land is dedicated to forest/bush, to forest trees and to fallow land. How do these quantities vary amongst different (sized) farms?

3.3 What types of land tenure exist, and which are most common? What are the advantages? Disadvantages associated with different types of tenure?

3.4 Which crops are more/less likely to be cultivated by large/small farmers? Why?

3.5 What size of farm is common? Do farmers have access to more land through other types of land tenure? Is land in short supply? What are the effects of this on the status of subsistence production?

4. CASSAVA PRODUCTION

4.1 What varieties of cassava are sown, and at what age are they harvested?

For each:

Is it sown in monoculture or intercropped?

Intercropped with what? Planting distances? How much (area or number of plants) is sown? When do farmers begin to harvest a) for subsistence? b) for sale?

4.2 What roles do crops that are intercropped with cassava play in subsistence and income generation?

4.3 Which varieties of cassava yield better? Which varieties does the farmer prefer, and why?

4.4 How long does cassava last once harvesting begins? What factors control its duration?

4.5 How much cassava is left over each year when the new harvest begins? Of which varieties?

4.6 Is this variable? How do farmers decide how much to sow the following year?

4.7 Are cassava yields still as high as when farmers began to cultivate the crop on their present farm?

4.8 How much cassava is used for human consumption, for how many people and for animals (which and how many) daily?

4.9 Do any farmers experience a shortage of cassava at any time? When and why? Which farmers? What types of food are eaten when the farmer has no cassava of his own? What is fed to animals in these periods?

5 SALE OF CASSAVA

5.1 Do farmers sell any cassava? Who and where? How much is sold and how often? At what prices (current)? When are cassava prices highest and for which market? Do any farmers sow some cassava specifically for sale? How much? What were prices like last year and the previous year?

5.2 For what type of use do farmers sell cassava (fresh market, farm production, etc.)

5.3 Do any farmers process cassava on the farm? What type of processing? Is there a starch factory or other processor of cassava? To where are the end-products sold? At what prices?

5.4 If there were more opportunities to sell cassava would farmers sow more? Why?

5.5 What problems does the farmer recognise which affect or are associated with cassava production (Pests, diseases, social problems, soil fertility, etc.)?

6. SOILS AND VEGETATION

6.1 When was the settlement founded? How long has farming been going on?

6.2 Do any farms have forest? How much? Do any farmers cultivate rozãdos?

6.3 How do farmers distinguish between different types of soil? What crops and what cassava varieties are used in each? Is there any significant differentiation with respect to cassava?

6.4 What types of soil give the best yields? Where are they in relation to topography and drainage and vegetation? What types of weeds are found in these? Why do differences in fertility occur, according to farmers?

6.5 Do farmers notice erosion in their fields? Do they cultivate all slopes? Do they use any methods of soil conservation? How is land prepared on sloping ground?

6.6 Do farmers sow cassava on poorly drained soils? Which? Does rotting occur? How is it avoided?

7. LABOUR

7.1 For which activities is family labour used? When does the farmer and his family have to work hardest?

7.2 For which activities is labour hired? In which months, and in which months is labour most expensive?

7.3 Do delays in cultivation occur due to scarcity of labour? When? Which activities and crops are affected?

7.4 Is minga (reciprocal labour) practised in the community? For which activities?

7.5 In which months is there little or no work for labourers?

8. ACCESS AND MARKETING

8.1 Which crops does the farmer market and which does he sell to intermediaries?

8.2 What types of transport are used by farmers to market their produce?

8.3 What type of road reaches the community? How far is it to the market where most farmers sell their produce?

9. SETTLEMENT CHARACTERISTICS

9.1 Does the community have: electric light; a church; a school?

9.2 Do extension agents visit the community? How often? Is there a farmer's cooperative or committee?

9.3 What types of rural industry or handicrafts exist in the community?

9.4 (What are the differences between older settlements and newly established settlement in terms of these characteristics?)

APPENDIX 2: Questionnaire used in the Formal Survey.

CASSAVA PRODUCTION AND AGROSOCIOECONOMIC CHARACTERISTICS
Version 2, October 1985, San Lorenzo, Paraguay

AGROECOLOGICAL STUDIES UNIT, CIAT, COLOMBIA
AND SERVICIO DE EXTENSION AGRICOLA GANADERA, MAG, PARAGUAY

Questionnaire Number : .....

Place: Compañia/Colonia : .....

Distrito : .....

Departamento : .....

Name of Interviewer : .....

Date of Interview. Day : .....

Month : .....

Year : .....

