AGRICULTURAL LAND USE AND RELATED INNOVATION AND GOVERNMENT ASSISTANCE IN RIO GRANDE DO SUL, BRAZIL

By

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ABSTRACT

AGRICULTURAL LAND USE AND RELATED INNOVATION
AND GOVERNMENT ASSISTANCE IN
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The economy of Rio Grande do Sul, Brazil's southernmost state, is based largely on agriculture and livestock production, and the variety of crops grown reflects the state's diversity of physical and cultural environments. Livestock ranching, commercial rice and wheat growing, and small-scale subsistence agriculture traditionally have been important in the state's economy. However, by the 1960s commercial soybean production also emerged as a major factor in agriculture, and by 1977 the export of this crop dominated the rural economy. Such rapid growth in the importance of one crop resulted in widespread changes in agricultural land use over a short period of time. Given the importance of agriculture in the state, there was a need to identify, delimit and map existing crop-livestock regions in Rio Grande do Sul, as well as to assess the role of government assistance to agriculture and the adoption of innovations.

The investigation is both descriptive and exploratory. The descriptive part includes an analysis of existing crop-livestock regions and subregions of the state, delimited in part through the author's preparation of an updated crop-livestock land-use map utilizing government air photographs. The review of literature, geographic overview of Rio Grande do Sul, and nonformal interviews with agricultural technicians, university professors, researchers, bankers, farmers and ranchers, were also descriptive in nature.

The exploratory portion of the study consisted of administering a formal interview schedule to a selected sample of thirty-two agriculturalists representative of large and small landholdings in eight <u>municípios</u> of the state. Those interviewed were also representative of farmers producing three major crops, i.e., wheat, soybeans and rice. The schedule consisted of thirty-eight questions concerning personal characteristics, type of crop produced, area cultivated, crop rotation, use of extension service, agricultural marketing and perception of success or failure in agriculture. Methods used in evaluating the statistical significance of the data consisted of Chi-Square, Analysis of Frequencies and Pearson Correlation.

Several conclusions are considered valid as a result of the statistical analyses:

1. Chi-Square analyses indicate that a significant relationship exists between agricultural yields and landholding size, and between agricultural yields and the use of extension services.
2. The Pearson Correlation analyses seem to indicate that:
   a. the higher the educational level, the less time in agriculture;
   b. the higher the educational level, the higher the agricultural yields;
   c. the higher the educational level, the greater the tendency of owners to rent property;
   d. the greater the organizational membership, the higher the ownership level;
   e. the higher the membership in agricultural organizations, the greater the use of extension centers;
   f. the smaller the landholding, the greater the use of extension services;
   g. the greater the use of extension services, the lower the incidence of crop diseases;
   h. the greater the participation in agricultural experiments, the greater the adoption of new ideas.

In addition, the study revealed widespread agricultural land-use changes, including expansion of the commercial soybean production zone. Strong geographic variations in the level of agricultural development were noted throughout the various regions of the state, i.e., some areas are characterized by dynamic agricultural changes, while others remain technologically stagnant. The creation of federal crop-livestock research centers, and the consolidation of agricultural extension services to eliminate duplication of effort, exemplifies the government's commitment to further agricultural development in Rio Grande do Sul.

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CHAPTER I

INTRODUCTION

Rio Grande do Sul is Brazil's southernmost state. Its economy is based primarily on agriculture and livestock, except near Porto Alegre and some nearby communities to the north. In general, the state produces middle latitude crops due to its poleward location compared with other parts of Brazil, but wet rice and manioc are also grown. Rio Grande do Sul is outside the primary coffee growing zones of the country since it is occasionally subject to low winter temperatures and killing frosts. The state is a major producer of soybeans, wheat, rice, black beans, corn, manioc and beef. Specialty crops such as tobacco, grapes, onions and peaches are also important in specific locations. Soybeans are produced mainly for export to Western Europe and Japan, and are processed both by Brazilian subsidiaries of multinational corporations operating in the state and by large agricultural cooperatives. The same is true of beef production. Other crop-livestock products are marketed primarily in Rio Grande do Sul or elsewhere in Brazil.

Soybeans are now Brazil's second ranking export after coffee, and Rio Grande do Sul is the nation's most important producer.[1] Large-scale production of soybeans in southern Brazil has increased dramatically in recent years. The output of Rio Grande do Sul increased from 432,000 tons in 1968 to 4,688,521 tons in 1975.[2] In 1976 the state harvested 5,107,000 tons, which accounted for slightly more than 40 percent of Brazil's total crop.[3] In 1977 production in the state reached 5,678,000 tons out of an estimated 13 million tons for all Brazil.[4] The crop is cultivated mainly in the central plateau area of the state, but recent research indicates that production is increasing in the central depression (a traditional rice-growing area) as well. Soybean production is mechanized where terrain permits, but a substantial amount is also derived from hilly, small landholding areas where mechanization is difficult or impossible.

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[1] Brazil, Ministério das Relações Exteriores, Boletim Especial No. 28 (Brasília: April 20, 1977), p. 1; and "Perspectivas da Soja," Folha da Tarde (Porto Alegre, Brazil: March 1, 1977), p. 4.

[2] Data furnished by the Comissão Estadual de Planejamento Agrícola--Rio Grande do Sul (CEPA-RS), Secretaria da Agricultura, Porto Alegre, Brazil, November 1977.

[3] Brazil, Fundação IBGE, Anuário Estatístico do Brasil, 1976 (Rio de Janeiro: IBGE, April 1977), p. 172.

[4] CEPA-RS, op. cit.

Wheat is grown mainly in the same areas as soybeans, as a complementary crop. As in the case of soybeans, Rio Grande do Sul is Brazil's leading wheat producer, followed by the state of Paraná. But, wheat yields have been highly variable in years past, due to rains, disease and warm weather. Attempts at national self-sufficiency in wheat production consequently have been unsuccessful. The state's wheat harvest of 708,750 tons in 1977 was only 39 percent of the previous year, when the state harvested 56 percent of the national total of 3,225,830 tons.[5]

The cultivation of wet rice is also important. Again, Rio Grande do Sul is the largest producer in Brazil, despite competition from new producing areas elsewhere in the country. Of the 9,560,389 tons produced nationwide in 1976, 1,850,000 tons, or about 20 percent, were from Rio Grande do Sul.[6] In 1977, rice production in the state was slightly more than 2,000,000 tons.[7] The crop is grown in many parts of the state, including coastal lagoon areas, the Uruguay River lowlands in the far west and the central depression west of Porto Alegre. Production is almost entirely mechanized, although some rice is harvested manually on small rented plots of land.

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[5]Ibid., and Anuário Estatístico do Brasil, 1976, p. 172.

[6]Anuário Estatístico do Brasil, 1976, pp. 167-168.

[7]CEPA-RS, op. cit.

Manioc, corn, black beans and sweet potatoes, plus a variety of citrus and other fruits, are produced in the state and especially in the escarpment zone of the Serra Geral north of Porto Alegre. These crops are cultivated principally on small landholdings owned by European colonists. Sale of the produce is mainly through government and public markets in the Porto Alegre area. In addition, specialty crops such as tobacco and grapes are produced to the north and west of Porto Alegre. Tobacco, and now wine, enter the international export trade of the state.

Porto Alegre is Rio Grande do Sul's chief domestic market for agricultural produce, as well as its capital city and a port of some significance. However, due to shallows and silting in the adjacent Guaíba estuary, most export crops as well as canned and frozen beef, are shipped via the deep-water port of Rio Grande about 150 miles south of Porto Alegre.

Agricultural expansion and improvement have tended to be slow outside the major soybean-wheat and rice producing areas. Disequalities in the level of agricultural development are evident in various parts of Rio Grande do Sul and quite pronounced between large and small landholdings. A worthy goal for planners would be to eliminate the strong contrast in agricultural and social development between and within existing agricultural regions. Major constraints on further agricultural development include competition from areas nearer the national urban markets

of São Paulo and Rio de Janeiro, insufficient capital to improve agricultural practices among small-scale farmers, increased soybean production at the expense of foodstuffs and land-use competition resulting from the disappearance of the state's agricultural frontier.

The national and state governments of Brazil have traditionally neglected agriculture in favor of more spectacular and dynamic developments in the industrial sector of the economy. This is evidenced by a 3.5 percent growth rate in agriculture for 1973 as compared with a 15 percent growth rate by industry in the same year.[8] However, planners throughout Brazil now realize that overall economic growth is especially dependent on agricultural development since secondary economic activities, such as agribusiness, are directly linked with the primary sector. The Second National Development Plan of Brazil, for 1975 through 1979, reflects the increased concern of government regarding agricultural growth. During this period, agriculture was expected to grow 7 percent per annum.[9] The growth rate for 1975 was only 3.4 percent, but this was due largely to high coffee crop losses from severe frosts in Paraná state rather

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[8] "Decon Study Shows Industry as the Leader," Brazilian Bulletin 562 (March 1974): 3.

[9] II PND-Plano Nacional de Desenvolvimento, Brazil's Second National Development Plan 1975-79 (Rio de Janeiro: British Chamber of Commerce in Brazil, May 1975), p. 92.

than to neglect on the part of agriculturalists, technicians or planners. In 1976 the rate of agricultural growth for Brazil was 4.2 percent, much of it due to increased soybean production in Rio Grande do Sul and Paraná states.[10]

Agricultural expansion in Brazil for the year 1977 was expected to substantially surpass the 1976 growth rate, due largely to a 41 percent increase in agricultural credit.[11] Such an increase should have a direct effect in Rio Grande do Sul, especially among small-scale farmers who can benefit from the additional credit. Likewise, Brazil's agricultural research and extension services are being expanded and reorganized. In Rio Grande do Sul, the Associação Sulina de Credíto e Assistência Rural (ASCAR) and some state government agencies providing similar functions were being consolidated in 1977 to provide better service and to eliminate duplication of effort.

The Problem

Agricultural development and farm income vary throughout Rio Grande do Sul to the extent that existing disequalities are major obstacles to economic growth. Much of the problem is rooted in the great diversity of

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[10]Brazil, Banco Central do Brasil, Banco Central do Brasil Annual Report 1976, Vol. 13, No. 4 (Brasília: Central Bank of Brazil, 1977), p. 15.

[11]Brazil, Ministério das Relações Exteriores, Boletim Especial No. 34 (Brasília: July 20, 1977), p. 1.

landforms, vegetation, climate and soils. In addition, certain historical and institutional factors reflected in the present crop-livestock land-use patterns restrict modernization and progress. Major constraints include great differences in agricultural yields between large and small properties in some areas, inefficient land-use practices in many extensive beef cattle areas, a paucity of agricultural innovation by both large and small producers due to lack of incentive, low market prices, and insufficient access to agricultural credit by those who need it most.

In some cases, agricultural land-use practices may limit crop and livestock productivity. For example, wheat is generally produced on the same landholdings as soybeans, as a sequential crop, since terrain favors the mechanized production of both. But, while the state's climate is favorable for soybeans, it is only marginal for wheat. Relatively moist weather and mild winter temperatures during the growing season favor disease and make wheat production a high risk activity. The success of soybeans as an export crop has encouraged many small operators to plant soybeans rather than such staple food crops as black beans, which are less lucrative. Ensuing shortages of black beans make importation necessary and result in higher prices. This, in turn, adversely affects nutrition among poor people of the state and nation. Livestock producers are confronted with serious problems as well. During winter months animal

nutrition is a serious problem, principally in the extensive grazing areas of the state. The carrying capacity of unimproved pasture is low, and large landowners are reluctant to invest in artificial pastures without additional government incentive and/or better beef prices.

Despite substantial improvements in agricultural research, extension services and rural credit programs, low income from agriculture remains the chief socio-economic problem of most small-scale farmers. Many are receptive to innovations but cannot afford to adopt them due to the high cost of procurement and implementation. Other obstacles to innovation adoption also exist. The small area of landholdings makes innovation uneconomical in many cases. Furthermore, some tenant farmers are reluctant to adopt innovations for use on lands to which they have no title.

Substantial changes over a short period of time in agricultural land use, government assistance programs and technology adoption made planning maps obsolete and served as the chief stimulus for this study. Upon arrival in Brazil it was noted that updated agricultural land use maps depicting the growth of soybean production as well as other recent changes in land use were unavailable for crop-livestock regionalization work or study purposes. The task at hand therefore was to prepare a new agricultural land-use map and crop-livestock regionalization, and to describe and interpret the regions and subregions delimited in

relation to a variety of factors including government assistance and innovation.

Purpose of the Study

The purpose of the study is to define, delimit, analyze and assess the crop-livestock regions in Rio Grande do Sul, relating this to innovation adoption and government assistance to agriculture. More specifically, the objectives are to:

1. Identify and delimit the major crop-livestock regions of Rio Grande do Sul.
2. Identify and describe expanding, contracting or shifting patterns of land use, for purposes of agricultural planning which is particularly important in view of the rapid growth of soybean production since 1965.
3. Identify the level of innovation adoption in each of the delimited regions with respect to the distribution of government assistance.
4. Evaluate the role of government assistance in the agricultural development of the state and provide insight for the improvement of agricultural programs.
5. Provide an updated agricultural land-use map of Rio Grande do Sul for comparative purposes that can be used by persons or institutions in that state charged with the regional planning of agriculture.

Methodology

This dissertation is designed to be both descriptive and exploratory. It constitutes a detailed geographic analysis of agriculture and ranching in Rio Grande do Sul. The location and areal extent of specific types of agricultural systems were ascertained through numerous field traverses and the interpretation of recent (1975) air photos covering the state. This resulted in an updated regionalization of agriculture and a new agricultural land-use map. Factors affecting the existing patterns of crop-livestock activities were also examined. These include the effect of time-distance, as well as transportation mode, on agricultural land use and marketing; innovation adoption and diffusion; agricultural research; and availability and utilization of agricultural extension services. Specific attention was given to agricultural land use as a function of market distance in the light of Griffin's findings in neighboring Uruguay.[12] To enhance this comparison a geographic traverse was made through that republic.

The dissertation consists of: (1) a comprehensive agricultural land-use map prepared specifically for this study; (2) smaller scale crop-livestock maps depicting major agricultural land-use regions and subregions in Rio Grande do Sul; and (3) presentation, description and

[12] Ernst C. Griffin, "Agricultural Land Use in Uruguay" (Unpublished Ph.D. dissertation, Michigan State University, 1972).

analysis of interview data obtained from farmers. Government agricultural personnel in many communities, representing every agricultural production zone in the state, were interviewed. Informal interviews using a short questionnaire were also conducted with agricultural cooperative officials, bankers, university personnel and others. The information obtained was used for descriptive purposes, unlike that from a formal interview schedule which was administered to obtain a statistical sample.

Formal interviewing included the administration of the structured interview schedule developed by the researcher to agriculturalists residing within eight selected <u>municípios</u> in predetermined crop and size-of-landholding regions. The instrument, prepared to test data collected, covered personal history, land tenure arrangements, size of landholding, agricultural land use, innovation in agriculture, government assistance and marketing time-distance. The intent of the formal interviewing was to test three research hypotheses formulated for the study which are stated in Chapter II--Design of the Study.

Definition of Terms

The following terms are defined here as used in this study:

1. Cluster sample: a representative sample of agriculturalists cultivating one of the crops under study

in a particular area of a selected _municípío_, which is roughly the equivalent in English to "county."

2. Large landholding: a property within the statistical sample which has at least 150 hectares of soybeans, rice or wheat under cultivation.
3. Small landholding: a property included in the selected samples which does not exceed fifty hectares of soybeans, rice or wheat under cultivation.
4. Rotation: the planned movement of crop-livestock activities from one area to another within the same landholding for purposes of soil rejuvenation and erosion control.
5. Succession: the sequential planting of a second crop on the same land but in a different season of the year.

Scope and Limitations of the Study

The study constitutes a geographical assessment of agricultural land use and related government assistance and agricultural innovation in Rio Grande do Sul. Although the scope of the study is broad, several limitations apply to interviewing. The informal interviews included government agricultural specialists, university personnel and government officials, but excluded farmers. Conversely, the structured interview schedule was administered only to agriculturalists in the eight selected _municípios_. The latter were either large or small-scale producers of one of the

three selected crops: soybeans, wheat and rice. These crops were selected on the basis of their great importance in the state's economy, and secondly because they are produced in quantity on both large and small landholdings. The _municípios_ chosen exhibit agricultural yields and land-holding size that typify much larger areas.

Because of the large size of Rio Grande do Sul, a cluster sample design was employed where possible. This procedure was adaptable to the time, budgetary and transportation constraints of the researcher, and to limitations of the cooperating government agency which provided transportation and personnel. The number of persons interviewed, usually five or six in each cluster, was necessarily small. But, the sample selected is as representative as possible under the conditions precedent.

Where interviews were conducted in a multi-crop region, i.e., the soybean-wheat region, they were mutually exclusive. That is, a farmer producing both crops was eligible to be interviewed only for one crop so as to maintain sample validity.

For purposes of the cluster samples selected for inclusion in this study, large landholdings are those which have at least 150 hectares of soybeans, rice or wheat under cultivation. Small landholdings are those with no more than fifty hectares of any of the crops being studied. Statistical analysis of the data is limited to the selected variables under study.

Sources of Information and Assistance

Principal sources of information and assistance in archival research included federal and government agencies, universities and agriculture-related firms. These organizations furnished maps, publications and verbal information.

During the study of agricultural land use, five major sources of information and assistance were employed. All are headquartered in Porto Alegre. The Central de Comandos Mecanizados de Apoio à Agricultura (CEMAPA) supplied land-use maps and gave the author permission to use its air photos of Rio Grande do Sul so that existing crop-livestock regions could be determined. The Superintendência do Desenvolvimento da Região Sul (SUDESUL) provided publications on rural areas of southern Brazil having specific development problems, including the western portion of Rio Grande do Sul's beef cattle area. The Fundação Metropolitana de Planejamento (METROPLAN), an organization charged with overall planning of the fourteen *municípios* comprising the Porto Alegre metropolitan area, provided information on the same as well as agricultural land use within the zone. The Instituto Nacional de Colonização e Reforma Agrária (INCRA) provided maps, cadastral data and soils information on the state as well as materials on agricultural colonization. Publications by the Fundação de Economia e Estatística (FEE) also were useful for this phase of the study.

Information on agricultural credit, marketing and production were provided mainly by four organizations: the Banco do Brasil, S.A., the Banco Central do Brasil, the Comissão de Financiamento da Produção (CFP) and the Comissão Estadual de Planejamento Agrícola (CEPA/RS). The Banco do Brasil, the nation's principal supplier of agricultural credit, provided information on agricultural loans and wheat marketing. The Banco Central supplied publications on government allocation of financial resources for agricultural development. The Comissão de Financiamento da Produção provided publications and interviews relative to minimum prices in agriculture and the market effect on agricultural land use. Finally, the Comissão Estadual de Planejamento Agrícola (CEPA/RS) provided statistical data on agricultural productivity and crop yields.

Five other organizations provided information on transportation development in Rio Grande do Sul. The Departamento Estadual de Portos, Rios e Canais (DEPRC) supplied data on waterborne commerce and agricultural exports. The Departamento Nacional de Estradas de Rodagem (DNER) and the Departamento Autônomo de Estradas de Rodagem (DAER) provided information on farm-to-market roads. Information on rail movements of agricultural products and fertilizers was furnished by the Rede Ferroviária Federal, S.A. (RFFSA). Data on the state's "export corridors" were provided by the Empresa Brasileira de Planejamento de Transportes (GEIPOT).

Four organizations provided most of the information obtained regarding diffusion and adoption of agricultural innovations, as well as technology transfer from government to agriculturalists. The Associação Sulina de Crédito e Assistência Rural (ASCAR) provided information on agricultural extension and innovation adoption patterns in various parts of the state. The author also received institutional support from ASCAR in the form of transportation to and from four of the six formal sampling areas. In addition, permission was granted to visit ASCAR facilities not involved in the formal sampling effort for the purpose of additional data collection on the study topic. The Instituto Rio Grandense do Arroz (IRGA) provided innovation information pertaining to rice production and extension services. In addition, IRGA provided transportation to and from the remaining two sampling areas. The recently created Associação Rio Grandense de Empreendimentos de Assistência Técnica e Extensão Rural (EMATER-RS), which succeeds ASCAR, provided information on the administrative reorganization of agricultural extension currently underway in Brazil and particularly in Rio Grande do Sul. Likewise, the Federação de Cooperativas Brasileiras de Soja e Trigo (FECOTRIGO) furnished data on soybean and wheat yields which were vital for sample area determination. This organization also provided much information on agricultural research and extension by member cooperatives.

Information on the role of agricultural research and development was supplied mainly by five organizations. The Instituto de Pesquisas Agronômicas (IPAGRO) was visited concerning new crops, hybrids, seeds, methods of cultivation and the effects of mechanization. The organization supplied data on research for all experiment stations in the state. The four agricultural research facilities of the Empresa Brasileira de Pesquisa Agropecuária (EMBRAPA) in Rio Grande do Sul were visited, as well as the EMBRAPA facility at the Universidade Federal de Pelotas (UFPel). EMBRAPA furnished the researcher with transportation to and from a nearby experiment station and provided printed materials.

Information and publications regarding university activities in the field of agricultural training and research were provided by the Faculdade de Agronomia e Veterinária of the Universidade Federal do Rio Grande do Sul (UFRGS), and by the Escola de Agronomia "Eliseu Maciel" of the Universidade Federal de Pelotas (UFPel). The Instituto de Ciências Rurais at the Universidade Federal de Santa Maria (UFSM) was contacted regarding agricultural training and research at that institution.

Other sources were also utilized. Information on mechanization and acceptance of new agricultural ideas was obtained from agribusiness representatives at state crop-livestock expositions. Conversations held at agricultural conferences, cooperative federations and public markets

also proved valuable. Prior to the author's arrival in Rio Grande do Sul, visits were made to the Instituto Brasileiro de Geografia e Estatística (IBGE), in Rio de Janeiro, and to EMBRAPA and INCRA headquarters in Brasília. These three agencies provided publications and orientation prior to the field research.

CHAPTER II

DESIGN OF THE STUDY

The design of the study required the delimitation of existing crop-livestock regions in Rio Grande do Sul as the central focus of the dissertation. This is reflected in the agricultural land-use map effort and subsequent regionalization of agriculture. The effect of government assistance, innovation adoption and other factors affecting land use was investigated during interviewing and incorporated within this context.

The descriptive part of the study is based on information obtained from publications and from visits to all areas of Rio Grande do Sul. This part focuses on the explanation and interpretation of the agricultural land-use map and the map of crop-livestock regions.

Interviews with government technicians were conducted in eighteen communities in various agricultural regions of the state. Since it was impossible to visit every agricultural extension office, representative centers were chosen. The offices were selected because of their location in specialty crop production areas, or because they are key assistance facilities for a larger region.

In very large regions, two offices relatively distant from each other were visited.

In nearly all cases the interview was conducted with the chief agronomist, who was asked twenty specific questions about agricultural land use, innovation and government assistance in the surrounding area. The technician was encouraged to expand upon any relevant topic or any question asked, if he so desired. Most interviews lasted about one hour. Offices of the Associação Sulina de Crédito e Assistência Rural (ASCAR) were frequently visited. Questionnaires were mailed to three ASCAR offices not visited, but no replies were received. The information obtained from interviews with ASCAR personnel was used only for descriptive purposes. Numerous other interviews were conducted with agricultural cooperative officials, bankers, university personnel and farmers.

The exploratory portion of the study was based on an interview schedule developed for use during conversations with farmers residing in selected areas. Six sampling areas, covering portions of eight municípios in four geographic regions of Rio Grande do Sul, were selected for formal interviewing. These areas were representative of different crop and size-of-landholding regions in the state. A special effort was made to select municípios that would constitute a cross-section of innovation adoption and government assistance utilization patterns.

All data for the study were collected personally by the researcher. It was originally anticipated that several trained interviewers would be employed during the formal interviewing phase of the study, but this proved unnecessary considering the sample size. Also, anticipated researcher-respondent language problems did not materialize, since the interviews were conducted during the latter stages of field work when the author had become sufficiently competent in Portuguese.

The statistical analysis presented in this chapter is based on responses tabulated from the interview schedule.

The Population Sample

Where possible, a cluster sample was used in selecting agriculturalists to be interviewed. Major parameters of the sample include the sampling frame, type of sample and sample size.

The Sampling Frame

The interview schedule was used to gather data from farmers producing one of the three selected "target crops," on small and large holdings, within selected municípios. The crops, namely soybeans, wheat and rice, were selected primarily for their importance and representativeness in the state's agricultural economy. Soybean cultivation has been extremely successful in Rio Grande do Sul and is a positive factor in Brazil's balance of payments. Conversely, due to climatic and disease factors, wheat has been and

continues to be a high risk crop despite substantial government assistance to producers. One of the principal staple crops in Rio Grande do Sul is wet rice, from which yields and receipts are gradually increasing. However, rice production is not characterized by speculative production, as is soybean cultivation, nor is it easily jeopardized by unfavorable weather conditions.

Other crops, such as black beans, grapes and tobacco are grown primarily on small holdings and were therefore subordinated to soybeans, wheat or wet rice in the statistical sample. Cattle ranching is associated primarily with large holdings and was therefore likewise excluded. These and other aspects of agriculture were investigated through the informal interviews.

A general idea as to suitable sampling areas was obtained through analysis of land-use maps and aerial photographs. Extensive field traverses and crop production data at the _município_ level provided additional information for the selection of specific _municípios_ for sampling purposes. Another criterion was that the selected _municípios_ be reasonably accessible from government extension centers, since innovation through government assistance comprises an integral part of the study.

The location and type of selected sampling areas are depicted in Figure 1. These include eight _municípios_ served by six different government extension offices. Six of the _municípios_ are served by four offices of the

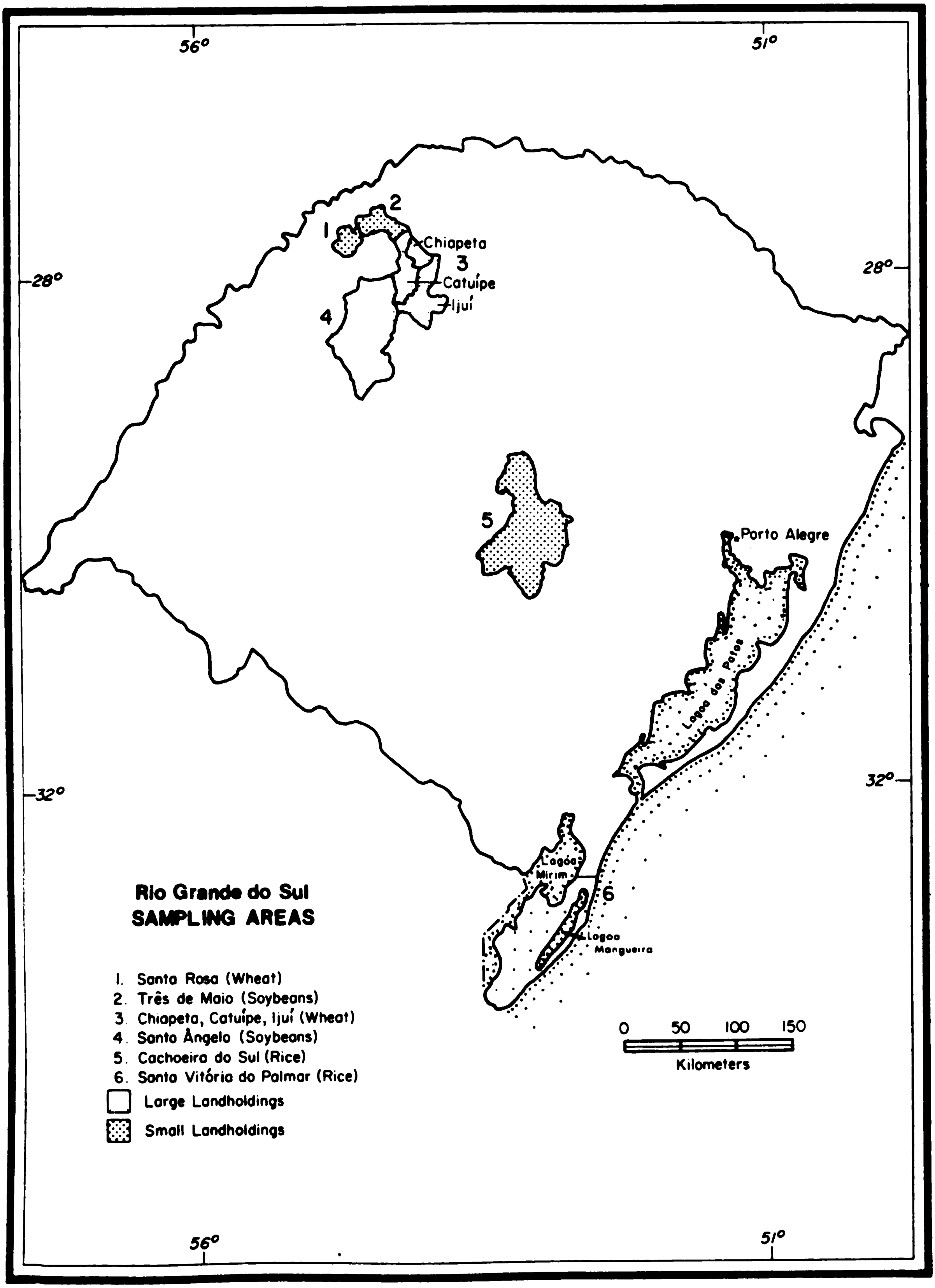

Figure 1.--Rio Grande do Sul, Sampling Areas.

Associação Sulina de Crédito e Assistência Rural (ASCAR) and are located in northern Rio Grande do Sul. The _municípios_ selected were Santo Ângelo, Ijuí, Catuípe and Chiapeta, which are large-scale soybean-wheat areas. Two other _municípios_, Três de Maio and Santa Rosa, are basically small landholding areas producing the same crops. The remaining two _municípios_, Cachoeira do Sul in the central part of the state and Santa Vitória do Palmar in the extreme south, are primarily small and large-scale rice producing areas, respectively. Extension services are provided mainly by the Instituto Rio Grandense do Arroz (IRGA). After consideration of the above factors, the selection of these eight _municípios_ was deemed appropriate for the sampling frame.

Prior to the initiation of formal interviewing, appropriate personnel were contacted at the Central de Comandos Mecanizados de Apoio à Agricultura (CEMAPA) regarding maps to be used in the interview areas. Transportation to the areas from the nearest office of ASCAR or IRGA was also arranged at this time.

Type of Sample

With the knowledge that no sample is completely representative in all cases and that all sampling techniques have specific limitations, it was decided to employ the cluster sample design, where possible, in both large and small landholding areas. The samples were representative

of agriculturalists from a particular area of a selected _município_ cultivating one of the crops under study. The procedure allowed for time and budgetary constraints of the researcher and especially of the government agency providing transportation and personnel.

Six areas were selected for interviewing. Three sampling areas with large holdings were included: one producing soybeans, one producing wheat and one producing rice. Three areas of small farms specializing in soybeans, wheat and rice, respectively, were likewise selected. This permitted the examination and comparison of land-use practices relative to the three crops under different terrain and landholding conditions.

As previously noted, nearly all soybean growers also raise wheat. But, representative soybean growers are not always representative wheat growers and vice-versa. The farmers selected were interviewed for soybeans or wheat, but not both, thereby maintaining sample independence.

As previously noted, large holdings are defined as having at least 150 hectares of rice, soybeans or wheat under cultivation. Small holdings are defined as those with less than fifty hectares of soybeans, rice or wheat.

The sample representing soybean cultivation on large landholdings was drawn from the Santo Ângelo area of northwestern Rio Grande do Sul (Figure 2), while the sample representing wheat cultivation on large holdings was from the Ijuí area immediately to the east (Figure 3).

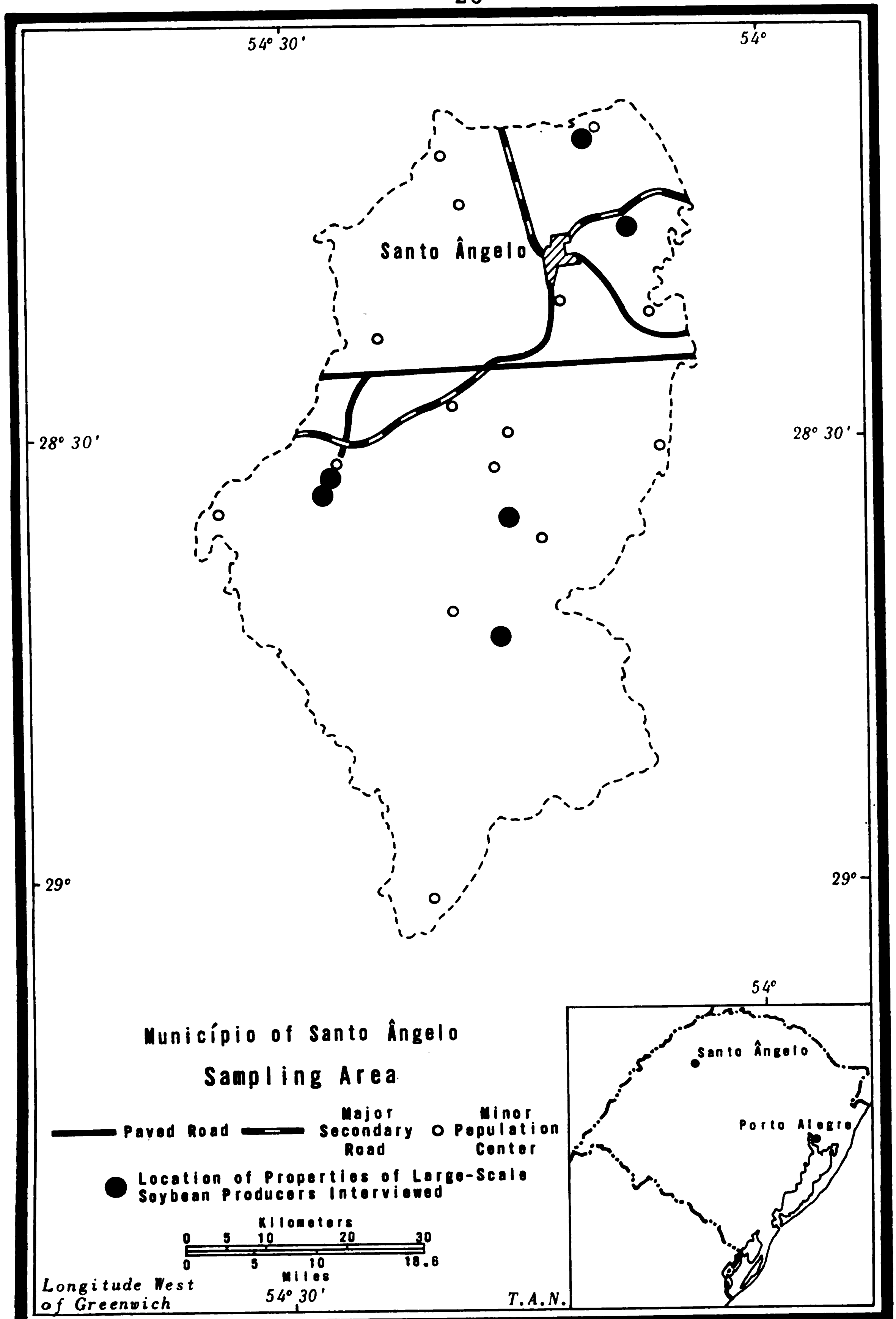

Figure 2.--Município of Santo Ângelo.

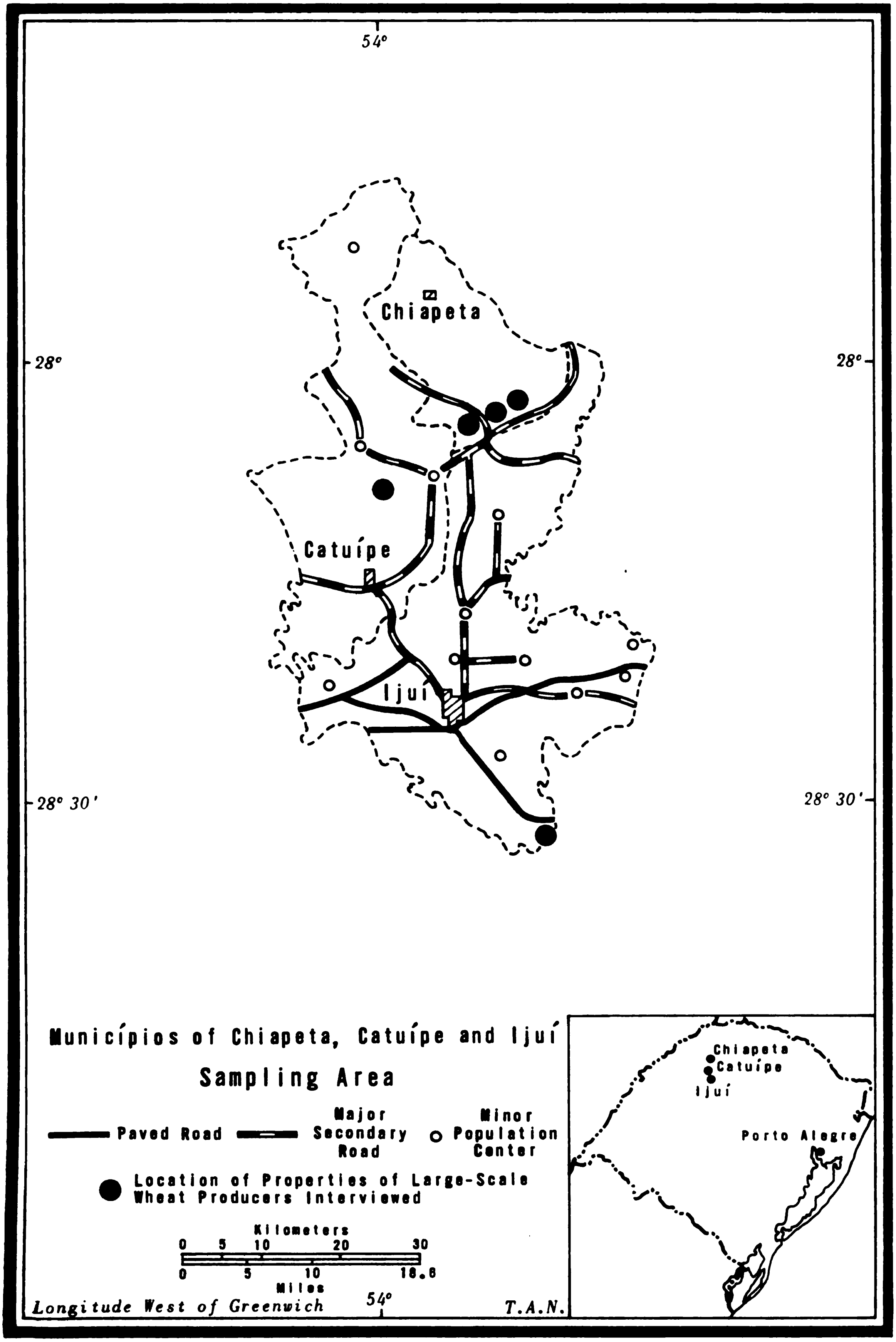

Figure 3. Municípios of Chiapeta, Catuípe and Ijuí.

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Large holdings with rice were represented by a sample selected from near Santa Vitória do Palmar, in the state's southernmost coastal lagoon area (Figure 4). Small-scale soybean and wheat producers were interviewed near Três de Maio and Santa Rosa, respectively, in the far northwestern portion of the state (Figures 5 and 6). The small holding with rice sample was drawn from the Cachoeira do Sul area in central Rio Grande do Sul (Figure 7).

In each of the six sampling areas, a small but representative group of farmers was interviewed. The actual cluster was selected by the researcher and accompanying government technician prior to field interviewing, in accordance with the parameters of the study. The cluster sampling technique was used for field interview purposes on all small properties. The cluster design was also used in some large landholding areas. It could not be used in the remaining areas due to constraints beyond the researcher's control. These include impassable roads due to heavy rains, remoteness of some large properties from extension centers, time shortages on the part of the agronomist and limited fuel for government vehicles. Only five or six persons were interviewed in each cluster, due to the same constraints on the part of assisting personnel.

All small-scale farmers raising soybeans, wheat or rice were interviewed in the field, usually on or near their properties. Four large-scale producers of soybeans and wheat were also interviewed on their properties.

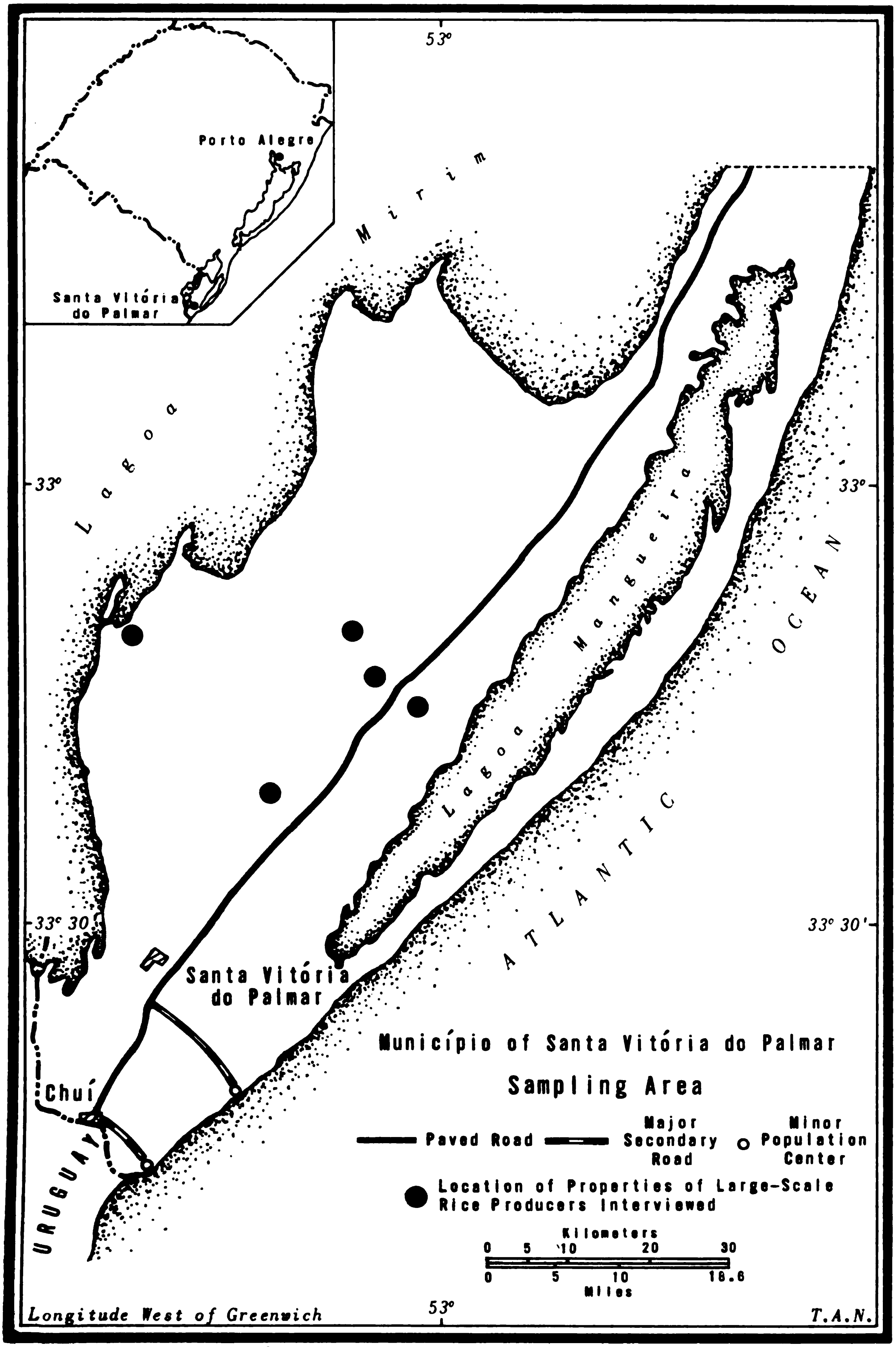

Figure 4.--Município of Santa Vitória do Palmar.

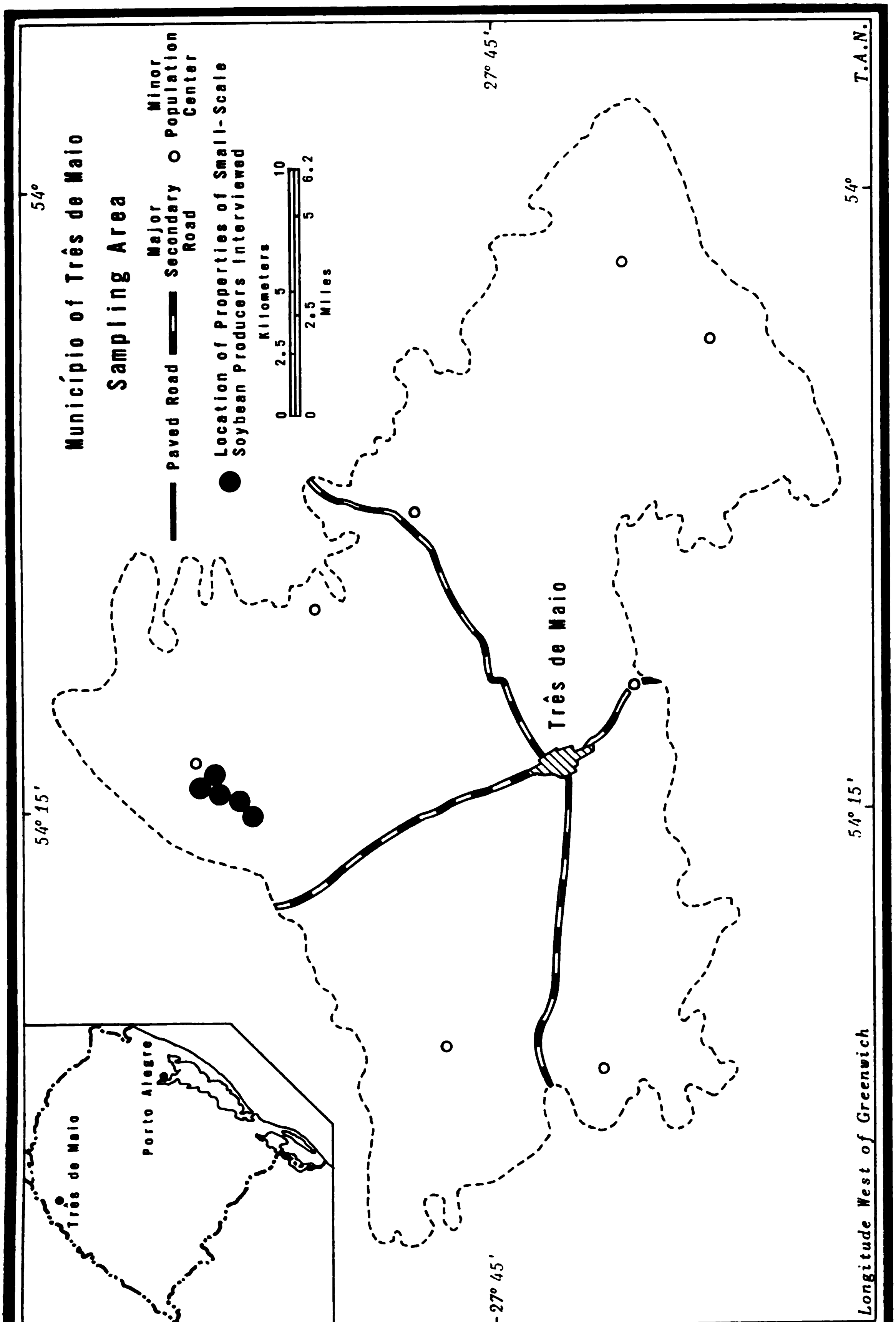

Figure 5.--Município of Três de Maio.

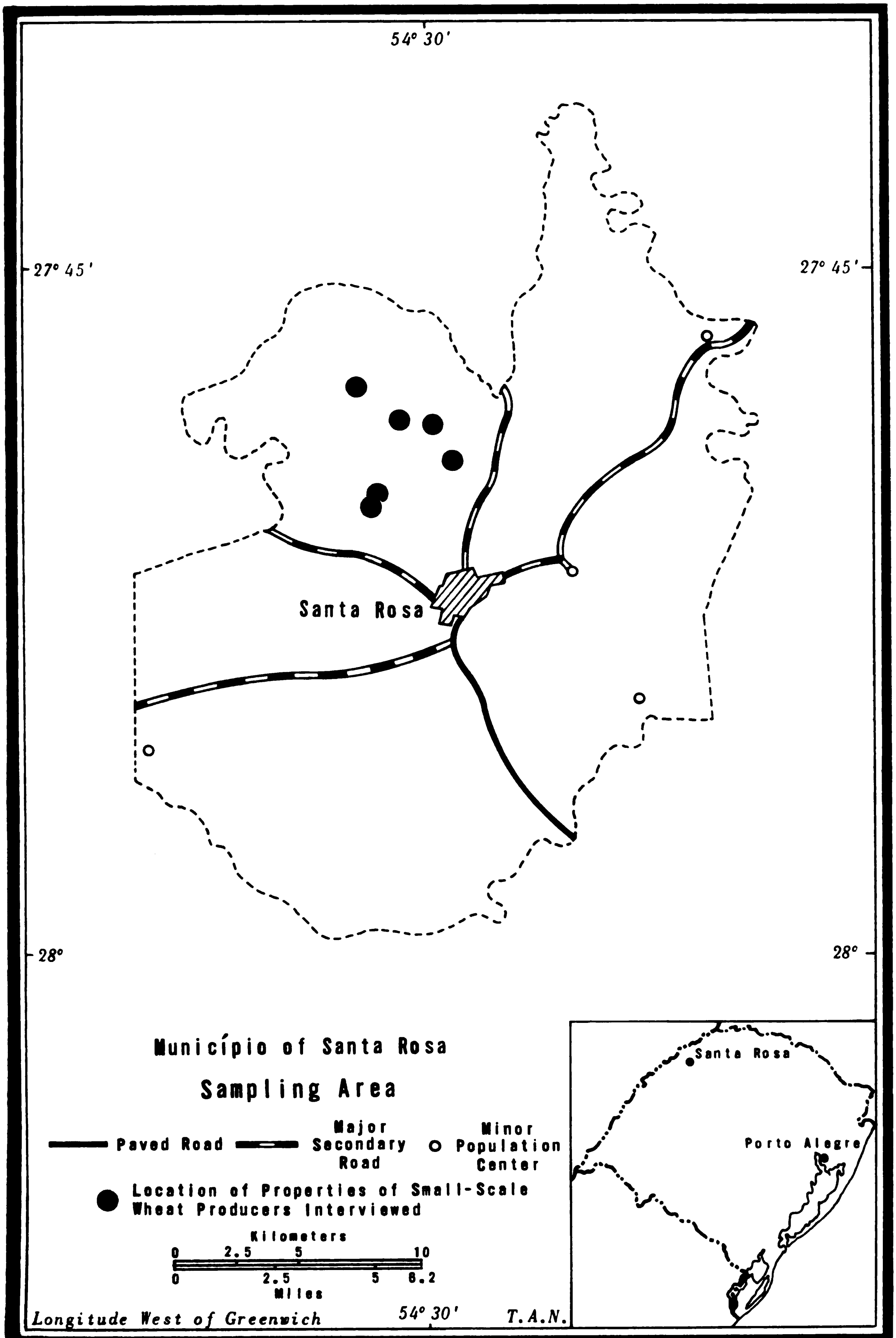

Figure 6.--Município of Santa Rosa.

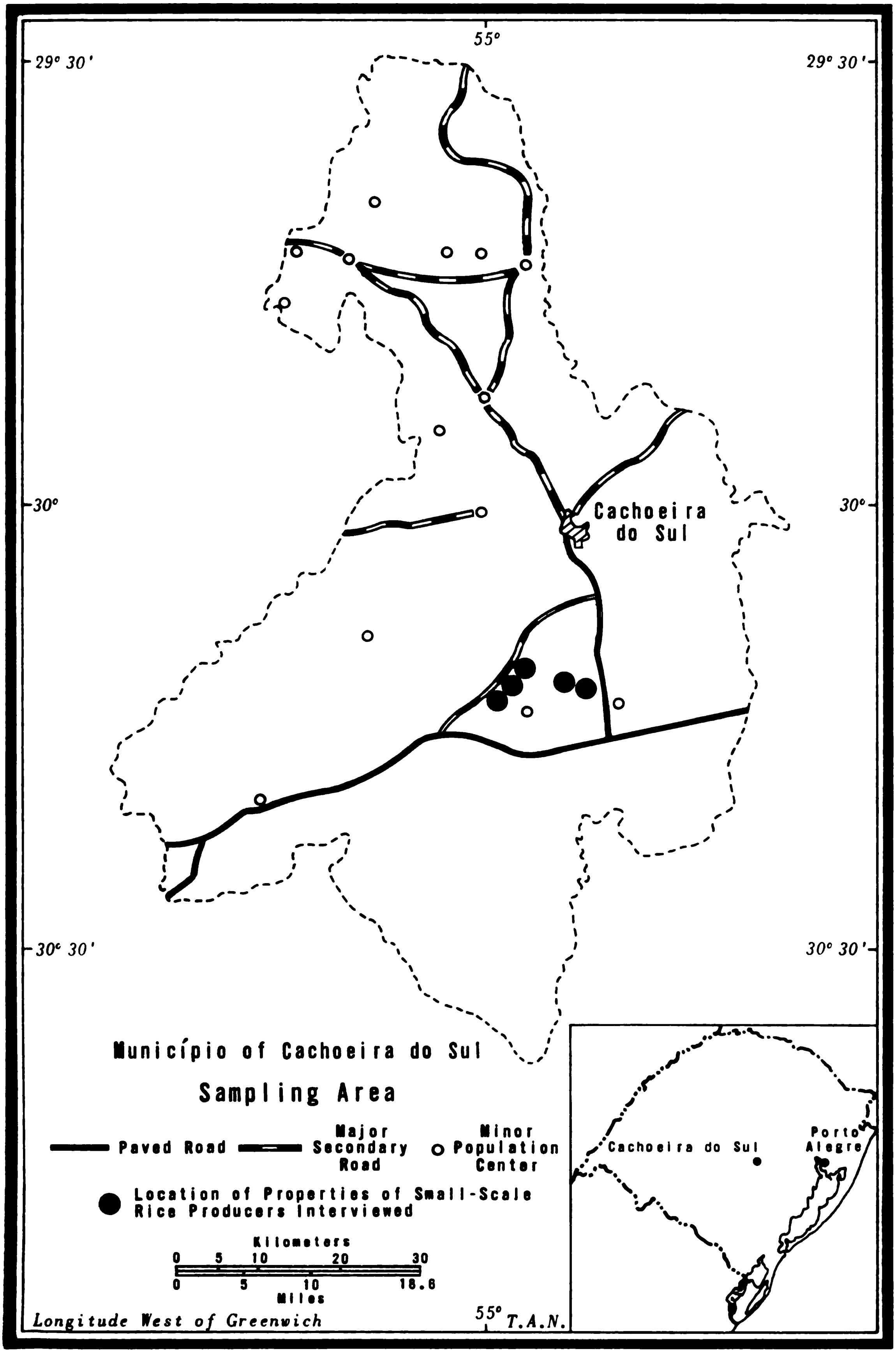

Figure 7.--Município of Cachoeira do Sul.

However, most large-scale growers do not reside on their farms, but live in nearby trade centers. The remaining twelve large-scale growers were therefore interviewed in their communities of residence. This proved advantageous since the extension offices from which assistance is obtained are located in the same communities.

Sample Size

The size of sample was not based on any specific selection formula but was instead related to time and monetary considerations. The time factor was especially significant since the agronomists assisting the researcher were working overtime to attend wheat producers whose crops suffered from rains and disease during the 1977 harvest seasons. Likewise, the researcher's financial resources were modest, formal institutional affiliation was lacking, and government transportation to the field was curtailed as an energy conservation measure. Given these constraints, the sampling areas selected had to be as representative as possible. This was done through the careful analysis of production data and other information related to the cultivation of soybeans, wheat and wet rice. However, the reader is cautioned that the statistical results obtained from the analysis of sample data apply only to that sample and generalizations should be avoided.

The dimensions of the sample are shown in Table 1. A total of forty-one interview attempts were made. The

Table 1.--Composition of the Sampling Frame.

Crops		Completed Interviews	Interviews Ineligible	No One Home	Not Available At the Time	Total
Rice	Large	5			1	6
	Small	5	2	1	1	9
Soybeans	Large	6			1	7
	Small	5				5
Wheat	Large	5	1			6
	Small	6		2		8
Total		32	3	3	3	41

results of nine were eliminated for various reasons. Three of the interviews attempted are in the category of "Ineligible Interviewees." These include two individuals in the sample from a small rice production area, one of whom did not plant rice as was anticipated and a second whose rice area exceeded the sample criterion. A third individual in the area of large wheat holdings was excluded, since it was found that he was not producing wheat.

In the third category, "No One Home," three persons, one in the area of small rice holdings and two in the area of small wheat holdings, were not present when the author visited their farms.

The last category, "Not Available at the Time," includes three other interview attempts. One large-scale rice producer, although willing to be interviewed, could not stay due to a prior commitment. A small-scale rice producer was unable to leave his fieldwork when the interviewer arrived on the scene. The third person listed was a large-scale wheat farmer who was not at his business address when the interviewer called. After the nine disqualifications thirty-two completed interviews remained, which represent an acceptable sample.

Source of the Sample Data

The data collected for this part of the study were based solely on responses to the interview schedule. The instrument contained thirty-eight questions focusing on land-use practices, innovation adoption and delivery, and government assistance to agriculture. The data should serve (1) as an index to land-use practices and innovation adoption patterns in the six sampling areas and (2) as a complement to the descriptive portion of the study. The variables studied are:

1. Personal history
    a. Age
    b. Marital status
    c. Place of birth
    d. Place of birth of grandparents
    e. Number of family members
    f. Number of children
    g. Educational level
    h. Time in agriculture in Rio Grande do Sul
2. Land tenure
    a. Farming arrangement
    b. Place of residence
3. Size of landholding
4. Land use
    a. Principal crop
    b. Area of principal crop
    c. Other uses of land
    d. Crop rotation
    e. Crop abandonment and/or substitution
    f. New crops
    g. Changes in cultivated areas
5. Yields
    a. Yields of principal crop
    b. Changes in yield in past year
        1. Factors responsible for changes
6. Government assistance
    a. Use of extension service
    b. Visits to farms by government personnel
    c. Servicing extension center
    d. Farmers' visits to government centers

e. Introduction of new ideas
f. Adoption of innovations
g. Participation in agricultural experiments

7. Marketing practices

   a. Marketing of crops
   b. Transportation mode
   c. Transportation time to market

8. Environmental factors

   a. Terrain
   b. Climatic conditions
   c. Plant diseases

9. Sources of agricultural information

   a. Friends
   b. Mass media
   c. Government channels
   d. Agricultural organizations
   e. Other

10. Membership in agricultural organizations

11. Progress in agriculture

    a. Past
    b. Present
    c. Future

A copy of the interview schedule is included as Appendix A.

Research Hypotheses

Three research hypotheses were formulated which relate to crop yield and landholding size, crop yields and use of extension service, and factors that could influence the adoption of innovations. The hypotheses are:

Hypothesis I - Yields per unit area of rice, soybeans and wheat are proportional to the size of landholding.

Hypothesis II - The distribution of high yields is directly related to those areas where the use of government extension service is greatest.

Hypothesis III - Innovation adoption is directly related to (a) use and accessibility to sources of agricultural assistance, (b) land tenure, and (3) information sources.

Statistical Analysis

Four analytical methods were used in the exploratory portion of the study: (1) Cross-Tabulation of variables, (2) Chi-Square analysis, (3) analysis of Frequencies, and (4) Pearson Correlation Coefficient analysis. All of the routines were conducted using the Statistical Program for the Social Sciences computer program (SPSS). These statistical techniques are appropriate for small samples, as in the case of this study. The Cross-Tabulation display provided percentage data by crop type and landholding size. The second phase consisted of a series of Chi-Square routines used to test for significant relationships among variables. This was followed by an analysis of Frequencies showing the distribution of high and low yields by crop type. Pearson Correlation Coefficient analysis was used in the testing of Hypothesis III, first to ascertain the correlation between specific variables as they pertain to the adoption of innovations; and second to analyze the relationship among twelve selected variables.

CHAPTER III

REVIEW OF RELATED LITERATURE

Literature on Brazilian agriculture and agricultural development is abundant. Much of it is directly relevant to this study, and even more is peripheral. Reference is made here to those studies, articles and books closely related to the author's own research. The review consists of two parts. The first centers upon studies undertaken on Brazil generally, both in and outside of Geography. The second deals with literature focused specifically on Rio Grande do Sul. In nearly all cases studies pertinent to the topic are grouped and discussed by general theme and in chronological order of publication.

Relevant Geographic Literature on Brazil

Scholars in various disciplines have contributed to the literature reviewed in this chapter. Agricultural economists tend to dominate, particularly with respect to dissertations on Rio Grande do Sul. Geographic literature on the state mainly consists of journal articles. Dissertations by geographers are generally more numerous on the national level than are articles, while few have been

written on Rio Grande do Sul. However, this comment applies specifically to literature related to agricultural land use, innovation in agriculture and the role of government in agricultural development. Geographers have undertaken much worthwhile research that is beyond the scope of this investigation, particularly in urban and transportation geography. Sociologists, anthropologists and historians have also produced a number of articles, books and dissertations on agricultural development. In general, North American geographers have tended to concentrate on the developing frontier areas of Brazil, while those from Europe have devoted their efforts mainly to southern Brazil, including Rio Grande do Sul.

Dissertations

Doctoral dissertations by geography graduate students in North American universities examine a variety of topics relevant to this study. Principal themes include settlement and the opening of new frontier areas, while agricultural land-use studies *per se* are almost nonexistent. Thirteen dissertations are included in this portion of the review. The first is Dozier's 1954 study of frontier development and settlement in northern Paraná state.[1] Carmin, in the same year, completed a study of Anápolis in Goiás

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[1]Craig L. Dozier, "Northern Paraná, Brazil: Settlement and Development of a Recent Frontier Zone" (Ph.D. dissertation, Johns Hopkins University, 1954).

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state in which the growing function of that community as a regional agricultural capital is discussed.[2] Shortly thereafter, Faissol studied the problems of agricultural development in the southeastern portion of Brazil's Planalto Central.[3] The area's physiographic setting, colonization projects, and agricultural potential were examined and evaluated. Eucalypt cultivation was investigated a decade later by Dickinson, who compared cultivation methods for forest land-use patterns in Minas Gerais state with those in the Peruvian sierra.[4] Nissly, in the same year (1967), completed a study on the geographic aspects of frontier settlement in Acre, a territory in Brazil's remote northwest.[5] Mandell's 1969 dissertation is more relevant since it concerns agricultural development

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[2]Robert L. Carmin, "Anápolis, Brazil: Regional Capital of an Agricultural Frontier" (Ph.D. dissertation, University of Chicago, 1954).

[3]Speridião Faissol, "O problema do desenvolvimento agrícola do sudeste do Planalto Central do Brasil" (Ph.D. dissertation, Syracuse University, 1956).

[4]Joshua Clifton Dickinson III, "The Cultivation and Utilization of the Eucalypt in the Peruvian Sierra and the Industrial Triangle of Brazil" (Ph.D. dissertation, University of Florida, 1967).

[5]Charles Martin Nissly, "Acre: An Amazonian Frontier of Brazil" (Ph.D. dissertation, University of Florida, 1967).

in southern Goiás state.[6] Major themes include the relation between interior and coastal development in Brazil, shifts in land use from cattle-raising to agriculture, migrant types and the recent influence of Brasília on the zone's agricultural development. Farther north, the territory of Roraima served as the subject of Kelsey's study (1972), which examines transportation improvements and their effect on the area's beef cattle industry.[7] Allderdice, also studying the frontier areas of Brazil, investigated agricultural expansion along the Belém-Brasília highway in his 1972 dissertation.[8] He compared farms having direct access to the highway with those in more remote locations. Darnel (1973) worked in the Brazilian Northeast, where he examined land settlement in seven agricultural priority areas of three states.[9] Bein (1974) examined the distribution of various types of rural landholdings in

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[6]Paul Irving Mandell, "The Development of the Southern Goiás-Brasília Region: Agricultural Development in a Land-Rich Economy" (Ph.D. dissertation, Columbia University, 1969).

[7]Thomas Fisk Kelsey, "The Beef Cattle Industry in the Roraima Savannas: A Potential Supply for Brazil's North" (Ph.D. dissertation, University of Florida, 1972).

[8]William Howard Allderdice, "The Expansion of Agriculture along the Belém-Brasília Road in Northern Goiás, Brazil" (Ph.D. dissertation, Columbia University, 1972).

[9]Bernard Wolfram Darnel, "Land Settlement in Northeast Brazil: A Study of Seven Projects" (Ph.D. dissertation, McMaster University, 1973).

southern Mato Grosso, as well as land resource depletion.[10] Special emphasis was given to production costs of cotton, rice, soybeans and peanuts as opposed to expenses incurred in livestock-raising.

Long's dissertation on the middle Paraíba Valley of Brazil is the only North American dissertation in geography having agricultural land use as its central theme, although the topic is discussed to some extent in other studies included in this section.[11] His dissertation was completed in 1950, which reflects the paucity of detailed agricultural land use studies undertaken by geographers in a country of near continental size. In contrast, many detailed agricultural land use studies were undertaken by North American geographers in Puerto Rico beginning about 1950.

Relevant dissertations by North American geographers on the production of specific crops in Brazil are few in number. Johnson (1972) examined cashew production in the Northeast, while Pierson studied the citrus industry of São Paulo state for his 1972 dissertation.[12]

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[10] Frederick L. Bein, "Patterns of Pioneer Settlement in Southern Mato Grosso: Two Case Studies" (Ph.D. dissertation, University of Florida, 1974).

[11] Robert G. Long, "The Middle Paraíba Valley of Brazil: A Study in Land Utilization" (Ph.D. dissertation, Northwestern University, 1950).

[12] Dennis Victor Johnson, "The Cashew of Northeast Brazil: A Geographical Study of a Tropical Tree Crop"

Dissertations by North American geographers on the role of government in the diffusion of agricultural innovations in Brazil are practically nonexistent, although such studies have been conducted elsewhere. Consequently, most of the dissertations reviewed in subsequent sections of this chapter are by persons in other disciplines.

Articles and Books

Journal articles and other publications by geographers pertinent to this study focus on three major themes: agricultural land use and its regionalization, colonization by foreign immigrants, and studies of specific crops. Twenty-six publications are reviewed in this section. Land use has been a popular topic for articles but not for dissertations. Agricultural colonization in southern Brazil was explored by geographers in numerous articles between 1940 and 1960. Today, the chief contributors to this topic are German and French geographers, whereas Brazilian geographers previously wrote more extensively on colonization. Many Brazilian geographers have now turned their attention to the nation's pressing urban problems and to the spatial aspects of national development planning.

Agricultural land-use and regionalization studies are numerous. Waibel, in 1948, examined the influence of

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(Ph.D. dissertation, University of California, Los Angeles, 1972); and Robert G. Pierson, "A Geographical Analysis of the Citrus Industry of São Paulo" (Ph.D. dissertation, University of Tennessee, 1972).

market distance on agricultural land use using the von Thünen model.[13] He also studied vegetation and land use in the Planalto Central.[14] James examined agricultural land-use patterns in the Northeast in 1953, while Valverde contributed an article on land use in eastern Paraíba state in 1955.[15] Valverde also analyzed the spatial aspects of Brazilian plantations.[16] In a 1957 article Carmin discussed the compilation of land use maps from census data and used Paraná state as an example.[17] Two other significant studies on land use followed in 1967. Noble analyzed the distribution of various types of land use in Santa Catarina state, while von Heloisa examined agricultural

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[13] Leo Waibel, "A theoria de von Thünen sôbre a influência da distancia do mercado relativamente a utilização da terra," Revista Brasileira de Geografia, Ano 10, No. 1 (1948): 3-40.

[14] Idem, "Vegetation and Land Use in the Planalto Central of Brazil," Geographical Review, Vol. 38, No. 3 (1948): 529-554.

[15] Preston E. James, "Patterns of Land Use in Northeast Brazil," Annals of the Association of American Geographers, Vol. 43, No. 1 (1953): 98-126; and Orlando Valverde, "O uso da terra no leste de Paraíba," Revista Brasileira de Geografia, Vol. 17, No. 1 (1955): 49-90.

[16] Orlando Valverde, "Caracteristiques et tendances des plantations brésiliennes," Aspects de l' agriculture commerciale et de l' élevage au Brésil, Travaux et Documents de Géographie Tropicale (Bordeaux, France: Centre d' Etudes de Géographie Tropicale du C.N.R.S. [n.d.]), pp. 51-116.

[17] Robert L. Carmin, "A Land Use Map from Census Data--Paraná, Brazil, as an Example," Transactions of the Illinois State Academy of Science, Vol. 50 (1957): 159-162.

expansion and changing agricultural systems in Paraná.[18] Quantitative methods, particularly factor analysis, were later employed in the determination of agricultural land use regions in southern Brazil in the late 1960s and early 1970s. Specific contributions include studies by Mesquita and Silva, Keller, and Gusmão.[19] Those by Mesquita and Silva, and Keller, deal with Paraná while Gusmão studied all of southern Brazil. Similar techniques have been employed by geographers working in Rio Grande do Sul. Berry and Pyle (1972), employing quantitative methods, identified major types of agriculture in Brazil and delimited the nation's land-use regions.[20] Recent descriptive studies include Correia de Andrade's investigation

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[18] Allen G. Noble, "Geographical Aspects of the Agriculture of Santa Catarina State, Brazil," Ohio Journal of Science, Vol. 67, No. 5 (1967): 257-273; and Barthelmess von Heloisa, "Methodologische uberlegungen zu einer dynamishen agrargeographie em beispiel paranás," Geographische Zeitschrift, Vol. 5, No. 3 (1967): 207-224.

[19] O. V. Mesquita and S. T. Silva, "Regiões agrícolas do Estado do Paraná: Uma definação estatística," Revista Brasileira de Geografia, Ano 22, No. 1 (1970): 2-42; Elza Coelho de Souza Keller, "Tipos de agricultura no Paraná: Uma análise fatorial," Revista Brasileira de Geografia, Ano 34, No. 4 (1972): 41-86; and R. P. de Gusmão, "Estudo da organização agrária da Região Sul através de uma análise fatorial," Revista Brasileira de Geografia, Ano 36, No. 1 (1974): 33-52.

[20] Brian J. Berry and Gerald F. Pyle, "Grandes regiões e tipos de agricultura no Brasil," Revista Brasileira de Geografia, Ano 34, No. 4 (1972): 5-39.

of agricultural production systems in the Northeast.[21] The principal objective was to examine the productivity of diverse farm crops under various conditions of capital and labor input. The paper was presented in 1973 and published in 1975 by the Conference of Latin Americanist Geographers (CLAG). An abstract by Dillman, published at the same time by CLAG, focuses on land and agricultural labor patterns in Brazil.[22]

Agricultural colonization studies proved useful for the author's own research. James wrote on settlement in southern Brazil in 1940, and Camara's article on foreign colonization in Santa Catarina state was published eight years later.[23] Monbieg's book, Pionniers et Planteurs de São Paulo, was published in 1952 and is one of the most definitive books on colonization.[24] The evolution of

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[21] Manuel Correia de Andrade, "The Modernization of Agriculture in Northeastern Brazil," Geographical Analysis for Development in Latin America and the Caribbean (Chapel Hill, North Carolina: CLAG Publications, Inc., 1975), 79-87.

[22] C. Daniel Dillman, "Land and Labor Patterns in Brazil: Latifundias in Social Context," Geographical Analysis for Development in Latin America and the Caribbean (Chapel Hill, North Carolina: CLAG Publications, Inc., 1975): 78.

[23] Preston E. James, "The Expanding Settlements of Southern Brazil," Geographical Review, Vol. 30, No. 4 (1940): 601-626; and Lourival Camara, "Estrangeiros em Santa Catarina," Revista Brasileira de Geografia, Vol. 10, No. 2 (1948): 211-255.

[24] Pierre Monbieg, Pionniers et planteurs de São Paulo (Paris: Librairie Armand Colin, 1952).

paulista agriculture is traced from Brazil's colonial era to the mid-Twentieth century. Monbieg also authored an article which analyzed the lifestyles of agriculturalists in southeastern Brazil.[25] Waibel continued his contributions to the geography of agriculture in Brazil in an article on frontier agriculture.[26] More recent articles, such as Kohlhepp's work published in the Revista Geográfica in 1969, are also noteworthy.[27] An agricultural land use article covering the three southern states of Paraná, Santa Catarina and Rio Grande do Sul was written by the French geographer Raymond Pébayle and published in Problemes d' Amerique Latine in 1973.[28] The "hollow frontier" of Brazil has been the subject of some current geographic research. Taylor examined this topic in 1973, and Casetti

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[25]Idem, "Evolution des genres de vie ruraux traditionnels dans le S.E. du Brésil," Annales de Géographie, Tome 58, No. 309 (1949): 35-43.

[26]Leo Waibel, "As zonas pioneiras do Brasil," Revista Brasileira de Geografia, Vol. 17, No. 4 (1955): 389-422.

[27]Gerd Kohlhepp, "Types of Agricultural Colonization on Sub-tropical Brazilian Campos Limpos," Revista Geográfica, No. 70 (June, 1969): 131-155.

[28]Raymond Pébayle, "Le Brésil meridional, Paraná, Santa Catarina, Rio Grande do Sul," Problemes d' Amerique Latine, 27 (March 23, 1973): 51-65.

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and Gauthier studied spatial shifts of the frontier zone through time in their 1977 article in Economic Geography.[29]

Crop studies by geographers comprise the third theme and the smallest category of articles, due largely to the fact that some geographers have broader interests and have left agricultural studies of a more specific nature to other scholars, government planners and specialists. Carvalho (1954) examined the geographic aspects of Brazilian wheat production, after previously studying sweet potato cultivation in southern Brazil.[30] Lysia Bernardes' study of rice cultivation in southern Brazil also dates from this time.[31] Expanding rice areas and accompanying growth in production was the subject of an article by Mandell in 1972.[32]

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[29]Harry W. Taylor, "São Paulo's Hollow Frontier," Revista Geográfica, No. 79 (December, 1973): 149-166; and Emilio Casetti and Howard L. Gauthier, "A Formalization and Test of the Hollow Frontier Hypothesis," Economic Geography, Vol. 53, No. 1 (January, 1977): 70-78.

[30]Eloisa de Carvalho, "O trigo no Brasil" (In Aspectos da Geografia Rio-grandense, Rio de Janeiro: Serviço Gráfico do Instituto Brasileiro de Geografia e Estatística, 1954): 183-195; and Idem, "A produção da batata inglêsa no sul do pais," Revista Brasileira de Geografia, Ano 14, No. 3 (1952): 354-362.

[31]Lysia Maria Cavalcanti Bernardes, "Cultura e produção do arroz no Sul do Brasil," Revista Brasileira de Geografia, Ano 16, No. 4 (1954): 403-438.

[32]Paul I. Mandell, "A expansão de moderna rizicultura brasileira. Crecimento da oferta numa economia dinâmica," Revista Brasileira de Economia, Vol. 26, No. 3 (1972): 169-256.

Among relevant government publications is the Geografia do Brasil which has been published periodically for many years by the Instituto Brasileiro de Geografia e Estatística (IBGE), now the Fundação IBGE.[33] The most recent Geografia do Brasil was published in 1977 as a five-volume set, one volume for each of the country's major geoeconomic regions.

Related Nongeographic Literature on Brazil

Much of the literature pertinent to this study was written by scholars outside of geography, particularly with respect to agricultural innovation, governmental assistance to agriculture, and institutional problems that are reflected in the spatial organization of crop-livestock production. Agricultural economists, perhaps more than any other scholars outside of geography, have contributed to the literature reviewed in this chapter. They are followed by sociologists, anthropologists and historians in descending order. The number of doctoral dissertations written by agricultural economists account for nearly one-half of the dissertations discussed that were written by nongeographers. Sixteen dissertations are noted, and all examine Brazilian agriculture. Major themes include agricultural modernization, research, credit and information systems.

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[33] Geografia do Brasil, Região Sul, Vol. 5, Rio de Janeiro: Fundação Instituto Brasileiro de Geografia e Estatística (IBGE).

Dissertations

Dissertations on agricultural modernization include Wharton's (1959) study on the economic impact of technical assistance, capital and Technology in Minas Gerais state.[34] It focuses on production increases and efficiency in agriculture. Two selected areas of the state receiving extension services were studied, and the results were compared with data on agricultural production and efficiency elsewhere in Minas Gerais. Numerous other studies on agricultural development followed, beginning with Patrick's (1970) study of education and agricultural development in "eastern Brazil."[35] One year later, Weiss completed a dissertation on the effect of feeder roads and communication on the growth of markets in northeast Brazil.[36] Peacock's (1972) dissertation is of special significance, since it centers on the adoption of new agricultural practices.[37] The

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[34]Clifton R. Wharton, Jr., "A Case Study of the Economic Impact of Technical Assistance, Capital, and Technology in the Agricultural Development of Minas Gerais, Brazil" (Ph.D. dissertation, University of Chicago, 1959).

[35]George Frederick Patrick, "Education and Agricultural Development in Eastern Brazil" (Ph.D. dissertation, Purdue University, 1970).

[36]Joseph S. Weiss, "The Benefits of Broader Markets due to Feeder Roads and Market News, Northeast Brazil" (Ph.D. dissertation, Cornell University, 1971).

[37]David Lewis Peacock, "The Adoption of New Agricultural Practices in Northeast Brazil: An Example of Farmer Decision-Making" (Ph.D. dissertation, Michigan State University, 1972).

attitude of agriculturalists in the Brazilian Northeast toward innovation is discussed, as is the educational level of producers. The study also evaluates credit opportunities for the various socio-economic strata of rural society within the region. Additional rural credit, risk-reducing methods for crop-livestock activities, and improved education in rural areas are three major recommendations of the study that are relevant to Rio Grande do Sul. Martin's dissertation (1976) is focused on the unbalanced development of Brazilian agriculture and discusses problems related to rural-urban linkages, investment in research and rural education.[38] Martin also examined the relationship between the distribution of investment and the location of agricultural growth areas, a topic distinctly geographic in nature.

Dissertations written on agricultural research in Brazil include Ayer's study on the costs, returns and effects of such research (1970).[39] Anderson researched the planning and development of Brazilian agriculture for his 1972 dissertation, while Ramalho de Castro developed

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[38] Marshall Allen Martin, "The Modernization of Brazilian Agriculture: An Analysis of Unbalanced Development," Vols. I, II (Ph.D. dissertation, Purdue University, 1976).

[39] Harry Wright Ayer, "The Costs, Returns, and Effects of Agricultural Research in a Developing Country: The Case of Cottonseed Research in São Paulo, Brazil" (Ph.D. dissertation, Purdue University, 1970).

an economic model to determine research priorities for Brazil's agriculture in a 1974 study.[40]

Three dissertations deal specifically with agricultural credit. Nehman (1973) studied the use of credit by small-scale farmers in São Paulo state.[41] Major topics discussed include credit service to farmers, credit allocation factors and the problem of insufficient credit to producers. Like Peacock's study, this dissertation is pertinent, since most rural credit in Brazil is disbursed through local branches of nationwide banks under centralized control. A similar study of credit problems in the Ribeirão Preto area of northern São Paulo state was completed by Pedroso in 1973.[42] From anthropology is Hurzeler's study (1973) examining the social implications of rural credit, credit sources and credit consumers in Northeast Brazil.[43] These

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[40] Marvin Sydney Anderson, "The Planning and Development of Brazilian Agriculture: Some Quantitative Extensions" (Ph.D. dissertation, Cornell University, 1972); and José Prazeres Ramalho de Castro, "An Economic Model for Establishing Priorities for Agricultural Research and a Test for the Brazilian Economy" (Ph.D. dissertation, Purdue University, 1974).

[41] Gerald Nehman, "Small Farmer Credit Use in a Depressed Community of São Paulo, Brazil" (Ph.D. dissertation, Ohio State University, 1973).

[42] Iby Arvatti Pedroso, "Resource Accumulation and Economies of Scale in Agriculture: The Case of São Paulo" (Ph.D. dissertation, Ohio State University, 1973).

[43] Richard Paul Hurzeler, "Unto Those That Have: Debt in a Northeast Brazilian Peasant Community" (Ph.D. dissertation, University of New Mexico, 1975).

three dissertations outside of Rio Grande do Sul are noted since the author's own research indicates a relationship between credit availability and innovation adoption among agriculturalists in the state.

Investigation of agricultural information systems by sociologists includes Fonseca's analysis of information systems and the adoption of new practices by Brazilian agriculturalists in a 1966 dissertation.[44] Dias-Bordenave (1967) studied the communication of information in agriculture in the nation's depressed Northeast, while Kochevar worked with information models pertaining to rural Brazilians and agricultural development.[45]

Other studies are more general in scope. Cone's 1968 study examined agricultural expansion in the "Triangle" of western Minas Gerais state.[46] A dissertation by Vilas (1975) includes a spatial equilibrium analysis of nineteen

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[44] Luís Fonseca, "Information Patterns and Practice Adoption among Brazilian Farmers" (Ph.D. dissertation, University of Wisconsin, 1966).

[45] Juan Dias-Bordenave, "The Search for Instrumental Information among Farmers of the Brazilian Northeast" (Ph.D. dissertation, Michigan State University, 1967); and John Joseph Kochevar, "Multivariate Causal Models of Information Flow in Rural Brazil" (Ph.D. dissertation, Michigan State University, 1972).

[46] Bruce Warren Cone, "Agricultural Expansion: The Minas Triangle, Brazil" (Ph.D. dissertation, Purdue University, 1968).

rice-producing areas, including those in Rio Grande do Sul.[47]

The study is an example of research by a nongeographer focusing on the variable character of rice production over geographic space.

Books and Other Publications

Eight books and three special studies were written mainly by sociologists, agricultural economists and other scholars on the general theme of agricultural development, particularly the effect of institutional and governmental factors on land use and innovation adoption. Publication dates range from 1963 to 1976. The American International Association, under contract to the United States Agency for International Development (USAID), completed a study on the agricultural potential of the Central Plateau of Brazil in 1963. This study, conducted at the request of the Brazilian government, included a detailed survey of the region's physical environment, an assessment of the potential role of agriculture in the Central Plateau's economy and an outline for suggested land-use practices.[48]

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[47]Andres Troncoso Vilas, "A Spatial Equilibrium Analysis of the Rice Economy in Brazil" (Ph.D. dissertation, Purdue University, 1975).

[48]American International Association for Economic and Social Development, Survey of the Agricultural Potential of the Central Plateau of Brazil, with a Foreword by Walter L. Crawford (Rio de Janeiro: American International Association for Economics and Social Development under U.S. contract AID, 12-120, 1963).

Three years later Brazil's campo cerrado areas were examined with respect to their crop-livestock potential. The economic use of the campo cerrado and agricultural research projects in the zone were investigated.[49]

Michigan State University in cooperation with two universities and government extension personnel in Minas Gerais, conducted a study to predict and explain the success of community-level programs of directed agricultural change in seventy-six communities in that state. This study was also financed by USAID and was completed in 1968. The role of social structure relative to innovation was examined, as were change agents and the prediction of innovation adoption.[50] One year later, a book by Whiting and Guimarães Comunicação das Novas Idéias (Pesquisas Aplicáveis ao Brasil), was released.[51] This book presents case studies of innovation adoption by agriculturalists and evaluates the findings of persons studying technological change with

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[49]Brazil, Conselho Nacional de Pesquisas, Comissão Técnica Executiva and Ministry of Agriculture, Coordinated Research Programs in Campo Cerrado Areas of Brazil, trans. Walter Crawford and Lawrence Witt (East Lansing: International Programs, Michigan State University, 1966).

[50]Gordon C. Whiting et al., Innovation in Brazil: Success and Failure of Agricultural Programs in 76 Minas Gerais Communities, Diffusion of Innovation Research Report 7, with a Foreword by Everett M. Rogers (East Lansing: Department of Communication, Michigan State University, 1968).

[51]Gordon Whiting and Lytton L. Guimarães, Comunicação das novas idéias (Pesquisas Aplicáveis ao Brasil) (Rio de Janeiro: Edições Financeiras, S.A., 1969).

particular reference to Brazil. Most case studies discussed are from the Brazilian Northeast, Minas Gerais or Rio Grande do Sul. In 1970 Whiting and Stanfield presented a paper on economic class/opportunity structure and innovativeness among Brazilian farmers.[52]

Books dealing with Brazilian agricultural development in a more general sense than that of Whiting and Guimarães are numerous. Among those meriting review is Schuh's work, The Agricultural Development of Brazil (1970).[53] It is a comprehensive examination of the physical, institutional and social bases of production. Agricultural research and technology are given special attention. A host of related topics, including agricultural education, are discussed in detail. Two books written by the sociologist T. Lynn Smith, Brazil, People and Institutions (1972) and Brazilian Society (1974) provide insight on the nation's agriculture.[54] Topics discussed include land tenure problems, the system of land division and the effect of population growth and internal

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[52]D. Stanfield and G. Whiting, "Economic Strata and Opportunity Structure as Determinants of Innovativeness and Productivity in Rural Brazil," paper presented to the Rural Sociological Society Convention, 1970.

[53]Edward G. Schuh, The Agricultural Development of Brazil (New York: Praeger Publishers, 1970).

[54]T. Lynn Smith, Brazil: People and Institutions (Baton Rouge: L.S.U. Press, 1972); and Idem, Brazilian Society (Albuquerque: University of New Mexico Press, 1974).

migration on Brazil's agrarian structure. Also published in 1974 was Syvrud's book, Foundations of Brazilian Economic Growth.[55] Past and present government policies concerning agricultural development, and the role of credit are major themes. A more recent book is Forman's work, The Brazilian Peasantry (1975), which focuses on critical agrarian problems of the Northeast.[56] Major socio-economic and institutional constraints that in Forman's opinion have retarded the region's agricultural development constitute the focus of research. Webb's book on the Brazilian Northeast and its agriculture (1974) is one of the few by North American geographers on this region and theme.[57] Webb selected eastern Paraíba and Pernambuco states for a case study of the region's agricultural geography. The evolution of the rural landscape, physical habitat and land-use systems are discussed in detail, as is crop production in the zona de mata, agreste and sertão.

Geographic Literature on Rio Grande do Sul

At least four doctoral dissertations have been written on agriculture in Rio Grande do Sul by geographers,

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[55] Donald E. Syvrud, Foundations of Brazilian Economic Growth (Stanford: Hoover Institution Press, Stanford University, 1974).

[56] Shepard Forman, The Brazilian Peasantry (New York: Columbia University Press, 1975).

[57] Kempton Webb, The Changing Face of Northeast Brazil (New York: Columbia University Press, 1974).

three North Americans and one Frenchman. Another geography dissertation has been written by a North American on agricultural land use in Uruguay and is included in this review due to similarities in crop-livestock activities of Uruguay with those in parts of Rio Grande do Sul.

The number of pertinent articles on Rio Grande do Sul by geographers is substantial. Some thirty studies, nearly all published in academic journals, have been reviewed. Scholars from the United States, France and Germany, as well as Brazil, have studied various aspects of agriculture in the state. Their articles were published mainly in the Revista Brasileira de Geografia, Revista Geográfica and Boletim Geográfico do RGS (Rio Grande do Sul). Others appear in non-Brazilian journals, such as Les Cahiers d' Outre-Mer, Geographische Zeitschrift and the Geographical Review.

Dissertations

The dissertations reviewed are mainly historical geographies of particular parts of the state and include transportation development, foreign colonization and the evolution of crop-livestock activities. Rogers' 1953 dissertation centers on the influence of rivers on settlement and economic development in the state.[58] The function of

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[58]Rolland C. Rogers, "The Influence of Rivers in the Development of Rio Grande do Sul" (Ph.D. dissertation, Stanford University, 1953).

the Jacuí River system as an artery of communication and transport into the agricultural hinterland of Porto Alegre forms the major theme. Rothwell focused on the evolution of Italian settlement to the north of Porto Alegre in his 1956 dissertation.[59] The development of artisan, habitat and agricultural industries in the Caxias do Sul area was stressed, as was the viticultural expertise of Italian colonists responsible for the growth of the area's grape and wine industry. Lobb's 1970 dissertation also focused on the historical and cultural aspects of rural economic activities in Rio Grande do Sul, mainly the cattle lands bordering Argentina and Uruguay.[60] The study centers on the temporal-spatial aspects of open-range cattle raising. Problems of livestock raising, including the lack of innovations and competing market influences, are noted. The diffusion of ranching from the early Jesuit settlements of northwestern Rio Grande do Sul southeastward into the Jacuí River basin and coastal plain is discussed, as are the competing Portuguese and Spanish influences on livestock land use. Pébayle, a French geographer, also wrote on the

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[59]Stuart Clark Rothwell, "The Old Italian Colonial Zone of Rio Grande do Sul, Brazil: A Geographic Interpretation" (Ph.D. dissertation, Syracuse University, 1956).

[60]Gary Charles Lobb, "The Historical Geography of the Cattle Regions along Brazil's Southern Frontier" (Ph.D. dissertation, University of California, Berkeley, 1970).

evolution of the state's crop-livestock activities.[61] His study (1974) is the most comprehensive geography dissertation on agriculture in Rio Grande do Sul written to date. Pébayle's work is mainly a social geography analyzing the effect of culture on land-use patterns, agricultural practices and spatial aspects of farmstead organization. Modernization and the constraint of tradition on innovation adoption in various rural areas constitute an important part of the study. Questionnaires were administered in two widely separated colonial areas to obtain information on agricultural innovation in dissimilar places. The study is nearly all-inclusive with respect to crop-livestock activities in the state, except for the Atlantic littoral.

Griffin's (1972) study on agricultural land use in Uruguay has much in common with the author's work in Rio Grande do Sul.[62] A comparison between land-use practices in the two areas is therefore made, and is presented in Chapter IV. Griffin delimited three major crop and livestock regions, which were subdivided into seven subregions. The applicability of the von Thünen model of agricultural land use for Uruguay was explored, and differences between existing and theoretical zones of crop-livestock land use

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[61]Raymond Pébayle, "Eleveurs et agriculteurs du Rio Grande do Sul (Brésil)" (Thèse pour le doctorat ès Lettres, Université de Paris, 1974).

[62]Griffin, "Agricultural Land Use in Uruguay."

form the central theme of the dissertation. Major problems confronting the Uruguayan rural economy were identified, and the role of government in agriculture assessed.

Articles and Books

Geographers have contributed studies of foreign colonization in Rio Grande do Sul, as well as publications on cultural geography pertaining to other regions of the state and particularly those devoted to extensive cattle and sheep raising. Increased emphasis on agricultural development in recent years has resulted in a number of significant studies in applied geography by Brazilians, but those studying Rio Grande do Sul have largely neglected the topics of innovation diffusion and government assistance. As in other areas of Brazil, such studies have been left to scholars outside of geography.

European colonization in Rio Grande do Sul was investigated by Jefferson in the 1920s and by Valverde in 1948.[63] Most studies are descriptive and focus on the colonization areas north of Porto Alegre, including São Leopoldo and Novo Hamburgo (German) and Caxias do Sul (Italian). Bernardes' article on rural colonization in northwestern Rio Grande do Sul, published in 1950 focused

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[63] Mark Jefferson, "Pictures from Southern Brazil," Geographical Review, Vol. 16, No. 3 (1926): 521-547; and Orlando Valverde, "Excursão a região colonial antiga do Rio Grande do Sul," Revista Brasileira de Geografia, Ano 10, No. 4 (1948): 477-534.

on the Santa Rosa area.[64] Agricultural systems and the rural settlement pattern are described. Pacheco and De Souza (1955) provided a more general analysis of the state's colonization zones.[65] Roche's book, A Colonização Alemã e o Rio Grande do Sul, was published in 1969 as a two-volume set.[66] Although relatively recent, it has become a classic on foreign agricultural colonization in Rio Grande do Sul. Emphasis is given to land use, crop types and the imprint of European culture on the agrarian landscape. Several articles by Roche were published in 1958-1959 as antecedents to his book.[67] One examines specific problems noted during his research in German colonization areas, while another examines agricultural systems in the same areas. The rural life of German

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[64] Nilo Bernardes, "A colonização no município de Santa Rosa, estado do Rio Grande do Sul," Revista Brasileira de Geografia, Ano 12, No. 3 (1950): 383-392.

[65] Maria F. Pacheco and Docca De Souza, "Colonização no Rio Grande do Sul," Boletim Geográfico, Porto Alegre: Secretaria da Agricultura, Ano 1, No. 1 (July-August, 1955).

[66] Jean Roche, A colonização alemã e o Rio Grande do Sul, Vols. I, II (Porto Alegre, Brazil: Editora Globo, 1969).

[67] Idem, "Alguns problemas sugeridos pelo estudo de colonização alemã no RGS," Boletim Carioca de Geografia, Vol. 11, No. 1 (1958): 53-63; and Idem, "Les systemes agraires dans les colonies allemandes du sud du Brésil," Etudes Rurales, Vol. 10 (July-September, 1959): 26-36; and Idem, "Quelques aspects de la vie rurale dans les colonies allemandes du Rio Grande do Sul," Les Cahiers d'Outre-Mer, Vol. XIII, No. 45 (1959): 5-21.

immigrants is described in an article published one year later. The latter two articles were published in French journals, and all reflect the French human geography tradition in method of description and analysis. The same is true of Pébayle's work.

In recent years, a number of articles directly related to the author's research have been published in the Boletim Geográfico do RGS. Moreno (1972) examined the role of education and residential location as developmental determinants affecting many small landholders along the Lower Taquari River valley in Rio Grande do Sul.[68] La Salvia and Handschunch (1974) studied the spatial aspects of colonization in Rio Grande do Sul and the evolution of landholding patterns in the various zones of foreign immigrant settlement.[69] This study is enhanced by numerous maps and air photos. Beretta's 1975 study of Italian colonization areas is more descriptive.[70] The spatial organization of farmsteads, major agricultural activities

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[68] José Alberto Moreno, "Experiência didática numa colonia do Vale do Taquari," Boletim Geográfico do RGS, Ano 17, No. 15 (January-December, 1972): 35-38.

[69] Flavia La Salvia and Nilbiamater S. B. Handschunch, "Processo de colonização no Rio Grande do Sul," Boletim Geográfico do RGS, Ano 19, No. 17 (January-December, 1974): 3-43.

[70] Pier Luigi Beretta, "Nota sôbre a ocupação rural na antiga área de colonização italiana do Rio Grande do Sul," Boletim Geográfico do RGS, Ano 20, No. 18 (January-December, 1975): 62-79.

and the influence of culture on landscape are noted. The microgeography of house types within the colonial zone is also given considerable attention. Pébayle, in addition to writing a dissertation related to the author's own topic, wrote numerous articles. Settlement geography of Rio Grande do Sul and specialized crop studies characterize his writing. Examples include a 1971 article on rural colonization in the Alto Uruguai region of northern Rio Grande do Sul.[71] The article discusses land-use patterns and the problem of fractionated landholdings, outmigration and the effect of geographic isolation on innovation adoption. A second article by Pébayle, published the same year, focuses on changing land use in the Planalto Riograndense.[72] The decline of livestock production in favor of soybean-wheat cultivation is stressed. Pébayle subsequently wrote two more articles on these general themes. One, published in 1974, examines agricultural expansion in the same general area of Rio Grande do Sul.[73]

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[71]Raymond Pébayle, "Geografia rural das novas colonias do Alto Uruguai (Rio Grande do Sul-Brasil)," Boletim Geográfico do RGS, Ano 16, No. 14 (January-December, 1971): 12-19.

[72]Idem, "O centro do planalto riograndense: Uma região rural em mutação," Boletim Geográfico do RGS, Ano 16, No. 14 (January-December, 1971): 44-55.

[73]Idem, "A expansão da agricultura na região de criação de gado do planalto riograndense," Boletim Geográfico do RGS, Ano 19, No. 17 (January-December, 1974): 44-54.

Questionnaires were administered in four different _municípios_ having different settlement and production characteristics. The more recent article (1975) delimits the geographic zone of contrast between small-scale farmers practicing polyculture, in this case _colonos_, and the traditional cattlemen, or _gaúchos_.[74] The lengthy study is essentially a comparative geography of rural activity, rather than a geography of crop-livestock patterns.

Studies related specifically to the determination of land-use patterns, as well as their regionalization, are also significant. La Salvia (1973) wrote on air photo interpretation for land-use determination, using Rio Grande do Sul as an example.[75] Numerous air photos are included in the article. Field patterns were identified from these photos and different vegetation complexes noted. The article proved valuable to this author during the land-use mapping phase of the dissertation research. The 1975 study of land use and the regionalization of agriculture in Rio Grande do Sul undertaken by Moreno and colleagues is also

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[74] Idem, "Os difíceis encontros de duas sociedades rurais," _Boletim Geográfico do RGS_, Ano 20, No. 18 (January-December, 1975): 3-22.

[75] Flavia La Salvia, "Identificação das formas de uso da terra e cobertura vegetal do Rio Grande do Sul através fotografias aéreas," _Boletim Geográfico do RGS_, Ano 18, No. 16 (January-December, 1973): 125-154.

pertinent.[76] In it, quantitative methods were used to delimit major and minor agricultural regions of the state. Twenty-five different crops and 142 variables were selected for this study. Factor analysis, grouping analysis and multidiscriminant analysis were employed. Following this series of statistical analyses, it was possible to identify sixteen distinct agricultural land-use regions for the state. These could be reduced to four much larger and more general regions, if desired. The regionalization has some shortcomings due to the large number of criteria used to differentiate one region from another, but the regions delimited are nevertheless homogeneous. In an earlier study (1972), Moreno examined native vegetation and existing agricultural land use patterns in Rio Grande do Sul.[77]

Crop studies on Rio Grande do Sul by geographers also have been important. Alonso and Moreno studied tobacco production in 1958 and 1973, respectively.[78] The

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[76]José Alberto Moreno et al., Regionalização do espaço agrícola do Rio Grande do Sul (Porto Alegre, Brazil: Secretaria da Agricultura, Central de Comandos Mecanizados de Apóio à Agricultura, 1975).