SECTION 1.1 CROPS AND OTHER SOURCES OF INCOME

1.1.1 Which of the following crops and plants are found in this COMPAÑIA? (Mark with an 'x' in the following table)

1.1.2 Of those which you have indicated which are sold only in small quantities (unimportant) and which are sold a lot (important)? (Mark with an 'x' in the Table)

	CROP/PLANT	PRESENT (DURING THE YEAR)	SOLD A LITTLE	SOLD A LOT
1	GARLIC			
2	ALFALFA			

	CROP/PLANT	PRESENT (DURING THE YEAR)	SOLD A LITTLE	SOLD A LOT
3	COTTON			
4	RICE			
5	PEAS			
6	BANANA			
7	SWEET POTATO			
8	COFFEE			
9	SUGAR CANE			
10	STRAWBERRIES			
11	SUNFLOWER			
12	BEANS (PHASEOLUS V.)			
13	CASSAVA			
14	"CHIPA" MAIZE			
15	"LOCRO" MAIZE			
16	"TUPI PYTA" MAIZE			
17	PEANUT			
18	BITTER ORANGE			
19	POTATO			
20	PINEAPPLE			
21	COWPEA			
22	MELON/WATERMELON			
23	SOYA			
24	TOBACCO			
25	CASTOR-OIL			
26	TOMATO			
27	WHEAT			

	CROP/PLANT	PRESENT (DURING THE YEAR)	SOLD A LITTLE	SOLD A LOT
28	TUNG			
29	GRAPES			
30	YERBA MATE			
31	SQUASH			
32	COCOTEROS			
33	OTHER FRUIT TREES			
34	OTHER VEGETABLES			
	OTHERS			

.1.3 Do farmers in the compañía have milk cows ?

Yes	
No	

.1.3.1 If they do, do they sell milk and other dairy products ?

0	No	
1	A little	
2	A lot	

.1.3.2 Where to ? .....

.....

1.1.4 Which of the cash crops grown provides most money for the farmers of this compañía (including dairy products) ?

.....

.....

1.1.5 Which of the following non-agricultural activities are practised by the farmers of this compañía ?

1	Charcoal making for sale	
2	Firewood cutting for sale	
3	Handicrafts	
4	Brick-making	
	Others:	

1.1.6 Which is the most important activity for earning money for the farmers here ?

1	Sale of agricultural produce	
2	Sale of handicrafts	
3	Non-agricultural work within the compañía	
4	Non-agricultural work outside of the compañía	

1.1.7 Generally, in which months is cash scarce for the families of the compañía ?

J	F	M	A	M	J	J	A	S	O	N	D

SECTION 2.1 CASSAVA CULTIVATION

2.1.1 What are the names of the first, second and third most commonly cultivated cassava varieties in this compañía ?

Variety 1 (most common)	
Variety 2	
Variety 3	

2.1.2 Do the farmers here sow a variety of cassava for harvest around about 6 months after planting ?

Yes	
No	

2.1.2.1 If they do, what is it called? (Indicate more if they sow more than one)

.....

.....

2.1.3 Do the farmers here sow a variety of cassava for harvest around about a year after planting ?

Yes	
No	

2.1.3.1 If they do, what is it called? (Indicate more if they sow more than one)

.....

.....

2.1.4 Do the farmers here sow a variety of cassava for harvest 18 months or more after planting?

Yes	
No	

2.1.4.1 If they do, what is it called. (Indicate more if they sow more than one)

.....

.....

2.1.5 Which of the varieties of cassava named are used for the following:

	USE	VARIETIES
1	Subsistence	
2	Sale	
3	Others:	

2.1.6 What are the cropping systems in which cassava is sown in the compañía ?

	CROPPING SYSTEM	AGE OF THE CROP	
		Year One	Year Two
1	Monoculture		
2	Intercropped with maize		
3	Intercropped with cowpea		
4	Intercropped with melon/watermelon		
5	Intercropped with peanut		
	Intercropped with other:		

2.1.7 Which is the most common cropping system practised by the farmers in this compañía ?

For recently sown cassava?	
For one year old cassava?	

SECTION 2.2 SALE OF CASSAVA

2.2.1 Do farmers in the compañía sell their cassava?

Yes	
No	

If cassava is not sold, continue in Section 2.3.

2.2.2 Where do they sell their cassava, and to whom ?

1	On the farm, to neighbours	
2	On the farm to an intermediary	
3	In a nearby town to an intermediary	
4	In a nearby town, to the inhabitants	
5	In Asunción's Mercado de Abasto	
	Other:	

2.2.3 In which months is most cassava sold ?

J	F	M	A	M	J	J	A	S	O	N	D

2.2.4 In which months is little or no cassava sold ?

J	F	M	A	M	J	J	A	S	O	N	D

2.2.5 If cassava is sold to an intermediary (on the farm) where is it taken to ?

.....

.....

2.2.5.1 What is it sold for ?

1	Fresh consumption	
2	Starch production	
	Other:	

SECTION 2.3 : STARCH PRODUCTION

2.3.1 Does anybody make starch in this compañia ?

(If not, continue in Section 2.4)

Yes	
No	

2.3.2 In which months is most starch made?

J	F	M	A	M	J	J	A	S	O	N	D

2.3.3 Which cassava varieties are used for starch production?

.....

.....

2.3.4 Is the starch produced here sold ?

0	No
1	A little
2	A lot

(If none is sold, continue in Section 2.4)

2.3.4.1 Where is it sold ?

.....

.....

2.3.5 In which months is no starch sold, or least starch sold?

J	F	M	A	M	J	J	A	S	O	N	D

2.3.6 Do any starch producers here buy cassava to make starch?

Yes	
No	

2.3.6.1 Do they buy in a local market?

Yes	
No	

2.3.6.2 Where?

.....

2.3.6.3 Do they buy from intermediaries that bring cassava from other zones?

Yes	
No	

2.3.6.4 Where do the intermediaries bring the cassava from?

.....

.....

SECTION 2.4 OTHER ASPECTS OF CASSAVA PRODUCTION

2.4.1 Do any farmers experience a shortage/scarcity of cassava (for subsistence) ?

0	There is never shortage of cassava	
1	Some farmers run short	
2	The majority of farmers run short	

(If there is never any scarcity/shortage of cassava, continue in Section 2.4.4)

2.4.2 In which months is scarcity experienced?

J	F	M	A	M	J	J	A	S	O	N	D

2.4.3 Why do some farmers experience scarcity of cassava on their farms?

1	Lack of land to sow enough	
2	They begin to harvest too early	
3	They sell cassava and don't leave enough for their needs	
4	They don't have enough seed	
	Others:	

.4.4 Does cassava get stolen in this compañía?

Yes	
No	

.4.4.1 If it does, in which months does it tend to happen ?

J	F	M	A	M	J	J	A	S	O	N	D

.4.5 If there is shortage of cassava for some farmers, do they bring cassava from elsewhere to meet their needs?

Yes	
No	

.4.5.1 In which months?

J	F	M	A	M	J	J	A	S	O	N	D

2.4.5.2 From where do they bring cassava?

.....

.....

2.4.6 Do intermediaries bring cassava from othe zones to sell in this compañía?

Yes	
No	

2.4.6.1 In which months?

J	F	M	A	M	J	J	A	S	O	N	D

2.4.6.2 From where do they bring the cassava?

.....

.....

2.4.7 What production problems affect cassava here, and which varieties suffer damage?

	PROBLEMS	VARIETIES AFFECTED
1	Root rots after prolonged rain ?	
2	Stemborers ?	
3	Hornworm ?	
4	Poor germination due to drought ?	
	Others:	

EPARTMENT / strict	FARM SIZE CATEGORIES (Ha.)									
	0	0-<1	1-<5	5-<10	10-<50	50-<200	200-<1000	1000+	Total <5 ha.	Total
RAGUARI										
raguarí	90	233	510	116	102	12	11	5	833	1079
ahay	138	258	920	506	396	29	5	1	1316	2253
apucú	7	328	328	105	156	94	37	32	663	1087
ballero	57	97	503	278	339	33	7	1	657	1315
rapeguá	9	533	1760	640	529	82	15	1	2302	3569
cobar	3	77	340	205	225	21	1	4	420	876
Colmena	1	18	132	121	201	30	5	0	151	508
uyapey	2	83	563	356	360	50	12	18	648	1444
rayú	17	360	639	239	95	19	4	0	1016	1373
iindy	45	382	1042	346	204	37	14	7	1469	2077
yquyhó	5	243	614	161	124	30	19	13	862	1209
que G.de Sta. Cruz	0	357	818	336	263	24	3	1	1175	1802
oucaí	11	153	203	377	238	9	2	0	367	993
oicuary-Mi	3	124	190	65	118	32	5	0	317	537
guarón	39	623	1077	331	139	5	6	3	1739	2223
ycuí	5	256	1284	764	833	100	30	8	1545	3280
ytimí	15	140	453	336	217	25	13	2	608	1201
Total	447	4265	11376	5282	4539	632	189	96	16088	26826
TOTAL	3773	20483	47723	30497	25750	2553	662	284	71979	131725