[77]Idem, "Uso da terra, vegetação original e atual do Rio Grande do Sul," Boletim Geográfico do RGS, Ano 17, No. 15 (January-December, 1972): 45-51.

[78]Delnida Martinez Alonso, "Aspectos geográficos da cultura fumageira no estado do Rio Grande do Sul," Revista Brasileira de Geografia, Ano 20, No. 3 (1958): 295-313; and José Alberto Moreno, "Pesquisa das causas dos diferentes rendimentos do fumo no município de Lajeado, RS," Boletim Geográfico do RGS, Vol. 18, No. 16 (January-December, 1973): 78-92.

study by Alonso is descriptive, while that by Moreno employed factor analysis on selected variables responsible for differing tobacco yields in one major production area. Irrigated rice production was investigated by Pébayle in a 1971 article published in the Boletim Geográfico do RGS.[79] The study describes methods of rice planting, cultivation and harvesting in various regions, and the socio-economic status of producers. The history of rice cultivation in the state is discussed, as well as the expansion of irrigated rice culture to zones outside the Depressão Central. Pébayle, in an article published in 1973, examined viticulture in the Italian colonization area of Rio Grande do Sul.[80] Themes discussed are types of producers, methods of harvesting and ethnic influences on production. Producer problems connected with the sale of grapes to local wineries are also noted.

Three articles and one book constitute the relevant geographic literature on the extensive cattle and sheep raising areas of southern and western Rio Grande do Sul. Pereira, writing in the Revista Brasileira de Geografia in the early 1940s, examined the charqueada as an expression

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[79] Raymond Pébayle, "A rizicultura irrigada no Rio Grande do Sul," Boletim Geográfico do RGS, Ano 16, No. 14 (January-December, 1971): 4-11.

[80] Idem, "Os viticultores do Rio Grande do Sul," Boletim Geográfico do RGS, Ano 18, No. 16 (January-December, 1973): 51-77.

of rural industry within the region.[81] A decade later, Alves de Lima contributed a more general study of the entire livestock region.[82] A third article on this region was written by Pébayle (1971) describing the geographic aspects of the livestock producing zone and the distribution of the various socio-economic strata of the rural population.[83] This article was originally published in Les Cahiers d' Outre-Mer, one of several French journals important to persons researching southern Brazil. A significant contribution to the methodology of settlement geography was made by La Salvia and Handschunch in their 1971 study of the Município of Bagé, an important livestock production area.[84] The authors examined and identified several types of rural habitats and crop-livestock patterns within the município. They then developed an index to measure the density of rural settlement using data from a

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[81] J. Verissimo da Costa Pereira, "Charqueada," Revista Brasileira de Geografia, Ano 6, No. 2 (1944): 277-280.

[82] Miguel Alves de Lima, "Contribuição ao estudo da Campanha Gaúcha," Anais, Associação dos Geógrafos Brasileiros, Vol. 8, No. 1 (1953-1954): 343-375.

[83] Raymond Pébayle, "A vida rural na 'campanha' riograndense," Boletim Geográfico do RGS, Ano 16, No. 14 (January-December, 1971): 36-43.

[84] Flavia La Salvia and Nilbiamater S. B. Handschunch, "Contribuição a metodologia do estudo do habitat rural-Bagé," Boletim Geográfico do RGS, Ano 16, No. 14 (January-December, 1971): 20-33.

1:50,000 scale map. The map was divided by a uniform grid suitable for tabulating residences, the density of which could be compared with various land-use patterns, and the tabulated data were then mapped. Another study in the município of Bagé was done by Medaglia in 1973, providing a concise appraisal of soils.[85] Finally, Pfeiffer's article, "Kontraste in Rio Grande do Sul: Campanha und Alto Uruguai," in Geographische Zeitschrift (1967), is basically a comparative study focusing on differences in agricultural land use, population and culture between two distinct regions of the state.[86] Extensive livestock raising in the south is contrasted with the intensive agricultural land use typical of colonization areas in the north of Rio Grande do Sul. The historical development of the state's agriculture is discussed, as is Rio Grande do Sul's prominence in Brazilian agriculture.

One monograph and two books constitute the remaining relevant literature. Rothwell's 1960 monograph on ports and hinterlands of Rio Grande do Sul still provides a basic understanding of the state's agricultural marketing

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[85]Maria Elisa Medaglia, "Estudo de solos no município de Bagé," Boletim Geográfico do RGS, Ano 18, No. 16 (January-December, 1973): 45-50.

[86]Gottfried Pfeiffer, "Kontraste in Rio Grande do Sul: Campanha und Alto Uruguai," Geographische Zeitschrift, Vol. 55, No. 3 (1967): 163-206.

economy from a geographic point of view.[87] The two books are a text and reference volume. Forte's Geografia Física do Rio Grande do Sul (1959) is a valuable source for general background information on agriculture.[88] However, extensive changes have occurred in the production of specific crops such as soybeans, which now dominate the state's agricultural economy, thus reducing the value of older publications. The Geografia do Brasil, Região Sul, Volume 5 (1977) is an updated reference covering all aspects of the state's geography.[89] Especially useful are the sections on topography, climate, soils and vegetation. Agricultural colonization is also discussed, as are land-use patterns and the existing level of rural development.

Related Nongeographic Literature on Rio Grande do Sul

Twenty doctoral dissertations and three masters' theses pertinent to this study have been written by nongeographers. Nineteen of the dissertations are North American works, while one is French. The three theses are by Brazilian graduate students at the Universidade Federal

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[87] Stuart C. Rothwell, Ports and Hinterlands of Rio Grande do Sul (Coral Gables, Florida: University of Miami, 1960).

[88] Amyr Borges Fortes, Geografia física do Rio Grande do Sul (Porto Alegre, Brazil: Livraria do Globo, 1959).

[89] Geografia do Brasil, Região Sul, Volume 5, 1977.

do Rio Grande do Sul, in Porto Alegre. Doctoral candidates in agricultural economics account for more than half of the studies, the remainder being by students of sociology, economics and history. The Brazilian theses are by students in economia rural or sociologia rural. Two major American universities, Ohio State University and the University of Wisconsin, predominate in the number of advanced degree candidates preparing dissertations on Rio Grande do sul. The interest of North American scholars in Rio Grande do Sul is rather recent, however, more than three-fourths of the dissertations reviewed being completed since 1970. Although agricultural economics dominates, history and sociology are also represented.

Articles and special studies related to the writer's research that have been undertaken by nongeographers focus mainly on: (1) agricultural information exposure, farmer receptivity to innovations and technology adoption, and (2) land-use and farm-size economic performance relationships. Seventeen studies by both Brazilian and North Americans, principally sociologists, are included. Approximately one-half of the studies appear in journals, while the remainder have been published or reprinted by the Centro de Estudos e Pesquisas Econômicas (IEPE) of the Universidade Federal do Rio Grande do Sul. Publication dates of the studies range from 1961 to 1976, with most appearing between 1965 and 1971.

Dissertations and Theses

The principal topic investigated in the twenty-three dissertations and theses include agricultural exports, land use, farm management, credit, modernization and innovation, and farm income problems. Nearly all of the studies pertain strictly to Rio Grande do Sul. Of major importance is Knight's work (1970), which examines export expansion, import substitution and technological change. The export of rice, soybeans, corn and beef was analyzed, as was the import of wheat, current agricultural technology, agricultural stagnation and fertilizer use. Knight's dissertation also provided him with the basis for a book on agricultural technology and trade which focused on the production of these same crops in Rio Grande do Sul.[90] Ahn's study on regional agricultural development in southern Brazil (1970) and Schuck's masters' thesis on land-use efficiency in Ibirubá, Rio Grande do Sul (1972), are noteworthy.[91] Slade's dissertation in history on

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[90] Peter Titcomb Knight, "Export Expansion, Import Substitution and Technological Change in Brazilian Agriculture: The Case of Rio Grande do Sul" (Ph.D. dissertation, Stanford University, 1970); and Idem, Brazilian Agricultural Technology and Trade, A Study of Five Commodities (New York: Praeger Publishers, 1971).

[91] Choong Yong Ahn, "A Recursive Programming Model of Regional Agricultural Development in Southern Brazil (1960-1970): An Application of Farm Size Decomposition" (Ph.D. dissertation, Ohio State University, 1972); and José Hilário Schuck, "Eficiência no uso da terra e das práticas agrícolas da produção de trigo, soja e milho, Ibirubá, RS." (Tese de Pós-Graduação, Universidade Federal do Rio Grande do Sul, Brazil, 1972).

nineteenth century land tenure systems and agricultural land-use patterns of São Lourenço, Rio Grande do Sul, is a useful micro-study.[92] The study area is a major wet rice producing zone today, and the São Lourenço area is typical of many cattle-rice zones along the Lagoa dos Patos. Farm management studies include Sorenson's 1968 dissertation on capital productivity and small farm management in the state and Richter's (1970) study on optimum ranch organization in the Bagé area.[93] Engler's dissertation on alternate wheat and cattle enterprises (1971) is addressed to the same general theme.[94] Steitieh's study (1971) on input productivity and productivity change on farms in southern Brazil can be classified under this topic, as can Noronha's dissertation (1973) on farm resource allocative efficiency and Kluck's study (1975) on decision making among farmers

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[92]James Jeremiah Slade III, "Cattle Barons and Yeoman Farmers: Land Tenure, Division, and Use in a County in Southern Brazil, 1777-1889" (Ph.D. dissertation, Indiana University, 1972).

[93]Donald Melvin Sorenson, "Capital Productivity and Management Performance in Small Farm Agriculture in Southern Brazil" (Ph.D. dissertation, Ohio State University, 1968); and Humberto Vendelino Richter, "Optimum Ranch Organization in Bagé, Rio Grande do Sul" (Ph.D. dissertation, University of Wisconsin, 1970).

[94]Joaquim José do Camargo Engler, "Alternative Enterprise Combinations under Various Price Policies on Wheat and Cattle Farms in Southern Brazil" (Ph.D. dissertation, Ohio State University, 1971).

of German descent in Rio Grande do Sul.[95] Three dissertations and one thesis deal with agricultural credit. Erven (1967) studied the economics of credit and related problems in Rio Grande do Sul, while Schneider (1967) examined communication and the use of agricultural credit in one selected <u>município</u>.[96] Rao investigated agricultural credit use in a 1960 dissertation, while Singh (1974) examined agricultural credit allocation factors.[97] Three studies involve agricultural modernization and innovation. Blair's dissertation on information exposure patterns in rural Rio Grande do Sul is a benchmark study, completed in 1956.[98]

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[95]Akram Mustafa Steitieh, "Input Productivity and Productivity Change of the Crop Enterprise in Southern Brazil" (Ph.D. dissertation, Ohio State University, 1971); José Ferreira Noronha, "A Study of Allocative Efficiency at the Farm Level in Southern Brazil" (Ph.D. dissertation, University of Kentucky, 1973); and Patricia Ann Kluck, "Decision Making Among Descendants of German Immigrant Farmers in Rio Grande do Sul" (Ph.D. dissertation, Cornell University, 1975).

[96]Bernard Lee Erven, "An Economic Analysis of Agricultural Credit Use and Policy Problems, Rio Grande do Sul, Brazil" (Ph.D. dissertation, University of Wisconsin, 1967); and Ivo Alberto Schneider, "Comunicação e uso de crédito rural, Ibirubá" (Tese de Pós-Graduação, Universidade Federal do Rio Grande do Sul, Brazil, 1967).

[97]Bodepudi Prasada Rao, "The Economics of Agricultural Credit-Use in Southern Brazil" (Ph.D. dissertation, Ohio State University, 1970); and Gurbachan Singh, "Farm Level Determinants of Credit Allocation and Use in Southern Brazil, 1965-1969" (Ph.D. dissertation, Ohio State University, 1974).

[98]Thomas Lucien Blair, "Patterns of Information Exposure Among Workers in a Rural Town Community in Southern Brazil" (Ph.D. dissertation, Michigan State University, 1956).

Few studies of this nature followed until Troller described the role of collective communication in agricultural modernization in a 1969 thesis.[99] Michael's (1972) dissertation focused on a similar theme: factors associated with innovation adoption in rural areas of southern Brazil.[100] Interviews were conducted in four rural <u>municípios</u>, two in Santa Catarina and two in Rio Grande do Sul, to collect data on innovation adoption among farmers. Mechanization studies include Stitzlein's dissertation (1974) on the economics of agricultural mechanization and Baur's work on capital and technological changes in farming.[101] Field research for the latter study (1974) was also conducted in both Santa Catarina and Rio Grande do Sul. Relevant sociological dissertations include Hansen's (1972) study on land tenure and social status on small farms and Scherer-Warren's work published in France (1973), which focuses on rural labor

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[99] Neiva Troller, "O papel da comunicação coletiva na modernização dos agricultores" (Tese de Pós-Graduação, Universidade Federal do Rio Grande do Sul, Brazil, 1969).

[100] Demissie Gebre Michael, "Factors Associated with Innovative Adoption Among Selected Farmers in Southern Brazil" (Ph.D. dissertation, Ohio State University, 1972).

[101] John Noel Stitzlein, "The Economics of Agricultural Mechanization in Southern Brazil" (Ph.D. dissertation, Ohio State University, 1974); and Roger Lee Baur, "Description of Capital and Technology Changes at the Farm Level in Four Southern Brazil Regions: 1960-1969" (Ph.D. dissertation, Ohio State University, 1974).

syndicates and changes in rural society.[102] Two dissertations deal with farm income. Rask, in 1964, completed a dissertation on farm size and income, using data collected from Santa Cruz do Sul, about 100 kilometers west-northwest of Porto Alegre.[103] Grawunder (1976) examined developmental and institutional variables responsible for low farm income in Rio Grande do Sul and southern Brazil as a whole.[104] Particular attention was given to the need for improving governmental assistance to farmers. The role of improved extension services in agricultural development is discussed, as is the need for more printed information and higher mechanization levels.

Articles and Special Studies

More than half of the journal articles and special studies are on agricultural information exposure, farmer receptivity to innovation and technology adoption. Oliveira and Fliegel (1965) studied the receptivity of

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[102] David Oliver Hansen, "The Relationship Between Land Tenure and Social Status in the Rural Colonia Region of Southern Brazil" (Ph.D. dissertation, University of Wisconsin, 1972); and Ilse Scherer-Warren, "Le syndicat et le changement de la société agraire du Rio Grande do Sul" (thèse de Troisième Cycle, Ecole Pratique des Hautes Etudes, Paris, 1973).

[103] Norman Rask, "Farm Size and Income: An Economic Study of Small Farm Agriculture in Southern Brazil" (Ph.D. dissertation, University of Wisconsin, 1964).

[104] Atos Freitas Grawunder, "The Southern Brazil Agricultural Sector: The Income Problem" (Ph.D. dissertation, University of Wisconsin, 1976).

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small landowners to agricultural innovations, as well as rural outmigration.[105] Fliegel, in another article published the same year, analyzed the effect of prestige on attitudes toward change.[106] A study undertaken by Bostian and Schneider (1966) examined the role of communication within government assistance programs.[107] The use of information sources and communication channels by agronomists and other technicians constituted the main focus of research. The study is unique in that it centers on the communicators of innovations (technicians), rather than on the receivers (agriculturalists). Fliegel was also concerned with this topic and authored an article on literacy and the utilization of "instrumental information" by farmers in Rio Grande do Sul.[108] More geographic in nature is Sturm's (1969) study of farmer isolation as related to the

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[105] F. C. Oliveira and Frederick C. Fliegel, "Receptividad a las ideas nuevas y exodo rural en una zona de pequeñas fincas agrícolas de Rio Grande do Sul, Revista Interamericana de Ciencias Sociales, Vol. 3, No. 1 (1965): 79-93.

[106] Frederick C. Fliegel, "Differences in Prestige Standards and Orientation to Change in a Traditional Agricultural Setting," Rural Sociology, Vol. 30 (September, 1965): 278-290.

[107] Lloyd Russel Bostian and Ivo Alberto Schneider, "O uso de comunicação pelos técnicos agro-pecuários do estado do Rio Grande do Sul," Centro de Estudos e Pesquisas Econômicas (IEPE), Universidade Federal do Rio Grande do Sul, Porto Alegre, Brazil, 1966. (Mimeographed.)

[108] Frederick C. Fliegel, "Literacy and Exposure to Instrumental Information Among Farmers in Southern Brazil," Rural Sociology, Vol. 31, No. 1 (1966): 15-28.

diffusion of new agricultural practices in the _município_ of Santa Cruz do Sul.[109] The area was well chosen, since it includes a variety of terrain types. Many rural areas are populated by descendants of German immigrants, who are commonly change-resistant farmers. Schneider also studied socio-cultural factors that influence innovativeness and work efficiency in two other _municípios_: Estrela, near the escarpment of the Serra Geral northwest of Porto Alegre, and Frederico Westphalen in the extreme north of the state.[110] The former area is an "old" German colonization zone, while the latter is a more recently settled area populated by descendants of the original German immigrants. Eli de Moraes Souza and others studied these same two _municípios_ when examining socio-cultural factors and the adoption of new farm practices.[111] Other studies include Fett's article in _Rural Sociology_ (1971), which is similar

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[109] Alzemiro E. Sturm, "O efeito do isolamento na difusão das práticas agrícolas em Santa Cruz do Sul, Brazil," IEPE, Universidade Federal do Rio Grande do Sul, Porto Alegre, Brazil, 1969. (Mimeographed.)

[110] João Elmo Schneider, "A influência de fatores sócio-culturais na inovabilidade e eficiência dos agricultores--Estrela e Frederico Westphalen, R.S.," IEPE, Universidade Federal do Rio Grande do Sul, Porto Alegre, Brazil, 1960. (Mimeographed.)

[111] Eli de Moraes Souza et al., "Análise sociológica de alguns fatores relacionados com adoção de práticas agrícolas en Estrela e Frederico Westphalen, R.S.," IEPE, Universidade Federal do Rio Grande do Sul, Porto Alegre, Brazil, 1976. (Mimeographed.)

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to Fliegel's 1966 study.[112] Fett emphasizes the exposure of farmers to mass media and its effect on the adoption of new ideas. Technology adoption was studied by Richter (1971), who investigated productivity systems and the use of modern technology in livestock ranching around Bagé, near the Brazil-Uruguay border.[113] Eli de Moraes Souza and colleagues, in a similar study, investigated capital formation and technological change in three municípios: Lajeado, a predominantly small landholding area populated largely by persons of German descent; Não-Me-Toque (Campo Real), an area of larger holdings in the Planalto Riograndense of the state; and nearby Carazinho, a large landholding area producing soybeans and wheat.[114]

Land-use and farm-size economic performance studies include a regionalization of agriculture published by ASCAR in 1964 and Hansen's 1973 research on land ownership and

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[112] J. H. Fett, "Education, Mass Media Exposure, and Farm Practice Adoption in Southern Brazil," Rural Sociology 36, No. 3 (1971): 359-366.

[113] Humberto V. Richter, "Análise econômica do sistema produtivo e uso de nova tecnologia na exploração de gado de corte--Bagé, Rio Grande do Sul," IEPE, Universidade Federal do Rio Grande do Sul, Porto Alegre, Brazil, 1971. (Mimeographed.)

[114] Eli de Moraes Souza et al., "Formação de capital e mudanças tecnológicas ao nível de empresas rurais--Lajeado, Carazinho e Não-Me-Toque, relatório descritivo," IEPE, Universidade Federal do Rio Grande do Sul, Porto Alegre, Brazil, 1971. (Mimeographed.)

land use in colonial areas of southern Brazil.[115] Three other studies were undertaken regarding farm size. Rask studied the Santa Cruz do Sul area in 1965, investigating property size and income from agriculture.[116] A second study by Rask in the same year, centered on farm size and agricultural activities on small landholdings.[117] Both of Rask's studies were published by IEPE, as were a number of articles that originally appeared in various English-language journals. A study was undertaken by Johnson and Buse and published in 1967 by the University of Wisconsin's Land Tenure Center.[118] The authors examined farm size and economic performance in Santa Rosa, a colonization area in northwestern Rio Grande do Sul. Farming activities, land-holding systems and attitudes toward change are discussed

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[115] Edmundo Gastal, Contribuição ao zoneamento agrícola do Rio Grande do Sul (Porto Alegre, Brazil: Associação Sulina de Crédito e Assistência Rural [ASCAR], 1964); and David Oliver Hansen, "Relação entre posse e uso da terra e status social do sul do Brasil," IEPE, Universidade Federal do Rio Grande do Sul, Porto Alegre, Brazil, 1973. (Mimeographed.)

[116] Norman Rask, "Tamanho da propiedade e renda agrícola: Santa Cruz do Sul," IEPE, Universidade Federal do Rio Grande do Sul, Porto Alegre, Brazil, 1965. (Mimeographed.)

[117] Idem, "Tamanho mínimo e combinação de atividades para pequenas propiedades, Rio Grande do Sul," IEPE, Universidade Federal do Rio Grande do Sul, Porto Alegre, Brazil, 1965. (Mimeographed.)

[118] Roger G. Johnson and Reuben Buse, "A Study of Farm Size and Economic Performance in Old Santa Rosa, Rio Grande do Sul, Brazil," Land Tenure Center, University of Wisconsin, Madison, August, 1967.

in detail. This study is of particular interest, since Santa Rosa constituted one of the six formal sampling areas from which interview data were obtained for the author's own dissertation research.

Remaining studies are more diverse. Thales de Azevedo (1961) studied colonization in the state's Italian immigrant area, while Erven and Rask (1971) studied agricultural credit and rural development in the Ibirubá innovation pilot project of northern Rio Grande do Sul.[119] That same year, Eli de Moraes Souza and other researchers studied the socio-economic impact of soil recovery programs underway in the Ibirubá area.[120]

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[119] Thales de Azevedo, "Italian Colonization in Southern Brazil," Anthropological Quarterly, Vol. 34, No. 1 (1961): 60-68; and Bernard L. Erven and Norman Rask, Credit Infusion as a Small Farmer Development Strategy--the Ibirubá Pilot Project in Southern Brazil, Agricultural Finance Center, Occasional Paper No. 48 (Columbus: Ohio State University, December, 1971).

[120] Eli de Moraes Souza et al., "Repercussão econômico-social da recuperação de solos, Ibirubá, R.S., primeiro relatório," IEPE, Universidade Federal do Rio Grande do Sul, Porto Alegre, Brazil, 1971. (Mimeographed.)

CHAPTER IV

OVERVIEW OF RIO GRANDE DO SUL

Rio Grande do Sul is the southernmost state of Brazil. It is bordered on the north by Santa Catarina, on the northwest and west by Argentina, on the southwest and south by Uruguay, and on the east and southeast by the Atlantic Ocean. The state is located well to the South of the Tropic of Capricorn. Nearly all of Rio Grande do Sul lies between 28° and 33° South Latitude and 50° and 57° West Longitude. The state is neither exceptionally large nor small by Brazilian standards. Its total area is 282,184 square km or 108,951 square miles.[1]

The location of the state relative to Uruguay and Argentina, and its proximity to the Río de la Plata basin, is noteworthy. Rio Grande do Sul represents the southernmost penetration of Luso-Brazilian settlement and influence bordering Spanish South America. It is therefore a true geopolitical frontier zone.

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[1]Brazil, Fundação Instituto Brasileiro de Geografia e Estatística (IBGE), Anuário Estatístico do Brasil, 1976 (Rio de Janeiro, 1977), p. 20.

KEY to STATES and TERRITORIES — **BRAZIL**

1 Amazonas
2 Terr. of Roraima
3 Pará
4 Terr. of Amapá
5 Maranhão
6 Piauí
7 Ceará
8 Rio Grande do Norte
9 Terr. of Fernando de Noronha
10 Paraíba
11 Pernambuco
12 Alagoas
13 Sergipe
14 Acre
15 Terr. of Rondônia
16 Mato Grosso
17 Mato Grosso do Sul
18 Goiás
19 Distrito Federal
20 Bahia
21 Minas Gerais
22 Espírito Santo
23 São Paulo
24 Rio de Janeiro
25 Paraná
26 Santa Catarina
27 Rio Grande do Sul (STUDY AREA)

Base Map: U.S. Department of Agriculture

Figure 8.--Brazil.

Physiographic Regions

Five major physiographic regions are found in Rio Grande do Sul. They are: (1) an extensive plateau area in the north, the Planalto Medio, which extends across most of the state; (2) the central depression or Depressão Central which parallels the Planalto Medio along its southern margin; (3) the extensive grasslands or Campanha of the southwest; (4) the Serra do Sudeste, an eroded crystalline shield south of the Depressão Central and west of the Lagoa dos Patos; and (5) the Atlantic littoral, a low area of very flat relief and coastal lagoons.

The Planalto Medio

The Central Plateau, or Planalto Medio, is an area of metamorphic rocks that was covered by an extensive flow of basaltic lava approximately 100 million years ago during late Mesozoic times.[2] This plateau area and associated basaltic lava flows constitute the southernmost portion of the Planalto Meridional of Brazil, which also covers much of Santa Catarina and Paraná. Related formations are found in eastern Paraguay and northeastern Argentina. Elevations on the Planalto Medio exceed 1,000 m in the extreme northeast but gradually decrease westward to approximately 700 m near Passo Fundo, 600 m at Carazinho and slightly less than

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[2]Brazil, Fundação Instituto Brasileiro de Geografia e Estatística (IBGE), Geografia do Brasil, Regiào Sul, Volume 5 (Rio de Janeiro, 1977), p. 8.

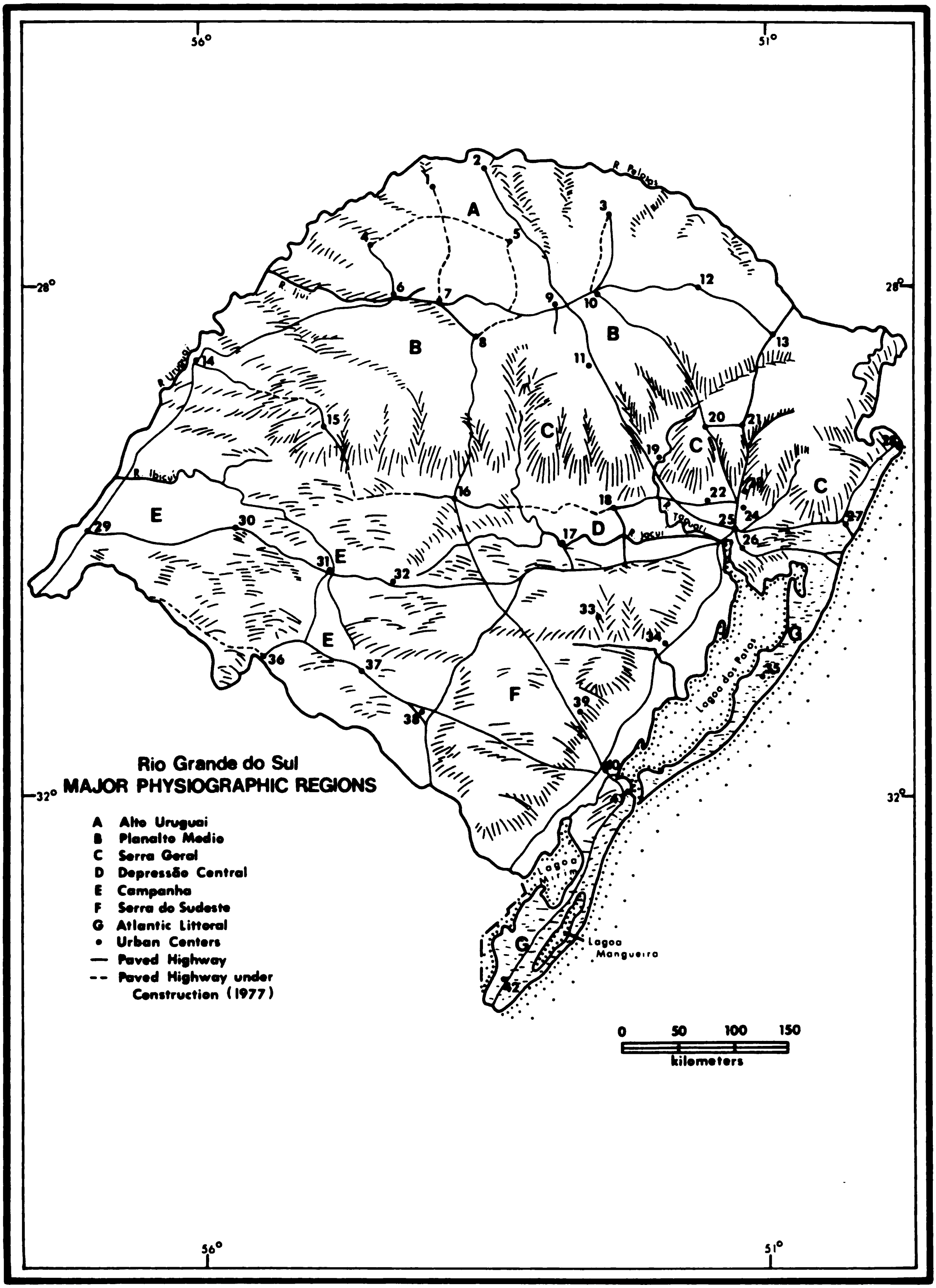

Figure 9.--Rio Grande do Sul, Major Physiographic Regions.

Index to Figure 9

1 - Três Passos
2 - Frederico Westphalen
3 - Erechim
4 - Santa Rosa
5 - Palmeira das Missões
6 - Santo Ângelo
7 - Ijuí
8 - Cruz Alta
9 - Carazinho
10 - Passo Fundo
11 - Soledade
12 - Lagoa Vermelha
13 - Vacaria
14 - São Borja
15 - Santiago
16 - Santa Maria
17 - Cachoeira do Sul
18 - Santa Cruz do Sul
19 - Lajeado
20 - Bento Gonçalves
21 - Caxias do Sul
22 - Montenegro
23 - Novo Hamburgo
24 - São Leopoldo
25 - Canoas
26 - Porto Alegre
27 - Osório
28 - Torres
29 - Uruguaiana
30 - Alegrete
31 - Rosário do Sul
32 - São Gabriel
33 - Encruzilhada do Sul
34 - Camaquã
35 - Mostardas
36 - Santana do Livramento
37 - Dom Pedrito
38 - Bagé
39 - Cangussu
40 - Pelotas
41 - Rio Grande
42 - Santa Vitória do Palmar

300 m near Santo Angelo. From Santo Ângelo elevations continue to decrease westward to the Rio Uruguai lowlands, which are below 100 m. To the north, the descent from plateau to river valley is much more abrupt and the terrain is more rugged. In extreme northern Rio Grande do Sul, the upper Rio Uruguai or Alto Uruguai has cut through the basaltic plateau. Headward erosion is pronounced, and the 300 m high northern flank to the Planalto Medio is heavily dissected. Relief atop the Planalto Medio is not marked.

The Depressão Central

The Depressão Central is a structural depression in central Rio Grande do Sul. It is bordered on the north by the Serra Geral escarpment zone of the Planalto Medio and on the south by a lower hilly region, the Serra do Sudeste. The depression has an east-west orientation and parallels the Serra Geral. Unlike the plateau area to the north, the depression was not covered by basaltic lava flows, but rather consists of fluvial sediments along major river courses and sandstone formations elsewhere. The depression roughly bisects the state from east to west and extends from the Porto Alegre area westward to roughly 100 km west of Santa Maria. Floodplain areas are found along the Rio Jacuí, and occasional low, poorly drained areas also occur in the depression. The terrain elsewhere in the depression is gently rolling, rather than flat.

Elevations in the depression vary from about twenty-five m to approximately 200 m on the margins. The Rio Jacuí is the region's principal waterway and the state's most important interior river. It originates in the Planalto Medio and descends the escarpment of the Serra Geral east of Santa Maria. It then follows the Depressão Central eastward to Porto Alegre. Other rivers, including the Rio Taquari, also descend the Serra Geral and join the Rio Jacuí in its lower course near Porto Alegre.

The Campanha

The state's extensive natural grassland zone or Campanha covers nearly all of southwestern Rio Grande do Sul. It is bounded on the north by the Planalto Medio, on the northeast by the Depressão Central, and on the east by the Serra do Sudeste. The Campanha extends westward to the Rio Uruguai valley and southward across the Brazil-Uruguay border. Considerable variation in vegetation cover occurs throughout the region. In lowland zones bordering the Depressão Central, grasses are quite lush while galeria forests are found throughout much of the Campanha. In contrast, some other areas exhibit greater relief, are more rocky, and support only sparse vegetation due to thin soils and water loss through permeable soils.

The underlying geologic structure of the Campanha is more complex. Formations of basalt associated with lava flows of the Planalto Medio occur west of a line from

Santana do Livramento to Rosário do Sul. The basalt formations of the region are underlain by sandstone, but extensive outcrops of the latter occur farther eastward. Likewise, siltites and clay are common in the eastern Campanha and extend to the western margin of the Serra do Sudeste.

The Campanha is an area of rolling terrain of low to moderate relief, and in no part does elevation exceed 600 m. Most of the area is below 200 m with lowest areas being found in the Rio Ibicuí valley and along its tributaries. However, elevation gradually increases to over 400 m along the western margins of the Planalto Medio and Serra do Sudeste. Hilly terrain and even some isolated buttes are found near Santana do Livramento, but elevation decreases northwestward toward the Rio Ibicuí. The Campanha is mainly drained by the Rio Ibicuí and its tributaries whose confluence with the Rio Uruguai is immediately upriver from Uruguaiana. The rolling expanses of the zone are heavily dissected by stream action in many areas particularly near Santana do Livramento and to a lesser extent near Bagé. The resulting interfluves, known locally as <u>coxilhas</u>, are long narrow ridges that are often 100 m higher than surrounding areas. The Campanha has traditionally been used for livestock-grazing purposes, but natural pastures are poor in many areas and must be burned in winter to stimulate fresh growth. Wet rice production is now important in several lowland clay areas, while soybean cultivation is practiced in some areas of rolling terrain.

The Serra do Sudeste

South of the Depressão Central and east of the Campanha is the Serra do Sudeste, a geologically old eroded crystalline shield composed of granitic rocks with some magmatic intrusions. Relief in the area is much lower than that of the Planalto Medio to the north of the Depressão Central, with highest elevations not exceeding 500 m. Maximum relief is found in the eastern part of the shield which borders on the low-lying Atlantic littoral and the nearby coastal lagoon area to the east. However, elevation gradually decreases where granitic formations interface with extensive formations of sandstone in the rolling plains or Campanha of southwestern Rio Grande do Sul. Drainage of the Serra do Sudeste is largely via the Rio Camaquã which flows eastward to the lowlands bordering the Lagoa dos Patos. Although relief in the region is not great compared with other highland areas of the state, agricultural settlement is sparse except along the southeastern flank. This is due mainly to the presence of thin, rocky soils of low fertility.

The Atlantic Littoral

The Atlantic littoral of Rio Grande do Sul extends from Torres, in the extreme northeast bordering Santa Catarina, southwestward for more than 600 km to Barra do Chuí. The littoral extends inland to the Serra Geral in the northeast, but farther south extends westward to the edge of the Serra do Sudeste.

The immediate coastal zone has a general southwest-northeast orientation and is backed by two large lagoons throughout much of its length. The Lagoa dos Patos is the northernmost and larger of the two lagoons, with a length of approximately 250 km. Width varies from about twenty km to more than fifty km. The Lagoa Mirim is approximately 160 km in length and varies considerably in width, narrowing in its southernmost portion which forms part of the Brazil-Uruguay boundary. In spite of their great size, both lagoons are shallow, and only the Lagoa dos Patos is navigable for ocean-going ships in certain dredged areas.

The terrain of Rio Grande do Sul's coastal zone is flat and consists of very recent (Quaternary) sediments. Low-lying marsh areas are common along lagoon margins, and mud flats occur in some areas.

The coastline separating the Atlantic Ocean from the two large interior lagoons is a barrier beach formed by the deposition of sediments by longshore currents. The beach is wide and sandy throughout its length, except at Torres where basaltic cliffs have created a rugged shoreline. Numerous areas of sand dunes occur along the coast, particularly in the central segment. Here "barchan" or crescent-shaped dunes occur in large numbers. The convex sides of the dunes point southwest as a result of prevailing northeasterly winds. In addition, numerous small lagoons occur inland from the dune and beach areas.

The drainage systems of the Lagoa dos Patos and Lagoa Mirim are complex. The Lagoa dos Patos contains mostly fresh water but salt water is also present in its southernmost section, which is connected to the open ocean at the Barra do Rio Grande. In the past, salt water entered the Lagoa Mirim from the Lagoa dos Patos via the Canal de São Gonçalo. However, a recently constructed dam south of Pelotas now prevents salt water entry. The waters of the Lagoa Mirim are therefore preserved for irrigation purposes while the flooding of low-lying pasturelands is controlled.

Climate

Nearly all of Rio Grande do Sul has a humid subtropical climate which places the state in the Cfa category within the Köppen system of climate classification.[3] Only the extreme northeast and a small portion of the Campanha have slightly cooler variants of this climatic type. Unlike tropical Brazil, the state experiences sudden daily changes in temperature and the seasonal temperature ranges are quite pronounced. Precipitation is less variable. Rainfall is

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[3]Brazil, Ministério da Agricultura, Departamento Nacional de Pesquisa Agropecuária, Divisão de Pesquisa, Levantamento de reconhecimento dos solos do Estado do Rio Grande do Sul, Boletim Técnico No. 30 (Recife), 1973, pp. 23 and 25.

plentiful and well distributed throughout the year, although there is a tendency toward a winter maximum in some areas. Chief climatic controls include latitude, elevation, and continentality. These controls give southern Brazil, and particularly Rio Grande do Sul, a unique climate within the larger Brazilian context.

Climatic Controls and Action Centers

The three climatic controls of latitude, elevation and continentality are especially noteworthy in the case of Rio Grande do Sul. The high latitude of the state compared to other parts of Brazil results in a greater amplitude of temperature variation than locations in Brazil nearer the Equator as well as a greater average annual temperature range. Likewise, elevation is a determinant in the change of temperature due to the normal lapse rate. The unequal heating and cooling properties of land and water masses is likewise significant and is contrasted in the climatic patterns of coastal and interior areas.

The latitude of the state, ranging from approximately 27° to 33.5° south of the Equator, places the state well poleward of the Tropic of Capricorn. Seasonality of temperature, day length variation and total insolation therefore vary greatly from the rest of Brazil where seasonal changes in precipitation are more significant than temperature variation. Rio Grande do Sul thus is located in a zone of transition between the tropical and middle latitude areas of South America. Because of this latitudinal position, marked changes in temperature occur from season to season and the average annual temperature range approximates that of parts of southeastern United States.

Elevation also plays a significant role as does continentality. The extensive Planalto Medio, which covers roughly 30 percent of the state, is considerably cooler in both summer and winter than adjacent regions, particularly in the higher eastern section which exceeds 1,000 m in elevation. In such areas heavy frost and even snow can occur during the winter season although the latter is of short duration. Precipitation in higher elevations is more abundant, due to adiabatic cooling. The influence of continentality is also evident in the state in terms of temperature variation. Summer temperatures tend to be much higher in the interior, where intense surface heating occurs. Areas near the Atlantic tend to be cooler in summer and warmer in winter. During the winter, freezing temperatures and severe frosts may occur from time to time at interior locations, especially on clear nights due to surface heat loss. In contrast, frost is rare along coastal areas due to the tempering marine influence during such periods.

Atmospheric pressure systems or action centers influencing the state's climate include the Inter-Tropical Convergence zone (ITC), the South Atlantic High, migrating subantarctic lows, the Antarctic High, and the Chaco Low.[4]

In summer the ITC migrates southward as a result of increased heating over land and water areas in the southern hemisphere. As this belt of low pressure shifts to the south, it brings atmospheric instability to Rio Grande do Sul and adjacent areas. Convectional thunderstorms resulting from the heating and uplift of unstable maritime tropical air moving onshore are common at this time. However, at other times, particularly in winter when the ITC has retreated northward, the South Atlantic High strongly influences weather patterns. During such times moist northeast winds bring fair, stable weather. Rio Grande do Sul and landmass areas to the south and southwest are also affected by eastward moving subantarctic winter storm systems imbedded in the mid-latitude westerlies of the southern hemisphere. The flow of cool and relatively unstable maritime polar air northeastward into the state brings cool, rainy and sometimes blustery weather. As these low-pressure troughs or _ondas_ pass through, light snow may even occur at higher elevations. On other occasions in winter a very strong cold wave or _friagem_ resulting from an outbreak of cold, stable antarctic air may occur. Fair weather, freezing temperatures and frost caused by surface heat loss under clear skies at night typify the _friagem_. The Planalto Medio,

[4] _Geografia do Brasil, Região Sul_, pp. 36-38.

including portions in adjacent Santa Catarina, is particularly affected because of its high elevation, as is the Campanha because of its interior location and higher latitude.

The Chaco Low centered over the continental interior is basically a thermal low over dry land overlain by a high pressure system aloft. This thermal low does not greatly influence Rio Grande do Sul's weather, although it may increase the flow of maritime tropical air toward the interior during summer thereby increasing precipitation. In winter, the Chaco Low does not exert any influence on the state's weather as the system tends to break down and retreat northward.

Temperature and Precipitation

Temperature and precipitation values for Rio Grande do Sul vary widely from one region to another because of the previously discussed climatic controls. Average annual temperatures for Rio Grande do Sul vary between 16° and 19.4°C (61°F to 67°F). Precipitation varies from 1,250 mm to 2,000 mm (49 inches to 79 inches). Mean January summer temperatures are highest in the valley of the Rio Uruguai, in the extreme west, because of low elevation and interior heating (over 26°C/79°F). Nearly as warm is the low Depressão Central, to the east, which includes Porto Alegre (over 24°C/75°F). Northward, the mean summer temperatures are slightly cooler (about 22°C/72°F), due to elevation. Similar temperatures prevail at this time along Brazil's frontier with Uruguay. The eastern portion of the state's planalto is much higher, and mean summer temperatures are correspondingly lower and pleasant, 20°C (68°F).[5]

Mean annual winter temperatures are less than 15°C (59°F) throughout the state's extreme west, the Depressão Central and Atlantic littoral zone. Temperatures in most of the Planalto Medio again are lower because of elevation (less than 13°C/56°F). The state's Campanha records about the same temperatures because of higher latitude and greater proximity to polar air masses. Coldest temperatures in the state occur in the eastern planalto and average about 10°C (50°F). In addition, temperatures may fall below freezing as many as fifteen times per year in this zone.[6]

Precipitation in Rio Grande do Sul is well distributed throughout the year and there are no distinct wet and dry seasons, such as characterize precipitation patterns in most other areas of Brazil. Likewise, droughts are not common, although precipitation varies from year to year. Nearly all precipitation occurs in the form of rain with the exception of occasional light snow, or hail associated with severe convectional thunderstorms during summer in the state's interior.

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[5]Ibid., p. 54.

[6]Ibid., pp. 58 and 63.

In general, precipitation is greatest in the state's northern Alto Uruguai region and adjacent western Santa Catarina. A second and much smaller area in highland northeast Rio Grande do Sul also receives large amounts of precipitation. Both areas receive more than 2,000 mm (79 inches) of rainfall annually, and small areas within the two zones receive more than 2,250 mm (89 inches) annually. Precipitation gradually declines to the south and west of these highest rainfall areas. Most of the Planalto Medio, for example, receives between 1,750 mm and 2,000 mm (69 inches to 79 inches). The escarpment zone of the Serra Geral north of Porto Alegre receives about the same amount. The Depressão Central area and the westernmost portion of the Planalto Medio receive between 1,500 mm and 1,750 mm (59 inches to 69 inches). Although rainfall is by no means deficient in this area, summer evapotranspiration rates are higher, due to lower elevation and higher temperatures.

Annual precipitation totals in the southwestern and western areas including the Rio Uruguai valley, as well as the northeastern coastal area, vary between 1,250 mm and 1,500 mm (49 to 59 inches). Low relief with the exception of some locally higher elevations in the Serra do Sudeste appears to be a major factor responsible for this decrease. In addition, the extreme south is more removed from the summer position of the ITC which generates more rainfall in the state's north. The central and southern coastal areas of

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of Rio Grande do Sul receive the least precipitation (less than 1,250 mm/49 inches).[7] Nevertheless, winter floods occurred in the latter area in 1977 due to the area's extremely low relief and poor drainage.

Soils and Vegetation

The soils of Rio Grande do Sul vary considerably in fertility, composition and origin. This is due primarily to differences in parent material, topography, climate and vegetation as well as soil maturity. Major parent materials include basalt, granite, schist, sandstone, siltite and marine deposits. Due to leaching, most of the state's soils are deficient in such nutrients as potassium and phosphorus, and soil acidity is high in the Planalto Medio. Organic content is low because of rapid decomposition of vegetative matter under humid subtropical conditions. However, much has been done in the Planalto Medio to enhance soil fertility. Costly application of lime and fertilizer has largely offset soil acidity and nutrient deficiencies in that region's major soybean-wheat production areas.

The state's most fertile areas are found mainly in interfluve zones along the rugged margin of the Planalto Medio. Deep relatively fertile soils of basaltic origin have accumulated on mountain slopes and hillsides in such areas. Other fertile soils occur in the high northeast Planalto region where organic content is high, and some

[7]Ibid., p. 43.

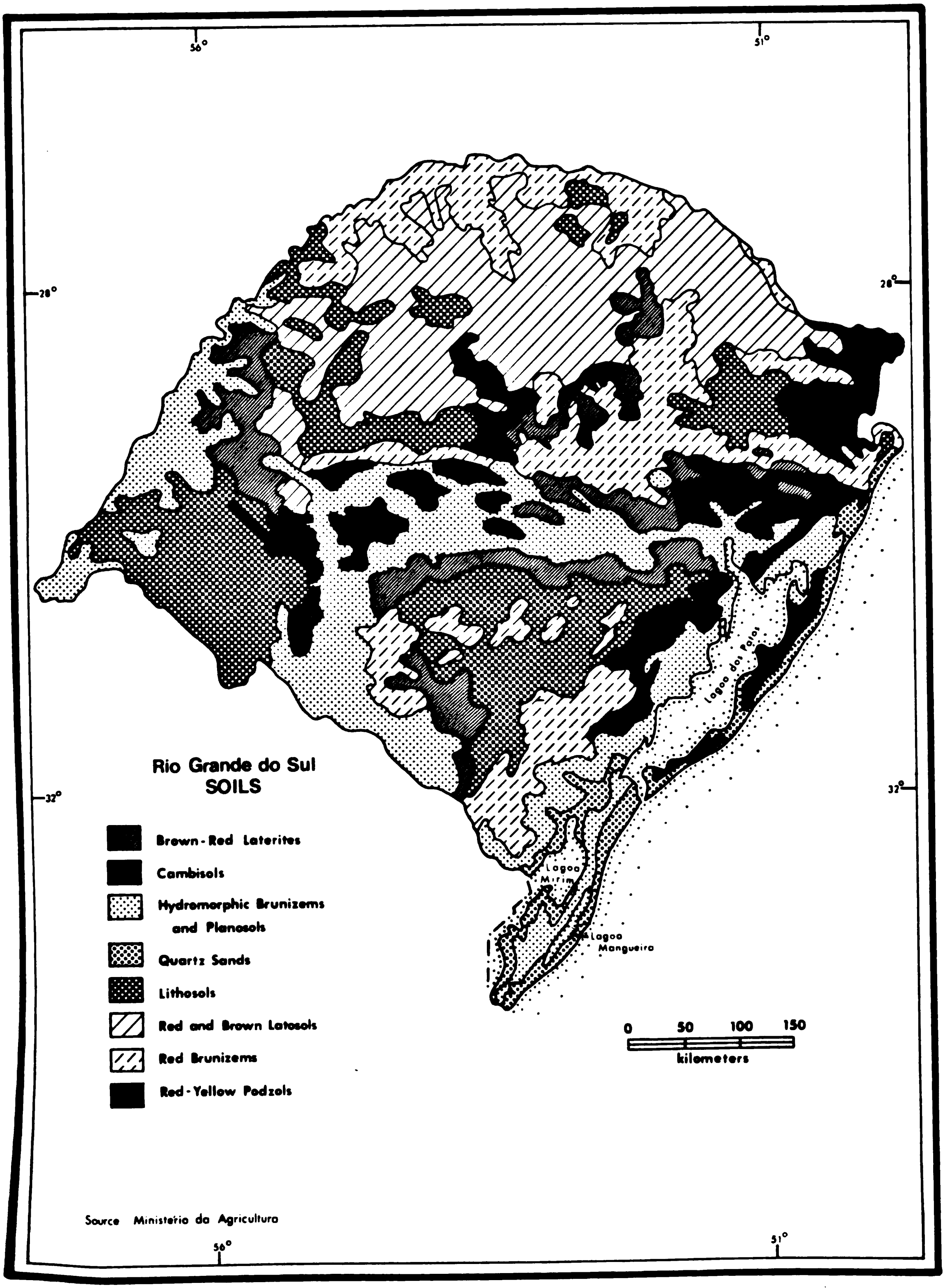

Figure 10.--Rio Grande do Sul, Soils.

soils of the Atlantic littoral zone are also reasonably productive without fertilizer. A negative feature of some of the state's soils is that they are clayey in texture, plastic, and difficult to work during wet periods.

Erosion is severe in parts of the Planalto Medio, Alto Uruguai region and the Serra Geral escarpment. In such areas copious rainfall and rugged terrain have combined to make soil erosion a major problem. Furthermore, widespread deforestation for agricultural purposes has accelerated erosion in areas of pronounced relief. Wind erosion is also a problem in western Rio Grande do Sul. One area near Alegrete is undergoing a process of desertification due to overgrazing and soil compaction.[8]

Distribution of Soil Types

Brown and red latosol soils are found throughout much of the basaltic Planalto Medio and extend from São Luís Gonzaga on the west to Lagoa Vermelha on the east. Similar soils occur north and south of the upper Rió Ibicuí in western Rio Grande do Sul. These soils are generally highly leached, deficient in potassium and phosphorus and contain much aluminum and oxidized iron. They are reddish in color, clayey in texture and highly acidic. The latter necessitates heavy liming prior to the

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[8]"Intensificado combate aos 'desertos' de Alegrete," Zero Hora, Porto Alegre, September 14, 1977, p. 23.

cultivation of soybeans, which are the region's most important crop.

Red-yellow podzolic soils occur sporadically along the northern margin of the Depressão Central which parallels the Rio Jacuí floodplain. These soils extend from northeast of Porto Alegre west to Santa Maria and then southwest to Santana do Livramento. They are also found along the eastern flank of the Serra do Sudeste west of the Lagoa dos Patos. Red-yellow podzol parent materials include sandstone and siltite in the Depressão Central, granite along the eastern margins of the Serra do Sudeste, and coastal sediments and sandstone near Porto Alegre. The state's red-yellow podzolic soils are generally somewhat sandy in the west but contain a higher proportion of clay elsewhere. Along the rolling eastern margin of the Serra do Sudeste and northeast of Porto Alegre, soils of this type are used mainly for polyculture. In the Depressão Central and points southwest, they are used for beef cattle pasture.

Lateritic soils which are highly leached occur with red-yellow podzols along the northern margin of the Depressão Central, and also much further west near São Borja. A more fertile variant of this soil occurs along the southern margin of the central depression and immediately northeast of Bagé. The state's lateritic soils are also derived from a variety of parent materials, including sandstone, granite and gneiss. These soils are easily eroded and are generally low in nutrients. Nevertheless, clay laterites are cultivated intensively by small-scale producers along the lower foothill margin of the Serra Geral immediately north of Porto Alegre.

Red brunizem soils are widely distributed in Rio Grande do Sul. They occur in the southern Serra do Sudeste, the higher elevations of the Serra Geral and parts of the adjacent Planalto Medio, as well as the Alto Uruguai region. These soils are rather fertile in the north, where they are derived from basaltic rock. Yet, they are poorly weathered, thin and rocky in texture. In the southern Serra do Sudeste granite is the parent material and the soils possess less agricultural potential. They support some polyculture but due to rugged topography and erosion are less preferred than sandstone-derived soils in areas of more moderate relief.

Hydromorphic planosols cover nearly all of the state's interior lowland areas, including the margins of the Lagoa dos Patos and the Lagoa Mirim. These lowlands include a large area south of Bagé, the Rio Santa Maria plain and flat areas along the Rio Uruguai near Itaquí and south of Uruguaiana. Planosols are highly leached and contain much clay in their middle horizon. Thus, they have a high water retention capacity making them suitable for wet rice cultivation. Not surprisingly, the location of wet rice production in Rio Grande do Sul correlates closely with the occurrence of planosols.

Lithosols, or very rocky soils still in the primary weathering phase, also cover much of the state. Such soils are sometimes rich in nutrients but are so poorly developed that they are of little use to agriculturalists. Lithosols occur in a broad band surrounding Alegrete on the west and farther north near São Luís Gonzaga. A very extensive area of lithosols is also found throughout the Serra do Sudeste. Near Alegrete and São Luís Gonzaga the lithosols are of basaltic origin, while those in the Serra do Sudeste are derived from granite or schist. Regolith cover is extremely thin in all areas and vegetation cover is consequently sparse. Given their unsuitability for agriculture, the state's lithosol areas are used mainly for sheep pasturing. An additional area of weathered lithosols occurs west and north of Caxias do Sul. These soils are used for agricultural purposes, particularly small-scale polyculture combined with viticulture.

Other soil types are found in Rio Grande do Sul, but their areal extent is limited. Humic cambisol soils consisting of reasonably fertile but acidic clays are present in the high plateau region of the extreme northeast and are used chiefly for beef cattle grazing. The organic content of these soils is quite high due to slower vegetative decomposition resulting from cooler temperatures. Hydromorphic clay soils of variable fertility occur elsewhere.

Hydromorphic sands and alluvial deposits are present along the Canal de São Gonçalo. The sands are marine in origin and are also found to a lesser extent elsewhere in the Atlantic littoral region. Along the southeastern margin of the Lagoa Mirim alkaline clays occur but are of little importance. Much farther north, infertile nonhydromorphic sands are used for pineapple production south of Torres on the coastal plain. These soils are highly permeable, low in nutrients and exhibit no soil horizon.[9]

Vegetation Types and Distribution

Five major vegetative associations occur in Rio Grande do Sul. These include (1) tropical broadleaf-evergreen rainforest, (2) subtropical semideciduous forest, (3) subtropical semideciduous forest with araucaria, (4) campo, and (5) coastal vegetation.[10]

A very small area of tropical broad-leaf rainforest is found in extreme northeast Rio Grande do Sul along the eastern lower flank of the Serra Geral. This forest comprises the southernmost zone of tropical forest in Brazil. It extends nearly to 30° South Latitude as a result of moderating marine influences and ample rainfall. Tall, broad-trunked trees with numerous epiphytes are found within the zone and are similar to coastal tropical forests farther northward. Small palms, in particular, comprise

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[9] Information on soils was obtained mainly from Levantamento de reconhecimento dos solos do Estado do Rio Grande do Sul, pp. 50-428 and accompanying map.

[10] Geografia do Brasil, Região Sul, p. 82.

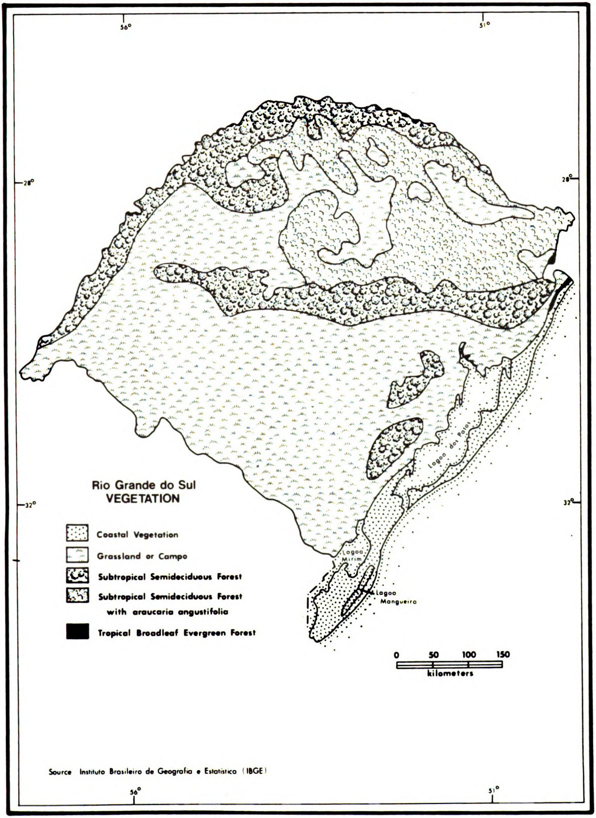

Figure 11.--Rio Grande do Sul, Vegetation.

the shaded vegetative understory. The total area of this vegetative type has been considerably reduced through deforestation.

Subtropical semideciduous forest is found along the southern margin of the Serra Geral, which extends across most of the state except for the extreme west. A second major zone of this forest type extends in an arc-like fashion across extreme northern Rio Grande do Sul and then southwestward along the Rio Uruguai valley to Uruguaiana. The Serra do Sudeste also supports some vegetative growth of this type. Tree height in the three areas varies widely depending on location, rainfall and temperature. Because of warmer temperatures and increased rainfall, forests in the Alto Uruguai region are luxuriant with numerous epiphytes, as is true of tropical areas. Trees are tall and well developed, and a vegetative understory occurs as well. Along the Serra Geral, tree growth is less luxuriant. Farther southward cooler climatic conditions, less rainfall and rocky soils greatly reduce tree size in the Serra do Sudeste. Forest growth is more sparse in the zone, and the area is definitely marginal for this type of vegetation.

Deforestation has been widespread in the various subtropical semideciduous forest zones. Along the Rio Uruguai land has been cleared for wet rice cultivation and pasture. Farther upstream in the Alto Uruguai region, nearly all the land has been cleared by <u>colonos</u> for small-scale subsistence agriculture. Similar land clearance has occurred in the Serra Geral. Where land has been abandoned due to soil exhaustion, capão or second growth vegetation has replaced the original forest growth. As a result, reforestation has been necessary to control erosion in some areas.

An extensive area of subtropical semideciduous forest with tall coniferous araucaria trees comprising the vegetative upper story occurs throughout much of the eastern Planalto Medio. Araucarias are prized for their timber as well as stately appearance. They occur most often with subtropical semideciduous forest in areas above 400 m in elevation, or in highland natural grassland zones.[11]

The natural grasslands or campos of Rio Grande do Sul cover more than half of its total area and to a great extent typify the landscape of the state to outsiders. The largest zone of campo vegetation covers the southwestern quadrant of the state, but the grasslands also extend northward to the Rio Ijuí and eastward into the Planalto Medio. In the latter area, the grasslands are interspersed with stands of subtropical semideciduous forest with araucaria. On the east campo vegetation borders the lowlands of the Depressão Central and farther southward, the Serra do Sudeste. The vegetation type also continues southwestward into neighboring Uruguay and Argentina. An isolated natural grassland zone is also found in the extreme northeast plateau area near Vacaria and continues into adjacent

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[11] Ibid., p. 89.

Santa Catarina. In this zone araucaria normally occupy low-lying sites surrounded by grassland.

Although the overall appearance of campo vegetation is one of uniformity, substantial differences do exist. In some areas very small bush-like herbaceous plants are found. Other areas of the campos consist of tall, rigid-stalked grasses, while short, thick grasses occur in moist lowland areas. Throughout most of the region galeria forests occur along water courses where moisture levels are sufficient to permit tree growth, as in the case of the Rio Ibicuí and Rio Ijuí. In addition, groves of eucalyptus have been planted by ranchers throughout the zone and form a distinctive part of the rural landscape.

The Atlantic littoral vegetation zone is extremely narrow in northeastern Rio Grande do Sul, but widens southward to include the seaward margins of inland lagoons. Forested areas along the immediate coast are rare due to sandy soils, dune encroachment, saline ground water and severe wind erosion. Vegetation consists of halophytic (salt-resistant) bushes and various types of beach grasses uniquely adapted to this environment. The former type is mainly found on the leeward side of sand dunes. Farther inland, mud flats are common along shore areas of the Lagoa dos Patos and the Lagoa Mirim. In adjacent better drained areas, grass and isolated stands of spreading figueira trees typify the vegetative complex of the flat, poorly drained coastal zone. In contrast with areas farther north, mangrove vegetation is not found along lagoonal, estuarine or riverine environments in Rio Grande do Sul. This is due to climatic limitations (winter cold waves) and the presence of cooler water offshore.

Historical Perspective

Rio Grande do Sul's settlement and development were determined largely by competing Portuguese and Spanish influences during colonial times, political separatism following Brazil's independence from Portugal and foreign agricultural colonization. This section examines: (1) the historical development of the state, and (2) foreign agricultural colonization as part of this historical context.

Settlement and Government

Rio Grande do Sul was a zone of conflict between Portugal and Spain during colonial times. Armed conflict resulted in some cases, territory was won and lost, and frontier settlements changed hands. Spanish colonial power was strong in northwestern Rio Grande do Sul where seven Jesuit missions or *reducciones* were established in the seventeenth century. In addition to their function of converting the area's Indians to Christianity, the *reducciones* served as centers of crop-livestock production. However, the Jesuit presence in the state soon attracted adventurers and freebooters from São Paulo state known as *bandeirantes* who sometimes attacked mission settlements in search of cattle and Indian labor. Rather than let their livestock be captured by the enemy, the Jesuits set their animals free. These cattle were later to diffuse throughout the lower Jacuí valley and neighboring highland areas.[12] The seven _reducciones_ were subsequently abandoned by the Spaniards in the face of increased Portuguese control which by 1800 extended as far south as Colonia do Sacramento on the Río de la Plata opposite Buenos Aires. In 1821 Rio Grande do Sul became a province of the Brazilian colonial empire only one year prior to independence from Portugal. In 1828 the _provincia cisplatina_ held by Brazil achieved independence as the new republic of Uruguay.

Other areas of Rio Grande do Sul outside the zone of Jesuit settlement remained unpopulated until about 1750. However, the following year saw the founding of Rio Grande de São Pedro (now Rio Grande) for the purpose of consolidating Portuguese control from Laguna, in Santa Catarina, to Colonia do Sacramento. The establishment of such settlements was of key importance to the Portuguese at that time since control was tenuous at best south of Santa Catarina.[13] This was confirmed when the Spaniards attacked Rio Grande de São Pedro only one year after its founding. More settlements were necessary, and in view of this, the

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[12] Lobb, "The Historical Geography of the Cattle Regions along Brazil's Southern Frontier."

[13] Arthur Ferreira Filho, _Hístoria geral do Rio Grande do Sul, 1903-1974_, 4th ed. (Porto Alegre, Brazil: Editora Globo, 1974), p. 52.

Portuguese encouraged the settlement of the eastern littoral near present day Porto Alegre. In 1773 the small settlement of Porto dos Casais was renamed Porto Alegre and became the seat of government of what is now the state of Rio Grande do Sul. Political separatism developed in the state following Brazil's independence from Portugal. This was due in part to remoteness from Rio de Janeiro as well as Rio Grande do Sul's own considerable importance. In 1835 part of the state seceded from the remainder of Brazil to become the independent Republica Piratini. Ten years of civil war followed and in 1845 the new nation was dissolved and reincorporated into Brazil. The state was beset by internal strife from 1893 to 1895 and again beginning in 1923. In addition, Rio Grande do Sul served as the base for the revolution of 1930 at which time Getúlio Vargas assumed the presidency of Brazil. More recently, João Goulart's controversial government had its inception when he proclaimed himself President of Brazil while in Porto Alegre during the political crisis of 1961.[14]

Government-Sponsored Colonization

Government attempts to populate Rio Grande do Sul began during the mid-eighteenth century and continued until the early twentieth century. During the period of Portuguese colonial rule, large tracts of land or *sesmarias* were

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[14] Ibid., pp. 112, 181, 210.

granted to selected persons along the Atlantic littoral and in the western Campanha cattle lands. This did much to stimulate livestock production for colonial Brazil's domestic market while insuring Portuguese control in frontier areas.

After independence, the new Brazilian imperial government began a program to colonize the forested regions of the Serra Geral. Most Luso-Brazilians preferred the grassland areas of the state for settlement and for cattle raising as a livelihood. Efforts were thus made to attract German immigrants to colonize and clear forested areas for agricultural purposes.

In 1824 the German settlement of São Leopoldo was founded immediately to the north of Porto Alegre.[15] From this original nucleus, settlement expanded mainly westward and later eastward along the foothills of the Serra Geral. Other German immigrant settlements were established some decades later. Among these colonies were Santa Cruz do Sul (1849), about 100 km west of São Leopoldo, and Estrela (1853), about eighty km northwest of the original colony. In 1857 the colony of Santo Ângelo (Agudo) was established along the upper Rio Jacuí. Nova Petrópolis, sixty-five km north of São Leopoldo, was established the following year along the upper margin of the colonization front. That

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[15]Flavia La Salvia and Nilbiamater S. B. Handschunch, "Processo de colonização no Rio Grande do Sul," Boletim Geográfico do RGS, Ano 19, no. 17 (1974): 3.

same year one extra-regional German immigrant colony was founded along the southwestern margin of the Lagoa dos Patos.[16] Lot size was twenty-five hectares in most cases, with much of the area being forested.[17] However, soils were reasonably fertile in many areas and, once the land was cleared, colonists began to produce a variety of grain and vegetables on a small scale. Dairy products also assumed some importance. Surplus agricultural products were soon transported via tributaries of the Rio Jacuí to markets in Porto Alegre.

In 1874 colonization of the Serra Geral above 600 m elevation was begun by Italian colonists with the help of the Brazilian government.[18] The important city of Caxias do Sul was founded the next year as were the colonies of Dona Isabel (Bento Gonçalves), Conde D' Eu (Garibaldi) and Nova Vicenza (Farroupilha). Two years later Nova Trento (Flores da Cunha) was established. Subsequent Italian colonies included Roça Reuna in 1884 (Veranópolis), Antonio Prado (1885) and Guaporé (1892).[19] Most colonies were located to the west and northwest of Caxias do Sul within a fifty km radius.

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[16]Ibid., p. 4. [17]Ibid., p. 19.

[18]Ibid., p. 4.

[19]Brazil, Instituto Gaúcho de Reforma Agrária (IGRA), Evolução administrativa do Rio Grande do Sul (Porto Alegre, n.d., approximately 1966), pp. 53-67.

The Italian colonists, like their German counterparts in the lower elevations of the Serra Geral to the south, were small-scale farmers with similar sized properties. However, viticulture and wine making soon supplemented subsistence agriculture and today are of major importance.

A second phase of colonization began about 1890 when the government of Rio Grande do Sul made available additional lands for settlement in the Alto Uruguai region. New colonies or colonias novas, similar to the older planned settlements of the Serra Geral (colonias velhas), were established to continue agricultural settlement in the state's forested zones and to populate the political frontier adjacent to Argentina. Major settlements founded were Ijuí (1890) in the Planalto Medio and two widely separated colonies immediately south of the upper Rio Uruguai, Erechim (1908) in the east, and Santa Rosa (1915) about 150 miles to the west.[20]

The number of new colonization projects declined greatly after World War I, but several more recent settlements deserve mention. In 1942 the colony of Passo Novo northeast of Alegrete was established and concentrated largely on cattle and rice production. Recent information on the colony's population is lacking, although it is known

[20] La Salvia and Handschunch, p. 5.

that approximately 100 families were resident there in 1964.[21] A second more important rural settlement zone designated Colonia Nova, south of Bagé, was colonized by Russians of German ancestry in 1949. Today the colony is important for wheat and dairy production as is nearby Trigolândia, an outgrowth of Colonia Nova.[22]

At the time of writing no foreign agricultural colonization is underway in the state. However, the Instituto Nacional de Colonização e Reforma Agrária (INCRA) has undertaken some agricultural resettlement projects. The largest of these was the relocation of 1,600 farm families from the Passo Real hydroelectric project site beginning in 1970. This agency has also expropriated some large rural properties where severe disequilibrium in landholding size and social tensions exist. Some idle government lands along the upper Rio Uruguai have also been turned over to small-scale farmers to ease agricultural land shortages within the region.[23]

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[21]Brazil, Associação Sulina de Crédito e Assistência Rural (ASCAR), Situação econômica atual do núcleo colonial de Passo Nôvo e de seus occupantes (Porto Alegre, 1964), pp. 7 and 9.

[22]Flavia La Salvia and Nilbiamater S. B. Handschunch, "Contribuição a metodologia do estudo do habitat rural-Bagé," Boletim Geográfico do RGS, Ano 16, No. 14 (January-December, 1971), pp. 25-26.

[23]Interview with Engineer-Agronomist Ivan J. Barros de Moraes, Porto Alegre, September 15, 1977.

Population

Rio Grande do Sul occupies sixth place among Brazil's states and territories in population. Of the nation's estimated 1978 total population of 116 million persons, nearly eight million are resident in the state.[24] The 1975 estimated population density of Rio Grande do Sul (27.88 persons per km^2) is modest compared with that of São Paulo state (83.44 persons per km^2).[25] It was in that year even somewhat lower than that of Paraná (42.45 persons per km^2) or Santa Catarina (35.10 persons per km^2).[26] Nevertheless, the state is not sparsely populated compared with the Brazilian North, certain states of the northeast or Minas Gerais.

The population of Rio Grande do Sul increased 89 percent from 1950 (4,164,821) to 1978 (7,971,400 estimated).[27] During this same period, Porto Alegre increased in population much more rapidly than the state as a whole. The city's 1950 population of 394,151 (município of Porto Alegre) increased dramatically to an estimated 1,043,964 in 1975, a 264 percent gain.[28] Metropolitan Porto Alegre

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[24] Anuário Estatístico do Brasil, 1976, p. 83.

[25] Ibid., pp. 115 and 107, respectively.

[26] Ibid., pp. 111 and 113, respectively.

[27] Ibid., pp. 64 and 83, respectively.

[28] Ibid., pp. 67 and 90, respectively.

includes the *município* of the same name plus fifteen contiguous *municípios* located mainly to the north of the central city. The 1975 estimated population of the Porto Alegre conurbation was 1,836,179, making it Brazil's fifth largest urban area.[29]

Population Distribution

The state has two major types of settlement patterns outside of Porto Alegre: (1) small, densely populated rural zones which comprise the state's old European colonial areas; and (2) areas of large rural landholdings having low population densities which were settled by Luso-Brazilians. Crop-livestock patterns and resulting settlement patterns in both areas have been greatly influenced by terrain, soils, climate, vegetation, accessibility and culture.

Most of the state's colonization zones are densely populated but few large regional centers exist. Instead, the population is dispersed among numerous small subregional centers.[30] In the past rugged terrain, poor communication and isolation encouraged the development of such a pattern, by which farm-to-market distance and time were significantly reduced. Small-scale subsistence agriculture remains the chief economic activity in both the

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[29] Ibid., p. 90.

[30] Brazil, Fundação IBGE, *Divisão do Brasil em regiões funcionais urbanas* (Rio de Janeiro, 1972), pp. 22 and 23.

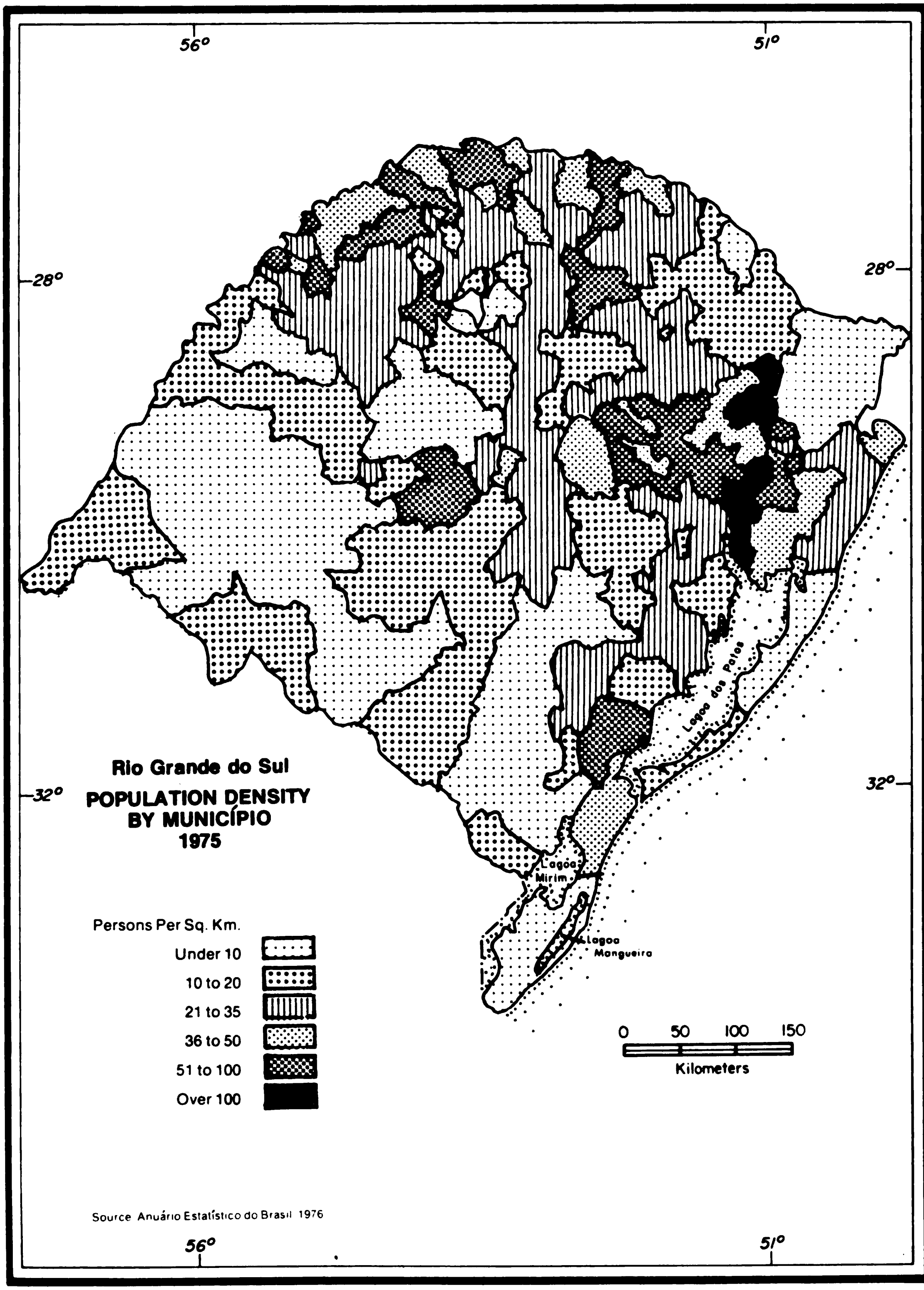

Figure 12.--Rio Grande do Sul, Population Density.

colonias velhas of the Serra Geral and the colonias novas of the Alto Uruguai region. Caxias do Sul, an important metallurgical and wine making center in the upper Serra Geral, is an exception among colonial urban centers because of its larger size and extra-regional orientation. Farther south, a much smaller area of colonial settlement in the eastern Serra do Sudeste has a lower population density than either the Serra Geral or Alto Uruguai zones. It is mainly tributary to Pelotas for farm-to-market purposes.

The east-west aligned soybean-wheat-beef cattle zone of the Planalto Medio contains larger rural properties and a more sparse population. Terrain is less of a transportation constraint in the Planalto Medio. Population is therefore concentrated in a few major agricultural trade centers of greater size having larger service areas than those of colonial zones. Among these centers are Passo Fundo, Erechim, Carazinho, Cruz Alta, Ijuí and Santo Ângelo. The extensive livestock ranching zone of Rio Grande do Sul is even more sparsely populated. However, it does include a number of regional and subregional centers, such as Bagé which is assuming great importance. Other major centers include Santana do Livramento, Alegrete, Uruguaiana, Rosário do Sul, São Borja and Dom Pedrito. Properties are very large in the Campanha but rural labor demands are low. With the exception of the Rio Uruguai lowlands, agriculture is much less important than in the Planalto Medio or colonial areas of the state. The Campanha thus has a higher percentage of urban population, with most rural areas being settlement voids.

The state's immediate coastal zone is generally sparsely populated. Rio Grande, the only major deepwater port between Paranaguá, Paraná, to the north and Montevideo to the south is an exception. This port city, along with Pelotas, is experiencing rapid population growth due to recent port and industrial expansion.

Porto Alegre is an example par excellence of a primate city. In 1975 it had more inhabitants than the combined population of Pelotas, Santa Maria, Canoas and Caxias do Sul, the state's second through fifth-ranking cities.[31] The growth of Porto Alegre has been stimulated since colonial times by the city's location on the Rio Guaíba, midway between the crop-livestock producing interior and the Atlantic Ocean. The metropolitan area has a general north-south alignment, much of which is an industrial corridor. The total length of the conurbation along this axis is approximately twenty-five km. Canoas is the state's third largest city and constitutes part of this urban system, as does São Leopoldo and Novo Hamburgo. The latter were once German colonial settlements but today are satellite cities of Porto Alegre.

Two main types of migration occur in Rio Grande do Sul. They are: (1) rural-to-urban migration and

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[31] Anuário Estatístico do Brasil, 1976, p. 115.

(2) rural-to-rural out-migration, primarily to other states in southern Brazil.

Rural-to-Urban Migration

There is considerable rural-to-urban migration, primarily from the state's large landholding areas where farm labor requirements have diminished due to mechanization. This is particularly evident in much of the Planalto Medio soybean-wheat zone and in the extensive livestock-raising area of the Campanha. With the loss of rural employment opportunities, many residents have migrated to nearby urban centers thereby accelerating the depopulation of rural areas. Porto Alegre, because of its size, employment opportunities and amenities has attracted large numbers of persons from the lower Jacuí basin, the state's economically depressed northeast littoral, and extreme southeastern Santa Catarina. Although stepwise migration in Rio Grande do Sul was not specifically investigated for this study, available information indicates that some migrants select regional urban centers as their destination while others move directly to Porto Alegre.

Rural-to-urban migration has created serious urban problems, particularly in Porto Alegre where population growth has been most rapid. Deficient municipal services as well as poor housing conditions exist in the malocas or shantytowns on the city's urban fringe where most migrants settle.

Rural-to-Rural Migration

One of Brazil's most significant population movements began with the disappearance of Rio Grande do Sul's agricultural frontier about 1940. Subdivision of rural landholdings among immigrant descendants in the state's colonial areas resulted in decreased farm size with succeeding generations. Rural overpopulation continues to be a serious socio-economic problem since fragmentation of landholdings has made agriculture uneconomical. The problem is especially acute in the Alto Uruguai region, but also exists elsewhere in the state. In response to the demand for new agricultural lands, thousands of colonos migrated to unsettled areas of extreme western Santa Catarina and particularly northwestern Paraná. In the latter state, agriculturalists from Santa Catarina and Rio Grande do Sul joined migrants from the states of São Paulo, Rio de Janeiro, Minas Gerais, Pernambuco and Bahia.[32] The influx of migrants to new agricultural settlement zones in Paraná is largely responsible for that state's 450 percent population increase since 1940. In 1970 more than 340,000 residents of Paraná indicated their birthplace as Rio Grande do Sul, while more than 258,000 residents of Santa Catarina were gaúchos by birth.[33] Out-migration from Rio

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[32] Geografia do Brasil, Região Sul, p. 180 (map).

[33] Ibid., p. 178.

Grande do Sul until 1970 therefore totaled nearly 600,000 persons. In contrast, fewer than 76,000 persons entered Rio Grande do Sul as in-migrants, due to the shortage of good agricultural land available to small-scale agriculturalists.[34]

Other types of migration occur in Rio Grande do Sul but are much less significant than rural-to-urban migration to Porto Alegre or the rural exodus northward. Some urban-to-urban migration occurs between Porto Alegre and other large Brazilian cities. In addition, entrepreneurs from Porto Alegre have settled in some of the state's soybean centers such as Passo Fundo. Other persons have immigrated to Rio Grande do Sul from Uruguay. These individuals have essentially transferred their economic pursuits from Montevideo to Porto Alegre. Small numbers of Guaraní Indians from Paraguay have also migrated to Porto Alegre, many of whom are urban squatters.

Economy

The economy of Rio Grande do Sul is based primarily on the production and processing of crop-livestock commodities. Large-scale cultivation of soybeans for export is the most important economic activity in the Planalto Medio, followed by wheat production. Large-scale rice production is important in lowland areas, while beef cattle dominate

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[34]Ibid., p. 178.

economic activity in the Campanha. In areas of rugged relief, such as the Serra Geral and upper Rio Uruguai valley, subsistence agriculture predominates.

The state is Brazil's largest producer of grapes, rice, onions, soybeans, wheat and wool.[35] It occupies second place nationally in potatoes and manioc.[36] In number of cattle, Rio Grande do Sul is exceeded only by Minas Gerais and is unsurpassed in beef production.[37] The production of black beans and oranges is significant, as is swine culture, on small landholdings. Soybean shipments to Europe and Japan have made Rio Grande the nation's third port after Santos and Paranaguá in terms of export value.[38] Rio Grande do Sul is likewise a major beef exporter to Europe and the United States. Wool exports to the United Kingdom also comprise a small part of the state's overseas trade. Rice and wheat are marketed only domestically.

Industries not related to crop-livestock production are increasing in importance. Metallurgical industries have long been important in Rio Grande do Sul. In recent years, shipbuilding, steel production, petroleum refining, electrical industries and shoe manufacturing have greatly

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[35] Anuário Estatístico do Brasil, 1976, pp. 166-167, 169, 172 and 174.

[36] Ibid., pp. 168 and 170.

[37] Ibid., p. 174. [38] Ibid., p. 244.

expanded the state's industrial base. A large petrochemical complex is also projected for Rio Grande do Sul as part of Brazil's 1975-1979 national development plan.[39]

Primary, Secondary and Tertiary Production

In general the composition of Rio Grande do Sul's economy is similar to that of Santa Catarina and Paraná, which comprise the remaining portion of southern Brazil. Southern Brazil in 1969 was more dependent on primary (crop-livestock) activities than Brazil as a whole and was less dependent on secondary activities (manufacturing). The region was also slightly below the national average in terms of income generated from tertiary activities (commerce and services).[40] However, manufacturing and heavy industrial investments are increasing within the region, especially in Rio Grande do Sul.

In 1969, 69 percent of Rio Grande do Sul's income within the primary sector was from agriculture while 28 percent was from livestock. Remaining income was derived principally from *erva mate* tea.[41]

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[39]"Inter-American Development Bank Lends $95.5 Million to Build Petrochemical Complex in Brazil," *Inter-American Development Bank News Release*, June 15, 1978, p. 1.

[40]Brazil, Ministério do Interior, Superintendência do Desenvolvimento da Região Sul (SUDESUL), *II Plano nacional de desenvolvimento*, Programa de ação do governo para a região sul 1975-79 (Porte Alegre, 1976), p. 17.

[41]Ibid., Table 3.1, p. 32.

A high degree of interdependence exists between the primary, secondary and tertiary sectors of the state's economy. In 1976 the primary sector accounted for 30 percent of Rio Grande do Sul's total income. However, the processing of agricultural-livestock products accounted for 60 percent of income derived in the secondary sector.[42] The state's primary and secondary activities are also closely linked with commercial, governmental and service (tertiary) activities. As growth in the first two sectors increased, tertiary activities assumed much greater importance. In 1970, the latter accounted for approximately one-half of Rio Grande do Sul's income.[43]

Major Centers of Economic Activity

Porto Alegre is the primary focus of economic activity, but other centers are also significant. The north-south aligned urbanized area from Porto Alegre to Novo Hamburgo is the state's main industrial corridor. Activities include chemical and fertilizer processing, petroleum refining, metallurgy, and the production of farm implements, electrical cable and shoes. Food-processing firms are located mainly within the city, while the state's

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[42] Brazil, Governo do Estado do Rio Grande do Sul, Secretaria da Indústria e Comércio, Informações econômicas do Rio Grande do Sul, Edição especial (Porto Alegre, 1977), p. 81.

[43] II Plano nacional de desenvolvimento (Programa de ação do governo para a região sul 1975-79), p. 55.

major shipyard is located just south of the city on the Guaíba estuary. Two large soybean processing facilities are also within the area.

Industrial zones exist elsewhere in the state, but on a much smaller scale. There are large metallurgical firms in Caxias do Sul, plus a modern plant on the city's periphery. The Pelotas area is noted for fruit and vegetable canning, rice milling and soybean processing. Considerable industrial development has also occurred near Rio Grande, where fertilizer processing and petroleum refining supplement port activities.

The interior cities of the Planalto Medio, Depressão Central and Campanha are centers for rice and wheat milling, but soybeans are trucked mainly to Porto Alegre or Pelotas for processing. Meat packing is a major activity near Bagé, Dom Pedrito and Santana do Livramento. Farther north, a large number of farm implement manufacturing concerns have been established mainly in the Planalto Medio soybean-wheat area.

The city of Santa Maria, in the center of Rio Grande do Sul, is a major rail transportation node and educational center. The marketing of agricultural products, such as rice, is somewhat less developed due to competition from other crop-livestock centers within the region.

CHAPTER V

BACKGROUND ON AGRICULTURAL LAND USE

Crop-livestock land use in Rio Grande do Sul is influenced by the natural environment, cultural traditions, marketing distance and time, and institutional factors such as market prices. No one factor is responsible for a particular type of land use. Rather, land use varies with the changing importance of specific combinations of these factors over time and space.

Physical Features

The terrain, soils and drainage of Rio Grande do Sul have to some extent influenced agricultural land use in crop-livestock areas. In the case of large-scale soybean-wheat areas, the rolling well-drained land of the Planalto Medio has facilitated mechanization. However, other factors, such as the availability of investment capital, high market prices and the desire to make better use of farm implements formerly used only for wheat cultivation, have been additional incentives. The region is climatically favorable for soybeans, whereas wheat cultivation has not always been successful, due to winter rains and disease.

But, costly inputs of lime and fertilizer have been necessary prior to soybean production.

Wet rice cultivation generally correlates closely with the availability of flat terrain and clayey soil subhorizons which prevent water loss. Coupled with this is sufficient precipitation or the availability of large amounts of water for irrigation. Meanwhile, the location of viticulture in Rio Grande do Sul appears to be governed more by the grape-growing and wine-making expertise of Italian colonists who settled the upper slopes of the Serra Geral.

The present rural economy has resulted largely from initiatives of the government of Rio Grande do Sul which encouraged foreign colonization. But, recent research indicates that parts of the state's Campanha region may be climatically more favorable for viticulture than the colonization zones. A number of other crops, such as bananas, manioc and sugarcane reach their southern climatic limit in central Rio Grande do Sul.

Rugged terrain in the Serra Geral, Alto Uruguai region and the Serra do Sudeste has severely limited mechanized agriculture. However, soils in the Serra Geral and Alto Uruguai zones are derived mainly from weathered volcanic materials and are reasonably fertile compared with soils in the Planalto Medio or Campanha. Temperature and rainfall also favor the cultivation of a wide variety of crops, including sugarcane, potatoes, sweet potatoes, black beans, corn and manioc. In the higher elevations, pears, apples and other middle latitude fruits can be grown. Environmental factors limiting agricultural production in the highland zones of Rio Grande do Sul are soil exhaustion and erosion. In summary, agricultural land use has been influenced by terrain, soils and climate, but historical, cultural and institutional factors are equally important.

Influence of Immigrants

Immigrant influence on agricultural practices and land-use patterns has been strong in the colonial areas of Rio Grande do Sul. The Serra Geral colonization zones and similar areas in the upper Uruguay valley and Serra do Sudeste differ from other parts of the state with respect to crop-livestock types and size of landholdings. These differences have been discussed in detail by Pébayle in a study of various rural societies in Rio Grande do Sul.[1] Especially different are the rural economies developed by German and Italian colonists in similar physical environments. Even greater differences in agricultural systems are to be found between the colonists and the traditional _gaúcho_ of Luso-Brazilian background.

Perhaps the primary influence of German and Italian colonists on land use was the creation of a landscape and

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[1]Raymond Pébayle, "Os difíceis encontros de duas sociedades rurais," _Boletim Geografico do RGS_, op. cit.

production system that exemplified the rural traditions of their native countries. Between 1824 and 1860, German immigrants were encouraged by the government of Rio Grande do Sul to establish agriculture in the forested Serra Geral. Land grants consisted of small lots which required clearing prior to cultivation. From this base, subsistence agriculture developed which included potatoes, sweet potatoes, manioc, corn and black beans, plus dairy animals. Tobacco and rice production was subsequently established by these colonists along the lower slopes of the Serra Geral and adjacent Depressão Central, respectively. Production by German immigrants has made tobacco a major commercial specialty crop, primarily around Santa Cruz do Sul.

Italian colonists who settled in the Caxias do Sul area developed small-scale subsistence agriculture after clearing forests from their properties, but this was soon supplemented by commercial viticulture and wine making. Lumbering and fruit production were and remain less important activities for farmers of Italian descent. Swine raising and wheat cultivation were practiced by both German and Italian groups, as well as by some colonists of Polish descent. The small-scale agriculture developed by these colonists is apparently due to the small size of properties granted during that period of colonization. With the passage of time, landholdings became increasingly fractionated as properties were subdivided among the sons of original _colonos_. The rugged terrain and necessity of clearing forests also may have encouraged a more intensive agriculture in which arable land was fully utilized until it was abandoned due to soil exhaustion. In later years new lands became scarce and crop rotation on already cleared lands became common. The demand for new lands encouraged the development of similar agricultural systems in the Alto Uruguai region. The colonization cycle has been repeated in that region, and many colonos are now seeking new lands elsewhere in Brazil, especially in western Paraná state.

The extensive beef ranching of the Campanha, mainly by descendants of eighteenth century Portuguese immigrants or persons of mixed Portuguese and African ancestry, contrasts sharply with the small-scale diversified agriculture in cleared forest zones. However, the relationship between immigrant and land use appears less distinct in parts of the Campanha and Planalto Medio near the region's major urban centers, because of internal migration. This has been particularly true in the Planalto Medio since 1965 due to the expansion of soybean production. Yet, the overall influence of immigrants on land use persists throughout the state. An example is commercial onion production, which is concentrated mainly between Rio Grande and the isolated coastal community of Mostardas some 100 km to the north. The crop remains important due to cultural tradition and to sandy soils that possess little potential for other use.

Marketing Distance

Marketing distance, expressed in the form of increasing transportation costs with distance, has to some extent influenced the state's land-use patterns. However, the cultural and physiographic diversity of Rio Grande do Sul tend to negate the state's utility as a testing area for land-use models such as the "Isolated State" developed by Johann Friedrich von Thünen in 1826.[2] In its most simple form, the von Thünen model envisages an isolated political state having one market in a central city. The state is assumed to be topographically uniform throughout, i.e., an isotropic plain. Other assumptions include a uniform climate, uniform transportation mode, and equal accessibility and transportation costs to the central city from all points equidistant from the center. Finally, agricultural producers are assumed to be economically rational. The basic tenet of the model, given these assumptions, is that those crops yielding the highest return after production and transportation costs will be grown nearest the city. Producers of certain crops can, in effect, outbid producers of other crops at given distances from the city. The result is that a series of concentric land-use zones are formed around the central city. Intensive agriculture (e.g., fruit

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[2]J. H. von Thünen, Der isolierte Staat in Beziehung auf Landwirtschaft und Nationalökonomie (Rostock: n.p., 1826).

and vegetable gardening) is located nearest the city, while more extensive activities are at a greater distance.

Griffin's 1972 dissertation on agricultural land use in Uruguay compares that nation's land-use patterns with those of von Thünen's "Isolated State."[3] Uruguay, which borders Rio Grande do Sul on the south, is one of the few areas in the world that approximates the assumptions of the von Thünen model and for this reason was chosen by Griffin for study. The results of Griffin's work indicate that Uruguay exhibits a pattern of land use that does approximate von Thünen's's idealized model, provided that some constraints are relaxed. Griffin identified the following crop and/or livestock zones in Uruguay:

I. Crop Regions

  a. Orchard-vineyard garden crops
  b. Intensive crop production
  c. Cereals

II. Crop-Livestock Regions

  a. Dairy
  b. Cereals-livestock

III. Livestock Regions

  a. Cattle grazing
  b. Sheep grazing

Intensive farming dominates the area closest to Montevideo, where fruit production, viticulture and market gardening are major rural occupations. Cereal production is farther

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[3]Michael Chisholm, Rural Settlement and Land Use (London: Hutchinson University Library, 1964), pp. 21-36.

removed from the city, being centered in the lower Río Uruguay valley. Crop-livestock activities include dairying north of Montevideo and a north-south aligned cereals-livestock complex in west-central Uruguay. Farthest from Montevideo are the extensive beef livestock and sheep ranching zones immediately south of the Brazil-Uruguay border. Sugarcane production in Uruguay's extreme northwest, and wet rice cultivation along the western margins of the Lagoa Mirim, deviate from the von Thünen model.

The von Thünen model has less applicability to neighboring Rio Grande do Sul, due to less uniform terrain and cultural influences on rural land use. Although market gardening and dairying near Porto Alegre replicate the land-use pattern near Montevideo, land use elsewhere in Rio Grande do Sul deviates considerably from the Uruguayan pattern. Cattle and wet rice production zones are located within twenty km of Porto Alegre, while the Serra do Sudeste intensive agricultural zone and the viticulture zone of the Serra Geral are more distant. Furthermore, the Alto Uruguai and Serra Geral zones of colono agriculture are separated by the large mechanized soybean-wheat zone in the Planalto Medio, an area of more extensive land use. An additional departure from the von Thünen model is the presence of a major wet rice region in Rio Grande do Sul bordering Argentina and Uruguay, 450 km west of Porto Alegre. However, much extensive livestock production is distant from the city. In general, crop-livestock patterns do not follow the von Thünen model, since market distance, although important, is subordinate to other factors in many areas.

Institutional Factors

Institutional factors, including landholding and land tenure systems, have greatly influenced crop-livestock land use in the state. Of particular significance was the establishment of extensive cattle ranching in the grassland expanses of Rio Grande do Sul during Spanish and Portuguese colonial times. Beef cattle were introduced by Spaniards from the Río de la Plata region in 1634, and subsequent influences of the Jesuit missions as centers of ranching reinforced the livestock tradition.[4] Shortly after 1800, when Portugal achieved control over Rio Grande do Sul from the Spaniards, large tracts of land or _sesmarias_ were granted to soldiers and nobles by the Portuguese Crown. Thus, the present system of large landholdings characterized almost exclusively by ranching can be traced back several centuries. The chief settlement and production unit in the region is the _fazenda_ or _estancia_. In this type of enterprise labor demands are low compared with agriculture, as is yield per unit area. Idle land on the _fazenda_ is commonly rented to tenant farmers or _arrendatários_ who pay a specified amount of money in exchange for permission to cultivate the land. Sharecroppers or _parceiros_, however,

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[4] _Programa 40ª Exposição de Animais_ (Porto Alegre: Secretaria de Turismo do Rio Grande do Sul, August, 1977), p. 4.

must turn over a portion of their livestock or produce to the landowner in lieu of monetary payment for use of the land. Rental and sharecropping agreements are more often verbal than written. No title is given, and the needs of _arrendatários_ and _parceiros_ have traditionally been subordinated to those of the large landowner. Small-scale agriculture is not important in the region, except where colonies have been established. The most successful of the latter is Colonia Nova, south of Bagé. The _fazenda_ remains the chief focus of economic activity and is an expression of rural society and culture as well.

In marked contrast to the Campanha were the government-sponsored colonies established by settlers from Portugal near Rio Grande and Porto Alegre, and later by German and Italian colonists in the state's hilly forested zones. Unlike the Campanha, the _colonias_ were devoted to intensive production of subsistence crops. Landholdings were small and yields high per unit area, as compared with southwestern Rio Grande do Sul. Moreover, the settlers had title to the land and used family manual labor rather than outside workers as a means of production. Although tenant farming and sharecropping are still found in the colonial zones, most agriculturalists depend upon themselves rather than others for their economic livelihood.

Crop demand and high market prices have further influenced land-use patterns, especially since 1950. The initiation of minimum price supports for wheat in the 1950s was an attempt by the federal government to achieve self-sufficiency. Mechanized wheat production assumed importance in the Planalto Medio, an area formerly devoted to cattle raising. In more recent years, soybean production has been stimulated greatly by an increasing world demand for soybean oil, soybean cake and other soya derivatives. With rising free market prices, soybeans for export assumed great importance as a foreign exchange earner for Brazil. Soybean cultivation has consequently surpassed that of wheat in the state's central plateau. Production of the crop is still increasing and the area devoted to soybeans has expanded continually since 1965.

Government reforestation and agrarian reform programs are factors that have influenced crop-livestock land use to a lesser extent. Some abandoned lands in originally forested zones have been reforested with eucalyptus and acacia. Land-use change was most significant in the Depressão Central, the southern margin of the Serra Geral and the northern Atlantic littoral. Although some expropriation and resettlement projects have been undertaken by the Instituto Nacional de Colonização e Reforma Agrária (INCRA) in recent years, only minor changes in land use have occurred as a result.

Agricultural Land Use and Crop-Livestock Regionalization

A major objective of this dissertation is to examine existing crop-livestock land use, and to identify and delimit the rural land-use regions of Rio Grande do Sul. To the extent possible, the regions have been delimited according to their true geographic area, rather than by município or other minor civil division. Existing agricultural land-use maps, including a 1:750,000 scale map based on 1965 air photographs, and published in 1972, were considered too outdated for the determination of present-day crop-livestock land use. Considering the great changes that have occurred in some parts of the state in recent years, the preparation of a new map was imperative. A 1:1,500,000 scale land-use map was therefore compiled and drafted (see Appendix). A primary source of information for the new map was a complete set of 1:110,000 scale air photographs taken in May 1975, which was made available for interpretation through the Central de Comandos Mecanizados de Apoio à Agricultural (CEMAPA). The information was verified through ground checks conducted via field traverse.