DEPARTMENT District,	FARM SIZE CATEGORIES (Ha.)									
	0	0-<1	1-<5	5-<10	10-<50	50-<200	200-<1000	1000+	Total <5 ha.	Total
GUAIRA										
Villarrica	145	595	938	447	338	36	16	4	1678	2519
Borja	9	119	505	381	381	45	13	4	633	1457
J.E. Estigarribia	3	43	195	277	433	78	8	2	241	1039
M.J. Troche	3	98	299	343	232	12	0	0	400	987
Cnel. Martínez	88	186	268	119	58	6	3	2	542	730
F.P. Cardozo	2	152	324	97	55	13	2	1	478	646
E. Garay	5	81	404	327	273	19	3	0	490	1112
Col. Independencia	0	168	554	834	726	66	8	0	722	2356
Itapé	20	159	440	173	109	10	1	2	619	914
Iturbe	53	82	283	184	202	23	9	3	418	839
José Fassardi	1	59	310	167	115	5	2	1	370	659
Mbocayaty	44	183	316	180	166	22	7	3	543	921
Natalicio Talavera	11	146	254	219	127	8	0	0	411	765
Ñumi	3	21	159	150	150	6	0	0	183	489
San Salvador	42	56	157	74	88	14	4	1	255	436
Yataitay	5	275	248	54	50	3	2	2	528	639
Paso Yobai	2	61	188	220	311	54	6	2	251	844
San Agustin	0	15	59	38	254	11	2	0	74	379
Total	433	2456	5706	4007	3635	353	78	24	8836	16692
CAAGUAZU										
Cnel. Oviedo	8	555	2072	1946	1645	64	25	10	2635	6325
Caaguazú	21	628	3591	3080	1545	131	38	4	4240	9038
Carayaó	33	150	486	596	384	35	21	4	669	1709
Cecilio Baez	1	62	309	267	346	31	5	4	372	1025
J.R. Chávez	10	117	589	820	497	49	18	3	716	2103
J.M. Frutos	4	90	550	484	379	33	5	0	644	1545
Repatriación	7	56	553	1170	1146	39	4	1	616	2976
Hugo Stroessner	0	124	380	303	329	67	11	6	504	1220
San Joaquin	4	162	939	673	510	26	12	3	1105	2329
San José	26	246	690	499	308	36	16	8	962	1829
Yhu	63	141	957	1847	1721	166	37	19	1161	4951
Total	180	2374	11311	11962	9243	755	200	64	13624	36089
CAAZAPA										
Caazapé	61	342	1180	686	727	70	28	5	1583	3099
Abaí	16	49	335	147	768	32	1	0	400	1348
Buena Vista	9	53	235	192	162	18	9	0	297	678
Moisés Bertoni	2	110	229	155	66	15	0	11	341	588
Gral. Morinigo	11	83	212	245	267	29	5	2	306	854
Maciel	16	54	253	177	97	9	3	6	323	615
San Juan Nepomuceno	3	256	651	688	1080	126	10	6	910	2820
Tabaí	19	29	311	198	241	48	8	1	359	855
Yegros	8	69	321	184	177	33	8	7	398	807
Yuty	49	452	1718	736	887	92	25	20	2219	3979
Total	194	1497	5445	3408	4472	472	97	58	7136	15643

PPENDIX 6: Farm size distribution by Department and District, 1981. (Source: Censo cional Agropecuario 1981. Datos Preliminares. M.A.G.).

PARTMENT strict	FARM SIZE CATEGORIES (Ha.)									
	0	0-<1	1-<5	5-<10	10-<50	50-<200	200-<1000	1000+	Total <5 ha.	Total
NTRAL										
eguá	67	554	350	91	63	7	0	0	971	1132
piatá	153	788	580	177	79	4	1	0	1521	1782
o. de la Mora	93	122	13	3	6	0	0	0	228	237
arambaré	16	262	136	44	21	3	1	0	414	483
á	3	667	1170	359	153	6	2	1	1840	2361
aguá	636	440	766	192	62	0	0	0	1842	2096
mbaré	171	57	30	2	2	0	0	0	258	262
mpio	42	520	271	39	23	9	2	0	833	906
que	133	591	332	63	43	6	3	2	1056	1173
riano R. Alonso	51	140	64	6	16	0	0	0	255	277
eva Italia	1	154	214	136	113	7	3	0	369	628
mby	56	309	152	26	5	1	0	0	517	549
n Antonio	27	210	70	11	11	2	0	0	307	331
n Lorenzo	279	498	147	21	23	4	0	0	924	972
lla Elisa	94	186	49	9	15	0	0	0	329	353
leta	16	284	621	151	127	22	10	10	921	1241
acaraí	76	127	168	47	55	11	3	0	371	487
ané	44	78	175	42	23	1	0	0	297	363
Total	1958	5987	5308	1419	840	83	25	13	13253	15633
RDILLERA										
acupé	137	370	614	283	197	16	2	0	1121	1619
os	4	338	453	208	176	21	2	0	795	1202
oyos y Esteros	34	470	705	225	225	36	13	11	1209	1719
rá	59	306	520	230	166	16	6	0	885	1303
aguatay	6	275	1126	397	275	23	4	3	1407	2109
oscada	64	123	103	53	52	4	5	2	290	406
ebio Ayala	46	348	616	357	263	14	6	1	1010	1651
a Pucú	6	239	648	253	117	9	1	0	893	1273
curubi de la C.	1	136	541	219	104	3	3	0	678	1007
n de Mera	35	102	248	93	57	14	7	3	385	559
a Grande	0	31	175	84	48	6	0	2	206	346
cayaty	17	52	231	148	150	14	3	3	300	618
va Colombia	9	57	170	225	121	8	0	1	236	591
ibebuy	87	488	1024	604	429	24	1	0	1599	2657
de Marzo	20	136	318	325	97	1	0	0	474	897
Bernardino	0	157	135	81	61	5	0	0	292	439
ta Elena	0	73	297	147	70	7	7	0	370	601
ati	36	145	300	264	135	12	11	3	481	906
enzuela	0	58	353	223	278	25	2	0	411	939
Total	561	3904	8577	4419	3021	258	73	29	13042	20842