The crop-livestock regionalization for this study was formulated after careful evaluation of numerous sources of information. The agricultural land-use map served as a major source document for this effort. However, information obtained from other studies, as well as crop-livestock production data for each of the state's 232 municípios, was also given attention.

Types and Patterns of Agricultural Land Use

Land-use categories shown on the map are: (1) Livestock Raising, (2) Small-Scale Diversified Agriculture, (3) Soybean-Wheat Double Cropping, (4) Wet Rice, (5) Second Growth Vegetation, (6) Original Vegetation, (7) Sand, Dunes and Beach Ridges, (8) Marsh and Other Poorly Drained Areas, and (9) Principal Urban Centers.

The extensive livestock zone covers approximately half of the state's total area and therefore occupies as much space as all remaining land uses combined. This type of land use clearly dominates in western and southwestern Rio Grande do Sul, particularly near the Brazil-Uruguay border. Hence, the term _fronteira_, which is loosely applied to this section of Rio Grande do Sul, is a continuation of the extensive cattle and sheep ranching zone examined by Griffin in neighboring Uruguay. The extensive livestock zone covers essentially all of the state's Campanha or natural grassland zone. The southern portion of the state's Planalto Medio is also included within this zone, as are parts of the Rio Uruguai lowlands to the west. A separate large zone of extensive livestock raising is found in the high _campos_ to the north of the Serra Geral bordering Santa Catarina. And, a very small area of extensive beef-livestock production has developed near Soledade, southeast of Passo Fundo.

A second major land-use type is small-scale diversified farming. Three major zones occur. The largest is north of Porto Alegre in the Serra Geral and centers on the old German and Italian colonial district. It is bounded on the south by the Serra Geral escarpment, which extends immediately inland from Torres on the east to an area about eighty km west of Santa Maria. The north-south extent of the zone averages about 150 km in its central portion. However, the zone narrows abruptly to the east and west. Near Torres and Osório in the east, its north-south extent is only about twenty-five to forty km. West of Santa Maria it is a finger-like projection of small-scale agriculture extending into the beef-livestock ranching zone. A small area of similar land use occurs immediately southeast of Porto Alegre. The Alto Uruguai region of Rio Grande do Sul is basically devoted to small-scale diversified agriculture extending roughly from Erechim westward to Santa Rosa. The zone is not contiguous in terms of land use. In northwest Rio Grande do Sul, areas of large-scale soybean-wheat production occur within or adjacent to small-scale agricultural areas. The Serra do Sudeste, in part, is also a zone of small rural landholdings. Two main areas are found within the Serra do Sudeste, one to the northwest of Camaquã and a second northwest of Pelotas.

Three major and one minor wet rice production zones occur in Rio Grande do Sul, occupying about 10 percent of the state's total area. The most extensive area is along the western margins of the Lagoa dos Patos and along both the eastern and northwestern margins of the Lagoa Mirim. The southwestern margin of the Lagoa Mirim lies within Uruguayan territory and is a southward continuation of the adjacent Brazilian rice production zone. A second major rice region is in the Rio Uruguai lowlands from Barra do Quaraí northeastward to São Borja, a distance of 200 km. It varies from less than ten km in width near Uruguaiana to fifty km at the junction of the Rio Uruguai and Rio Ibicuí. Wet rice cultivation on the opposite shore in neighboring Argentina is less important, and beef ranching dominates. The Depressão Central is the third rice growing region. Riziculture began here in the early twentieth century and expanded to include the Lagoa dos Patos margins and Rio Uruguai valley. The region extends from immediately south of Santa Maria eastward nearly 250 km to Porto Alegre. Wet rice production again occurs east and southeast of Porto Alegre where the Depressão Central meets the flat coastal plain and northwestern margin of the Lagoa dos Patos. Other smaller but still significant zones of wet rice are found in the Rio Santa Maria floodplain south of Rosário do Sul, and near Dom Pedrito and Bagé. In summary, wet rice cultivation is widely dispersed in the state and corresponds closely with the occurrence of coastal lowlands, river valleys or natural depressions.

The soybean-wheat zone of Rio Grande do Sul occupies about the same total area as riziculture, but the distribution of plantings is much less widespread. It forms a contiguous agricultural region in the state's Planalto Medio. The region is characterized by large-scale mechanized production of both soybeans and wheat and has expanded greatly in area since 1965. It has a maximum east-west width of about 300 km and extends from an area immediately northeast of Passo Fundo westward almost to São Borja on the Rio Uruguai. The soybean-wheat region is bordered on the north by small-scale subsistence landholdings which predominate in the Alto Uruguai region of Rio Grande do Sul. The southern boundary of large-scale soybean and wheat cultivation is not well defined except southeast of Passo Fundo. Along the region's southeastern margin, soybean-wheat cultivation gives way abruptly to beef raising near Soledade. To the northeast and southwest, surface relief is more pronounced and subsistence agriculture replaces mechanized soybean-wheat operations. The southern and western margins of soybean-wheat cultivation constitute a rural land-use transition zone where the expansion of soybean cultivation is replacing traditional ranching. This transition zone was devoted almost exclusively to cattle production in 1965, but favorable market prices for soybeans have resulted in significant land-use change. Similar changes have occurred farther south near Cachoeira do Sul, São Gabriel, and Alegrete for the same reason. In contrast, expansion of large-scale soybean cultivation to the northeast has been slower, due in part to rugged terrain. Instead, production of the crop has increased on small landholdings adjacent to this region.

Sizeable areas of second growth forest cover less than 1 percent of Rio Grande do Sul. Eucalyptus and acacia trees have been planted extensively in many areas, particularly along the southern margin of the Serra Geral. Reforested zones extend fifty to one-hundred km east of Santa Maria and near the Rio Jacuí interfluve. Farther eastward, reforested areas exist from São Leopoldo to Taquara and also from northeast of São Francisco de Paula northward to the Rio Grande do Sul-Santa Catarina border. Other major zones of second growth vegetation occur immediately north and northwest of Caxias do Sul in the upper Serra Geral, along the Rio Camaquã adjacent to the Lagoa dos Patos, and west of Tramandaí on the Atlantic coast. These range from about twenty-five to several hundred square km in extent. Much smaller areas of second growth vegetation or capão are virtually ubiquitous throughout the Serra Geral and Alto Uruguai. They form an integral part of the rural landscape where land clearings or roças have been abandoned because the soil has been exhausted and vegetation allowed to regenerate. In addition, eucalyptus has been widely planted in woodlots throughout the flat Lagoa dos Patos region and much of the Campanha where it serves as a source of fuel, building material and shade.

Because of widespread deforestation for agriculture, few original forest tracts remain in Rio Grande do Sul. There are only two large tracts of several hundred square km each, both in the extreme north. Areas of marsh or other poorly drained land are of little importance for crop cultivation, although aquatic plants are sometimes used as forage for cattle. The largest such area is immediately southwest of Pelotas, along the Canal de São Gonçalo. Two others occur on the eastern margin of the Lagoa Mirim. A third marshy zone is in the Rio Uruguai lowlands from Uruguaiana to São Borja. In addition, extensive areas of poorly drained land occur in the upper Rio Ibicuí and Rio Santa Maria valleys midway between Santa Maria and Alegrete.

The state's remaining land area is classified as urban. Metropolitan Porto Alegre is encroaching on areas to the southeast and north that were formerly devoted to small-scale market gardening. Some land previously in rice has been converted to industrial use on the city's northeastern margin. However, little urbanization has occurred west of the city on the opposite shore of the Rio Guaíba.

Background on Agricultural Regionalization

The identification and delimitation of land-use regions in Rio Grande do Sul are dependent upon the criteria employed. The Secretaria da Agricultura of Rio Grande do Sul is charged with overall agricultural planning on the state level. This organization has delimited eleven regions based upon topographic considerations rather than crop-livestock type.[5] These regions are the (1) Alto Uruguai, (2) Campos de Cima da Serra, (3) Planalto Medio, (4) Missões, (5) Encosta Superior do Nordeste, (6) Encosta Inferior, (7) Depressão Central, (8) Campanha, (9) Serra do Sudeste, (10) Encosta do Sudeste, and (11) Litoral. These regions correspond with the various physiographic areas of the state, except for Missões the name of which is historical in context. However, such a typology is useful only for general planning purposes, since no mention of a crop-livestock type is made.

The crop-livestock regionalization used by the federal government (Ministério da Agricultura) is more specific. For general planning purposes, Brazil is divided into five major geoeconomic regions. These include (1) the North, (2) the Northeast, (3) the Center-West, (4) the Southeast, and (5) the South, which includes Rio Grande do Sul. These are each subdivided into much smaller units termed "Homogeneous Microregions," which consist of <u>municípios</u> sharing similar physiographic, historical or crop-livestock bases. Thus, Brazil's homogeneous micro-regions possess similar geoeconomic and socio-economic

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[5]Information obtained through personal interview at the Secretaria da Agricultura, Secção de Produção Vegetal, Porto Alegre, September 1977.

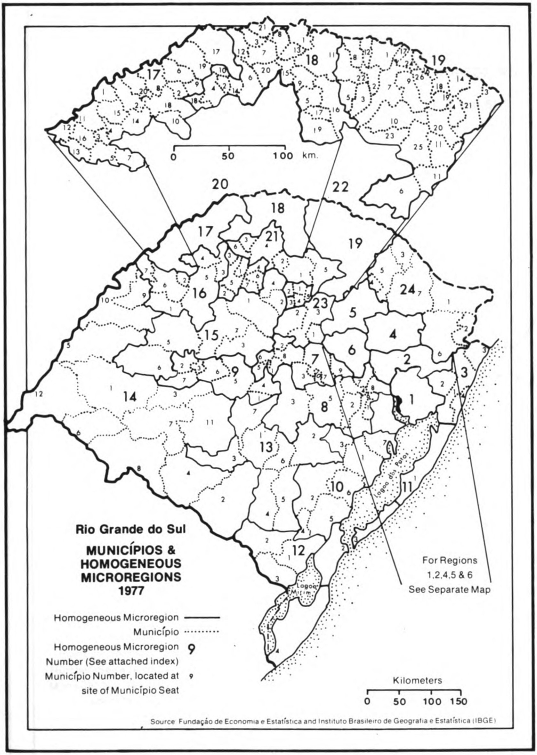

Figure 13.--Rio Grande do Sul, Municípios and Homogeneous Microregions I.

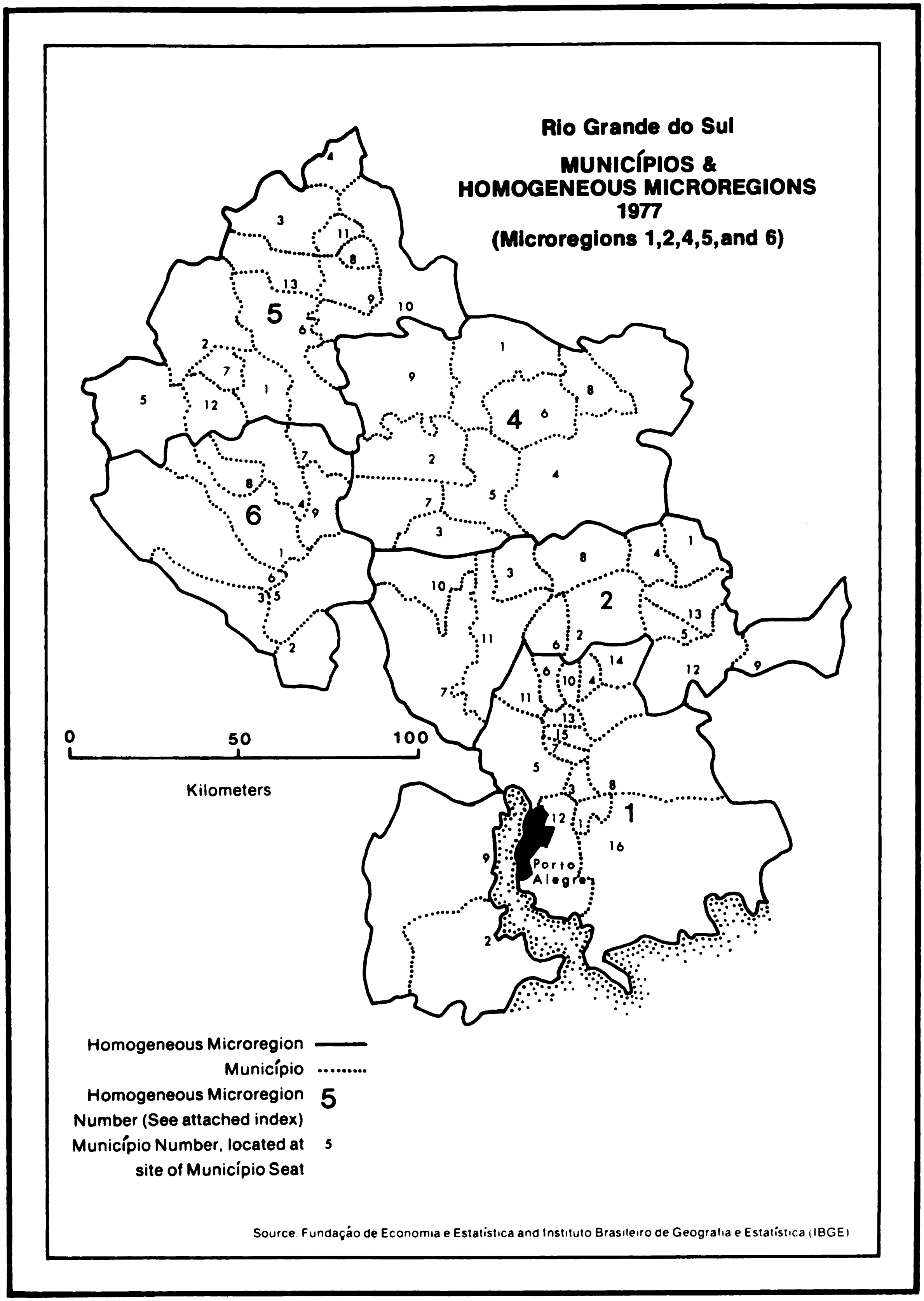

Figure 14.--Rio Grande do Sul, Municípios and Homogeneous Microregions II.

Table 2.--Municípios and Homogeneous Microregions.

1. Porto Alegre
- 1 Alvorada
- 2 Barra do Ribeiro
- 3 Cachoeirinha
- 4 Campo Bom
- 5 Canoas
- 6 Estância Velha
- 7 Esteio
- 8 Gravataí
- 9 Guaíba
- 10 Novo Hamburgo
- 11 Portão
- 12 Porto Alegre
- 13 São Leopoldo
- 14 Sapiranga
- 15 Sapucaia do Sul
- 16 Viamão

2. Colonial da Encosta da Serra Geral
- 1 Canela
- 2 Dois Irmãos
- 3 Feliz
- 4 Gramado
- 5 Igrejinha
- 6 Ivoti
- 7 Montenegro
- 8 Nova Petrópolis
- 9 Rolante
- 10 Salvador do Sul
- 11 São Sebastião do Caí
- 12 Taquara
- 13 Três Coroas

3. Litoral Setentrional lo Rio Grande do Sul
- 1 Osório
- 2 Santo Antônio
- 3 Torres
- 4 Tramandaí

4. Vinicultura de Caxias do Sul
- 1 Antônio Prado
- 2 Bento Gonçalves
- 3 Carlos Barbosa
- 4 Caxias do Sul
- 5 Farroupilha
- 6 Flores da Cunha
- 7 Garibaldi
- 8 São Marcos
- 9 Veranópolis

5. Colonial do Alto Taquari
- 1 Anta Gorda
- 2 Arvorezinha
- 3 Casca
- 4 David Canabarro
- 5 Fontoura Xavier
- 6 Guaporé
- 7 Ilópolis
- 8 Nova Araçá
- 9 Nova Bassano
- 10 Nova Prata
- 11 Paraí
- 12 Putinga
- 13 Serafina Corrêa

6. Colonial do Baixo Taquari
- 1 Arroio do Meio
- 2 Bom Retiro do Sul
- 3 Cruzeiro do Sul
- 4 Encantado
- 5 Estrela
- 6 Lajeado
- 7 Muçum
- 8 Nova Bréscia
- 9 Roca Sales

7. Fumicultura de Santa Cruz do Sul
- 1 Agudo
- 2 Arroio do Tigre
- 3 Candelária
- 4 Dona Francisca
- 5 Faxinal do Soturno
- 6 Nova Palma
- 7 Santa Cruz do Sul
- 8 Sobradinho
- 9 Venâncio Aires
- 10 Vera Cruz

8. Vale do Jacuí
- 1 Arroio dos Ratos
- 2 Butiá
- 3 Cachoeira do Sul
- 4 General Câmara
- 5 Rio Pardo
- 6 São Jerônimo
- 7 Taquari
- 8 Triunfo

9. Santa Maria
- 1 Formigueiro
- 2 Jaguari
- 3 Mata
- 4 Restinga Seca
- 5 Santa Maria
- 6 São Pedro do Sul
- 7 São Vicente do Sul

10. Lagoa dos Patos
- 1 Camaquã
- 2 Canguçu
- 3 Dom Feliciano
- 4 Pedro Osório
- 5 Pelotas
- 6 São Lourenço do Sul
- 7 Tapes

11. Litoral Oriental da Lagoa dos Patos
- 1 Mostardas
- 2 Rio Grande
- 3 São José do Norte

12. Lagoa Mirim
- 1 Arroio Grande
- 2 Erval
- 3 Jaguarão
- 4 Santa Vitória do Palmar

13. Alto Camaquã
- 1 Caçapava do Sul
- 2 Encruzilhada do Sul
- 4 Pinheiro Machado
- 5 Piratini
- 6 Santana da Boa Vista
- 7 São Sepé

14. Campanha
- 1 Alegrete
- 2 Bagé
- 3 Cacequi
- 4 Dom Pedrito
- 5 Itaqui
- 6 Quaraí
- 7 Rosário do Sul
- 8 Santana do Livramento
- 9 Santo Antonio das Missões
- 10 São Borja
- 11 São Gabriel
- 12 Uruguaiana

15. Triticultora de Cruz Alta
- 1 Cruz Alta
- 2 Ibirubá
- 3 Júlio de Castilhos
- 4 Santa Bárbara do Sul
- 5 Santiago
- 6 São Franciso de Assis
- 7 Tupanciretã

16. Colonial das Missões
- 1 Bossoroca
- 2 Caibaté
- 3 Catuípe
- 4 Giruá
- 5 Santo Ângelo
- 6 São Luís Gonzaga
- 7 São Nicolau

17. Colonial de Santa Rosa
- 1 Alecrim
- 2 Boa Vista do Buricá
- 3 Campina das Missões
- 4 Cândido Godói
- 5 Cerro Largo
- 6 Crissiumal
- 7 Guaranai das Missões
- 8 Horizontina
- 9 Humaitá
- 10 Independência
- 11 Porto Lucena
- 12 Porto Xavier
- 13 Roque Gonzales
- 14 Santa Rosa
- 15 Santo Cristo
- 16 São Paulo das Missões
- 17 Tenente Portela
- 18 Três de Maio
- 19 Três Passos
- 20 Tucunduva
- 21 Tuparendi

18. Colonial de Iraí
- 1 Alpestre
- 2 Braga
- 3 Caiçara
- 4 Campo Novo
- 5 Constantina
- 6 Erval Seco
- 7 Frederico Westphalen
- 8 Iraí
- 9 Liberato Salzano
- 10 Miraguaí
- 11 Nonoai
- 12 Palmitinho
- 13 Planalto
- 14 Redentora
- 15 Rodeio Bonito
- 16 Ronda Alta
- 17 Rondinha
- 18 São Martinho
- 19 Sarandi
- 20 Seberi
- 21 Vicente Dutra

19. Colonial de Erechim
- 1 Aratiba
- 2 Barão de Cotegipe
- 3 Barracão
- 4 Cacique Doble
- 5 Campinas do Sul
- 6 Ciríaco
- 7 Erechim
- 8 Erval Grande
- 9 Gaurama
- 10 Getúlio Vargas
- 11 Ibiaçá
- 12 Itatiba do Sul
- 13 Jacutinga
- 14 Machadinho
- 15 Marau
- 16 Marcelino Ramos
- 17 Mariano Moro
- 18 Maximiliano de Almeida
- 19 Paim Filho
- 20 Sananduva
- 21 São José do Ouro
- 22 São Valentim
- 23 Sertão
- 24 Severiano de Almeida
- 25 Tapejara
- 26 Viadutos

20. Colonial de Ijuí
- 1 Ajuricaba
- 2 Augusto Pestana
- 3 Chiapeta
- 4 Condor
- 5 Ijuí
- 6 Panambi
- 7 Pejuçara

21. Passo Fundo
- 1 Carazinho
- 2 Chapada
- 3 Coronel Bicaco
- 4 Palmeira das Missões
- 5 Passo Fundo
- 6 Santo Augusto

22. Colonial do Alto Jacuí
- 1 Campo Real (Não-Me-Toque)
- 2 Colorado
- 3 Selbach
- 4 Tapera
- 5 Victor Graeff

23. Soledade
- 1 Barros Cassal
- 2 Espumoso
- 3 Soledade

24. Campos de Vacaria
- 1 Bom Jesus
- 2 Cambará do Sul
- 3 Esmeralda
- 4 Ibiraiaras
- 5 Lagoa Vermelha
- 6 São Franciso de Paula
- 7 Vacaria

NOTE: Homogeneous Microregions are underlined.

characteristics that give a distinct subregional identity. Since the distinction is based largely on varying cultural and crop-livestock combinations, much of Brazil's crop-livestock production information and statistical data is published on the homogeneous microregion level. The data normally are further disaggregated, with crop-livestock information also being published on the município level. Rio Grande do Sul's 232 municípios are grouped into twenty-four homogeneous microregions for state and national planning purposes (see Figures 13 and 14, and Table 2).

A detailed national regionalization of crop-livestock activities was recently prepared by the Instituto Nacional de Colonização e Reforma Agrária (INCRA) at the homogeneous microregion level.[7] Eight distinct crop-livestock regions are identified in Rio Grande do Sul. This regionalization is based upon a grouping of the state's twenty-four homogeneous microregions into units that are similar in terms of crop-livestock land-use characteristics. Crop-livestock regions identified in Rio Grande do Sul include: (1) Soybeans-Wheat, (2) Soybeans-Wheat-Maize-Swine, (3) Beef Cattle, (4) Rice, (5) Tobacco, (6) Grapes, (7) Market Gardening, and (8) Diversified

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[6]Anuário Estatístico do Brasil, 1976, pp. 19, 115-116.

[7]Regiões Homogêneas da Agricultura (Brasília: Ministério da Agricultura, Instituto Nacional da Colonização e Reforma Agrária [INCRA]/Universidade Estadual de Campinas [UNICAMP], 1976).

Small-Scale Farming. Among the various maps published in the study were five of different crop-livestock regions, one for each of the nation's major geoeconomic regions. Rural land use in Rio Grande do Sul was depicted with that of Santa Catarina and Paraná states. This regionalization provides a reasonably good overview of crop-livestock land use in Brazil for national planning purposes, for which it was intended. However, the regionalization is too general for detailed analysis or agricultural planning at the state level. The eight regions delimited in Rio Grande do Sul are approximations in terms of the spatial extent of crops and livestock, since they are based on "microregion" boundaries. In addition, significant agricultural activities are deleted in most of the regions for the sake of generalization. One such example is the upper Rio Uruguai valley which, although classified within the soybean-wheat zone, is also an important producer of black beans, manioc and other food crops.

Agricultural land use and regionalization studies specifically on Rio Grande do Sul have provided information on crop-livestock land use. Pfeiffer's 1967 comparative study of crop-livestock land use in the Campanha and Alto Uruguai regions includes an agricultural land-use/regionalization map.[8] Seven major regions are identified and

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[8]Pfeiffer, "Kontraste in Rio Grande do Sul: Campanha Und Alto Uruguai," 1967.

delimited in that study. These include areas of swine culture and beef cattle raising in the livestock category, as well as zones devoted to the cultivation of black beans, manioc, soybeans, tobacco, and grapes. The spatial extent of these regions is quite accurately depicted. The boundary of each represents the actual limit of a particular rural economic activity, rather than that of a município in which a particular crop or livestock product dominates. The value of Pfeiffer's regionalization becomes apparent when the following is considered. In areas where small municípios predominate, regionalizations based upon município-level data may differ only slightly from the actual boundaries of crop-livestock regions. However, regions delimited by boundaries of large municípios may differ greatly from reality, since regional boundaries are determined on the basis of the predominant land-use category in each of these civil divisions.

A limiting factor of Pfeiffer's study is that substantial land-use change has occurred since the study was undertaken. The area devoted to black beans in Rio Grande do Sul in 1977 was much less than in 1967. Conversely, the soybean-wheat region expanded greatly during this period, due largely to favorable market prices.

The most detailed land-use regionalization to date is the 1975 study coordinated by Geógrafo José Alberto Moreno of the Central de Comandos Mecanizados de Apoio à

Agricultura (CEMAPA).[9] This regionalization was derived from factor analysis, grouping analysis and discriminant analysis on 1970 crop-livestock production data for each of the state's 232 _municípios_. Twenty-two crops and three livestock products were included in the factor analyses. Six production variables were employed for each crop, including: (1) density in km per hectare, (2) percentage of production in relation to the state total, (3) percentage of hectares in relation to the state total, (4) density in _cruzeiros_ per square km, (5) percentage of _cruzeiros_ in relation to state total, and (6) percentage of hectare/ _cruzeiros_ in relation to the total for Rio Grande do Sul. The third and sixth variables were omitted for cattle and sheep raising, while the second and fifth were deleted in the case of swine culture. These variables were then consolidated using factor analysis in which twenty-eight factors determining land use were identified from the original variables. From this analysis, seven major agricultural land-use regions were identified: (1) traditional agriculture, (2) wheat-soybeans-flax, (3) rice, (4) rye-barley, (5) cattle, (6) black beans, and (7) onions. A cluster analysis followed the factor analysis routines in which these seven regions were analyzed with respect to each of the state's _municípios_. An excessive number of regions

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[9]Moreno et al., _Regionalização do espaço agrícola do Rio Grande do Sul_, 1975.

resulted and further attempts were ruled out. A five-stage multi-discriminant analysis was then undertaken. Crop-livestock regions of various sizes were delimited in the course of these analyses, and variables were added and later substituted until a satisfactory regionalization was obtained. In the final analysis, sixteen crop-livestock regions were delimited using twenty variables. The regions are statistically homogeneous, although not spatially contiguous in all cases. For conceptual and planning purposes, the sixteen regions can be reduced to four larger groups, each representing a different type of crop-livestock activity.[10] The four groups are:

I - stagnant areas of poorly developed traditional agriculture using rudimentary and/or outmoded techniques.

II - traditional areas of commercial specialty crop production that are of considerable economic significance to Rio Grande do Sul.

III - areas of traditional agricultural and cattle ranching that are evolving or being transformed into commercial agricultural zones where mechanization and modern technology are employed.

IV - typical commercial cattle ranching and wet rice areas characterized by high-quality livestock.

Each of the sixteen crop-livestock regions is classified in one of the four agriculture-type categories. Six of the regions are zones of traditional agriculture. These include regions of (1) diversified products, (2) diversified products with barley and maize predominating, (3) diversified

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[10] Ibid., pp. 4-25.

products with a predominance of black beans, (4) diversified products with tobacco and sugarcane, (5) livestock products with rice, onions, tobacco, and beef cattle, and (6) diversified products with soybeans. Four land-use regions feature traditional agriculture specializing in the commercial production of tobacco, grapes, sugarcane and onions, respectively. Three regions are zones of traditional agriculture and ranching undergoing transformation into commercial wheat-soybean-flax cultivation. They include areas of high, medium and low production density. The fourth major agricultural type, commercial ranching and wet rice, is represented by three regions devoted to wet rice cultivation and the raising of beef cattle and sheep. These regions, each featuring the same products, are areas of high, medium and low production density, respectively.

The quantitative regionalization study coordinated by Moreno is a major contribution toward an increased understanding of rural land use in Rio Grande do Sul. Major crop-livestock complexes are identified, and the delimitation of regions is accurate where small <u>municípios</u> predominate. However, as noted earlier, such regionalizations are necessarily less accurate where large <u>municípios</u> prevail. Statistical analyses relegated each <u>município</u> to one of the sixteen crop-livestock regions, depending upon its dominant land use. Yet, the land-use category assigned to large <u>municípios</u> was not always representative of all rural land use in those civil divisions. For example, the <u>municípios</u>

of Uruguaiana, Itaqui and São Borja, in extreme western Rio Grande do Sul, are important for wet rice as well as cattle and sheep. However, they are classified as zones of livestock production in Moreno's work.[11] This by no means negates the value of that study, but demonstrates that even the best statistical analysis is subject to limitations.

An earlier study of Rio Grande do Sul's crop-livestock land use was prepared in 1964 by Gastal, an ASCAR agronomist. The study is shorter and less analytical than Moreno's 1975 work but nevertheless was a useful planning document for extension personnel. Maps of nine crop and four livestock zones were prepared as well as a map of the crop-livestock regions of Rio Grande do Sul, in which the regions were groups of contiguous municípios having similar economies. The study was a major contribution at the time of publication since there was need for such an appraisal. Furthermore, it provided this researcher with a means for assessing spatial changes in crop-livestock zones through time.[12]

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[11] Ibid., Mapa 2, Regionalização do espaço agrícola, Resultados (Map).

[12] Edmundo Gastal, Contribuição ao zoneamento agrícola do Rio Grande do Sul, 1964.

CHAPTER VI

CROP-LIVESTOCK REGIONS OF RIO GRANDE DO SUL

Rio Grande do Sul has eight major crop-livestock regions, one of which contains nine subregions. Some regions occur as a single area while others, although homogeneous in crop or livestock type, landholding size and production characteristics, are not contiguous. The eight major regions are: (1) small-scale diversified agriculture, (2) viticulture, (3) tobacco, (4) sugarcane, (5) onion, (6) soybean-wheat, (7) extensive ranching and (8) rice-livestock (see Figure 15). The small-scale diversified agriculture region consists of nine subregions. These subregions are: (a) nonspecialized diversified agriculture, (b) Porto Alegre market gardening, (c) dairying, (d) pineapple-banana, (e) corn-soybean-swine, (f) black bean, (g) soybean-wheat, (h) corn-black bean, and (i) vegetable-fruit-dairying (see Figure 16).

The small-scale diversified agriculture region is composed of noncontiguous zones of subsistence agriculture. Small farms established by descendants of German and Italian colonists characterize the region. A great variety

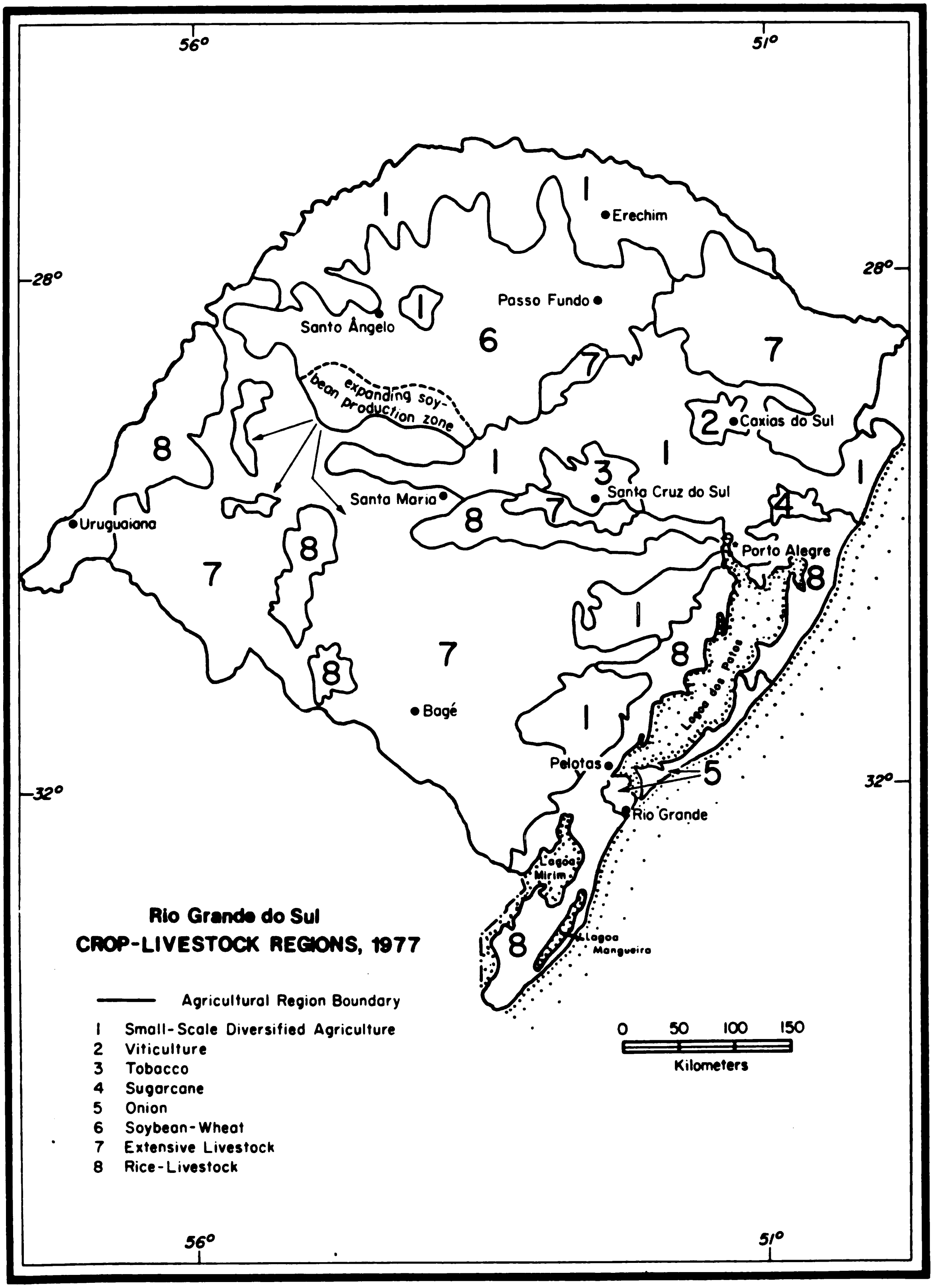

Figure 15.--Rio Grande do Sul, Crop-Livestock Regions.

of crops is grown, while swine culture and dairying are also well developed in some areas.

Closely related to the small-scale diversified agriculture region in terms of landholding size, farm labor structure and in some cases ethnic influence, are the (1) viticulture, (2) tobacco, (3) sugarcane, and (4) onion regions. However, they differ from it in that they are zones of specialty agriculture which produce mainly for commercial marketing rather than subsistence. Small-scale diversified agriculture for subsistence is common to each region, but commercial production of a specific commodity predominates.

The soybean-wheat region includes areas of established soybean-wheat cultivation, and a transition zone where soybean cultivation is gradually replacing beef ranching. Medium to large landholdings and mechanized cultivation characterize the entire region.

The extensive livestock ranching region is the largest of Rio Grande do Sul's agricultural zones. Commercial livestock raising on extensive properties clearly dominates the region's economy. However, a limited amount of farming also occurs. Wet rice, sorghum, sunflowers and wheat are important in some areas.

The rice-livestock region is devoted mostly to rice, while beef cattle production is secondary. The rotation of rice and cattle on large landholdings is common practice, with cattle being pastured on rice straw on fallow lands after the harvest.

The soybean-wheat, extensive livestock ranching, and rice-livestock regions differ markedly from the first five regions discussed. Properties are medium to large, rather than small. Mechanization and hired or tenant farm labor predominate, in place of family farm labor, and capital rather than labor inputs are the rule. Subsistence agriculture is generally of little importance.

Small-Scale Diversified Agriculture

The region of small-scale diversified agriculture is composed of three separate areas having similar rural economies: the Serra Geral, Alto Uruguai, and eastern margin of the Serra do Sudeste. Small landholdings, family manual labor and subsistence production of foodstuffs characterize these areas, although commercial agriculture is increasingly significant.

Viticulture

The commercial viticulture region of Rio Grande do Sul is located approximately 125 km north of Porto Alegre in the upper Serra Geral, at a mean elevation of about 700 m. The region is small, measuring about 45 km from east to west and slightly less from north to south. It includes nine *municípios*, which produce about 98 percent of the state's grapes.[1] In turn, Rio Grande do Sul produced 63 percent (402,000 tons) of the nation's grapes in 1976, a figure nearly triple that of São Paulo state, which ranks second.[2]

Some 18,000 to 20,000 farmers, nearly all of Italian descent, cultivate grapes in the region. Of these, 10,000 to 12,000 are private landowners, or <u>proprietários</u>, and the remainder are renters (<u>arrendatários</u>) or sharecroppers (<u>parceiros</u>). Nearly all of the grapes are used for wine making, but 2 percent are consumed as fresh fruit or grape juice.[3]

Most of Brazil's major wine-making firms are located in the larger urban centers of the viticulture region, including Caxias do Sul, Bento Gonçalves and Garibaldi. Garibaldi leads with nine firms, followed by Bento Gonçalves with five. Caxias do Sul is third with three firms, while Flores da Cunha, immediately to the north, has one. The small town of Viamão, adjacent to Porto Alegre, is an extra-regional producer. The remaining 60 percent of the state's wine comes from nineteen grape cooperatives

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[1] Information obtained through personal interview at the Unidade de Execução de Pesquisa de Âmbito Estadual de Bento Gonçalves (UEPAE/BG), of the Empresa Brasileira de Pesquisa Agropecuária (EMBRAPA), Bento Gonçalves, Rio Grande do Sul, 1977.

[2] <u>Anuário Estatístico do Brasil, 1976</u>, p. 166.

[3] Information obtained through personal interview at UEPAE/BG, op. cit., November 1977.

within the region, located in Caxias do Sul (5), Farroupilha (3), Garibaldi (3), Bento Gonçalves (3), Flores da Cunha (3), São Marcos (1) and Antonio Prado (1).[4]

Bento Gonçalves, although much smaller in size than Caxias do Sul, is the major center for grape growing and wine making while the latter occupies second place. Garibaldi, located about ten km south of Bento Gonçalves, ranks third in grape and wine production. Caxias do Sul was the original focus of these activities but lost its prominence to Bento Gonçalves when the economic base expanded to include manufacturing, particularly metallurgic products, silverware and cutlery. However, viticulture and wine making remain important pursuits but the percentage of persons employed in these activities is lower because of the city's much larger size. Factors responsible for the westward shift of production may include the loss of advantage that Caxias do Sul originally enjoyed on early north-south transportation routes, as additional roads were built. Secondly, the "early start" of Caxias do Sul as a regional center and the availability of capital probably encouraged the establishment of other industries, thereby expanding the city's economic base.

A major problem in the viticulture region has been the selection of grapevines that are disease-resistant, yet

[4]Information furnished by the Instituto de Pesquisas Enológicas, Caxias do Sul, Rio Grande do Sul, November 1977.

high in sugar content. American grape varieties, including the Isabel and Concord and their hybrids, are disease-resistant and widely planted in the zone. In addition, some vineyards have been established near Bagé in southern Rio Grande do Sul by a private American firm to evaluate the possibilities of mechanized viticulture.[5] The suitability of the Campanha for viticulture, given its less humid climate and cooler winters is also being studied.

Tobacco

The state's tobacco region encompasses seven municípios along the southern margin of the Serra Geral about 100 km west-northwest of Porto Alegre. Small landholdings characterize nearly all of the region, and tobacco culture on these properties constitutes about 90 percent of the rural economy.[6] Rio Grande do Sul is Brazil's largest tobacco producer. In 1976 some 112,300 tons (37.6 percent) of the national total of 298,536 tons were produced in the state.[7] Flue-cured Virginia tobacco, amarelinho and galpão tobacco, and air-cured Burley tobacco are the major types grown. About 45 percent of tobacco lands are devoted to Virginia tobacco and an equal amount to amarelinho and

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[5] Ibid.

[6] Information obtained through personal interview at the Companhia de Fumos Santa Cruz, Santa Cruz do Sul, Rio Grande do Sul, November, 1977.

[7] Anuário Estatístico do Brasil, 1976, p. 169.

galpão. Burley tobacco occupies the remaining tobacco-producing properties.[8] Rio Grande do Sul's Virginia and Burley tobacco is exported, while amarelinho and galpão are marketed domestically.

The major agricultural trade center of the tobacco region is Santa Cruz do Sul, on the southern margin of the Serra Geral adjacent to the Depressão Central. The city of Venâncio Aires, to the northeast, is a secondary tobacco and rural trade center.

Seventeen tobacco firms operate in the region, of which sixteen are located in Santa Cruz do Sul and one in Venâncio Aires. Companies operating in the region represent both national and foreign commercial interests. Seven are Brazilian and four are American multinational firms. The remaining six are British-American, British-Dutch, Rhodesian, German and Japanese. Four of the companies produce cigarettes for the Brazilian market, while the remainder export tobacco mainly to Western Europe and the United States.[9]

Technical assistance to tobacco growers is provided almost exclusively by nine private firms. Company technicians advise growers on seed types, planting procedures, harvesting methods, fertilizer use and disease control. Agricultural credit is also available through tobacco firms.

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[8] Information obtained through personal interview at the Companhia de Fumos Santa Cruz, op. cit.

[9] Ibid.

Credit is furnished to the farmer on the premise that the company will be reimbursed from the sale of tobacco. The sale may be directly to the company or through a tobacco buyer who purchases the crop from the growers and sells to the firm. Thus, a close dependency exists between the tobacco grower and tobacco firm. A complete technical assistance program, including credit, helps the small farmer and assures a consistent supply of high quality tobacco for the company.

In total, about twenty agronomists are employed by the region's tobacco firms. Each agronomist trains five to ten instructors who, in turn, each attend fifty to sixty tobacco growers. This "multiplier effect" in agricultural extension has been successful. In 1977, about 8,000 growers received technical assistance in this manner.[10]

Sugarcane

A third specialty crop of Rio Grande do Sul is sugarcane, grown mainly along the lower slopes of the Serra Geral immediately northwest of Osório. The commercial sugarcane region is very small, roughly comparable to the commercial viticulture region in the Italian colonial zone. The cane is grown on small properties in areas of rolling or rugged relief and on large properties of the adjacent Atlantic coastal plain. The only sugar refinery in Rio

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[10] Ibid.

Grande do Sul is operated by Açúcar Gaúcho, S.A. (AGASA), a mixed enterprise in which the state government has a controlling interest. About 9 percent of the total sugarcane refined comes from large company properties. The remaining 91 percent is produced by farmers on small hillside properties who, in turn, sell their crop to the firm.[11]

Rio Grande do Sul is not a major producer of cane, since most of its area is climatically unsuited for cane cultivation. The state produces only 4 percent of its consumption, with the balance imported largely from São Paulo state. Nevertheless, government planners working in conjunction with AGASA are trying to bring suitable lands under cultivation and increase production. In 1977 AGASA produced 110,000 tons of sugarcane, 82 percent of which was grown on small properties.[12] Nearly all of the crop was refined by AGASA for the Porto Alegre urban market. The company also sells molasses to major livestock feed companies headquartered in greater Porto Alegre.

As in the tobacco region, there exists a close dependence between the small producer and the firm that buys, refines and ultimately markets the crop. AGASA provides technical assistance and production incentives to

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[11]Information obtained through personal interview at Açúcar Gaúcho, S.A. (AGASA), Osório, Rio Grande do Sul, November, 1977.

[12]Ibid.

growers, and in recent years increased sugarcane yields have reflected this effort. The company would like to see more small farmers grow sugarcane and is promoting expansion of production near Torres. Increased production involving more agriculturalists would have positive social effects not only in this region, but also in the banana-pineapple zone northeast of Osório. The rural economy in the latter area is depressed, and expansion of sugarcane into the zone would help stem rural outmigration to Porto Alegre.

Onions

Rio Grande do Sul's onion region extends from Mostardas southwestward to Pelotas and Rio Grande. It covers the southern half of a narrow peninsula separating the Atlantic Ocean and the Lagoa dos Patos, plus the southern lagoon margin. The peninsula is a longshore bar composed of recent sediments deposited by ocean currents and is a poorly vegetated zone of coastal dunes and mud flats. In contrast, the southern margin of the Lagoa dos Patos is marshland.

Where conditions permit, onions are grown on small properties, mainly by descendants of immigrants from Portugal and the Azores. In 1976, Rio Grande do Sul led Brazil in onion production. Nearly 136,000 tons, or 32 percent of the national total of about 432,000 tons, were harvested in the state.[13] Parts of the three large _municípios_ of Pelotas, Rio Grande and Mostardas, as well as the _município_ of São José do Norte, comprise the region. Together they account for more than 60 percent of the state's 1976 harvest, with São José do Norte occupying first place.[14]

Serious problems confront onion producers in the peninsular portion of the region. Among these are dune encroachment and isolation, particularly in the area immediately south of Mostardas. Coupled with isolation is the lack of suitable farm-to-market access between Mostardas and São José do Norte. Truck transport is via an unimproved road that is often blocked by drifting sand or made impassable by summer rains.[15] Also, government technical assistance has traditionally been lacking, but attention is now being paid to the needs of producers.

Onions grown in the region are marketed principally in São Paulo, but some shipments are destined for Porto Alegre. Most of the onions are marketed through Produtos Gaúchos, S.A. (PROGASA), a government-controlled enterprise in São José do Norte.

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[13] _Anuário Estatístico do Brasil, 1976_, p. 169.

[14] _Plano anual de produção e abastecimento para 1977/78_ (Porto Alegre: Secretaria da Agricultura, Comissão Estadual de Planejamento Agrícola (CEPA/RS), 1977), p. 45.

[15] "As dunas invadiam São José do Norte-Hoje estão controladas," _Folha da Tarde_ (Porto Alegre), September 5, 1977, 32-33.

Onion production in Rio Grande do Sul remained stable from 1974 through 1976. However, dramatic increases occurred in São Paulo state during the same period, with the latter contending for first place in 1976.[16]

Soybeans and Wheat

The soybean-wheat region covers most of the Planalto Medio of Rio Grande do Sul. It is bordered by areas of diversified agriculture on the north and southeast and extensive beef cattle areas on the east and southwest.

Mechanized soybean-wheat cultivation on medium and large properties dominates the rural scene, and the region contrasts sharply with the Alto Uruguai zone in size of landholdings and land tenure systems. Absentee ownership and jointly owned properties are common, and large commercial enterprises characterize the region's economy. The level of agricultural innovation is high, as is use of government agricultural extension services. The core area of soybean production extends from Santo Ângelo on the west to Passo Fundo on the east, including portions of eight _municípios_.

The major wheat production zone is centered farther westward within the region. The Cruz Alta-Santo Ângelo-Giruá axis is the principal area, but wheat cultivation near São Borja in the Rio Uruguai lowlands is also significant. Wheat assumed importance in the region following

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[16] _Anuário Estatístico do Brasil, 1976_, p. 169.

World War II. By 1947 Brazil had increased its production to 200,000 tons, most of which was grown in the Planalto Medio. National self-sufficiency in wheat became a major goal at this time, and wheat cultivation was encouraged. Production in Brazil reached 500,000 tons in 1950 and more than 1,000,000 tons by 1956. Nearly 2,000,000 tons were produced in 1971 and slightly more than 3,000,000 tons in 1976.[17] Despite such increases, national self-sufficiency has not been achieved. In the Planalto Medio yields are variable from year to year depending largely upon winter temperatures, and disease.

Wheat production in Rio Grande do Sul averaged slightly less than 1,500,000 tons from 1970 through 1977. However, shortfalls in 1972 and 1977 resulted in harvests of only 623,000 tons and 709,000 tons, respectively.[18] Such oscillations necessitated imports and led some producers to abandon the crop. A drought in 1978 reduced soybean production but resulted in a wheat bumper crop exceeding 1,400,000 tons.[19]

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[17]"O Brasil na produção mundial do trigo," COTRIJORNAL, Ijuí Rio Grande do Sul, Ano 5, No. 44 (August 1977): 16.

[18]Information obtained at the Comissão Estadual de Planejamento Agrícola (CEPA/RS), Porto Alegre, November, 1977.

[19]Brazil, Ministério das Relações Exteriores, Brasília, Boletim Especial, No. 68 (December 18, 1978): 1.

Soybean cultivation expanded rapidly in the region after 1965, stimulated by world protein demand and a desire to reduce the dependence upon wheat. In 1968, Rio Grande do Sul produced about 433,000 tons of soybeans. Two years later output reached nearly 1,000,000 tons, and since then the production and area devoted to the crop have expanded annually. Between 1968 and 1977, soybean cultivation was enormously successful. The number of hectares devoted to the crop increased seven-fold, and the amount of soybeans produced in 1977 was thirteen times that of 1968. The 1977 harvest was 5,678,000 tons, a record for the state.[20] However, a drought in 1978 reduced the harvest 30 percent from the previous year.[21]

Passo Fundo (1975 estimated município population: 108,487) is the major trade center in the soybean-wheat region.[22] It is a regional center for technical assistance as well as research in agriculture. Secondary cities include Santo Ângelo, Ijuí, and Cruz Alta, while Carazinho is a third-order community. All of the trade centers are served by paved all-weather highways leading to Porto Alegre or the port of Rio Grande. These highways have been

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[20] Information obtained at the CEPA/RS, November 1977.

[21] "The Drought in Southern Brazil," The Review of the River Plate, No. 4035 (May 19, 1978): 739.

[22] Anuário Estatístico do Brasil, 1976, p. 116.

designated "export corridors" by transportation planners. Three major routes are used by truckers: (1) the "Diagonal Soja-Trigo" route from northwestern Rio Grande do Sul to Rio Grande via Santiago, Santa Maria and Pelotas; (2) a route via Santo Angelo-Ijuí-Cruz Alta-Santa Maria and the "Diagonal Soja-Trigo"; and (3) Santo Ângelo-Ijuí-Carazinho-Passo Fundo-Porto Alegre. A fourth market route is the "Ferrovia do Trigo" or "wheat railroad" inaugurated in November, 1978. This 250 km railroad extends from Passo Fundo to Roca Sales in the Serra Geral. The market time for shipping wheat from Passo Fundo to Porto Alegre via the new rail line is reduced by eighteen hours.[23] Roca Sales is a break-of-bulk point from which cargo is trucked the remaining distance to Porto Alegre.

The soybean-wheat region is expanding. This is particularly evident along the southern margin from immediately south of Júlio de Castilhos westward to Santiago. Soybean-wheat cultivation has relegated cattle ranching to second place in this land-use transition zone. Large-scale soybean-wheat cultivation has also expanded eastward from Passo Fundo, but wheat rather than soybeans is preferred because of the higher elevation. Other soybean areas have developed in the Depressão Central and are expanding at the expense of rice cultivation.

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[23] Boletim Especial, No. 68, p. 1.

Extensive Livestock Ranching

The extensive livestock ranching region is the largest rural land-use zone delimited in the study. It includes nearly all of Rio Grande do Sul south of the Depressão Central except for the Serra do Sudeste diversified farming zone and the cattle-rice lands of the Atlantic littoral.

Extensive cattle and sheep raising, rather than agriculture, dominate the region. Rio Grande do Sul in 1976 had 13,134,000 cattle, mostly beef.[24] Of the total number of beef animals, more than 50 percent were raised in extensive livestock ranching zones. The leading beef cattle _municípios_ include Santana do Livramento, Uruguaiana, and Bagé in the state's _fronteira_ zone, as well as Tupanciretã in the southwestern Planalto Medio and Pelotas in the southeast. Each has more than 1,000,000 head. In addition, the region contained more than 75 percent of the state's 12,356,000 sheep in 1975. Leading _municípios_ include Bagé, Uruguaiana, Santana do Livramento and Alegrete, accounting for 39 percent of the state total.[25] About ten other _municípios_ in the region also depend on sheep and wool

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[24] _Informações econômicas do Rio Grande do Sul, Edição Especial_ (Porto Alegre: Governo do Estado do Rio Grande do Sul, 1977), p. 15.

[25] _Anuário Estatístico do Rio Grande do Sul, 1972-75_, Vol. 5.8, tomo 1, Agropecuária (Porto Alegre: Fundaçào de Economia e Estatística, 1976), 54-56.

production. Beef cattle are ubiquitous, while sheep are raised mainly within 100 km of the Brazil-Uruguay border.

There is a much smaller zone of extensive livestock ranching and sheep raising near Vacaria in the high _campos_ of the northeast. Much of this zone is tributary to Lajes, Santa Catarina, for livestock marketing. In 1976 the beef cattle population in this zone approached 700,000 head.[26]

The extensive livestock region produces beef animals for both domestic and international markets. Brazilian dietary habits make beef an extremely important food item. Thus, about 80 percent of the state's beef is consumed internally, while the remainder has traditionally been exported to Western Europe or the United States. Meat packing has been prominent in the urban centers of the Campanha since 1917, when the first meat-packing plant or _frigorífico_ was established. Six commercial _frigoríficos_ now operate within the region, plus two in Pelotas and two in Rio Grande. Three of the plants account for 96 percent of all beef exported from the state.[27] These are the Swift-Armour plants in Rosário do Sul and Santana do Livramento, and the Frigorífico Anglo in Pelotas. Canned corned beef is exported mainly to the United States. However, the

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[26] _Informações Econômicas do Rio Grande do Sul Edição Especial_, p. 22.

[27] Information obtained through personal interview at the Federação das Cooperativas de Carne do Rio Grande do Sul, Ltda. (FECOCARNE), Porto Alegre, August, 1977.

United States does not permit the importation of frozen beef from Brazil, since the latter is not free of foot-and-mouth disease. Western Europe purchased frozen beef from Rio Grande do Sul until 1974, when the European Common Market prohibited further imports. However, a Brazilian official interviewed in 1977 was optimistic that the European market would be reopened soon.[28] Eleven meat-packing cooperatives also operate within the region and supplement production by private firms. Four of the cooperatives meet standards established by the United States Department of Agriculture (USDA) for beef exports.[29]

Major livestock trade centers include Santa Maria on the northern margin of the region and Bagé, 175 km to the south. Both offer a wide variety of livestock producer services. Santa Maria is a rail and highway center and also provides university crop-livestock extension services. Bagé is a commercial center and the headquarters of two meat packing firms and one cooperative. It is growing rapidly and expanding its functional area because of its location between livestock-producing areas and Pelotas-Rio Grande. Secondary centers include Uruguaiana and Santana do

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[28]Information obtained through personal interview at the Unidade de Execução de Pesquisa de Âmbito Estadual de Bagé (UEPAE), of the Empresa Brasileira de Pesquisa Agropecuária (EMBRAPA), Fazenda Cinco Cruzes, Bagé, Rio Grande do Sul, November, 1977.

[29]Information obtained through personal interview at FECOCARNE, August, 1977.

Livramento bordering Argentina and Uruguay, respectively. Both have frigoríficos, as does Rosário do Sul in the west-central Campanha and Pinheiro Machado east of Bagé. Likewise, most meat cooperatives are found in these communities.

Sheep raising in Rio Grande do Sul is mainly for the sale of wool rather than meat. From 1963 through 1976 about 44 percent of the wool was exported, principally to the United Kingdom, while 31 percent was absorbed by the São Paulo market. Nearly all of the remainder was marketed in Rio Grande do Sul. Production during that period totaled slightly more than 32,000,000 tons.[30]

The livestock economy of the extensive ranching zone is subject to a number of problems, some of which have influenced rural land use. The low carrying capacity of the region's natural pasture is especially critical and is due mainly to poor, rocky soils and thin vegetation cover. During winter the problem is intensified, and natural pastures must be burned to ensure new grass sprouts during that season. Yet such measures are insufficient, and many beef cattle perish during winter due to lack of forage. Many also exhibit slow weight gain and have low calving rates. Marketing age is prolonged, so the average slaughter

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[30] Informações econômicas do Rio Grande do Sul, Edição Especial, Table 2.5.1, p. 39.

age of most beef animals is about four years.[31] On the other hand, producers have been reluctant to invest in improved pastures, given low beef prices and market uncertainties. Operational costs negate gains from cattle sales, and traditional ranching operations are therefore maintained. In addition, animal parasites have adversely affected sheep herds in the region. In view of these problems, ranchers have reduced the size of their livestock operations and have begun to cultivate soybeans and wet rice, especially near Bagé and Dom Pedrito.

Rice and Livestock

Rio Grande do Sul has three major wet rice zones: the Rio Uruguai lowlands in the far west, the Depressão Central, and the Lagoa dos Patos-Lagoa Mirim lowland. A small but important rice area also has developed near Dom Pedrito and Bagé within the extensive livestock ranching zone. Riziculture is therefore widely dispersed in the state from the Depressão Central southward.

Wet rice cultivation in Rio Grande do Sul began early in the twentieth century on a small scale, but soon expanded. In 1914 about 10,000 tons of rice were harvested, most of it grown near the Rio Jacuí immediately west of Porto Alegre. Production reached 232,000 tons by 1930 and

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[31] Getúlio Marcoantonio, "O fome e suas consequencias," O Grande Santa Rosa, Santa Rosa, Rio Grande do Sul (December 8, 1977): 13.

further accelerated when minimum price guarantees were enacted in 1940.[32] Associated with this was an increased demand for rice in the urban markets of São Paulo and Rio de Janeiro. The state's 1968 rice harvest was 1,286,000 tons.[33] In 1976 Rio Grande do Sul was the nation's foremost producer and accounted for 1,850,000 tons.[34] The harvest increased to an all-time high of 2,105,000 tons the following year, then declined abruptly in 1978 due to drought.[35]

Three municípios produced 25 percent of the state's rice in 1976. Santa Vitória do Palmar in the far south led with 189,000 tons, while Itaqui and Uruguaiana in the far west produced 144,000 tons and 132,000 tons, respectively.[36] The municípios of Camaquã and Arroio Grande, bordering the Lagoa dos Patos and Lagoa Mirim, respectively, are also major rice zones, as is Cachoeira do Sul and Bagé-Dom Pedrito.

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[32] Raymond Pébayle, "A rizicultura irrigada no Rio Grande do Sul," Boletim Geográfico do RGS, op. cit.

[33] Information obtained at the Comissão Estadual de Planejamento Agrícola (CEPA/RS), November, 1977.

[34] Anuário Estatístico do Brasil, 1976, p. 167.

[35] Ibid., and "The Drought in Southern Brazil," p. 740.

[36] Plano anual de produção e abastecimento para 1977/78, p. 43.

The state's largest area of rice cultivation, the Lagoa dos Patos-Lagoa Mirim lowland, also leads in total production. Second in importance is the Rio Uruguai lowland, followed by the Campanha and Depressão Central. However, the Rio Uruguai lowlands obtained the highest rice yields in Rio Grande do Sul in 1977, averaging 4,000 to 6,000 kg/hectare. The Lagoa dos Patos-Lagoa Mirim zone reported 3,500 to 3,800 kg/hectare for the same year. Yields were lowest in the Depressão Central, where 2,500 kg/hectare was the mean.[37]

In general, the amount of land devoted to rice cultivation correlates with expanding production, and rice culture is replacing cattle and sheep ranching in some areas. Examples include the western margin of the Lagoa Mirim and southern limits of the Depressão Central. In addition, soybean cultivation has penetrated much of the latter region because of more favorable market prices. Many rice producers, in turn, have left the Depressão Central and Lagoa dos Patos zones to farm new lands near Santa Vitória do Palmar.

Three types of rice growers are found in the state: large landowners, renters who are also large-scale producers, and small-scale producers. Mechanized rice cultivation is restricted mainly to large operators who can

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[37]Information obtained in personal interview at the Instituto Rio Grandense do Arroz (IRGA), Porto Alegre, February, 1977.

afford the cost of farm implements, while the small farmer plants and harvests the crop manually.

Crop-livestock rotation is practiced on most farms within the region. Field interviews near Camaquã disclosed that cattle-rice rotation was practiced on 70 percent of the large rural properties. In such cases, rice is normally grown on a parcel of land for one year, after which the land reverts to pasture for three years. During the fallow period rice is raised on adjacent properties. Rice plantings are rotated in this manner mainly to facilitate soil recuperation.

Trade centers include Pelotas and Cachoeira do Sul, as well as Porto Alegre. Rice milling occurs in all three cities and largely dominates the economy of Pelotas and especially Cachoeira do Sul. Producers sell their rice to private firms or cooperatives which beneficiate the crop. Upon receipt, the crop is winnowed, dried, and the husk removed prior to polishing. Most of Rio Grande do Sul's beneficiated rice is marketed nationally. The transportation mode is coastwise shipping or road, depending upon the location of the rice mill. Rice processed in Pelotas that is destined for the urban markets of São Paulo and Rio de Janeiro is shipped by sea, while that from Cachoeira do Sul is trucked. If rice stocks exceed domestic demand, the surplus may be released for export. This was the case in 1976, when some rice was exported to the Soviet Union.

Although wet rice cultivation has been successful in Rio Grande do Sul, producers are sometimes plagued with serious problems. Prolonged drought in 1978 reduced production 18 percent in Brazil from the previous year.[38] Winter flooding in lowland rice areas sometimes occurs. The entry of the sea into the Lagoa Mirim, which increased the salt content of irrigation water used in rice cultivation, was another problem until 1977 when a large flood control dam was completed south of Pelotas. Large-scale producers are faced with rising production and machinery costs that are not compensated for by minimum prices offered by the government. Small producers often have insecure tenure arrangements, and few financial resources, while off-season unemployment is high due to mechanization on nearby large landholdings.

Agricultural Subregions of Rio Grande do Sul

The small-scale diversified agriculture region is a complex, noncontiguous land-use zone (see Figure 16). It encompasses three major physiographic provinces of Rio Grande do Sul: the Serra Geral, the Alto Uruguai zone and the Serra do Sudeste. In addition, the northeast Atlantic littoral and the immediate urban hinterland of Porto Alegre comprise integral parts of this region.

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[38] "Brazil," ABECOR Country Report, 1st November 1978, p. B.

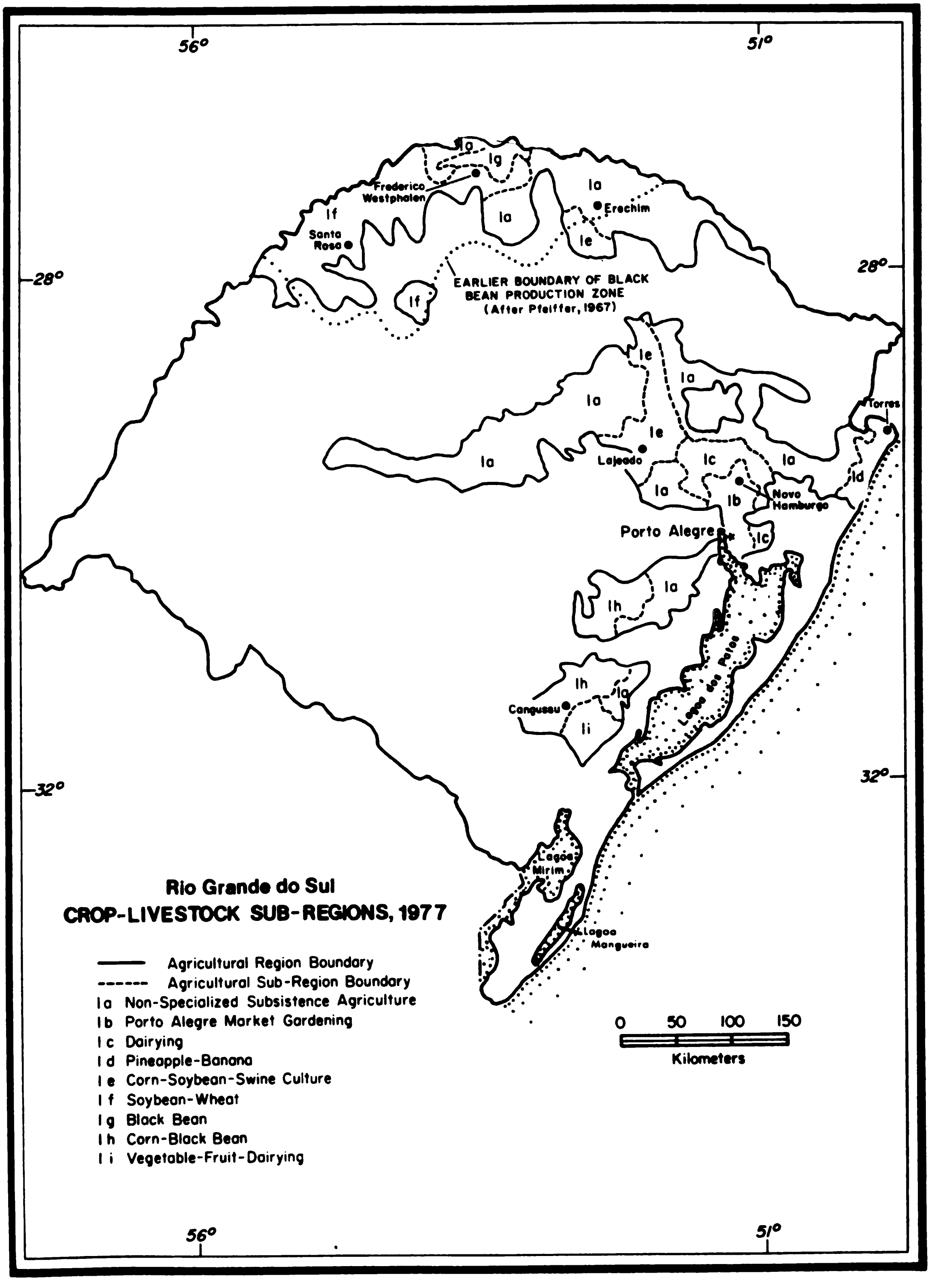

Figure 16.--Rio Grande do Sul, Crop-Livestock Sub-Regions.

Nonspecialized Subsistence Agriculture

Most of the small farms in Rio Grande do Sul are extremely diversified. Corn, oranges and black beans predominate. Areas of especially diversified production include the eastern Alto Uruguai region, the northeastern and western margins of the Serra Geral, and the northeastern flank of the Serra do Sudeste. Corn and black beans are grown in all of these zones, while manioc is important on small farms nearly everywhere north of the Depressão Central. Sweet potatoes, tomatoes, pineapples and bananas are less extensive. Swine culture and dairying occur but are of greater significance elsewhere. The nonspecialized subregion of small-scale agriculture is almost purely subsistence in nature. Agriculture is much less dynamic since markets are distant and most residents remain outside the mainstream of economic activity.

Porto Alegre Market Gardening

A zone of intensive agriculture supplies fruits and vegetables for the Porto Alegre urban market. This subregion, which has a general north-south alignment, includes the entire urban fringe of the city and much of the lower Serra Geral foothills to the north. Except on the west, Porto Alegre is ringed by a zone of green vegetable production which includes cauliflower, celery, cabbage, lettuce and carrots. In some cases, such cultivation is by persons of Japanese ancestry. A number of small communities being absorbed by greater Porto Alegre are the current foci of market gardening. A small but interesting ancillary activity is the cultivation of fresh flowers, particularly roses, for the urban market. Floriculture occurs on the eastern fringe of Porto Alegre and between São Leopoldo and São Sebastião do Caí. Manioc is important farther northeastward, between Cachoeirinha and Gravataí, while oranges are raised northwest of Porto Alegre near Montenegro. Still farther from Porto Alegre, at the northern limit of the region, is a zone of potatoes which extends from Carlos Barbosa eastward to Dois Irmãos. Cultivation is almost exclusively by persons of German ancestry. The higher elevation and cooler climate favor potato growing and dairying.

In 1974, the Brazilian government opened a large public market on the northern fringe of Porto Alegre to promote market gardening and to provide a facility tailored to the needs of small-scale vegetable producers or hortigranjeiros. A major objective was to involve the farmer directly in the sale of produce, thereby lowering food prices.

Dairying

Dairying, including the production of fluid milk, cheese, butter and other derivatives, is significant in three zones of Rio Grande do Sul: the northwestern Serra Geral, northwestern Planalto Medio and adjacent southwestern Alto Uruguai region, and near Pelotas. Nevertheless, dairying in northwestern Rio Grande do Sul is overshadowed by soybean and wheat cultivation, while fruit and vegetable growing near Pelotas make that area a distinct subregion. Dairying in the Serra Geral is well developed due to the proximity of the Porto Alegre market, although the city also receives dairy products from points farther north and west.

The greater Porto Alegre dairying subregion includes areas between Montenegro and Lajeado-Estrela, between Carlos Barbosa and Nova Petrópolis, and near Taquara. The urban milkshed is roughly crescent shaped and forms an outer arc immediately north of Porto Alegre's market gardening subregion. To this extent, the state's land-use pattern is nearly identical to that depicted in the von Thünen model.

Dairying in the subregion is associated with small farms operated by colonos. The principal breed is Holstein (about 75 percent), with Jerseys comprising the balance. Although total output is substantial, many problems exist. Milk yields per animal are low, and many small-scale producers lack funds to invest in new equipment.[39] These problems, combined with poor pastures and the small size of landholdings, have resulted in strong fluctuations in milk yields throughout the year. Poor pastures for dairy cattle during the winter season have resulted in production

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[39] "Leite," Zero Hora, Porto Alegre (May 8, 1977): 22-26.

decreases of 20 percent near Estrela and 30 percent at Encantado and Carlos Barbosa.[40] Oscillations elsewhere in the state are equally great due to the same factors. Rio Grande do Sul ranks third nationally after Minas Gerais and São Paulo states, and much of its production is in the Porto Alegre subregion.[41] The communities of Estrela, Encantado and Carlos Barbosa have milk and creamery cooperatives, and four commercial enterprises in the subregion also buy milk from producers. At Taquara, northeast of Porto Alegre, a powdered milk plant serves the Porto Alegre market. Dairying in northwestern Rio Grande do Sul covers a large area in which the economy is based on cash crops. Yet, dairying is significant and major producer cooperatives are operating in Giruá, Santo Ângelo, Cruz Alta, Ijuí, Panambi, Santa Bárbara do Sul, Palmeira das Missões in the Planalto Medio, and Santa Rosa and Três de Maio in the Alto Uruguai region. Two private dairies, in Santa Rosa and Passo Fundo, also buy milk from producers. In 1978 it was estimated that 56 percent of Rio Grande do Sul's milk originated through

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[40] Information obtained during personal interview at the Cooperativa Central Gaúcha de Leite, Ltda., Porto Alegre, September, 1977.

[41] Anuário Estatístico do Brazil, 1976, p. 174.

cooperatives and mixed private/government operations. The balance was produced by private firms.[42]

Pineapples and Bananas

The eastern scarp of the Serra Geral from Torres to Osório accounts for more than 95 percent of the state's bananas, while the adjacent coastal plain is noted for pineapples.[43] The subregion parallels the Atlantic coastline immediately to the east. A major factor influencing banana cultivation is climate. Maritime influences moderate winter temperatures, and frost rarely if ever occurs. The bananas are marketed mainly in Porto Alegre, about 125 km distant. Yet, Rio Grande do Sul is not self-sufficient in bananas, and the balance is imported mainly from São Paulo state. Capital and technological inputs of the banana-pineapple subregion are less than in most other areas of Rio Grande do Sul, since nearly all farmers lack the financial resources to make needed improvements. However, banana culture seems to be a rational activity, considering the limited processing required and proximity to market.

Pineapple cultivation is restricted to reasonably well drained areas of the coastal plain, where the fruit is

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[42] Information obtained through personal interview at the Cooperativa Central Gaúcha de Leite, Ltda., September, 1977.

[43] *Plano anual de produção e abastecimiento para 1977/78*, p. 44.

grown on small holdings. The principal zone extends north-northeast from Osório to Torres on the Rio Grande do Sul-Santa Catarina border. Yields have been stable since 1970, but the area devoted to pineapples decreased by more than 10 percent from 1970 to 1977 with a corresponding decline in production. The greatest decrease occurred between 1975 and 1976, when 23,680,000 and 18,713,000 units were produced, respectively. Pineapple production was projected to remain at the 1976 level through 1979.[44]

Pineapples produced in the zone are small in size, but reportedly have a sweeter taste than those from elsewhere in Brazil such as Bahia. As in the case of bananas, the fruit is marketed in Porto Alegre. In general, pineapple growing is characterized by low capital and technological inputs and few innovations.

Corn, Soybeans and Swine

Two major areas of corn-soybean-swine culture occur in Rio Grande do Sul. The largest is immediately northwest of the Serra Geral dairying subregion. The subregion extends from Lajeado-Estrela northward to Marau, about thirty km southeast of Passo Fundo. It is about thirty km wide in the south but gradually narrows northward. A second much smaller zone lies immediately south and west of Erechim. Both are composed of small private farms owned by

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[44] Information furnished by the Comissão Estadual de Planejamento Agrícola (CEPA/RS), November, 1977.

descendants of Italian immigrants. Corn is used mainly to feed hogs, while soybeans have gained importance because of favorable market prices and the opening of a new terminal at Estrela in late 1977. Hogs are sold to meat-packing cooperatives in Estrela, Encantado and elsewhere within the larger subregion as well as in Erechim.

Subsistence agriculture predominates, but commercial crop-livestock production has increased. The meat and soybeans are marketed in Porto Alegre and both are transported by truck via all-weather paved highway. Soybeans are also barged to Porto Alegre for processing and export via a new terminal in Estrela. Farm-to-market access is via all-weather highways from Erechim to Porto Alegre, but feeder roads need improvement.

Corn, soybeans and swine are raised throughout much of northern Rio Grande do Sul, particularly north of Erechim and Santa Rosa. However, they are most prominent in the subregion just discussed.

Soybeans and Wheat

The soybean-wheat subregion covers much of extreme northwestern Rio Grande do Sul. A wide variety of crops is grown, but notable changes have occurred in recent years. A decline in corn, black beans and hogs corresponds to an increase in soybeans and wheat. The zone consists mainly of small holdings farmed by descendants of German immigrants. This colonia nova zone produced slightly more than

1,000,000 tons of soybeans in 1975, or nearly 20 percent of Rio Grande do Sul's total.[45] Wheat cultivation is less important, but the production statistics obtained are not complete. The author estimates that the subregion produced slightly less than 10 percent of Rio Grande do Sul's wheat in 1975. As in the Serra Geral, population density is quite high and there are some sizeable trade centers. The colonial city of Santa Rosa is the largest in population and service area. Major enterprises include a large agricultural cooperative, farm machinery manufacturing, food processing and commercial services. Cerro Largo, Três de Maio, Chiapeta and Frederico Westphalen are smaller centers. More accessible places, such as Santa Rosa, have good highway connections, while areas closer to the Rio Uruguai are more isolated. Many farm-to-market roads within the subregion are inadequate and difficult to negotiate in periods of rainy weather.

<u>Black Beans</u>

The black bean zone of diversified agriculture is of special significance, since black beans, rice and meat are staples in the Brazilian diet. The subregion is an area of small landholdings in which family labor is used for planting, cultivating and harvesting black beans. It is

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[45]Production figures furnished by the Federação de Cooperativas Basileiras de Soja e Trigo (FECOTRIGO), Porto Alegre, September, 1977.

small in extent and is located in the northernmost part of the state. It encompasses all or part of six small <u>municípios</u> and has an east-west orientation being considerably wider on the eastern margin.

The black bean subregion accounts for a high proportion of the state's crop. Six of its <u>municípios</u> rank among the top twenty in Rio Grande do Sul in terms of production. The <u>município</u> of Alpestre occupies first place. Combined production of the twenty <u>municípios</u> in 1976 totaled slightly more than 50,000 tons. Of this, more than 18,000 tons (nearly 37 percent), were grown in this subregion and marketed in nearby Frederico Westphalen or Iraí.[46] However, black bean production has decreased dramatically in recent years, creating serious shortages for consumers. In 1975, Rio Grande do Sul produced about 245,000 tons of black beans, whereas the 1977 harvest was only 126,000 tons. Output was expected to increase only slightly in 1978 and 1979.[47] The chief reason for the decline was the desire by farmers to plant soybeans because of their greater market value. Thus, land-use change within the area has been significant since 1970. Black beans had to be imported from Mexico in 1977, which further aggravated the nation's balance of payments problems.

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[46] <u>Plano anual de produção e abastecimento para 1977/78</u>, p. 45.

[47] Information furnished by the Comissão Estadual de Planejamento Agrícola (CEPA/RS), November, 1977.

Corn and Black Beans

The western portion of the Serra do Sudeste is a zone of small landholdings where corn and beans dominate the diversified farming scene. Two noncontiguous zones of corn and bean production are separated by a small enclave of cattle and rice. Production of corn and beans is really more extensive than in the eastern Serra Geral or Alto Uruguai region. However, soils are thinner, rocky and less fertile, and the population density is much lower. Transportation is difficult in the north, where few roads exist, but Cangussu, on the southern margin of the region, has an all-weather paved highway to Pelotas and points northwest. This município led Rio Grande do Sul in corn production in 1976 and was third in beans.[48]

Soybean cultivation has also increased in the subregion but on a modest scale. Poor soils, isolation and a less innovative attitude among producers appear to be the major factors. Except for Cangussu, the subregion has no major trade centers. Thus, produce is transported to Camaquã, Porto Alegre or Pelotas, depending on market preference.

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[48] Plano anual de produção e abastecimento para 1977/78, pp. 45, 47.

Vegetables, Fruit and Dairying

The vegetable-fruit-dairying subregion is located along the southeastern margin of the Serra do Sudeste immediately northwest of Pelotas, the state's second largest city. It is roughly rectangular in shape and occupies about thirty square km. Nearly all of the land-holdings are less than fifty hectares in size. The sub-region specializes in peaches. In 1976 almost 16,000 hec-tares were devoted to this fruit, nearly double the area in 1970. Yields per unit area have not kept pace with the rate of areal expansion, but in fact declined 25 percent from 1970 to 1976. Production totaled about 862,000,000 fruits in 1970, and 1,125,000,000 six years later.[49] No specific reasons are apparent for this decline. However, the need for technological assistance to small producers, soil exhaustion, and limited financial resources may be responsible. Competition from producers in Argentina, many of whom export peaches to Brazil, may also be a disincentive to improve yields. Asparagus is concentrated immediately north of Pelotas. About 2,500 hectares were planted in 1977 along with lesser amounts of celery, lettuce, cabbage and onions.[50]

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[49] Information furnished by CEPA/RS, November, 1977.

[50] Information furnished by the Associação Gaúcha das Produtores de Pêssego, Pelotas, Rio Grande do Sul, November, 1977.

Dairying is another major activity on small properties within the subregion. The Pelotas area is one of the state's three major milksheds, along with the Santa Rosa-Ijuí area and Lajeado-Estrela in the lower Serra Geral. In recent years soybeans and strawberries have also been grown.

Pelotas is the major market for nearly all of the subregion's products, but Cangussu to the northwest is the center of peach production. Farm-to-market access between Cangussu and Pelotas is excellent via all-weather paved highway. A substantial fruit and vegetable canning industry has developed in Pelotas, based upon produce from the subregion.

Crop-Livestock Landholdings and Land-Use Patterns

In 1970 some 23,807,000 hectares of land were classified as rural properties in Rio Grande do Sul. About 88 percent of this land was owned by individual farmers or ranchers. An additional 10 to 11 percent of the state's properties, in terms of area, were owned by private firms or held in group ownership. In contrast, public domain totaled only about 300,000 hectares, slightly more than 1 percent of the total area. Unclaimed lands in Rio Grande do Sul comprised only 61,000 hectares, or about .25 percent of all rural land. Private property, whether held on an individual, joint ownership, or large farm enterprise basis accounted for nearly all rural lands in 1970.[51]

The total number of rural establishments in Rio Grande do Sul in 1970 was slightly more than 512,000. Of this number about 481,000 were owned by single individuals, and in many cases the same individual owned more than one property. The number of rural establishments in the state has increased nearly 300 percent since 1920 when only 123,000 were reported.[52] This increase reflects not only population growth but the fractionalization of landholdings, particularly in the Serra Geral and Alto Uruguai colonial zones.

In 1920 about 2,000 rural properties were under joint family or company ownership, but by 1970 the number had increased to 15,000. Since large inputs of capital rather than labor are common on these properties, their importance is far greater than the number suggests. Holdings of the public domain also number about 15,000 and include some forest. However, they are much less significant economically since they are largely noncommercial. About 800 rural enterprises are reported as "undeclared" in terms of ownership.[53]

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[51] Anuário Estatístico do Rio Grande do Sul, 1972/75, Vol. 5.8, Tomo 1, Agropecuária, p. 15.

[52] Ibid.

[53] Ibid.

In Rio Grande do Sul there are about 367,000 rural property owners. The lands owned by these individuals constitute nearly 72 percent (15,165,000 hectares) of the state's total inventoried area (23,807,000 hectares). Tenant farmers, who rent land from private owners, are much less numerous. Nearly 86,000 persons operated rented lands in 1970. The total area of rented lands was about 2,550,000 hectares, or nearly 17 percent of all lands inventoried. In addition, about 44,000 persons were classified as sharecroppers or parceiros. Landholdings under this type of tenure arrangement comprised only 742,000 hectares, or slightly more than 3 percent of the total area. And, about 15,000 of the state's rural properties are operated by administrators or majordomos, who manage farm-ranch operations for a firm or absentee landowner.[54]

The number of very small landholdings is notable. About 178,000 of Rio Grande do Sul's 512,000 rural establishments are smaller than ten hectares, i.e., nearly 35 percent of the state total. About 6,000 farms are less than one hectare in size, while more than 16,000 are between one and two hectares. Farms from two to five hectares in area number more than 63,000 while 91,000 farms have an area from five to ten hectares. Some 271,000 farms range from ten to fifty hectares in size. Those from ten to twenty hectares number about 144,000 and comprise 28 percent of the

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[54]Ibid.

state's total. Farms from twenty to fifty hectares in size are also numerous (127,000), and account for 25 percent of the total. Thus, small farms are by far the most numerous. Rio Grande do Sul had 448,000 farms of less than fifty hectares in 1970, which represented 87 percent of the state's total number, but only 27.3 percent of its area.[55]

Conversely, farms and ranches of 50 to 500 hectares accounted for only 86,000 properties but comprised nearly 32 percent of Rio Grande do Sul's crop-livestock area. As farm size increases, fewer properties account for a proportionately larger share of the total area. Farm-ranch enterprises from 500 to 1,000 hectares number somewhat more than 4,000, while 3,200 properties range from 1,000 to 10,000 hectares. In the latter case, about .6 percent of Rio Grande do Sul's enterprises account for 27.4 percent of the total area.[56]

Of greatest significance is the rapid increase in small rural properties between 1920 and 1970. This resulted mainly from subdivision of colono properties among immigrant descendants. In many cases, farms are so small that production becomes uneconomical. Marketing and agricultural input costs often exceed farm earnings and the land is either abandoned or its owners become financially destitute. The response to the situation has been migration

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[55]Ibid.

[56]Ibid.

to other areas within the state or nation where pressure on the land is less acute.

Distribution of Properties by Size

In 1972 the Instituto Nacional de Colonização e Reforma Agrária (INCRA) published a map depicting rural property size and potential land use in Rio Grande do Sul. A six-category classification is shown on the map denoting various landholding size combinations. The classification represents various combinations of the three property sizes which constitute distinct landholding regions: (1) small properties of less than fifty hectares, (2) medium-size properties from 50 to 250 hectares, and (3) large properties over 250 hectares.[57]

Small properties (less than fifty hectares) used mainly for subsistence and specialty crops prevail throughout most of the Serra Geral and Alto Uruguai regions and along the eastern margin of the Serra do Sudeste. The distribution of small properties correlates closely with the incidence of *colono* holdings farmed mainly by persons of German and Italian ancestry. *Minifúndia* also coincides with the occurrence of rough terrain.[58]

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[57] *Mapa socio-econômico, setor primário, Rio Grande do Sul* (Map) (Rio de Janeiro: Ministério da Agricultura, Instituto Nacional de Colonização e Reforma Agrária [INCRA], 1972).

[58] Ibid.

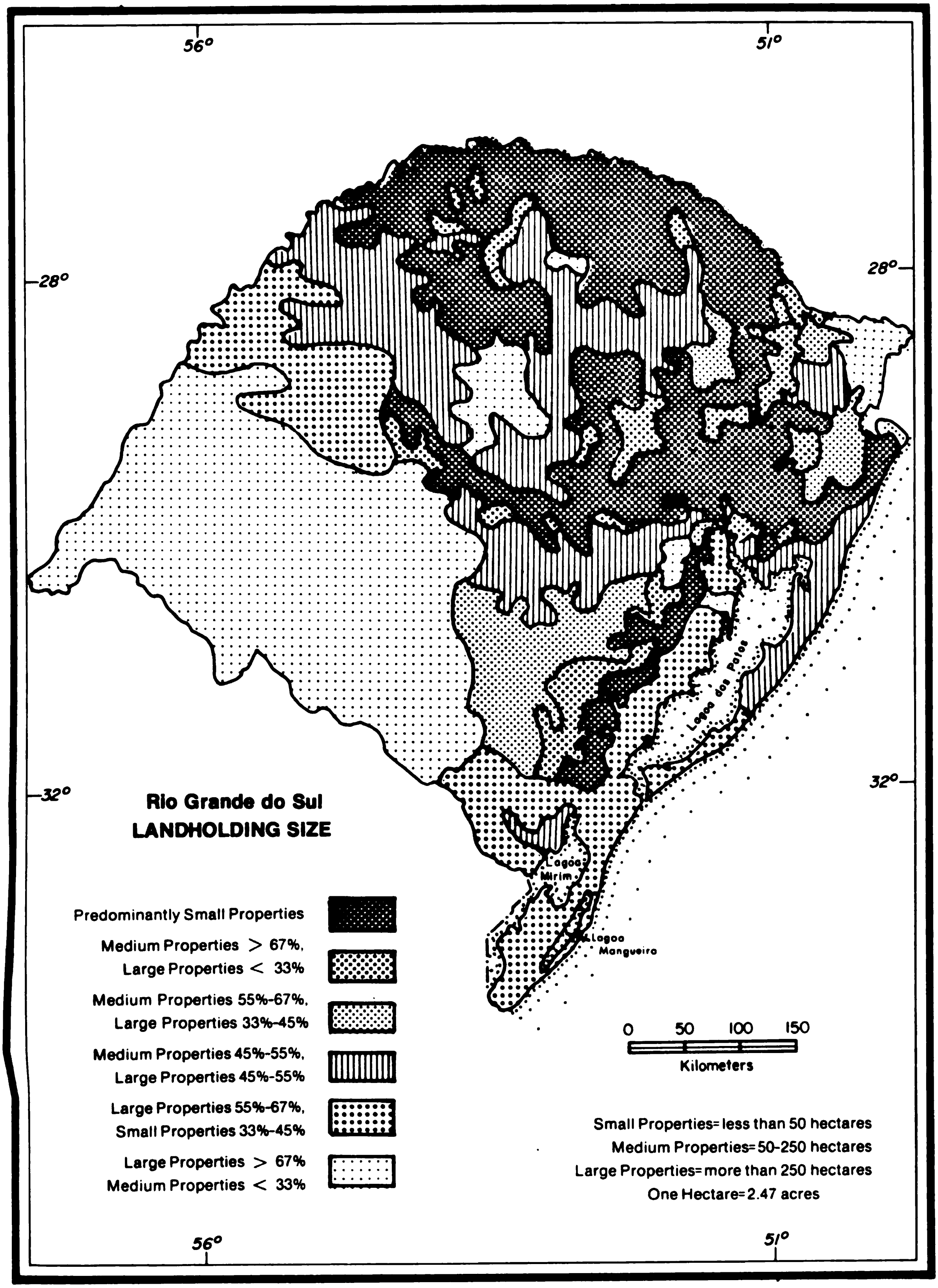

Figure 17.--Rio Grande do Sul, Landholding Size.

Predominantly medium-size properties (50 to 250 hectares) are found along the periphery of the major small landholding zones. Areas of medium-size properties, interspersed with larger holdings, occur along the forest-grassland margin in the state's northeast and near Soledade and Santa Maria farther west. Other such areas are found along the southern margin of the Alto Uruguai _minifúndia_ zone and along the immediate western flank of the Serra do Sudeste.[59]

The western Serra do Sudeste-northeastern Campanha transition zone is an area of predominantly medium-size properties mixed with numerous large properties. The area is devoted mainly to livestock, although some corn and beans are also grown. A much smaller area with a similar landholding pattern occurs in the high _campos_ of the state's northeast. As in the previous zone, cattle raising rather than agriculture, predominates.[60]

The soybean-wheat region of the Planalto Medio and the cattle-rice zones of the Depressão Central are areas of mixed properties with medium and large holdings equally represented. Smaller areas of mixed holdings also occur in extreme northeastern Rio Grande do Sul, where beef ranching is concentrated, and in the cattle-rice zone immediately northwest of the Lagoa Mirim.[61]

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[59] Ibid. [60] Ibid. [61] Ibid.

Two areas of the state are dominated by large properties. The Missões soybean-wheat zone of northwestern Rio Grande do Sul is one such area. Mechanized soybean-wheat cultivation predominates, with some cattle raising, but small-scale farming is also significant. Corn and black beans, as well as swine, are raised on small farms within this larger region. The second zone borders the Lagoa dos Patos and Lagoa Mirim. Cattle-rice production on large properties is the chief activity, but asparagus and onions, plus dairying, on small properties are also noteworthy.

Large landholdings, or latifúndia, for pasturing beef cattle and sheep typify the rural landscape of southwestern Rio Grande do Sul and adjacent parts of Uruguay and Argentina. Some medium-size properties used for wet rice, soybeans and wheat are also found in the zone. And, a very small area of large holdings mixed with medium-size properties borders Santa Catarina in the extreme northeast. As in other parts of the highland campo, cattle raising is the chief economic pursuit.

Landholding Size and Productivity

The relationship between size of landholding and productivity, specifically yields per unit area, is highly variable in Rio Grande do Sul. The yield of some crops is more or less constant regardless of property size. That of others may increase or decrease with changing property size. Factors such as local relief and drainage, soils, motivation and background of farmers, market price and capital inputs appear to be related to specific landholding sizes and may therefore be reflected in high or low yields.

In 1975, wheat yields in some _municípios_ outside the main Planalto Medio production zone were considerably higher than yields within it. Highest yields are found in either the southern Campanha or high _campos_ within the _campos de cima da serra_. The _município_ of Bagé leads the state in yields per unit area, followed by Bom Jesus, Vacaria, Esmeralda and Arroio Grande.[62]

Rio Grande do Sul's leading wheat _municípios_ (1975), in terms of tonnage, are Cruz Alta, Santo Ângelo, Giruá, Ibirubá and Itaqui.[63] The first four of these comprise a contiguous wheat region, while Itaqui is part of the Rio Uruguai lowlands. All five _municípios_ have yields substantially lower than the extra-regional areas. Two exceptions are Esmeralda, a small landholding _município_ in the far north, and Colonia Nova, within the larger _latifúndia_ zone

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[62]Information furnished by the Federação de Cooperativas Brasileiras de Soja e Trigo (FECÔTRIGO), September, 1977.

[63]Ibid. Wheat production data were unavailable for forty-two of the state's 232 _municípios_. Major wheat-producing _municípios_ for which no data were available include Palmeira das Missões, Passo Fundo and Santa Bárbara do Sul.

near Bagé.[64] Most of the state's wheat is grown on medium to large farms.

Two major factors responsible for higher wheat yields outside the Planalto Medio zone may be: (1) more favorable climate (lower winter temperatures and less disease) and (2) the secondary role of wheat in the soybean-wheat double-cropping system of the Planalto Medio. Natural soil fertility in the Planalto Medio is not high and soil acidity makes liming necessary. However, fertilizer and lime application is widely practiced throughout the region and tends to offset this negative aspect.

The highest soybean yields in 1976 were reported mainly in municípios having medium and small properties in the Planalto Medio and Serra Geral-Alto Uruguai zones, respectively. Leading municípios in terms of yield were Não-Me-Toque (Campo Real), Colorado, Selbach, Tapera and Victor Graeff, all in the south-central planalto. These were followed by seven other small-farm municípios in the Serra Geral, Alto Uruguai and Serra do Sudeste. In soybean tonnage in 1976, the leading municípios were Santo Ângelo, Palmeira das Missoes, Carazinho, Passo Fundo and Santa

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[64] Ibid.; and Flavia La Salvia and Nilbiamater S. B. Handschunch, "Contribuição a metodologia do estudo do habitat rural-Bagé," Boletim Geográfico do RGS, op. cit.

Bárbara do Sul.[65] The spatial pattern of high wheat yields differs greatly from that of soybeans. Wheat yields are much greater outside the most important production areas, while high soybean yields tend to be concentrated in or near the major production zone. A lucrative soybean market, favorable climatic conditions, and producer interest in maximizing yields appear to be major factors responsible for the uniformly high yield. Conversely, higher extra-regional wheat yields may indicate that the crop is grown in the Planalto Medio because of historical reasons and to recoup investment costs on farm equipment, even though climatic and edaphic conditions are less favorable.

Wet rice cultivation in Rio Grande do Sul is almost exclusively associated with large farms, except for some medium-size properties in the Depressão Central along the western margin of the Lagoa dos Patos and a few small holdings south of Erechim. Rice yields on large holdings in 1976 averaged 4,000 to 4,500 kg per hectare, while yields on small and medium-size holdings were about 25 percent less. The municípios of Santa Vitória do Palmar, Itaqui and Uruguaiana reported very high yields and accounted for 25.1 percent of Rio Grande do Sul's 1976 wet rice crop, or

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[65]Information furnished by the Federação de Cooperativas Brasileiras de Soja e Trigo (FECOTRIGO), September, 1977.

465,000 tons. Yields in other _municípios_ were about 4,000 kg/hectare although production was much less.[66]

Comparisons concerning the relationship between landholding size and yield are also difficult for other crops. Some, such as garlic, potatoes, black beans and corn are confined mostly to small farms of less than fifty hectares or medium-size properties that are only slightly larger. Garlic yields in 1973 were variable, with both high and low yields reported. In some cases, great differences in yield existed even between adjacent _municípios_ having similar property size.[67] The same was true of potatoes on small properties in 1976. A wide range of yields also existed among the five leading potato producing _municípios_ in the Serra do Sudeste and Serra Geral.[68] Extremely low yields of black beans were experienced in 1976 in the leading _município_ of Alpestre in the northernmost part of the state, and in the Serra do Sudeste, while higher yields were obtained in the western Serra Geral and parts of the Planalto Medio immediately to the west.[69] Corn yields on small farms in both small and medium-size _municípios_ varied only slightly in the same year. The western Serra do Sudeste zone leads in production, but

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[66]_Plano anual de produção e abastecimento para 1977/78_, p. 43.

[67]Ibid. [68]Ibid., p. 44. [69]Ibid., p. 45.

cultivation is dispersed throughout the state with the exception of the extensive livestock and rice-livestock areas.[70]

[70]Ibid., p. 47.

CHAPTER VII

GOVERNMENT ASSISTANCE IN AGRICULTURE

In recent years the government of Brazil has given priority to agricultural assistance and extension programs so as to integrate the rural sector into the mainstream of the national economy. This move was spurred by the fact that in the past the needs of Brazilian agriculture were subordinated to those of the industrial sector, with a number of negative effects. Income for most of the country's farmers remained low, as did the level of living of many rural residents. Beginning in the early 1970s the government implemented various programs to accelerate agricultural development, based on the belief that the nation's overall progress is dependent upon a dynamic rural economy. Measures included the consolidation of extension services, establishment of national and regional crop-livestock research centers, and increased government-university cooperation. However, little progress was made in agricultural credit since interest rates remained high as a result of government anti-inflationary measures.

Extension Centers

Until 1977, two major agricultural assistance and extension organizations operated in Rio Grande do Sul. Both employed a large number of technicians and maintained assistance centers throughout the state. The Associação Sulina de Crédito e Assistência Rural (ASCAR) was created in 1955 as a public enterprise to provide technical orientation and extension services to farmers. With the provision of such services, much could be done to resolve production problems and raise rural standards of living. In 1977 ASCAR maintained ninety-six extension centers in Rio Grande do Sul, of which ten were regional in scope. These centers serve 66 percent of the state's rural population, the majority being low-income farmers cultivating small holdings. Specific services include on-site orientation for all types of crop production, animal husbandry and veterinary assistance, and instruction in the proper use of pesticides. Other services include the determination of credit eligibility for farmers, orientation concerning rural legislation, and home economics extension. In addition, ASCAR is active in the promotion of 4-S Clubs (equivalent to 4-H Clubs in the United States) and cooperative development. In 1977 nearly 70 percent of the agency's operating funds were provided by the Empresa Brasileira de Assistência Técnica e Extensão Rural (EMBRATER), a federal government organization created in 1975 to oversee and coordinate Brazil's agricultural extension organizations.

The balance of ASCAR's funds came from state or local government sources, principally the Secretaria da Agricultura.[1]

A second system of extension services in the state is provided by Delegacias Regionais Agrícolas, which are regional extension centers subordinate to the Secretaria da Agricultura of Rio Grande do Sul. Eighteen such centers were in operation in 1977, each staffed with agronomists or rural technicians specializing in veterinary services. In some cases both types of specialists are assigned to the same center, depending upon local extension needs. Subordinate to the eighteen regional delegacias, or regional centers, were 159 município-level agricultural assistance offices.[2]

The need for an integrated national system of agricultural extension can be traced back about thirty years. Brazil's first agricultural extension service, the Associação de Crédito e Assistência Rural (ACAR), was established in São Paulo state in 1948 with United States assistance. The founding of ASCAR, in 1955, was followed by the advent of similar extension services in the states of

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[1]Relatório 75 ASCAR (Porto Alegre: Associação Sulina de Crédito e Assistência Rural, 1976), pp. 1-3; "ASCAR completou 22 anos de atividades," Jornal do Comércio, Porto Alegre (June 7, 1977): 10; ASCAR, o que faz, como trabalha (Porto Alegre: Associação Sulina de Crédito e Assistência Rural, 1976), p. 1 (hereafter cited as ASCAR).