Farm	Area in fallow	Area occupied by natural pastures	Area occupied by artifical pastures	Area occupied by forest	Number of adults	Number of children	No.of animals fed cassava				
							milk cows.	adult pigs	young pigs	oxen	horses
42	20000	30000	15000	80000	4	3	3	3	0	2	0
43	10000	0	0	0	3	3	0	0	2	0	0
44	40000	0	0	20000	5	3	1	2	0	2	0
45	20000	0	0	0	6	3	1	3	0	2	0
46	0	40000	0	5000	7	10	4	0	9	2	0
47	0	0	15000	30000	2	4	2	5	0	2	0
48	0	0	10000	60000	4	0	4	0	6	2	0
49	0	0	0	2500	3	2	3	2	0	3	0
50	20000	10000	0	0	2	3	1	0	2	0	0
51	0	0	15000	60000	4	3	2	1	4	0	0
52	0	30000	0	0	4	4	5	0	3	2	0
53	2500	0	0	15000	5	2	3	7	0	3	0
54	0	2500	0	20000	3	1	2	0	0	0	0
55	0	7500	1000	10000	5	0	1	0	0	3	0

re	Area in fallow	Area occupied by natural pastures	Area occupied by artifical pastures	Area occupied by forest	Number of adults	Number of children	No.of animals fed cassava				
							milk cows.	adult pigs	young pigs	oxen	horses
1	20000	0	0	0	3	5	1	1	0	4	2
2	12000	0	0	0	2	8	2	2	0	0	0
3	0	0	0	0	2	5	1	3	0	0	0
4	0	0	0	0	5	0	0	2	0	0	0
5	0	200	100	0	2	5	0	1	0	2	0
6	0	0	20000	7500	2	0	1	4	0	2	0
7	0	80000	10000	0	2	1	1	2	0	0	0
8	0	0	0	8000	4	5	1	0	2	2	0
9	0	0	0	0	2	5	1	0	1	0	0
0	0	6000	0	0	1	0	3	1	0	0	0
1	5000	0	0	5000	7	3	3	3	3	0	0
2	0	0	0	0	2	9	1	0	2	0	0
3	15000	15000	2300	0	5	4	0	12	0	0	0
4	0	0	0	0	3	0	2	2	0	0	0
5	5000	0	500	0	2	4	1	0	3	2	0
6	0	5000	5000	0	5	5	3	0	2	2	0
7	0	10000	0	0	2	4	0	3	0	0	0
8	5000	0	10000	0	3	2	2	2	0	0	0
9	0	0	14000	5000	2	4	3	2	0	0	0
0	0	0	1600	0	3	7	0	2	0	0	0
1	0	0	0	0	2	6	4	2	0	0	0
2	10000	0	5000	0	3	2	2	3	0	4	1
3	0	0	0	0	3	2	1	2	0	2	0
4	0	15300	0	0	2	6	1	0	2	0	0
5	0	0	30000	0	2	7	2	0	2	2	0
6	0	0	7000	0	4	3	1	5	0	2	0
7	0	5000	0	0	2	8	0	0	0	4	0
8	0	15000	5000	0	3	3	1	4	0	2	1
9	0	15000	0	0	5	10	3	2	0	0	0
0	0	20000	0	0	1	0	0	0	0	0	0
1	10000	0	15000	45000	5	0	0	0	0	2	0
2	0	5000	0	5000	4	2	3	5	0	2	0
3	0	0	0	10000	8	5	3	5	9	2	0
4	0	0	0	7500	2	6	1	1	0	2	0
5	0	0	0	5000	3	7	1	1	4	0	0
6	0	40000	0	10000	4	2	2	1	3	1	0
7	0	0	0	0	7	1	0	2	3	0	0
8	25000	0	20000	15000	2	2	4	3	0	1	0
9	0	0	35000	80000	4	6	4	7	0	2	0
0	20000	0	0	20000	4	7	1	0	5	2	0
1	130000	0	0	7500	6	5	0	3	0	0	0

Farm	Estimated Area	Area Cultivated	Percent	Area occupied by cash crops	Area occupied by recently sown cassava	Area occupied by 1 year old cassava	Area occupied by 2 year old and older cassava
42	227336	77336	34.0	60000	20000	20000	5000
43	45385	32385	71.3	25000	3000	3000	0
44	184900	119900	64.8	90000	30000	5000	0
45	86200	61200	70.9	50000	10000	5000	0
46	151600	91600	70.9	50000	15000	7500	1200
47	116650	66650	57.1	55000	25000	5000	0
48	210000	140000	66.7	135000	20000	4000	0
49	52900	40400	76.4	30500	11500	6500	0
50	87000	57000	65.5	45000	40000	5000	1000
51	167700	87700	52.3	80000	40000	5000	0
52	65400	35400	54.1	10000	2500	400	0
53	56100	36100	64.3	31500	7500	12500	300
54	84500	60000	71.0	45000	2500	5000	5000
55	123700	90200	72.9	54250	18500	0	5000

APPENDIX 5. Selected land-use data, inhabitants and animals which are fed cassava from the case-study sample of farms.

Farm	Estimated Area	Area Cultivated	Percent	Area occupied by cash crops	Area occupied by recently sown cassava	Area occupied by 1 year old cassava	Area occupied by 2 year old and older cassava
01	157108	135108	85.9	100000	10000	3000	0
02	76476	63976	83.6	22500	9500	0	0
03	29920	29420	98.3	15000	4000	1200	0
04	33300	32400	97.3	22400	2500	1500	0
05	31140	30840	99.0	17500	5600	1000	0
06	106400	78900	74.1	41950	1500	3300	0
07	211100	121100	57.4	80000	15000	8000	0
08	94450	85950	91.0	35000	8700	2800	0
09	17450	16250	93.1	10000	2000	500	0
10	21200	14700	69.3	3800	4500	700	0
11	107170	87170	81.3	40000	9000	3000	0
12	24166	22666	93.8	3600	5500	3000	0
13	139100	103800	74.6	53750	19500	4000	0
14	66316	62316	93.9	21000	13000	2700	0
15	46112	38112	82.6	20750	6000	1800	0
16	93825	83825	89.3	55000	6500	4000	0
17	41245	31245	75.7	16500	5600	1800	0
18	86900	66900	76.9	40000	11000	4000	0
19	63436	41436	65.3	26000	3200	3000	0
20	27450	24850	90.5	15000	5400	0	0
21	20170	19170	95.0	10750	3000	0	0
22	105400	82900	78.6	33000	8000	4000	0
23	61325	58825	95.9	30400	4800	2500	0
24	48760	30760	63.0	20000	9500	0	0
25	72870	39870	54.7	15000	3000	6000	0
26	108225	98225	90.7	62000	9500	7000	0
27	79325	73325	92.4	44000	8000	4500	0
28	55570	35570	64.0	17250	6400	2600	0
29	58725	38725	65.9	8000	11500	4400	0
30	56350	33850	60.0	22500	1300	800	0
31	200550	125550	62.6	120200	15000	10000	0
32	93420	78420	83.9	54000	7400	5000	0
33	111530	91530	82.1	80000	35000	4000	0
34	61600	44100	71.6	38800	10000	1800	0
35	48325	40825	84.5	37600	16000	1200	0
36	105300	45300	43.0	29000	6000	2500	2500
37	14450	12450	86.1	9000	9000	0	0
38	106496	36496	34.3	33000	7000	6000	0
39	218725	93725	42.8	61000	12500	5000	1000
40	126050	86050	68.3	46000	10000	10000	0
41	204500	67000	32.8	55000	0	5000	0

D4. When was the last time the field was left in fallow and for how long?

_____

D5. Have you ever applied fertilizers or animal manure to this field? When (approximately), what type of fertilizer did you apply and how much?

_____

_____

_____

C3. Have you used chemical fertilizer this year?

Yes	
No	

On which crops?

_____

_____

SECTION D. SOIL SAMPLE

Soil sample, to be collected from the farmer's recently sown cassava field.