[2]Information obtained through personal interview at the Secretaria da Agricultura, Porto Alegre, August, 1977.

Santa Catarina and Paraná. Subsequent years saw the emergence of extension centers elsewhere in Brazil. In 1956, the Associação Brasileira de Crédito e Assistência Rural (ABCAR) was established to coordinate extension activities on a national scale, but it met with only partial success.[3]

The existence of two large agricultural extension organizations with similar functions, as well as smaller ones with closely related objectives, prompted the federal government in 1975 to consolidate extension activities on the state level throughout Brazil. In the same year, EMBRATER was created and charged with coordination of government support to extension organizations. The consolidated extension agencies in each state are Empreendimentos de Assistência Técnica e Extensão Rural (EMATER). In Rio Grande do Sul the official consolidation of ASCAR, the Delegacias Regionais Agrícolas, and a number of small agencies to form EMATER-RS (Associação Riograndense de Empreendimentos de Assistência Técnica e Extensão Rural) occurred in June, 1977. However, a gradual approach was adopted so as to give personnel at ASCAR and the Secretaria da Agricultura sufficient time to reorganize their work and avoid interruptions in extension services. Complete assimilation of the former extension systems was anticipated by mid-1979. About 180 of the state's 232 _municípios_

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[3]_EMBRATER, Relatório de Atividades 1975_ (Brasília, Empresa Brasileira de Assistência Técnica e Extensão Rural, 1976), p. 4.

are directly dependent upon crop-livestock activities. Of these, 150 were programmed to be served by EMATER-RS in 1978, with service being extended to the remaining thirty by the following year. However, conversion was initially slow. By December, 1977, only nine former ASCAR centers had been converted to EMATER-RS extension centers.[4]

The consolidation of extension organizations in Rio Grande do Sul to create EMATER-RS was based upon a number of considerations. Most important was the elimination of parallelismo, or duplication of effort, which previously existed between ASCAR and the Delegacias Agrícolas. Time and effort would be saved while administrative organization, introduction of new ideas to farmers, and the quality of technical assistance would be enhanced in the new organization. The involvement of federal government funds for agricultural development was considered particularly beneficial in 1977. EMATER-RS is more than 80 percent dependent on public funds at a time when a greater amount of public assistance is desired. Ostensibly, EMATER-RS should result in greater organizational flexibility to meet the technical assistance and extension needs of farmers and ranchers.[5]

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[4] Information obtained through personal interviews at the Empresa Brasileira de Assistência Técnica e Extensão Rural (EMBRATER), and the Associação Riograndense de Empreendimentos de Assistência Técnica e Extensão Rural (EMATER-RS), Porto Alegre, September, 1977.

[5] Information obtained through personal interview at the Secretaria da Agricultura, Porto Alegre, December, 1977.

Organizations for Specialized Assistance

Three governmental organizations provide specialized technical assistance and extension services to agriculture. Foremost among those is the Instituto Rio Grandense do Arroz (IRGA), headquartered in Porto Alegre. Founded in 1942, IRGA provides on-site orientation to rice producers throughout the state. Technical orientation is provided by twenty-five IRGA centers located mainly in major communities of the coastal lowlands, Depressão Central and Rio Uruguai valley. In rice production zones, assistance is highly specialized and IRGA, rather than EMATER-RS, is predominant. Other functions of IRGA are the purchase and storage of rice through a minimum price program, marketing assistance and rice research. A second entity providing specialized assistance and extension is Açúcar Gaúcho, S.A. (AGASA). AGASA operates largely on government funds and is attempting to stimulate sugarcane production along the state's northeast littoral. Assistance includes technical visits to farms, seed and growing stock development, and agricultural credit. AGASA has brought innovation to formerly change-resistant producers, as well as improved technology. However, mechanized sugarcane cultivation remains limited, since most of the crop is grown on small hillside plots.[6]

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[6]Information obtained through personal interviews at the Instituto Rio Grandense do Arroz (IRGA), February, 1977; and Açúcar Gaúcho, S.A. (AGASA), Osório, Rio Grande do Sul, November, 1977.

The government-financed Produtos Gaúchos, S.A. (PROGASA), in São José do Norte, provides a much more limited assistance program to onion growers. The firm purchases onions from producers and markets the crop both locally and nationally. Some technical information and assistance to growers is provided, but no formal extension service exists.[7]

Two specialized organizations serve cattle ranchers in Rio Grande do Sul. The Superintendência de Desenvolvimento do Extremo-Sul (SUDESUL), through its "Projeto Sudoeste," seeks to upgrade the state's beef cattle industry. Pasture improvement and better veterinary care are major goals. In fulfilling this task, SUDESUL maintains linkages with the Ministério do Interior and Ministério da Agricultura on the federal level, as well as the state-level Secretaria da Agricultura. The organization has also focused on the problems of rice producers along the Lagoa Mirim, where the entry of salt water into ricelands was a serious problem until 1977. A second organization is the Central Riograndense de Inseminação Artificial (CRIA), part of the Secretaria da Agricultura. CRIA operates artificial insemination centers for cattle in seventy-two of the state's _municípios_. The organization supplies semen at a nominal cost to ranchers and dairymen and maintains

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[7]Information obtained through personal interview at Produtos Gaúchos, S.A. (PROGASA), São José do Norte, Rio Grande do Sul, November, 1977.

a staff of artificial insemination technicians who are employed where on-farm services are needed.[8]

Innovation and Extension

The primary task of the newly created EMATER-RS is to provide technical orientation and guidance to crop-livestock producers. An integral part of the orientation process is the introduction of innovations. Extension visits to farms and ranches for the evaluation of problems confronting producers provides an opportunity to introduce new ideas, techniques and equipment. In the past ASCAR, and to a lesser extent the Secretaria da Agricultura, have been responsible for bringing new ideas directly to the farmer. During the 1950s, a university-sponsored extension system modeled on those already operating in the United States was discussed. However, the relatively low level of agricultural development in Rio Grande do Sul at the time, plus the many needs of producers, necessitated extension assistance on a larger scale. Given these circumstances, government at the state level was entrusted with the provision of extension services, while agricultural research was delegated to the state's universities. However, the Universidade Federal do Rio Grande do Sul published its first agricultural extension plan in 1977. The plan, which

[8]Information obtained through personal interview at the Superintendência de Desenvolvimento do Extremo-Sul (SUDESUL), Porto Alegre, March, 1977; and the Central Riograndense de Inseminação Artificial (CRIA), Esteio, Rio Grande do Sul, May, 1977.

will be carried out from 1978 to 1982, emphasizes extension training for both government technicians and farmers.[9]

EMATER-RS serves as an intermediary between researcher and producer. Its function is to apply new ideas in agriculture by incorporating them as an integral part of the orientation given to farmers. Innovations can reach the farmer through publications, radio and television, word of mouth or through extension visits. The latter method of promoting new ideas has been employed in many areas of the state where farmers are change-resistant. Under such conditions the utility of a new idea, concept, method or apparatus must be demonstrated, with performance or results being superior to the traditional method. Resistance to change is justified in some cases where the risk of change may outweigh the benefits obtained. Proven time-honored methods of farming, while not always productive, reduce the fear of uncertainty. Thus, the extensionist must demonstrate that the producer has something to gain by the adoption of a particular innovation.

From 1966 through 1969, ASCAR and the Faculdade de Agronomia e Veterinária of the Universidade Federal do Rio Grande do Sul, as well as participating government

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[9]Information obtained through personal interview at the Faculdade de Agronomia, Universidade Federal do Rio Grande do Sul (UFRGS), October, 1977; and I° Plano de Extensão Universitaria da Faculdades de Agronomia 1978-1982 (Porto Alegre: Universidade Federal do Rio Grande do Sul, 1977), 8-13.

agencies, undertook a project aimed at teaching farmers the value of soil sampling and liming. The project dubbed "Operação Tatú" included the systematic collection of more than 22,000 soil samples and involved more than 1,100 farmers from nine municípios of the Planalto Medio. Resistance to change was considerable at the outset, but as the benefits of soil sampling and liming became known, adoption rates accelerated in succeeding pilot project municípios. Other experiments using innovative techniques on test plots of soybeans, corn and wheat were conducted to demonstrate their utility in increasing yields. "Operação Tatú" was successful, and techniques used in the project are now widely practiced by Rio Grande do Sul farmers. In more recent years ASCAR has provided erosion control orientation, particuularly to farmers in the Planalto Medio and Serra Geral where the problem is especially acute.[10]

Since 1975, extension agents have been faced with the problem of accidents involving the careless and improper use of pesticides by untrained farm workers. Pesticides gained acceptance in Rio Grande do Sul about 1970 and adoption of the innovation was so widespread that

[10] I° Plano de Extensão Universitaria da Faculdade de Agronomia 1978-1982, op. cit., pp. 2-6.

extensionists had insufficient time to instruct the rural populace on correct handling procedures.[11]

It is difficult to generalize about the relationship, if any, between innovation adoption and landholding size. In Rio Grande do Sul some large-scale soybean growers quickly adopt new technology, while large-scale ranchers are technologically conservative. Likewise, some small-scale subsistence farmers are extremely traditional, while many tobacco and grape producers are quite progressive. Information obtained from agriculturalists during field work suggests that innovation adoption is often a cost-benefit situation, rather than an awareness factor.

ASCAR and the Delegacia Regionais Agrícolas have pursued different development strategies. ASCAR attempted to propagate change through pilot projects in which specific innovations were introduced. If such projects were successful, i.e., the innovation was adopted, subsequent projects were undertaken, resulting in a multiplier effect and diffusion of the innovation. In contrast, assistance centers operated by the Secretaria da Agricultura did not focus their efforts in any particular pilot project, but tried to serve the maximum number of farmers with the widest possible range of services. In general, ASCAR was more involved with change in agriculture, while the

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[11]Information obtained through personal interview with agricultural implement dealer, Esteio, Rio Grande do Sul, August, 1977.

Secretaria da Agricultura was more concerned with agricultural assistance.[12]

Distribution of Extension Facilities

The location of agricultural extension facilities in Rio Grande do Sul is governed largely by population distribution. The Campanha and southern Atlantic littoral are areas of large municípios with low rural population densities as are the highland campos of the northeast. Such areas contain fewer extension centers. Conversely, the number of centers is much greater in the densely populated colonial zones of the Serra Geral and Alto Uruguai region, both of which are composed mainly of small municípios. As a result, extension centers in large municípios have more comprehensive programs, tend to assume more importance and larger service areas than those of extension centers elsewhere.

In 1977 the Secretaria da Agricultura's 159 offices throughout the state were staffed by regional agronomists, while others were staffed with rural technicians. Fifteen of the offices were designated as regional centers or Delegacias Regionais Agrícolas. Most were located in the Serra Geral or Alto Uruguai zone, the southern Planalto Medio and the Depressão Central. Conversely, the livestock

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[12]Information obtained through personal interview with agronomist at the Secretaria da Agricultura, Pelotas, Rio Grande do Sul, November, 1977.

producing _municípios_ of southwestern Rio Grande do Sul, as well as the extreme northeast, remained somewhat isolated from these regional centers.[13]

The ASCAR extension centers exhibit a different locational pattern. The ninety-six centers are rather evenly distributed throughout the state, so as to provide maximum accessibility to producers, particularly small-scale farmers. However, the distribution of ASCAR facilities is influenced to a lesser degree by population density and number of _municípios_ than is that of extension centers operated by the Secretaria da Agricultura. Regional ASCAR centers are located in the Serra Geral and Alto Uruguai colonial areas, and near Porto Alegre, Pelotas and Santa Maria, all of which contain small farms on their urban fringes.[14]

Six major agricultural assistance and extension "poles" can be identified in Rio Grande do Sul. They include Porto Alegre and five regional centers. The regional centers are Santa Rosa, Erechim, Passo Fundo, Santa Maria and Caxias do Sul. The five offer a wide array of technical assistance to producers of soybeans, wheat, grapes, vegetables and livestock, depending upon location.

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[13] Information obtained through personal interview and map furnished by the Secretaria da Agricultura, Porto Alegre, August, 1977.

[14] _ASCAR, o que faz, como trabalha_, p. 4.

Two secondary centers are Alegrete, in the western Campanha, and the rice center of Camaquã on the western margin of the Lagoa dos Patos.

There are also several centers of specialized agricultural assistance in Rio Grande do Sul. These include Cachoeira do Sul, where the Instituto Rio Grandense do Arroz (IRGA) supplies technical assistance to growers, and Osório, the center of AGASA sugarcane extension services. At Santa Cruz do Sul the funds for tobacco grower assistance and extension come from corporate rather than government sources.

There are still areas in Rio Grande do Sul that remain isolated from extension centers because of both distance and poor roads. Such zones are found within the Alto Uruguai region, much of the northeastern campos and especially the central Atlantic littoral from Mostardas southward to São José do Norte. With the creation of EMATER-RS, an attempt was made to provide services in such areas.

The first EMATER-RS extension centers were inaugurated in specific priority areas for agricultural development. The nine centers operating in December 1977 were located in certain small and medium-size landholding areas of Rio Grande do Sul. These included Porto Lucena, Guaraní das Missões and Cerro Largo in the northwest; Erechim, Esmeralda and Lagoa Vermelha in the north; Roca Sales in the

Serra Geral, Colorado in the Planalto Medio, and Torres on the Atlantic coast bordering Santa Catarina.[15]

Government Research Organizations

Agricultural research in Rio Grande do Sul is conducted by the federal government, federal universities and the state government. The Empresa Brasileira de Pesquisa Agropecuária (EMBRAPA) and its many subordinate organizations conduct and coordinate crop-livestock research at both federal and state levels. Three federally-supported universities in Rio Grande do Sul are also involved in crop and livestock research projects. The Instituto de Pesquisas Agronômicas (IPAGRO) is the chief agricultural research organization of the state government.

EMBRAPA is Brazil's primary crop-livestock research organization and is charged with the overall supervision, coordination and promotion of research for purposes of national agricultural development. Instituted by Law No. 5,851 of December 7, 1972, EMBRAPA officially began functioning as a government agency on April 26, 1973, replacing the Departamento Nacional de Pesquisas Agropecuárias founded in 1948.[16]

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[15] Information obtained through personal interview at EMATER-RS, Porto Alegre, September, 1977.

[16] EMBRAPA ano 4 (Brasília: Empresa Brasileira de Pesquisa Agropecuária, 1977, p. 4, 63).

Some fifty-one research and special service agencies are subordinate to EMBRAPA. These include eleven national research centers, each of which conducts research related to a particular crop or type of livestock. One such facility in Rio Grande do Sul is the Centro Nacional de Pesquisa de Trigo (CNPT), headquartered in Passo Fundo which is Brazil's chief wheat research center. A second center is the Centro Nacional de Pesquisa de Suínos (CNPS) in Concórdia, Santa Catarina, a major swine culture area, part of which is in Rio Grande do Sul. Another center with research activities closely related to the state's agriculture is the Centro Nacional de Pesquisa de Soja (CNPS) in Londrina, Paraná. Elsewhere in Brazil, national centers have been established to study the production of rice and black beans, manioc and fruit, corn and sorghum and beef and dairy cattle. In addition, EMBRAPA maintains twenty-five research centers with programs that are local or regional in scope, the Unidades de Execução de Pesquisa de Âmbito Estadual (UEPAE). Four of the twenty-five UEPAE centers are located in Rio Grande do Sul. One in the Serra Geral at Bento Gonçalves is devoted exclusively to viticulture and aenological research. A second UEPAE center is at Fazenda Cinco Cruzes near Bagé, in the Campanha, and specializes in beef cattle and sheep research. Rice and vegetable research are major activities at UEPAE-Pelotas located at the Universidade Federal de Pelotas. A fourth center immediately northwest of Pelotas, near Cascata, focuses on temperate fruit.[17]

EMBRAPA also operates four agricultural research centers. Three are devoted to the study of agricultural resources and potential in their respective major natural landscape regions: the cerrados, humid tropics, and the dry Northeast. Genetic research on crops at the Centro Nacional de Recursos Genéticos (CENARGEN), in Brasília, is of direct importance to Rio Grande do Sul. The organization, through its Bancos Ativos de Germoplasmas (BAGS) located throughout Brazil, maintains supplies of genetic plant material. Grape, wheat, barley, strawberry, asparagus and onion materials are available in Rio Grande do Sul from CENARGEN sources. Two other EMBRAPA divisions are the Serviço Nacional de Levantamento e Conservação de Solos (SNLCS) in Rio de Janeiro and the Serviço de Produção e Sementes Básicas (SPSB) near Brasília. Both organizations are vital to agriculturalists in Rio Grande do Sul, given the serious soil erosion problems of the Serra Geral and the need for more complete soil surveys in areas of small landholdings. Likewise, improved certified seed is needed, particularly for the state's wheat producers. General agricultural research centers are also maintained by EMBRAPA in nine Brazilian states, but none are located in Rio Grande do Sul.[18]

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[17] Ibid., p. 24.

[18] Ibid.

<u>Federal Research Organizations</u>

The Centro Nacional de Pesquisa de Trigo, at Passo Fundo in the eastern Planalto Medio, was established in 1974 to integrate wheat technology on a national scale. A major emphasis at the center is the study of wheat phytopathology, especially the origins, causes and effects of wheat diseases prevalent in Rio Grande do Sul, Brazil's chief wheat producer. Wheat research applicable to other areas of Brazil where the crop is produced, such as the <u>campo cerrado</u> of Goiás state, is an important secondary objective. Research on soybeans, barley and rye is likewise conducted.

A major goal of wheat research at the center is to integrate particular aspects of wheat technology that are common to all producing areas of Brazil, while concurrently seeking solutions to problems of specific wheat production zones. Studying the effect of soil fertility on wheat yields is also a major research endeavor. In 1977, the center employed thirty-eight technicians, two of whom were on research assignment from the Food and Agricultural Organization (FAO) of the United Nations. In Addition, FAO provided the center with funds for laboratory research and the purchase of related equipment.[19]

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[19] Information obtained through personal interview at the Centro Nacional de Pesquisa de Trigo, Passo Fundo, Rio Grande do Sul, November, 1977.

Federal Research Centers at the State Level

Three of the UEPAE research centers are located in areas of southern Rio Grande do Sul having distinct rural economies and land-use patterns. A fourth center is located in the Italian colonial zone of the upper Serra Geral about 100 km north-northwest of Porto Alegre.

UEPAE de Pelotas

The Unidade de Execução de Pesquisa de Âmbito Estadual de Pelotas is the largest of the four UEPAE centers in Rio Grande do Sul in number of researchers/technicians employed (fifty-eight). The center, established in 1975, is engaged in five major research projects pertaining to the production of soybeans, rice, sorghum, beef cattle and dairy cattle. These projects, in turn, are divided into fifty-nine subprojects, the largest of which focuses on soybeans (twenty subprojects). Following is research on rice (eleven subprojects), sorghum (eleven subprojects), dairy cattle (nine subprojects) and beef cattle (eight subprojects).

UEPAE-Pelotas maintains a close working relationship with the Universidade Federal de Pelotas (UFPel) and the Instituto Rio Grandense do Arroz (IRGA) for purposes of rice research. The relationship between UEPAE-Pelotas and UFPel is also geographically close. The UEPAE center comprises an integral part of the university's campus and about fifty professors spend from 30 to 40 percent of their time engaged on UEPAE research. UEPAE-Pelotas also employs sixteen full-time research personnel.[20]

UEPAE de Cascata

The Unidade de Execução de Pesquisa de Âmbito Estadual de Cascata (UEPAE) is located about twenty-five km northwest of Pelotas in rolling terrain cultivated by small-scale farmers. Green vegetables and mid-latitude fruit are raised in the area and these form the major objects of research at the center. Specific research projects on asparagus, onions, strawberries, peaches, plums, nectarines, figs and apples are underway. The center began operation in 1974 and subsequently has expanded in area from 150 to 450 hectares.[21]

In 1977 twenty-one researchers were employed at UEPAE de Cascata, primarily in fruit production and processing technology projects. The Cascata facility has been particularly active in the development and promotion of apple raising. In 1977 apple production research was being conducted in the highland _campos_ of Rio Grande do Sul near Vacaria, as well as in adjacent Santa Catarina. Similar efforts were underway near Veranópolis on the northwestern

[20]Information obtained through personal interview at UEPAE de Pelotas, Pelotas, Rio Grande do Sul, November, 1977.

[21]Information obtained through personal interview at UEPAE de Cascata, in Cascata, Rio Grande do Sul, November, 1977.

margin of the viticulture region in the upper Serra Geral. In addition, the production of tung oil, formerly an important activity near Veranópolis, was being promoted. Other projects between the center and the thirty-two fruit canning enterprises in Pelotas deal specifically with food technology innovations. Technology transfer from research to application in industry is the major objective of this effort. The center employs one person to work specifically on the diffusion of new ideas relative to vegetable and fruit cultivation, as well as the processing of these products by local industry. An additional objective of the UEPAE center in Cascata is to promote increased cooperation between government research agencies and extension centers, which is judged by many to be inadequate.[22]

UEPAE de Bagé

The UEPAE de Bagé research center is located in the state's extensive livestock raising zone on the site of a former <u>fazenda</u>, which was purchased by the federal government in 1974. It occupies 2,680 hectares and is used mainly for three research projects: beef cattle, dairy cattle and sheep. The projects consist of seventeen subprojects: beef cattle (eight), dairy cattle (two) and sheep (seven), which provide employment for seventeen government research personnel. In turn, about two major experiments are

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[22]Ibid.

underway in each of the subprojects. Among the beef cattle subprojects are studies pertaining to forage crops and seeds, meat production systems, soil inputs, beef cattle weaning, parasite control, epidemiology and animal cross-breeding. The dairy cattle subprojects involve winter pasture research and milk production systems. The sheep project includes research on genetic improvement, major organ parasitology, shearing, reproduction, wool, and wool production systems. The need for research is well established since ranchers in the state face numerous problems. Winter pastures are poor, resulting in slow animal weight gain and high mortality rates. Increased costs resulting from inflation, and the loss of markets because of foot-and-mouth disease, are additional constraints. Poor winter pastures pose problems to dairy producers, including reduced milk yield, whereas sheep production problems are less acute. In general, the research center is attempting to achieve improved disease control, better animal health, and more efficient meat, milk and wool production.[23]

UEPAE de Bento Gonçalves

The UEPAE de Bento Gonçalves is located in Brazil's chief grape and wine region in the Italian colonial zone of the upper Serra Geral. The original facility was established in 1942 and subsequently became part of the

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[23]Information obtained through personal interview at UEPAE de Bagé, Fazenda Cinco Cruzes, Bagé, Rio Grande do Sul, November, 1977.

Departamento Nacional de Pesquisa Agropecuária (DPNEA). In 1975, the center was redesignated the UEPAE de Bento Gonçalves and was absorbed by EMBRAPA.[24]

The two main divisions of the center are a support section responsible for information and technology diffusion and a technical section charged with viticulture and wine research. Personnel in the latter section are members of a multidisciplinary team or are project coordinators. Between fifteen and twenty research personnel are on the facility's staff. Major objectives of the center are the study and evaluation of existing viticulture methods. Information can then be furnished to producers in future viticulture expansion areas. In addition, the center conducts research on genetic improvement of vine stock, grape viruses, plant nutrition, propagation of vines, and grape by-products. Genetic improvement of vine stock is a major concern, as researchers seek ways to combine the disease-resistant qualities of American grapes with the fine, high sugar content of European grapes.[25]

In 1976 and 1977 a three-phase research endeavor entitled "Projeto Uva" was undertaken, involving vine studies, production research, and the potential for grape

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[24] Unidade de Execução de Pesquisa de Âmbito Estadual, Bento Gonçalves, RS (Bento Gonçalves: Empresa Brasileira de Pesquisa Agropecuária, 1977).

[25] Ibid.

cultivation elsewhere in Rio Grande do Sul where environmental conditions are favorable. Experimental vineyards were established near Bagé, Santana do Livramento, Quaraí and Uruguaiana for this purpose. Additional vine production and marketing research is programmed from 1978 through 1980.[26]

Closely related to "Projeto Uva" is "Projeto Vinho," a concurrent wine research project. This project includes research on the expansion of wine production, product technology, wine and juice chemistry, and grape by-products.[27]

Research in Federal Universities

Three federal universities in Rio Grande do Sul provide indirect assistance to crop-livestock producers through the training of extension agents and by conducting agricultural research. These institutions include the Universidade Federal do Rio Grande do Sul (UFRGS) in Porto Alegre, the Universidade Federal de Pelotas (UFPel), and the Universidade Federal de Santa Maria (UFSM). All three institutions provide graduate training in the agricultural sciences and are active in research. Some research is undertaken in joint venture with specific federal government agencies, such as EMBRAPA or the Secretaria da Agricultura on the state level.

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[26]Ibid. [27]Ibid.

Universidade Federal do Rio
Grande do Sul (UFRGS)

Two colleges of the UFRGS, the Faculdade de Agronomia and the Faculdade de Veterinária are charged with agricultural education. The Faculdade de Agronomia, founded in 1920, consists of three major departments: Soils (Solos), Animal Husbandry (Zootecnia) and Crop Sciences (Fitotecnia). The Departamento de Solos offers courses in soil fertility, soil chemistry, soil physiology, microbiology and soil classification. The Departamento de Zootecnia offers work in animal nutrition, cattle management, equine studies, beef and dairy cattle, animal management and breed improvement. The Departamento de Fitotecnia provides training in both field and forage crops. In 1977 the three departments included sixty-eight faculty members, of whom twelve were pursuing Ph.D. degrees. The veterinary school, a part of the Faculdade de Agronomia until 1972, consists of three departments: Clinical Medicine, Preventive Veterinary Medicine and Clinical Surgery. Forty-nine faculty were employed in the three departments in 1977.[28]

The major thrust of crop-livestock research has been in soil analysis and improvement of livestock. The participation of the UFRGS in the promotion and diffusion of soil sampling among small farmers in northwestern Rio

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[28] Information obtained through personal interview at the Viamão campus of the Universidade Federal do Rio Grande do Sul (UFRGS), October, 1977.

Grande do Sul in the late 1960s increased yields and accelerated agricultural development. The Faculdade de Agronomia coordinates soil sampling through eight outlying laboratories, one of which is in Santa Catarina. Animal research includes studies on genetic improvement of beef cattle and cross-breeding experiments. The university took an early lead in artificial insemination research as well, but the diffusion of this innovation has been carried out by the Secretaria da Agricultura (Central Riograndense de Inseminação Artificial--CRIA). Most of the crop-livestock research is conducted at the university's experimental station near Guaíba, immediately west of Porto Alegre.

Although much valuable crop-livestock research has been undertaken by the UFRGS, there is a need to integrate the teaching-research function with current problems faced by producers in the field. In addition, data required for relevant research are often lacking, indicating the need for more rigorous field investigation.[29]

The Centro de Estudos e Pesquisas Econômicas (IEPE), affiliated with the Faculdade de Ciências Econômicas of the UFRGS, conducts research on many aspects of the state's economy. Topics studied include crop and livestock production, rural land use and diffusion of innovations. In addition, IEPE offers Master's degree programs

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[29]Information obtained through personal interview with Prof. Pedro Cabral, Chief, Department of Preventive Veterinary Medicine, UFRGS, October, 1977.

in Economics, Agricultural Economics and Rural Sociology. An integral part of IEPE activities has been administration of the Programa de Educação Agrícola Superior (PEAS) for Rio Grande do Sul. Visiting professors, and both long-term and short-term consultants, have been contracted through IEPE for the purpose of upgrading the university's programs in agriculture. In 1976 eight professors from other Brazilian universities were contracted to teach courses in crop science, soils, veterinary medicine, parasitology and pathology, while an equal number of UFRGS faculty were sent abroad for further training. Two Brazilian and six United States university consultants served as advisory personnel in 1976, with similar visits continuing in 1977. Personnel contracted were experts on soils, veterinary medicine, plant physiology and agricultural education. These activities comprised part of a much larger national program to upgrade Brazilian graduate education in agriculture. The UFRGS was one of six universities participating in a $15.2 million program in which Michigan State University served as the contracting agency.[30]

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[30] Programa de Educação Superior (PEAS), <u>Relatório de atividades da coordinação local do PEAS no exercício de 1976</u>, Ministério da Educação e Cultura, Universidade Federal do Rio Grande do Sul, 1977; and "MSU prepared to fulfill Brazil contract," <u>Michigan State News</u> (East Lansing), August 6, 1975, p. 8.

Universidade Federal de Pelotas
(UFPel)

The Universidade Federal de Pelotas (UFPel), founded in 1969, is an outgrowth of the earlier Universidade Federal Rural do Rio Grande do Sul (UFRRS). Associated with the latter, and still functioning, was the Faculdade de Agronomia "Eliseu Maciel," the nation's oldest, founded in 1883. Seven academic departments comprise the Faculdade de Agronomia: Agrarian Social Sciences, Rural Engineering, Plant Sanitation, Plant Technology, Nutrition and Foods, Soils, and Animal Husbandry. The Faculdade de Veterinária includes three departments: Veterinary, Preventive Veterinary Medicine, and Animal Pathology. Master's degrees are awarded in animal production and temperate fruit culture, and post-graduate work in seed technology are also offered. Much of the research is conducted at the university's experimental station near Piratini in the adjacent Serra do Sudeste.[31]

Since 1970 the University has become a research center in its own right and a partner in research efforts by EMBRAPA. The university's research and teaching linkages with other government organizations, and with international agencies, are also significant. In 1970 and 1971 UFPel offered agricultural courses in conjunction with the Inter-American Institute of Agricultural Sciences (IIAS)

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[31] Oito anos de universidade, 1969/1977 (Pelotas, Rio Grande do Sul, Ministério de Educação e Cultura, Universidade Federal de Pelotas, 1977), p. 15; Ibid., p. 52.

and the Organization of American States (OAS). The following year agricultural engineering courses were offered for the first time in conjunction with the same organizations. During this period, undergraduate courses were developed in subtropical and temperate fruit culture, and the university expanded into seed development with the federal government. In 1973 forage crop seed studies were initiated, as was tomato research. In 1974 pesticide research was undertaken, followed by related conferences and entomology research. In 1976 and 1977 UFPel was involved in a wide range of agricultural research covering wheat, rice, soybeans, sorghum, green vegetables and livestock. The university has research agreements not only with EMBRAPA (Ministério da Agricultura), but also with the state Secretaria da Agricultura. Linkages with EMBRAPA have fostered joint research on seeds, soybeans and asparagus, wheat, rice and beef cattle. On the state level, combined research ventures between UFPel and IRGA are noteworthy.[32]

Crop livestock research has benefited from outside expertise as well. This has included tomato research by Purdue University (1973), forage seed assistance by the University of Mississippi (1974), and pesticide research by Ball State University (1977). Dutch researchers, in 1977, contributed much to the development of agricultural engineering activities at UFPel.[33]

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[32]Ibid., pp. 5-12. [33]Ibid.

Universidade Federal de Santa
Maria (UFSM)

The Faculdade de Agronomia e Veterinária of the Universidade Federal de Santa Maria (UFSM) was established in 1961, but has since been divided into the Faculdade de Agronomia and the Faculdade de Veterinária. Departments comprising the former include Agronomy, Plant Engineering and Agricultural Engineering, while the latter includes Animal Husbandry and Veterinary Medicine. The university has become a center for training engineer-agronomists and veterinarians, who later follow a career as extension agents, technicians or consultants.[34]

Research programs have been initiated both for crops and livestock under the direction of the Instituto de Ciências Rurais. Information relevant to research is published in the university magazine O Quero Quero, which is distributed to government agencies, libraries and ranchers. It appears that the delivery of information from researcher to farmer in the case of the UFSM is emphasized to a greater degree than with the UFRGS or UFPel. However, the academic programs at the latter universities appear to be as comprehensive as those of the UFSM, while the respective university-government linkages are comparable.[35]

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[34] Information obtained through personal interview with Prof. Pedro Cabral, UFRGS, as time constraints precluded visiting the USFM in October, 1977. Moreover, no reply was received from subsequent correspondence initiated with UFSM.

[35] Opinion expressed is that of the author.

An example of innovation introduction by the UFSM was the Charolais calf embryo transplant experiment conducted in 1977. The procedure was undertaken by a visiting West German veterinarian, with assistance from a UFSM veterinarian and was the first experiment of this type ever conducted in South America. The transplant was performed on a private <u>fazenda</u> and the event was attended by ranchers, technicians and students. The university's role as a change agent is enhanced by its location in the state's interior, a traditional livestock ranching zone.[36]

State Research Organizations

Agricultural research in Rio Grande do Sul sponsored by the state government is conducted mainly by the Instituto de Pesquisas Agronômicas (IPAGRO), but important studies are also undertaken by the Instituto Rio Grandense do Arroz (IRGA). Both IPAGRO and IRGA are component organizations of the Secretaria da Agricultura. The crop-livestock research conducted by IPAGRO is closely linked with other activities within the Secretaria da Agricultura, such as seed production and plant and animal disease control. IRGA's objectives include rice research, extension and marketing. The organization is large and enjoys considerable autonomy, due to the specialized nature of the

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[36] "Primeiro transplante de embriões bovinos," <u>Zero Hora</u> (Porto Alegre), May 2, 1977, 20-21.

studies undertaken and the importance of rice in the state's economy.

IPAGRO was concerned mainly with agronomy research until about 1975. Since then the organization has expanded to include state zootechnical and veterinary research institutes which formerly had equal rank with IPAGRO. In 1977, following consolidation, IPAGRO had three main research components: the Supervisão de Pesquisas Zootécnicas, formerly the Instituto de Pesquisas Zootécnicas; the Supervisão de Pesquisas Veterinárias, the former Instituto de Pesquisas Veterinárias; and the Supervisão de Pesquisas Agronômicas, formerly the Instituto de Pesquisas Agronômicas. A fourth organization under IPAGRO is the Instituto de Recursos Naturais Renováveis, which administers soil conservation programs and is not research oriented.[37]

The Supervisão de Pesquisas Zootécnicas conducts research on problems that confront the state's livestock producers. Specific research focuses on livestock management, animal feeding, genetic improvement, and production. Much of the research is undertaken at the seven experiment stations operated by the organization and its swine evaluation facility. Major projects include cross-breeding studies among Charolais, Santa Gertrudis and Holstein

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[37]Information obtained through personal interview at the Instituto de Pesquisas Agronômicas (IPAGRO), Porto Alegre, September, 1977; and Estado do Rio Grande do Sul, Programa de Ação, 1976, "Agropecuaria" (Porto Alegre, 1975), 31-32, 40-41.

cattle (1969), reproductive evaluations of beef cattle (1971), and swine evaluation and certification (1974). Ten ongoing experiments in poultry science, including work in management and nutrition, were being conducted in 1976, as were twenty-three cattle forage studies.[38]

The Supervisão de Pesquisas Veterinárias, headquartered in Guaíba, provides direct veterinary research support for the Secretaria da Agricultura animal disease control section. The research is particularly valuable since foot-and-mouth disease has yet to be eradicated in Rio Grande do Sul. In 1975 the Supervisão de Pesquisas Veterinárias was engaged in thirty-two research projects, including foot-and-mouth disease, tuberculosis and brucelosis, and swine and poultry diseases. In addition, vaccine production and related laboratory work is carried out by this organization.[39]

The Supervisão de Pesquisas Agronômicas is engaged primarily in research designed to improve those crops that are of major importance in Rio Grande do Sul's economy, such as soybeans. However, research also includes crops of lesser importance such as corn, sorghum, black beans and sweet potatoes. Soil analyses and fertilizer studies are related activities.[40] An integral part of the organization's

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[38]Programa de Acão, 1976, op. cit., p. 31.

[39]Ibid., pp. 31-32. [40]Ibid., p. 40.

operations is seed research and testing. In 1977 some twenty-one varieties of soybeans were available through IPAGRO, many of which were developed specifically for Rio Grande do Sul's growing conditions. Five types of seeds are certified for import, export, interstate transportation and commercial sale. However, seed testing did not begin in Brazil until about 1960. Thus, a major concern of the Supervisão de Pesquisas Agronômicas has been to develop new improved seeds for mass marketing as rapidly as conditions permit.[41]

IPAGRO, through its Coordenaria de Estações Experimentais, administers twenty-two crop-livestock experiment stations in Rio Grande do Sul. The stations do not provide extension services and are limited to pure research. Most stations are in the Serra Geral subsistence agriculture zone, the western Campanha ranching zone, or the soybean-wheat zone in the state's northwest. Crop-livestock research at each of the twenty-two experimental stations is geared to the local economy but is applicable to similar areas elsewhere in the state. Stations in subsistence farming areas specialize in fruit, vegetable, dairy or swine

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[41]Information obtained through personal interview at the Instituto de Pesquisas Agronômicas (IPAGRO), Porto Alegre, September, 1977.

research, while those in large landholding areas are active in livestock, forage crop, or soybean-wheat research.[42]

The Instituto Rio Grandense do Arroz (IRGA) is the state's major rice research entity. It maintains a rice experiment station near Cachoeirinha, immediately northeast of Porto Alegre, and operates twenty-five extension centers elsewhere in the state where the research can be applied. Principal activities at the Cachoeirinha facility are the study of rice diseases, pesticides and fertilizer investigations, and evaluation of various plowing and cultivating techniques. Much progress has been made in the development of new hybrid rice strains, including short cycle types adaptable to Rio Grande do Sul. More than a dozen varieties of rice were being grown and tested at Cachoeirinha in 1977. Of these, one Colombian type was nearly ready for release as a new rice variety in 1978. In addition, IRGA was studying the feasibility of using fallow rice lands to better advantage. Crop rotation schemes received particular attention during this period.[43]

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[42]Information obtained through personal interview at the Coordenaria de Estações Experimentais (IPAGRO) and through an agricultural experimental station list furnished by the same.

[43]Information obtained through personal interview at IRGA, Porto Alegre, February, 1977, and during personal visit to the Estação Experimental do Arroz, Cachoeirinha, Rio Grande do Sul, March, 1977; and Programa de Ação, 1976, op. cit., p. 39.

Other Government Support

The Brazilian government, in addition to providing technical assistance and extension services, is attempting to stimulate agriculture through specific incentives. These include farm credit, guaranteed minimum prices for certain crop-livestock commodities, and marketing assistance. Strong support for cooperatives has also been given in recent years to promote self-help among farmers, and long neglected farm-to-market roads are now being improved.

Credit

The provision of agricultural credit is controlled by the Banco Central do Brasil which approves the disbursement of rural credit loans through all of the nation's banks. The bank maintains nine offices throughout Brazil, including one in Porto Alegre. Lending agencies in Rio Grande do Sul and elsewhere must adhere to the provisions of the Manual de Crédito Rural, a document that provides credit guidelines and outlines requirements for farm loans.

In recent years a substantial amount of funds has been designated by the Banco Central do Brasil for agricultural and livestock improvement. In 1976, Cr$4,656 million were invested in state rural credit throughout Brazil. Although the exact amount disbursed in Rio Grande do Sul is unknown, it can be assumed that it comprised a sizeable portion of the national total. During the same year the nation's commercial banks and the Banco do Brasil, S.A., Brazil's leading development bank, received Cr$54 billion which were channeled nationwide into agriculture and ranching. Of this amount Cr$36.8 billion were allocated to agriculture, and Cr$17.2 billion for livestock improvement.[44]

Interest rates on rural loans have fluctuated periodically due to changes in the level of inflation. In 1966 they soared to 24 percent per annum as the government attempted to use the rate to combat inflation, and as an investment disincentive. Interest rates subsequently declined and until February, 1977, the interest on farm loans did not exceed 15 percent, with full bank participation. However, they were raised after February, 1977, as an anti-inflationary measure, and the level of bank participation declined. Farm loans of less than Cr$877,000 were still assessed 15 percent interest but with 90 percent bank participation. Loans from Cr$878,000 to Cr$4,300,000 were charged 18 percent interest at 90 percent bank participation. Loans exceeding this amount were payable at 21 percent interest with only 75 percent bank participation. Such fiscal controls do not favor small producers, who are most adversely affected by interest

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[44] Banco Central do Brasil, Annual Report 1976, Vol. 13, No. 4, April, 1977 (Brasília: Editora Gráfica Alvorada, Ltda., 1977), p. 17, 38.

increases. Consequently, agricultural development in small farm areas may be curtailed.[45]

The Banco do Brasil is the nation's largest bank and maintains more than 1,000 offices, 116 of them in Rio Grande do Sul (1977). This organization, which is basically a government development bank operating under the aegis of the Banco Central do Brasil, is the world's largest disburser of agricultural credit. It provides about 60 percent of Brazil's total agricultural credit, including 50 percent of all general agricultural credit and 80 percent of the credit used to defray production and mechanization costs. The bank provides technical assistance and diffuses government resources for development in areas not yet able to support commercial banking activities. The Banco do Brasil has exceedingly wide powers. It purchases all wheat grown in the country through its affiliate agency, the Departamento Geral de Comercialização do Trigo Nacional (CTRIN). In addition, it provides the financial resources for the minimum price and marketing programs of the Comissão de Financiamento da Produção (CFP).[46]

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[45]Information obtained through personal interview at the Banco Regional de Desenvolvimento do Extremo Sul (BRDE), Porto Alegre, October, 1977.

[46]Information obtained through personal interview at the Banco do Brasil, S.A., Porto Alegre, September, 1977.

Commercial banks in Rio Grande do Sul also provide farm credit. These include, but are not limited to, the Banco do Estado do Rio Grande do Sul (BANRISUL), Banco Sul Brasileiro, S.A., and União de Bancos Brasileiros, S.A. (UNIBANCO). All three institutions have agricultural technicians trained to evaluate the economic feasibility of loan requests submitted by crop-livestock producers.

A more specialized banking agency serving agriculturalists is the Banco Nacional de Crédito Cooperativo (BNCC) founded in 1946, which is subordinate to the Ministério da Agricultura. By 1977 eighteen BNCC branches were operating in Brazil, with an additional twelve planned for the near future. The BNCC offices in Rio Grande do Sul are located in Porto Alegre and Ijuí, the latter being within the soybean-wheat zone of the western Planalto Medio. Expansion plans call for BNCC banks in Passo Fundo, the chief trade center of the Planalto Central, and Bagé, the center of the state's livestock industry. The Bank serves only members, or groups of members, of agricultural cooperatives. Funds are disbursed to the cooperatives which, in turn, provide loans to their members. The loans are available for all aspects of agricultural production, including seeds, fertilizer, machinery and crop storage facilities. Loans for rice, soybean and wheat production account for much of the assistance provided. However, crops must be marketed through cooperatives to receive financial assistance.

Loans for black bean cultivation are not available because of this restriction.[47]

The Banco Regional de Desenvolvimento do Extremo Sul (BRDE) is a development bank that provides financial assistance to stimulate growth in all sectors of the economy in Rio Grande do Sul, Santa Catarina and Paraná. Although the bank's major objective is to promote industrial development, agriculture is by no means neglected. In 1975 about 31 percent of the bank's resources were invested in agricultural development projects. Major forms of assistance in 1975 in Rio Grande do Sul included support for farm implement manufacturing, for agricultural cooperatives in the procurement of lime and phosphate fertilizers, and for studies on proposed agribusiness firms. Nevertheless, government anti-inflationary measures applied in 1977, including higher bank interest rates, resulted in a 21 percent decrease in BRDE farm credit loans.[48]

All of the banks discussed, except the Banco Nacional de Crédito Cooperativo (BNCC), maintain agreements with EMATER-RS for loan approval purposes. A government

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[47] Information obtained through personal interview at the Banco Nacional de Crédito Cooperativo (BNCC), Porto Alegre, September, 1977.

[48] BRDE, Relatório da Diretoria-1975 (Porto Alegre: Grupograf, 1976), p. 1; and information obtained through personal interview at the Banco Regional de Desenvolvimento do Extremo Sul (BRDE), Porto Alegre, October, 1977.

extension agent, upon evaluating a producer's request, may or may not recommend that the loan be approved.

Minimum Prices and Marketing Assistance

The chief organization responsible for guaranteed support prices on crops produced in Brazil, and which also provides marketing assistance, is the Comissão de Financiamento da Produção (CFP). The CFP has undergone numerous organizational changes since it was founded in 1943. Because of vested government interests over the administration of the CFP during its early years, the organization was not effective and the first minimum price guarantees were not offered until 1951. The CFP received little attention during the 1950s when industrial development, rather than agriculture, was the foremost national priority. After additional organizational changes in the early 1960s, the CFP assumed its present form in 1967 as an entity subordinate to the Ministério da Agricultura.[49]

The CFP offers the producer the opportunity to sell certain crops to the government for a guaranteed minimum price, or financial assistance, which permits the sale of the crop to be delayed until open market prices improve. Two specific programs are offered to producers by the CFP: Aquisição do Governo Federal (AGF) and Empréstimo do

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[49]João do Carmo Oliveira, Política de Preços Mínimos no Brasil (Brasília: Comissão de Financiamento da Produção, 1977), 5-7.

Governo Federal (EGF). The AGF option is the direct purchase of the producer's crop by the CFP, at a designated minimum price. Although the minimum price is lower than the free market price when demand is heavy, it offers the producer a guaranteed market with the government when open market prices are unfavorable. The decision whether to sell crops to the CFP, or on the open market, must be made by the producer. Once the decision is made to sell to the government, the crop cannot be sold on the open market. For this reason, minimum prices are announced annually, two months prior to the planting season. The EGF option offers the producer more flexibility than the single sale of the crop directly to the government (AGF). In the EGF arrangement the Banco do Brasil, under the auspices of the CFP, lends the producer the minimum price value of the crop for a period of 330 days. This permits the producer to wait for better open market prices, rather than having to sell directly to the government at a lower price. If open market prices improve before 330 days, the producer can sell the crop on the open market, repay the government, and yet earn a profit. However, if open market conditions do not improve after 330 days, the crop must be turned over to the CFP as collateral payment on the loan or be confiscated.[50]

A second EGF arrangement is available in which 80 percent of the minimum price is loaned to the producer for

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[50]Ibid., pp. 8-13.

a period of 180 days. Again, this permits the farmer to wait for better open market prices, with a portion of the money received being used to repay CFP. This short-term arrangement differs in that the crop need not be used as collateral. Conversely, the CFP is not obligated to buy the crop should open market prices be less than the minimum government price.[51]

The CFP attempts to maintain market equilibrium by reducing supply-demand oscillations. This is done by purchasing crops during times of low market prices and releasing stocks during periods of increased demand. Yet, problems have arisen due mainly to increasing production costs for rice and wheat, both minimum price support crops. In 1977 producers in Rio Grande do Sul appealed to the government to make rice a free market crop so they might at least recoup production costs.[52] The problem remained unresolved at the close of 1977. Likewise, wheat is sold only to the Departamento Geral de Comercialização do Trigo Nacional (CTRIN) to guarantee sufficient stocks for the domestic demand and to reduce foreign wheat imports. However, poor harvests due to inclement weather have reduced the effectiveness of this program. A chief task of extension workers

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[51] Information obtained through personal interview at the Banco Central do Brasil regional office in Porto Alegre, October, 1977.

[52] "Preços do arroz serão liberados pelo governo," Zero Hora (Porto Alegre, March 14, 1977), p. 18.

in the last three months of 1977 and early 1978 was to assess wheat losses covered by the Banco do Brasil's wheat insurance program, the Programa de Garantia de Atividade Agropecuária (PROAGRO). The program ensures that producers are reimbursed for up to 80 percent of their investment costs during bad harvest years.[53]

Cooperatives

Government support for the cooperative movement has increased greatly in recent years as a means to encourage agricultural development. The cooperatives accelerate mechanization and modernization, since both credit and technical assistance are provided.