Depth of sample (core/pit): _____ cm

D1. Description of field:

Topography:

_____

_____

Type of soil according to farmer:

_____

_____

Crops present:

_____

D2. Use last year:

_____

D3. Use the year before last:

_____

_____

B8. Why don't you plant more cassava?

SECTION C. USE OF CREDIT AND FERTILIZERS

C1. Did you get credit this year?

Yes	
No	

If yes, from who?

What for, and what form did the credit take (money, seeds, etc.)?

C2. If you have cattle or oxen, do you collect the manure? what do you do with it?

Yes	
No	

B5. Do you still have cassava for consumption at the present time? (see A3)

Yes	
No	

If you do still have cassava, how long do you believe it will last?

_____

_____

_____

B6. If you do not normally produce enough cassava for subsistence, or if you have run out during recent years, why do you think this happens?

_____

_____

_____

_____

_____

_____

B7. Have you sold cassava this year

Yes	
No	

If you have, how much did you sell, approximately, when, where/who to?

Date	Quantity sold	Destination/buyer

SECTION B. CASSAVA PRODUCTION AND USE

B1. How many people are there living permanently on the farm?

Adults (14 +) _____

Children (< 14) _____

B2. Do you have a milk cow, pigs, or other animals which are fed cassava regularly? How many?

Milk cows	
Pigs	
Others:	

B3. What date (for example to the nearest 1/2 month) did you begin to harvest new cassava this year?

_____

Why did you begin to harvest at that time?

_____

_____

B4. When you began to harvest new cassava, did you still have cassava from last year, or had it run out?

_____

_____

If it had already run out, for how many months approximately did you not have your own cassava?

_____

_____

A6. Which crops do you prefer to grow for sale and why?

CROP	REASONS

Crop	Intercropped or associated with (Do not repeat for intercrops)	Area (m^2) (No. of lines, length and distance between)	Sale or subsistence
Tobacco			
Castor oil			
Tomato			
Grapes			
Yerba Mate			
Squash			
Vegetable garden			
Others:			

A4. How much of the farm (approximately) is occupied by the following:

Use	Area (m^2)
Fallow (Cocuré)	
Natural passtures	
Artificial pastures	
Forest	
Unoccupied land including (House):	
Other:	

A5. If farmer does not use all the land on his farm (for example if he has forest or fallow land) why not?

_____

_____

A3. Which of the following crops are present on this farm, and how much area does each occupy, in monoculture and intercropped? State whether each is grown principally for sale or for subsistence.

Crop	Intercropped or associated with (Do not repeat for intercrops)	Area (m^2) (No. of lines, length and distance between)	Sale or subsistence
Garlic			
Alfalfa			
Cotton			
Rice			
Peas			
Banana			
Sweet potato			
Sugar cane			
Strawberries			
Beans (Phaseolus V.)			
Cassava:			
Recently sown			
One year old			
2 or more years old			
Maize "chipa"			
Maize "locro"			
Maize "tupi pyta"			
Peanuts			
Bitter orange			
Potato			
Pineapple			
Cowpea			
Watermelon/melon			
Soya			

APPENDIX 4: Questionnaire used in case-study samples in Paraguarí and Caaguazú.

LAND USE AND CASSAVA PRODUCTION

S.E. Carter. Agro-ecological Studies Unit
Cali, Colombia
Version 2, October 1985. San Lorenzo, Paraguay

Questionnaire number [ ] Date: _____

Compañía _____

Distrito _____

SECTION A. LAND USE:

A1. How many hectares has your farm in total? _____ m²

Do you own your land or occupy it without a title?

_____

(If respondent owns the farm it should be distinguished whether he has his title, or is in the process of acquiring it (provisional ownership))

A2. Do you cultivate land on somebody else's farm or rent land?

Yes	
No	

Area _____m²

If yes, under what form of tenure?

_____

Total Area (sum of A1 and A2): _____

APPENDIX 3: Named cassava varieties recorded during the formal survey.

1. Acá chará
2. Azabache
3. Azuca-í
4. Brasilero
5. Caballero (caballero-í)
6. Canó (cano-í)
7. Canó guazú
8. Canó Pytá-i
9. Cele
10. Chaco
11. Chará (cahará; chará-í; Tava-i)
12. Chiquita
13. Clavel
14. Concepción (conché)
15. conché-i
16. Coronel
17. Curuguaty
18. Curupica-y
19. Especial
20. Especial-í
21. Jhovy
22. Lambaré-í
23. Mamone
24. Mandi-ó Coronel Oviedo
25. Mandi-ó Pytá
26. Meza-í
27. Mitá
28. Morenita
29. Moroti (Rama Moroti)
30. Palanca
31. Palomita
32. Paraguarí
33. Pirayú
34. Pomberí
35. Punta Acuá
36. Pytái-í
37. Querobe
38. Raí
39. Raza
40. Raza-i
41. Rama Pytá (Pytá)
42. Rubito
43. Say-yú
44. Say-yú-í
45. Señorita
46. Señorita guazú
47. Señorita pytá
48. Señorita tempranera
49. Tacú
50. Tacuará
51. Tacuará jhovy
52. Tacuará say-yú
53. Tapo yo-á
54. Tihí
55. Toque-í
56. Toledo (Toledo-í)
57. Toto
58. Verde olivo
59. Yacarati-á
60. Yerutí
61. Yerutí caballero
62. Yerutí-í
63. Yerutí-jhovy
64. Yu (Yu-í)

SECTION 3.6 CREDITO

3.6.1 . Do any farmers in the compañía get credit to finance their crops?

Yes	
No	

3.6.2 Who provides them with credit?

1	Friends (private sources)	
2	Intermediaries	
3	Banco Nacional de Fomento	
4	Crédito Agrícola de Habilitación	
	Other:	

3.6.3 For which crops is credit available?

.....

.....

3.4.4.2 How do they take them to market (means of transport)?

.....

.....

SECTION 3.5 LAND TENURE AND FARM SIZE

3.5.1 What size of farm is most common in the compañía?

1	Less than 3 hectares	
2	3-7 hectares	
3	More than 7 hectares	

3.5.2 What type of tenure do most farmer in the compañía have?

1	Titled ownership	
2	Provisional ownership	
3	Squatting	

3.5.3 Do any farmers rent land in the compañía (payment in cash)?

1	Nobody	
2	Some farmers	
3	The majority of the farmers	

3.5.4 Do any farmers sharecrop land in the compañía (paying with produce)?

1	Nobody	
2	Some farmers	
3	The majority of the farmers	

SECTION 3.4 ACCESS AND MARKETING

3.4.1 Which of the following types of roads serve the compañía?

1	Dirt	
2	Cobbled	
3	Asphalt	

3.4.1.1 If there is only a dirt road, how far is it to the nearest asphalt or cobbled road?

.....

3.4.2 If sugar-cane is cultivated for sale in the compañía, does there exist a winch for loading cane onto trucks in the compañía?

Yes	
No	

3.4.2.1 If there isn't, how far away is the nearest?

.....

3.4.3 Is there an intermediary who buys agricultural produce from the farmers in the compañía?

Yes	
No	

3.4.3.1 If there is, which crops, etc. does he buy most often?

.....

.....

3.4.4 Do the farmers of the compañía take produce to market to sell themselves?

Yes	
No	

3.4.4.1 Where to?

.....

3.2.4.2 If not, on which crops is it used?

.....

.....

3.2.5 Do any farmers put chemical fertilisers on their crops?

Yes	
No	

3.2.5.1 On which crops?

.....

.....

SECTION 3.3 SOILS

3.3.1 Which of the following soil types are found around the compañía?

3.3.2 Which are used for cultivation?

	S O I L	Exists	Cultivated
1	Yby pytá-ité (clay)		
2	Yby pytá (sandy loam)		
3	Ybycui-Moroti (sand)		
4	Itarayi (stony)		
	Others:		

3.3.3 Of the soils indicated, which is most common around the compañía?

.....

.....

SECTION 3.2 LAND USE AND SOIL FERTILITY

3.2.1 Do farmers of the compañía leave land in fallow after cultivation?

Yes	
No	

3.2.1.1 If not, why?

1	Not necessary	
2	There isn't enough land	
	Other:	

3.2.2 Which of the following agricultural weeds are found in fallow land in the compañía?

1	Chirca	
2	Aguararuguay	
3	Malva Blanca	

3.2.3 Are there tree trunks from deforestation in the fields around the compañía?

Yes	
No	

3.2.4 Do any farmers in the compañía use animal manure on their fields?

Yes	
No	

3.2.4.1 Do they put it on all their crops?

Yes	
No	

SECTION 3.1 SETTLEMENT AND VEGETATION

3.1.1 In what year was the compañía colonised (founded)?

.....

If the exact date is not know, was it:

1	Less than 10 years ago?
2	10-20 years ago?
3	20-50 years ago?
4	50-100 years ago?
5	More than 100 years ago?

3.1.2 Is there any secondary forest/bush around the compañía?

Yes	
No	

3.1.2.1 If there is, do the farmers cultivate rozados in it?

Yes	
No	

3.1.3 Is there any high primary forest around the compañía?

Yes	
No	

3.1.3.1 If there is, do the farmers cultivate rozados in it?

Yes	
No	