The Programa Nacional de Cooperativismo (PRONACOOP 76/79) is an effort to consolidate the goals of the Second National Development Plan. Four organizations are contributing support and assistance in the first PRONACOOP plan from 1976 to 1979. The Instituto Nacional de Colonização e Reforma Agrária (INCRA) is providing administrative support for the program. The Banco Nacional de Crédito Cooperativo (BNCC) assists in procuring cooperative development funds, training technical and administrative personnel, and providing administrative support. Information on agricultural research and cooperative technical

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[53]Information obtained through personal interview at ASCAR offices in Ijuí and Três de Maio, Rio Grande do Sul, December, 1977.

assistance is the responsibility of the Empresa Brasileira de Assistência Técnica e Extensão Rural (EMBRATER), while general coordination of the entire effort rests with the Organização das Cooperativas Brasileiras (OCB). It was expected that 800 technicians and 3,000 administrators would receive training in cooperativism through the PRONACOOP program by 1979. Other major goals include an increase in cooperative membership in Brazil by 60 percent, doubling the sale of crops marketed in cooperatives, doubling the number of cooperatives receiving BNCC assistance, and improving rural electrification systems.[54]

As of March, 1976, there were about 450 cooperatives in Rio Grande do Sul, of which about 260 were engaged in crop-livestock production. Of the 260, about 200 were directly involved in agriculture, thirty-five in livestock and meat packing, and the remainder in the provision of rural credit. Over half of the cooperatives serve producers cultivating a variety of crops. Less numerous but of much greater size are the specialized soybean-wheat cooperatives of the Planalto Medio. The Cooperativa Regional Tritícola Serrana, Ltda. (COTRIJUI) and the Cooperativa Tritícola Erechim, Ltda. (COTREL) are representative. Both cooperatives are very large (COTRIJUI had over 15,000 members in 1977) and dominate agricultural

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[54] _I Programa Nacional de Cooperativismo - PRONACOOP - 1976/1979_ (Brasília: Ministério da Agricultura, Instituto Nacional de Colonização e Reforma Agrária [INCRA] 1976), 10-15.

marketing activities in their respective service areas. Furthermore, these and other large cooperatives, some of which are subsidiaries of multinational corporations, compete against private firms in the export of soybeans. Large rice cooperatives also function in the state's coastal lowland zones, the Depressão Central, and in the far west bordering Argentina. In contrast, all of Rio Grande do Sul's major grape and wine cooperatives are concentrated in a small zone of the upper Serra Geral from Caxias do Sul westward to Bento Gonçalves. Remaining crop-livestock cooperatives are devoted to marketing, aviculture or artificial breeding.[55]

The number of cooperatives in Rio Grande do Sul decreased from about 1,000 in 1963 to about 450 at present, mainly because of consolidation. Yet, the state still ranks second nationally in cooperatives after São Paulo.[56]

Consolidation of cooperatives in Rio Grande do Sul has resulted in the creation of larger, more efficient units able to provide more services to members. New farming techniques have been introduced, and the adoption of improved

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[55] Relação das Cooperativas Sediadas no Rio Grande do Sul (Porto Alegre: Organização das Cooperativas do Estado do Rio Grande do Sul [OCERGS], March, 1976. Additional information on this topic obtained through personal interview at OCERGS, Porto Alegre, September, 1977.

[56] I Programa Nacional de Cooperativismo - PRONACOOP - 1976/1979, op. cit., p. 23.

seeds, fertilizer and erosion control measures has been encouraged. The larger cooperatives maintain technical staffs that provide extension services and credit to members, making the adoption of innovations more feasible. In 1974, COTRIJUI sent 150 of its personnel to the United States to study all aspects of farm cooperatives.[57] The successful transfer of technology and administrative expertise has made cooperatives effective change agents in Rio Grande do Sul, particularly in the major soybean-wheat zones. In such areas, cooperatives have largely replaced government as the major source of agricultural assistance.

Transportation Infrastructure

A major objective of both the federal and state governments is to improve farm-to-market transportation routes in Rio Grande do Sul. The integration of existing and future transportation routes into a viable multimodal system is given high priority by the Empresa Brasileira de Planejamento de Transportes (GEIPOT) and the Departamento Estadual de Portos, Rios e Canais (DEPRC). Highway integration and improvement is the responsibility of the Departamento Autônomo de Estradas de Rodagem (DAER) and the Departamento Nacional de Estradas de Rodagem (DNER). Railroad operation and planning are mainly the responsibility of the Rede Ferroviária Federal, S.A. (RFFSA).

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[57] Information obtained through personal interview at OCERGS, Porto Alegre, September, 1977.

In Rio Grande do Sul the integration and improvement of farm-to-market routes is imperative, given the importance of agriculture and particularly soybean exports in the state's economy. The transportation of rice, wheat and meat to local and national markets also must be facilitated. Of major importance are the corredores de exportação, or "export corridors," used mainly for the shipment of soybeans grown in the Planalto Medio to the deep-water port of Rio Grande. The primary export corridor is the "Diagonal Soja-Trigo," the northwest-southeast aligned truck route for soybean transport that runs from São Borja to Santa Maria and Rio Grande. Nevertheless, it was paved from Rio Grande northwest only as far as Santa Maria by 1973. Road building was subsequently accelerated, and by 1977 about 70 percent of the highway connecting Santa Maria and São Borja was paved. The remaining portions were scheduled for completion in 1978. A northern salient of this export corridor extends from Santa Maria northward to Cruz Alta and then northwestward through Ijuí and Santo Ângelo to Santa Rosa and is completely paved. The two major routes originating in São Borja and Santa Rosa, respectively, traverse the soybean-wheat region and converge in Santa Maria.[58]

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[58] Plano Nacional Rodoviário (Map of Rio Grande do Sul: n.p., Departamento Nacional de Estradas de Rodagem, 1973); and DAER Mapa Rodoviário 1977 (Porto Alegre: Secretaria dos Transportes, 1977).

The long term outlook for farm-to-market transportation is quite favorable. New roads penetrate formerly isolated areas of the Alto Uruguai region, which should benefit the region's small farmers. All-weather roads under construction in 1977, including those connecting Santa Rosa and Sarandí, Três Passos and Ijuí, and Cruz Alta and Seberi via Palmeira das Missões were scheduled for completion by 1979. Work was also in progress along the Brazil-Uruguay border from Santana do Livramento to Quaraí, and from Caxias do Sul eastward to Lajeado Grande. Another paved farm-to-market road was under construction from Santa Maria to Santa Cruz do Sul to improve livestock, rice and tobacco marketing. Smaller roadbuilding projects in the Serra Geral, when completed, should facilitate fluid milk transportation.[59]

Rail transportation of agricultural products is increasing but remains much less significant than truck transportation. A major line of the RFFSA parallels the "Diagonal Soja-Trigo" truck route as far south as Santa Maria, then turns westward before turning south to Bagé, and ultimately Rio Grande. Of the total rail cargo to Rio Grande from the northwest in 1977, 32 percent was soybeans, 19 percent wheat and 6 percent forage crops. Backhauls

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[59]Information obtained through personal interview at Empresa Brasileira de Planejamento de Transportes (GEIPOT), Porto Alegre, October, 1977; and DAER Mapa Rodoviário 1977, op. cit.

were mainly lime fertilizer and other agricultural necessities.[60]

A second major rail corridor is the newly completed "Ferrovia do Trigo" from Passo Fundo to Roca Sales in the Serra Geral. From Roca Sales, soybeans are trucked to the multimodal shipping terminal at Estrela on the Rio Taquari for barge and ship transportation south to Porto Alegre and Rio Grande. Another major line, the "Tronco Sul," northward from Porto Alegre to Santa Catarina and Paraná states was formerly important for wheat shipment, but has lost traffic due to ocean shipping competition.[61]

The "Ferrovia do Trigo," which traverses mountainous terrain, was opened in 1978. The new rail line, a major engineering achievement, passes through thirty-two tunnels and crosses one of the world's highest railroad trestles. A similar terminal has been planned for Cachoeira do Sul, on the Rio Jacuí, to facilitate river transport of rice, soybeans and other crops to Porto Alegre. At Porto Alegre and Pelotas, rice and soybeans are stored and processed prior to international export via ocean-going vessels. Soybean shipments via the export corridor are greatest between April and September, while most wheat is transported from October to January.

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[60]Information obtained through personal interview at GEIPOT, Porto Alegre, October, 1977.

[61]Ibid.

Recent improvements on the lines near Santa Maria and west of Pelotas should further increase the importance of railroads. Brazil's dependence on foreign petroleum may result in more soybeans being hauled by train as an energy conservation measure. Yet, railroads in Rio Grande do Sul face many obstacles. The lines are of meter gauge, unlike those elsewhere in Brazil. Track conditions are poor in many areas, and weight limits on some bridges reduce the amount of freight that can be transported. Rugged topography in the Serra Geral is an additional negative factor.[62]

The port facilities at Rio Grande have expanded steadily since 1970. Because of the port's deep-water location, its volume of shipping is increasing, while that through Porto Alegre has gradually declined. Infrastructure projects continue to be implemented almost exclusively at Rio Grande. But, Porto Alegre's break-of-bulk function, river access, and adjacent agricultural hinterlands remain significant.

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[62]Information obtained through personal interview at GEIPOT, op. cit.

CHAPTER VIII

ANALYSIS OF THE DATA

The methods of statistical analysis used to evaluate the significance of the findings of this investigation consist of Cross-Tabulation, Chi-Square, analysis of Frequencies, and Correlation Metrics. The three crops studied (rice, soybeans and wheat) were treated as dependent variables for the Cross-Tabulation and Chi-Square analyses. The crop under cultivation was chosen as the dependent variable, while the independent variables were: landholding size, agricultural yields per unit area, use of government extension service, suggestions received from government, participation in agricultural experiments, visits to ASCAR or equivalent extension centers, distance from agricultural credit centers, farm to market access, land tenure and use of information sources. These variables were identified through previous research, personal observation, and informal interviews with government and university personnel as significant factors in the study of agricultural land use. All data were collected from the interview schedule administered to the selected sample.

In the analysis of Frequencies the three crops were treated as dependent variables, with yield per unit area constituting the independent variable. For the correlation metrics, the adoption of innovations, i.e., the use of new ideas introduced by government personnel was treated as the dependent variable, while use of extension service, accessibility, land tenure, and information sources were held as independent variables. Two other correlation analyses were conducted, one using crops as the dependent variable, the other using size of landholding. In both cases the independent variables remained the same. A final correlation analysis was performed using selected variables, which were treated as dependent variables in relationship to each other.

The Selected Sample

Selection of the sample drawn in Rio Grande do Sul is discussed in Chapter II. As explained, the sampel was drawn from six different areas specializing in rice, soybeans or wheat, on either large or small holdings. Dimensions of the sample are shown in Table 1 (p. 34). Forty-one interviews were attempted, of which thirty-two were completed. Given the scope of the study, the thirty-two completed interviews represent an acceptable sample.

General Findings of the Study

The SPSS Chi-Square program, based on Pearson's Chi-Square test of association, was employed in this section of the study. The analysis indicates whether or not a significant relationship exists between two variables but does not measure the association between variables. It indicates the probability of a chance distribution differing as much from statistical independence (theoretical distribution) as the observed distribution. The formula employed for this analysis is:

$$X^2 = \Sigma^i \frac{(fo^i - fe^i)}{fe^i}$$

Composition of the Sample

A summary of findings related to the personal data of respondents is depicted in Table 3. The mean values of each variable are included in this table, representing the average value for thirty-two cases. The Chi-Square results of the general observations of respondents is depicted in Table 4.

Table 3.--Personal Data on Farmers Interviewed.

Variables	Mean
Age	44.38 years
Family Size	5.5 members
Number of Children	3.37 children
Educational Level	5.13 years
Time in Agriculture	14.69 years

Table 4.--X^2 Analysis of General Observations.

Control Variable	Dependent Variable	Raw X^2	df	Significant Table Value at .10	Significance of X^2
Age	Crop	19.89	16	23.54	NS
Family Size	Crop	20.16	16	23.54	NS
No. of Children	Crop	24.14	18	25.99	NS
Educational Level	Crop	7.87	8	13.36	NS
Time in Agriculture	Crop	17.94	24	33.20	NS
Marital Status	Crop	1.12	2	4.61	NS
Birthplace	Crop	5.47	6	10.65	NS
Birthplace of Grandfather	Crop	15.56	8	13.36	S
Birthplace of Grandmother	Crop	16.98	12	18.55	NS
Member of Agricultural Organization	Crop	2.47	2	4.61	NS
Place of Residence	Crop	2.02	2	4.61	NS
	Size	13.85	1	2.71	S

Educational Level

Respondents were asked to indicate the number of years of formal education completed. The sample mean for the group was 5.13 years, well within the elementary school level. However, large-scale farmers tend to have higher educational levels than the small landholders. In addition, rice and wheat producers appear to have higher educational levels than soybean growers.

Time in Agriculture

The mean time in agriculture for farmers interviewed was 14.69 years, but values range from two years to twenty-five or more. The time in agriculture among large producers is highly variable, while that of small farmers is characterized by a generally greater number of years. The respondents were also asked whether or not they had always farmed in Rio Grande do Sul, and responded affirmatively. Such responses reflect the lack of in-migration to Rio Grande do Sul. In fact, some parts of the state are zones of out-migration, as is noted in Chapter IV.

Birthplace of Respondents and Grandparents

The place of birth of respondents and of their grandparents was investigated so as to determine possible relationships between place of origin, crop cultivation and landholding size. This was particularly significant given the importance of foreign colonization in the state's rural development. Answers were coded in eight categories: (1) same <u>município</u>, (2) different <u>município</u> but in Rio Grande do Sul, (3) outside Rio Grande do Sul, but in Brazil, (4) Argentina, (5) Paraguay, (6) Uruguay, (7) Europe, and (8) No Information. The results are as follows in Tables 5 and 6.

Table 5.--Birthplace of Respondents, By Crop.

Crop	Same <u>Município</u>	Different <u>Município</u> But In RGS	Outside RGS But In Brazil	Argentina	Total
Rice	4	6			10
Soybeans	7	4			11
Wheat	4	5	1	1	11
Total	15	15	1	1	32

Whereas thirty-one respondents were born in Brazil, most of the grandfathers were born in Europe. This is especially significant since it accounts for thirteen respondents, eight of whom are wheat growers. The remaining grandfathers, especially those of rice and soybean producers, were born in Rio Grande do Sul or elsewhere in Brazil (see Table 6).

The origins of grandmothers are mostly within the categories of "Same <u>Município</u>," "Different <u>Município</u>" and "Europe." This situation is similar to that of

Table 6.--Birthplace of Grandfathers, By Crop.

Crop	Same Município	Different Município But In RGS	Outside RGS But In Brazil	Europe	No Information	Total
Rice	4	3	1	2		10
Soybeans	1	6		3	1	11
Wheat		3		8		11
Total	5	12	1	13	1	32

Table 7.--Birthplace of Grandmothers, By Crop.

Crop	Same Município	Different Município	Outside RGS But in Brazil	Argentina	Paraguay	Europe	No Information	Total
Rice	4	3	1		1	1		10
Soybeans	2	5				2	2	11
Wheat	1	2	1	1		6		11
Total	7	10	2	1	1	9	2	32

respondents' grandfathers, although the origin of grandmothers include countries bordering Rio Grande do Sul. Europe as a birthplace was less important. However, the European origin of wheat producers' grandmothers is notable. As in the case of grandfathers, the grandmothers of most rice and soybean producers were born in Rio Grande do Sul. It therefore appears that the birthplace of grandparents may influence rural land use (see Table 7).

Membership in Agricultural Organizations

The thirty-two respondents were queried as to their membership in agricultural organizations to determine any influence membership might have on land use, innovation adoption and use of technical assistance. Cooperatives, in particular, are significant change agents in Rio Grande do Sul. Their influence in some parts of the state exceeds that of government with respect to agricultural assistance. Cooperatives introduce farmers to new ideas and equipment, encourage the adoption of modern practices and technology, facilitate marketing of crops and provide agricultural credit. Twenty-nine of the farmers interviewed are members of agricultural organizations. Only three rice and soybean producers do not belong to any organization. Of the twenty-nine persons who responded affirmatively, twenty-eight are members of cooperatives. Twelve of the twenty-nine belong to more than one organization. All wheat producers interviewed are members of agricultural organizations, and of the twelve persons who belong to more than one organization, six are wheat producers.

Place of Residence

Respondents were interviewed regarding their place of residence to ascertain any possible relationship between the place of residence, landholding size and crops produced. All sixteen small producers, as well as five large producers, live on their rural properties. The remaining eleven are large producers residing in nearby towns (seats of <u>municípios</u>). When the latter were asked their reasons for living in town rather than on the properties they cultivate, nearly all indicated that urban amenities, particularly education for their children, are the chief factors. Others include accessibility to services provided by commercial, governmental and financial organizations, as well as proximity to social and cultural attractions.

When the place of residence was compared with principal crops under cultivation, it was noted that only two of the eleven large-scale farmers are wheat producers. And, most wheat growers, with the exception of two large operators, live on their properties. Most large producers of rice (four) and soybeans (five) live in nearby towns.

Land Use and Marketing

An effort was made to determine if there is any significant relationship between land use related variables, marketing practices and crop cultivated. A summary of the

Table 8.--X^2 Analysis for Observations Related to Land Use and Marketing, By Crop.

Independent Variable	Raw X^2	df	Significant Table Value at .10	Significance of X^2
Município	.18	2	4.61	NS
Terrain	16.22	4	7.78	S
Property Size	30.21	16	23.54	S
Cultivated Area	18.60	18	25.99	NS
Hectares in Principal Crop	12.39	14	21.06	NS
Crop Rotation	16.94	2	4.61	S
Yields of Principal Crop	9.92	4	7.78	S
Cultivation of New Crops	0.35	2	4.61	NS
Crop Abandonment	3.69	4	7.78	NS
Marketing	7.28	2	4.61	S

findings is presented in Table 8, followed by a discussion of each variable in this table.

As previously indicated, the sample includes three crops and two landholding sizes. Large holdings were defined as properties on which at least 150 hectares of rice, soybeans or wheat are cultivated. Small holdings refer to properties on which no more than fifty hectares of these crops are cultivated. The sample composition of the thirty-two respondents is depicted in Table 9.

Table 9.--Landholding Size, By Crop Under Cultivation.

Crop	Large	Small	Total
Rice	5	5	10
Soybeans	6	5	11
Wheat	5	6	11
Total	16	16	32

Terrain

An effort was made to determine if there is any significant relationship between terrain and crop cultivated. In general, large-scale rice cultivation is limited to lowland areas where mechanization is possible. Large-scale soybean and wheat cultivation is practiced mainly in areas of rolling terrain, but where mechanization is possible. Small-scale producers of the three crops are less dependent on mechanization and therefore cultivate the same crops in areas of greater relief.

The findings indicate that within the sample large producers of rice, soybeans and wheat occupy flat or rolling terrain, while small producers of the three crops occupy predominantly rolling and hilly rural properties. This is illustrated in Table 10.

Table 10.--Crop Cultivation and Terrain.

Crop	Flat	Rolling	Hilly	Total
Rice	5	5		10
Soybeans		6	5	11
Wheat		5	6	11
Total	5	16	11	32

Property Size

Property size was examined to ascertain if there is a significant relationship between the number of hectares in the property and the type of crop under cultivation. Answers were ordered from one to ten in a classification representing property sizes from zero to 5,000 hectares. Most small-scale farmers own land ranging from twenty-one to forty hectares in area, while most large-scale farmers have properties in the 201 to 1,000 hectare category. No producers have properties within the forty-one to sixty hectare range. All rice producers have correspondingly larger properties than their counterparts cultivating soy-beans and wheat, and small wheat producers have the

Table 11.--Property Size and Crop Produced.

Crop	0-10	11-20	21-40	61-100	101-200	201-500	501-1,000	1,001-2,000	2,001-5,000	Total
Rice			2	2	1		3	2		10
Soybeans		3	2			4	1		1	11
Wheat	4		2			2	2		1	11
Total	4	3	6	2	1	6	6	2	2	32

smallest properties of all farmers interviewed. Property size represents the total farm area in hectares and is not to be confused with the number of hectares devoted to the principal crop under cultivation, for which respondents were interviewed.

Cultivated Area

The area cultivated was examined first to determine what portion of the total landholding is being used for agriculture, and second to determine what portion of the cultivated land is devoted to the principal crop.

Soybean and wheat producers, both large and small, use all of their cultivated area for raising their principal crops. However, this is not true of rice producers. Small rice growers, in particular, devote a sizeable portion of their cultivated area to subsistence crops.

A relationship appears to exist between land-use intensity and size of holding when small- and large-scale producers are compared. Small-scale farmers tend to cultivate all the land they have, while large producers cultivate a portion of their land and leave the remainder as unimproved pasture.

Other Crop-Livestock Land Use

Crop-livestock land use, in addition to that of the principal crop under cultivation, was examined to identify the overall land use. All thirty-two respondents simultaneously use their land for crops and/or livestock other than the principal crop. In fact, they all use their land for at least five other types of crops or livestock. Included are the cultivation of corn, manioc, black beans, sweet potatoes, soybeans and wheat, plus the raising of swine and beef cattle (see Table 12).

Crop Rotation

Crop rotation, i.e., planting crops sequentially on different parcels of land to facilitate soil recovery and reduce soil erosion, was examined to determine its practice among farmers. Of the thirty-two respondents, only ten stated that they rotate their crops.

Crop rotation is most practiced among rice farmers. Eight of the ten respondents using crop rotation were cultivating rice, while the remaining two produce wheat. Soybean growers included in the sample do not rotate their crops. Rice and beef cattle are the chief rotation components, followed by soybeans by rice and wheat producers. Other crops rotated by all the farmers are manioc, black beans, sorghum and corn, as well as pasture for dairy cattle. Each of the respondents practicing this technique was rotating at least two crops.

Yields of Principal Crops

Soybean cultivation has been generally successful due to large capital inputs and favorable environmental factors. Conversely, wheat has been a problem crop due mainly to unfavorable climate and the prevalence of disease.

Table 12.--Other Crop-Livestock Land Use, By Crop.

Crop	Sorghum	Corn	Soybeans	Rice	Black Beans	Grapes	Potatoes	Sweet Potatoes	Manioc	Wheat	Poultry	Swine	Beef Cattle Pasture	Dairy Cattle Pasture	Sheep Pasture	Other	Total
Rice		3	2		4		3	2	3		1	1	6	2	1	2	30
Soybeans	1	10		4	7		4	4	10	11	2	8	3			1	65
Wheat	1	10	11	4	8	1	7	7	8		3	6	1	2		1	70
Total	2	23	13	8	19	1	14	13	21	11	6	15	10	4	1	4	165

Rice has tended to be more stable in terms of yields. Therefore, the status of crop yields among producers of rice, soybeans and wheat with reference to the preceding year was examined. Yields obtained during the most recent harvest are shown in Table 13.

Table 13.--Yields of Most Recent Harvest, By Crop.

Crop	Increased	Remained the Same	Diminished	Total
Rice	1	2	7	10
Soybeans	5	3	3	11
Wheat		2	9	11
Total	6	7	19	32

An effort was made to determine the factors responsible for changes in yield of the three principal crops. The major factor influencing yields for all farmers was weather. Weather conditions were responsible for decreasing yields of wheat and rice, whereas they resulted in an increased yield of soybeans. A second factor influencing yields of rice and wheat was plant disease. Improvement of soils, including liming, was a key element accounting for increased soybean yields. A summary of other factors influencing yields of rice, soybeans and wheat is presented in Table 14.

Table 14.--Factors Influencing Yields, By Crop.

Crop	Weather Conditions	Diseases	Seed Varieties	Fertilization Methods	Soil Correction	Agricultural Inputs	Less Rural Credit	Improved Technical Assistance	Other	Total
Rice	9	2			1		1	1		14
Soybeans	7			1	4			1	2	15
Wheat	11	9	1			3				24
Total	27	11	1	1	5	3	1	2	2	53

Cultivation of New Crops

Producers of rice, soybeans and wheat were interviewed concerning crops not planted the previous year. Only five individuals, all large operators, indicated that they were cultivating a new crop during the year of research. These included producers of the three crops under study. The new crops were soybeans, black beans, sorghum, vegetables and tremoso, a type of clover. The statistical analysis of this information shows no significant relationship between cultivation of new crops and principal crop under cultivation.

Crop Abandonment or Reduction

The rapid growth of soybean cultivation, and concomitant decline in the production of staple food crops such as black beans, has resulted in significant land use changes. These include crop abandonment or reduction in some areas. Respondents were interviewed regarding abandonment or reduction so as to assess rural land-use change. Ten of the thirty-two respondents were planning to abandon and/or reduce the area of a crop cultivated. These respondents were representative of the larger sample and include two rice, three soybean and five wheat growers. Each was abandoning or reducing the area of one specific crop. The crops being abandoned or reduced were rice and wheat. Rice producers were abandoning/reducing rice cultivation, while soybean producers were abandoning/reducing wheat cultivation. Wheat producers were likewise abandoning/ reducing wheat cultivation. Both soybean and wheat growers sampled were abandoning or reducing wheat cultivation, since in reality soybean and wheat producers are one and the same, i.e., these producers cultivate both crops. However, for interviewing purposes they were considered separately.

When respondents were asked what crop, if any, would be substituted, the following information was obtained. Five producers, all cultivating large holdings, were shifting wheat lands to pasture, and one of these was increasing soybean area concurrently with pasture. The remaining respondents, all small-scale farmers, were diversifying their plantings to include corn, soybeans, black beans and vegetables. No significant relationship was found between the variables under study and the crops under cultivation.

Area Cultivated

The area cultivated was compared with that of the previous year to ascertain any land use changes or crop reduction. The extent of cultivated area compared with that of the previous year was noted as decreasing, remaining the same, or decreasing. Table 15 indicates these changes.

The largest group of producers (thirteen) maintained the same cultivated area as in the previous year. Ten respondents decreased their cultivated area, while

Table 15.--Crop Area 1977 Compared with Previous Year.

Crop	Increased	Remained the Same	Decreased	Total
Rice	3	2	5	10
Soybeans	5	5	1	11
Wheat	1	6	4	11
Total	9	13	10	32

nine expanded theirs. Soybean growers in equal proportion, are increasing or maintaining their planted area, five and five, respectively. In contrast, wheat producers are maintaining or decreasing their cultivated area, six and four respondents respectively. Three rice producers increased their cultivated area, two allocated the same area as in the previous year, and five decreased their area. Although the sample is small, the table does indicate the relative stability of rice production in the state. The increasing importance of soybean production can also be noted, as can the decline of the area in wheat due largely to unfavorable weather. Interviewees were also asked about the factors responsible for change in cultivated area. Responses included change in market price and a desire for diversification.

Marketing

Producers of the three crops were asked to indicate how their crops are marketed, so as to identify any relationship between form of marketing and the principal crops cultivated. Most respondents market their crops through cooperatives or private firms, and to a lesser extent through direct sale to the government. However, none sell their products directly to local markets. The soybean growers market their crops in a variety of ways, using at least two or more market modes per person, while rice and wheat producers vary between one and two marketing modes.

Table 16.--Marketing Mode, By Crop.

Crop	Cooperatives	Private Firms	Direct Sale to Government	Total
Rice	7	5	3	15
Soybeans	11	6	7	24
Wheat	11	5	2	18
Total	29	16	12	57

The analysis conducted was for each of the three marketing modes: cooperatives, private firms, and direct sale to government. The Chi-Square results are as follows in Table 17.

Table 17.--Significance of Marketing Mode.

Mode	Raw X^2	df	Significant Table Value at .10	Significance of X^2
Cooperatives	7.28	2	4.61	S
Private Firms	.18	2	4.61	NS
Direct Sale to Government	5.20	2	4.61	S

Farm-to-Market Transportation

Farm-to-market transportation modes were examined to ascertain how the three principal crops are marketed. Truck transportation is the only mode employed by the thirty-two respondents, but a variety of arrangements are used in reference to trucking. Major forms of truck transportation include: hired independent trucker (twelve producers), collective truck (eight producers), private truck (seven producers), truck provided by other farmer (six producers) and trucking company (one producer). Only two of the respondents use more than one of these arrangements.

Large-scale soybean and wheat farmers generally use their own trucks, while large-scale rice producers hire private truckers. In the latter case, the long distances from producing areas to trade centers appear to be an influencing factor. Other transportation modes such as railroads and barges are also used, but not by individual farmers. Instead, such modes are reserved for bulk shipments of soybeans and wheat from cooperatives or agri-business firms in the Planalto Medio to Porto Alegre and Pelotas.

Specific Findings of the Study

This section presents an analysis of responses to the related questions of the research hypotheses.

Hypothesis I

The first research hypothesis tested was:

> Yields per unit area of rice, soybeans and wheat are proportional to the size of landholding.

The analysis of this hypothesis was based on answers related to crop (CROP) under cultivation, the number of hectares (HECTAR) in the respondent's property, and the yields (YIELD) obtained in the past harvest. The analyses used to test this hypothesis were Chi-Square and Frequencies.

The number of hectares in each property, as well as the principal crops planted, were examined to ascertain if there is any relationship between the two variables. It was found that within the sample most small-scale farmers cultivate from twenty-one to forty hectares while most large-scale producers cultivate from 201 to 1,000 hectares.

It was observed that within the sample small-scale farmers cultivate properties larger in area than those cultivated by small-scale producers of soybeans and wheat. Among small-scale producers, wheat farmers cultivate properties that are smallest in area. Meanwhile, large-scale rice producers cultivate properties having larger total areas than those of large-scale soybean or wheat producers (see Table 11).

It was found that large-scale rice producers have higher yields than their small-scale counterparts. In the case of soybean producers, the reverse is true, i.e., small-scale producers are obtaining higher yields than large-scale producers. In the case of wheat, no pronounced yield pattern was found, variable yields being common to all land-holding sizes. However, large wheat farms tend to have slightly higher yields per unit area than small farms. This information is depicted in Tables 18, 19 and 20.

Three Chi-Square analyses were undertaken with respect to Hypothesis I which are relevant to the observations previously discussed. The first analysis, related to HECTAR by CROP, showed a Raw X^2 of 30.21. The significance level at .10 with sixteen degrees of freedom is 23.54. This indicates that a significant relationship exists between the number of hectares in properties sampled and principal crops produced.

The second analysis, HECTAR by YIELD, indicated a Raw X^2 of 135.56. The significance level at .10 with 112 degrees of freedom is 131.44. These findings indicate that a significant relationship exists between the number of hectares in properties and yields per unit area.

Table 18.--Frequencies: Yields From Rice Holdings.

Producer Yield (kg/hectare)	Absolute Frequency	Relative Frequency (Pct)	Cumulative Frequency (Pct)
2500	1 Small	10.0	10.0
2586	1 Small	10.0	20.0
2816	1 Small	10.0	30.0
2874	1 Small	10.0	40.0
4200	1 Large	10.0	50.0
4483	1 Small	10.0	60.0
4500	1 Large	10.0	70.0
5500	1 Large	10.0	80.0
6500	1 Large	10.0	90.0
7600	1 Large	10.0	100.0
Total	10	100.0	100.0

Mean: 4355.900

Valid Cases: 10

Standard Deviation: 1752.324

Missing Cases: 0

Table 19.--Frequencies: Yields From Soybean Holdings.

Producer Yield (kg/hectare)	Absolute Frequency	Relative Frequency (Pct)	Cumulative Frequency (Pct)
1200	1 Large	9.1	9.1
1320	1 Large	9.1	18.2
1600	1 Large	9.1	27.3
1680	2 Large	18.2	45.5
1800	1 Small	9.1	54.5
1861	1 Small	9.1	63.6
1920	1 Small	9.1	72.7
2046	1 Small	9.1	81.8
2100	1 Large	9.1	90.9
2760	1 Small	9.1	100.0
Total	11	100.0	100.0

Mean: 1815.182

Valid Cases: 11

Standard Deviation: 417.960

Missing Cases: 0

Table 20.--Frequencies: Yields From Wheat Holdings.

Producer Yield (kg/hectare)	Absolute Frequency	Relative Frequency (Pct)	Cumulative Frequency (Pct)
240	1 Large	9.1	9.1
258	1 Small	9.1	18.2
360	1 Small	9.1	27.3
400	1 Small	9.1	36.4
420	1 Large	9.1	45.5
460	1 Large	9.1	54.5
500	1 Small	9.1	63.6
560	1 Small	9.1	72.7
700	1 Large	9.1	81.8
765	1 Small	9.1	90.9
1015	1 Large	9.1	100.0
Total	11	100.0	100.0

Mean: 516.182

Valid Cases: 11

Standard Deviation: 232.365

Missing Cases: 0

The last Chi-Square analysis employed the same variables as those depicted in the Tables of Frequencies, i.e., CROP by YIELD. This analysis was conducted in an effort to ascertain any significant relationship between these two variables that may not have been indicated in the analysis of Frequencies. The Raw X^2 of 59.93 at an alpha level of .10 with twenty-eight degrees of freedom was beyond the expected Chi-Square value of 37.92. This indicates that a significant relationship exists between the principal crops produced and yield per unit area.

In summary, four analyses were undertaken in relation to Hypothesis I to ascertain any significance between the discussed variables. In regard to the three Chi-Square analyses, the Raw X^2 at a .10 alpha level was above the value required for significance. On the basis of these findings, the research hypothesis was retained.

Hypothesis II

The second hypothesis tested was:

> The distribution of high yields is directly related to those areas where the use of government extension service is greatest.

The variables employed in testing this hypothesis were yields per unit area (YIELD) and the use of extension centers (EXTENS), (AGVISI) and (VISAS). The latter variable was also compared with the principal crops (CROP) produced to ascertain any differences in extension service use between producers of rice, soybeans and wheat. It was found that twenty-five of the respondents are using their local government extension service. Of the twenty-five (twelve large and thirteen small producers), ten are soybean growers, eight are rice growers and seven raise wheat. All soybean producers, except one, use government extension services, while two rice producers do not. Among wheat growers, four of the eleven respondents do not use government extension service.

Table 21.--Use of Government Extension Services, By Crop.

Crop	Yes		No		Total
	Large	Small	Large	Small	
Rice	4	4	1	1	10
Soybeans	5	5	1		11
Wheat	3	4	2	2	11
Total	12	13	4	3	32

When nonusers were asked why they do not use this form of assistance, most replied that they have no need for the extension services provided. Another individual stated that he has little faith in government extension and therefore uses other sources of assistance. Respondents were also asked if government extension personnel ever visited their properties (AGVISI), to determine the degree of extension penetration in rural areas. Twenty-seven of the thirty-two respondents indicated that government extensionists have visited their properties, while twenty-five of these stated that they likewise visited the local extension center in a nearby community. It seems clear that government assistance is reaching rural producers, although the decision to adopt new technology rests with the farmer. Extension visits to rural properties were evenly divided among large-scale and small-scale farmers, as well as between producers of the three principal crops. All farmers are served by extension agents based in the same _município_, with the exception of four large wheat producers in the _municípios_ of Catuípe and Chiapeta. These two _municípios_ do not have extension centers, but depend upon nearby Ijuí for the provision of services.

Table 22.--Agronomist Visits to Producers, By Crop.

Crop	Yes		No		Total
	Large	Small	Large	Small	
Rice	5	4		1	10
Soybeans	4	5	2		11
Wheat	4	5	1	1	11
Total	13	14	3	2	32

Two Chi-Square analyses were conducted in relation to this hypothesis. One was conducted to ascertain any significant relationship between yields per unit area

(YIELD) and use of government extension service (EXTENS). A second analysis was conducted to identify any significant relationship between YIELD and farmer visits to government extension centers (VISAS).

The Chi-Square results of the first analysis indicates that at an alpha level of .10, with fourteen degrees of freedom, the X^2 value required for significance is 21.06. The Raw X^2 of 23.25 is above the significance level. This indicates that a significant positive relationship exists between yields per unit area and the use of extension services. The same held true when YIELD was compared with VISAS. In this analysis, the Raw X^2 obtained was 22.93 at an alpha level of .10, with fourteen degrees of freedom The Chi-Square table value required for significance was 21.06. This indicates that a significant relationship exists between the two variables, i.e., the greater the frequency of farmer visits to extension centers, the higher the yield obtained.

The research hypothesis was retained, since significant relationships were found between (1) yields per unit area and the use of extension service, and (2) yield per unit area and farmer visits to extension centers.

<u>Hypothesis III</u>

The third hypothesis is:

Innovation adoption is directly related to (a) use and accessibility to sources of agricultural assistance, (b) land tenure and (c) sources of information.

The analysis of this hypothesis is based on data collected which relate specifically to the adoption of innovations. The variables included in the analysis are those which have been proven to be significant in previous studies regarding innovation adoption by farmers. The variables selected were: adoption of innovations (IDEAS); use of extension service (EXTENS); visits to ASCAR or similar extension center (VISAS); participation in government-sponsored agricultural experiments (EXPMT); accessibility to sources of agricultural assistance (TEMPO), (DISTAN); land tenure (OWN), (RENT); and information sources, i.e., friends and relatives (INFO1); ratio (INFO2); television (INFO3); cooperatives (INFO4); artificial insemination centers (INFO5); agricultural magazines (INFO6); crop-livestock associations (INFO7); agribusiness representatives (INFO8); other (INFO9); and newspapers (INFO10). In the Chi-Square analysis conducted to test this hypothesis, IDEAS was used as the dependent variable while all remaining variables were held as independent variables. The Chi-Square results are shown in Table 23.

In addition to the Chi-Square routine, a Pearson Correlation analysis was done with IDEAS as the dependent variable and all others as independent variables. The purpose was to determine the proportion of variation in IDEAS that can be explained by the other variables

Table 23.--X^2 Analysis of Hypothesis III, By IDEAS.

Independent Variable	Raw X^2	df	Significance Table Value at .10	Significance of X^2
EXTENS	.49	1	2.706	NS
VISAS	.32	1	2.706	NS
EXPMT	5.95	1	2.706	S
OWN	.08	1	2.706	NS
RENT	1.22	2	4.605	NS
INFO1	Not Computable: All YES Answers			
INFO2	Not Computable: All YES Answers			
INFO3	.01	1	2.706	NS
INFO4	.08	1	2.706	NS
INFO5	.08	1	2.706	NS
INFO6	.07	1	2.706	NS
INFO7	.39	1	2.706	NS
INFO8	1.09	1	2.706	NS
INFO9	.41	1	2.706	NS
INFO10	.05	1	2.706	NS
TEMPO	5.10	5	9.236	NS
DISTAN	6.88	5	9.236	NS

considered. As observed in Table 24, only 26 percent of the variation in IDEAS can be explained by all remaining variables.

Two other Pearson Correlation analyses were undertaken to determine any other possible relationships between the variables under study, first as related to crops grown (CROP) and second as related to landholding size (HECTAR). The R^2 results when correlated with CROP, indicate that only 24 percent of the variation in crops grown can be explained by the other variables. The maximum proportion of variation in landholding size (HECTAR) is 23 percent. In both cases, the maximum proportion that can be explained is less than when correlated with the adoption of innovations (IDEAS), in which case 26 percent of the total variation can be explained.

The third hypothesis had a total of seventeen questions used in the analysis for significance between variables, controlling by IDEAS. A Chi-Square analysis revealed no significant relationship between variables, with the exception of EXPMT. In the case of EXPMT, a significant relationship was found between farmer participation in experiments and adoption of innovations (IDEAS) introduced by government.

The research hypothesis was rejected on the basis of two factors: (1) only one significant relationship was found in the Chi-Square analysis when controlling by IDEAS, and (2) the proportion of variation that can be

Table 24.--Pearson Correlation--Dependent Variable IDEAS.

Variables Entered	Multiple R	R Squared
1. DISTAN	-.0029	.0000
2. OWN	-.0301	.0009
3. INFO5	.0301	.0009
4. INFO10	.0305	.0009
5. TEMPO	-.0328	.0011
6. INFO3	.0808	.0065
7. INFO6	-.1112	.0124
8. INFO4	.1304	.0170
9. VISAS	.1697	.0288
10. INFO7	.1905	.0363
11. RENT	-.2141	.0458
12. INFO9	-.2425	.0588
13. INFO8	-.2471	.0611
14. EXPMT	.5114	.2615

Table 25.--Pearson Correlation--Dependent Variable CROP.

Independent Variables	Multiple R	R Square
1. RENT	-.0933	.0087
2. IDEAS	.1185	.0140
3. DISTAN	.1441	.0208
4. EXTENS	.1663	.0277
5. EXPMT	.1793	.0321
6. INFO5	-.2164	.0468
7. INFO7	-.2164	.0468
8. OWN	.2164	.0468
9. INFO4	.2164	.0468
10. INFO10	-.3193	.1020
11. INFO8	-.3457	.1195
12. TEMPO	-.3853	.1485
13. INFO3	-.4485	.2016
14. INFO6	-.4597	.2113
15. VISAS	-.4910	.2411

Table 26.--Pearson Correlation--Dependent Variable HECTAR.

Independent Variables		Multiple R	R Square
1.	CROP	-.0142	.0002
2.	IDEAS	-.0519	.0027
3.	DISTAN	.0589	.0035
4.	INFO7	-.0645	.0042
5.	RENT	-.0990	.0098
6.	EXPMT	-.1266	.0160
7.	OWN	.1438	.0207
8.	INFO4	.1452	.0211
9.	VISAS	.1700	.0289
10.	TEMPO	.1980	.0392
11.	INFO8	.2339	.0547
12.	INFO5	.3655	.1336
13.	INFO10	.3697	.1367
14.	INFO6	.3769	.1421
15.	INFO3	.4054	.1643
16.	EXTENS	-.4863	.2365

explained by IDEAS in the Pearson Correlation analysis is too low (26 percent).

To identify any other significant relationship, two additional analyses were conducted. The first, a Chi-Square analysis, used the principal crop produced (CROP) as the dependent variable, while retaining the same independent variables used in the previous Chi-Square analysis. This was followed by a Pearson Correlation Coefficients routine in which twelve variables were examined in relation to each other. The Chi-Square analyses using CROP as the dependent variable showed that nine variables are statistically significant. This indicates that there are many other factors that affect the adoption of innovations including the type of crop under cultivation, which in this analysis proved to be more significant than anticipated (Table 27).

Of the thirty-two respondents interviewed, fifteen are using new ideas introduced by government extension agents. Of the three types of farmers interviewed, soybean growers lead in the adoption of innovations (nine), followed by wheat producers (four) and rice cultivators (two). Most of the farmers using new ideas are large producers. The new ideas employed by all respondents are presented in Table 28.

Each of the fifteen respondents using innovations has adopted at least two new methods or techniques related to the principal crop cultivated. Most of the innovations

Table 27.--Chi-Square Controlling, By CROP.

Independent Variables	Raw X^2	df	Significant Table Value at .10	Significance of X^2
IDEAS	8.78	2	4.61	S
EXTENS	2.42	2	4.61	NS
VISAS	10.46	2	4.61	S
EXPMT	4.55	2	4.61	NS
OWN	5.50	2	4.61	S
RENT	9.08	4	7.78	S
INFO1	Not Computable: All YES Answers			
INFO2	Not Computable: All YES Answers			
INFO3	6.44	2	4.61	S
INFO4	1.51	2	4.yl	NS
INFO5	1.51	2	4.61	NS
INFO6	7.82	2	4.61	S
INFO7	4.79	2	4.61	S
INFO8	5.57	2	4.61	S
INFO9	4.07	2	4.61	NS
INFO10	3.26	2	4.61	NS
TEMPO	18.78	10	15.99	S
DISTAN	23.37	18	25.99	NS

Table 28.--Suggestions Provided by Extension Personnel, By CROP.

	New Seeds		Fertilizing		Pests and Diseases		Use of Pesticides		New Techniques		Terracing		Agricultural Equipment		Rotation of Crops		Soil Erosion		Soil Sampling		Agricultural Publications		Other		Total
	L	S	L	S	L	S	L	S	L	S	L	S	L	S	L	S	L	S	L	S	L	S	L	S	
Rice	5	5	4	3	4	4	4	3	4	1		1	1	1	4	1		1	4	2	3		1	1	57
Soybeans	5	2	5	3	4	2	5	1	3	1	4	5	1	1	3	2	5	3	4	3	2	1	1	4	70
Wheat	3	2	2	3	3	1	2	1	2	1	2	3	1	1		1	3	2	2	1	1	1		2	40
Total	22		20		18		16		12		15		6		11		14		16		8		9		167

L = Large Producers

S = Small Producers

concern the control of insect pests and crop disease, use of fertilizers, and soil conservation. As expected, soybean growers have adopted more innovations than have rice or wheat producers. Those respondents not adopting any agricultural innovations were queried as to their reasons. The principal reasons given are that they feel no need for the advice or technique and the cost of adopting some innovations is high.

Although only fifteen respondents indicated that they are using innovations, twenty-three stated that they visit their local extension centers when necessary. To the writer's surprise, all rice producers visit their extension centers, although only two are using the new ideas introduced through these centers. When respondents were asked if they have received suggestions from their local extension agent, all replied affirmatively. A summary of the suggestions provided by government extension personnel is presented in Table 28.

It appears that large-scale soybean growers tend to solicit advice from government extension centers more than do either rice or wheat producers, possibly due to their higher level of education and sophistication. Large-scale producers receive more suggestions from extension agents than do small-scale rice producers, but the number of suggestions received by wheat producers, large and small, is about equal.

Another major aspect in the adoption of innovations is the exposure of farmers to information sources, including mass media. The average person interviewed has used an average of five or six information sources. Friends and relatives, as well as radio, are the major sources of information and are used by all respondents. Twenty-six respondents, of whom fifteen are large-scale producers, rely upon agricultural cooperatives for information. Newspaper readership is less important among all respondents, but relatively more important among large-scale farmers. Twenty-three respondents use newspapers as a source of information. Of these, sixteen are large-scale farmers. Presumably, high readership among large-scale producers is positively related with higher levels of education. A similar situation exists concerning crop-livestock magazine readership, where fourteen of the twenty-one readers are large-scale farmers. Twenty respondents use television as an information source, 75 percent of these being large-scale producers. In most instances, large-scale farmers can afford to purchase a television set for home use, as contrasted with small-scale producers who must rely upon radio for information to a greater degree because of lower income. Agribusiness representatives have provided information to twelve large and three small operators. Mechanized agriculture is practiced to a much greater degree in large operations than on small holdings. Most information received from agribusiness representatives is furnished by commercial grain buyers, seed/pesticide firm personnel, or agricultural implement dealers.

Respondents were asked how far they have to travel for agricultural credit or other financial assistance related to their farm operation. It was found that large-scale rice and soybean producers live nearest the sources of credit (seat of município), while large-scale wheat producers must travel greater distances to procure these services (Table 29). However, in the case of small-scale farmers, the reverse is true. Small-scale wheat producers live closer to the community offering credit and related services, while small-scale rice and soybean growers live on more distant properties. The Chi-Square analysis showed a significant relationship between crops produced (CROP) and distance traveled for agricultural credit (DISTAN).

The amount of time required to transport crops to market was examined to determine if any significant relationship exists between marketing time (TEMPO) and crops grown (CROP). The marketing time for all thirty-two respondents is between thirty and forty-five minutes. Rice takes longer to reach the market (one hour), while soybeans require an average of twenty minutes. Wheat occupies an intermediate position in terms of marketing time.

Rice areas tend to be more distant from market than those of soybeans or wheat, since there are fewer trade centers in rice production zones. This accounts for the greater marketing time for rice, although some rice is

Table 29.--Distance Traveled for Agricultural Credit, By CROP.

Crop	0-5 kms		6-10 kms		11-15 kms		16-25 kms		26-50 kms		51-100 kms		Total
	L	S	L	S	L	S	L	S	L	S	L	S	
Rice	4							4	1	1			10
Soybeans	5		1					5					11
Wheat	1			5		1			3		1		11
Total	10		6		1		9		5		1		32

L = Large-scale producers

S = Small-scale producers

Table 30.--Marketing Time, By CROP.

Crop	10 min.		20 min.		30 min.		45 min.		1 hour		4 hours		Total
	L	S	L	S	L	S	L	S	L	S	L	S	
Rice			1			1		3	2	1	2		10
Soybeans	3		2			2	1	3					11
Wheat			2	1	1	4	1		1	1			11
Total	3		6		8		8		5		2		32

L = Large-scale producers

S = Small-scale producers

is marketed via paved highway. For some soybean and wheat growers, the advantage of being closer to market is offset by hilly terrain and poorer farm-to-market roads.

The final Pearson Correlation routine conducted was an analysis of twelve variables in relation to each other. The variables included in the correlation analysis are: educational level (EDLEV), membership in agricultural organizations (ORG), time in agriculture (AGTIME), residence on rural property (RES), ownership of cultivated land (OWN), number of hectares in property (HECTAR), yield per unit area (YIELD), weather conditions (YIFA1), crop diseases (YIFA2), use of extension service (EXTENS), adoption of new ideas introduced by government (IDEAS), participation in agricultural experiments (EXPMT), and distance traveled for credit or other financial assistance (DISTAN) (Table 31).

The most significant relationships found among the thirty-two respondents were:

1. A negative correlation between EDLEV and AGTIME, implying that the higher the educational level, the less time in agriculture.
2. A negative correlation between EDLEV and RES, implying that the higher the educational level, the lower the residency level on property.
3. A positive correlation between AGTIME and RES, implying that the greater the time in agriculture the higher the residency level on property.

Table 31.--Pearson Correlation Coefficients.

	EDLEV	ORG	AGTIME	RES	OWN	HECTAR	YIELD	YIFA1	YIFA2	EXTENS	IDEAS	EXPMT
ORG	.129											
AGTIME	-.487	-.087										
RES	-.500	-.007	.498									
OWN	-.358	.395	.220	.158								
HECTAR	.089	-.246	-.102	-.286	.144							
YIELD	.263	-.072	-.084	-.266	-.025	.174						
YIFA1	-.056	-.138	.081	.232	-.207	.007	-.076					
YIFA2	.102	.007	.044	.247	-.158	-.003	-.482	.312				
EXTENS	-.023	.349	.014	-.065	-.061	-.486	.033	-.228	-.413			
IDEAS	.140	.087	-.191	-.243	-.030	-.052	-.175	-.286	-.284	.194		
EXPMT	.072	.155	.021	.011	.027	-.127	-.188	-.014	-.011	.061	.511	
DISTAN	-.029	.045	.117	.341	-.293	.059	-.127	.095	.329	-.001	.003	-.042

Significant R = ±.25.

4. A negative correlation between EDLEV and OWN, implying that the higher the educational level, the lower the ownership level for land cultivated.
5. A positive correlation between ORG and OWN, implying that the greater the organizational membership, the higher the ownership level for land cultivated.
6. A negative correlation between HECTAR and RES, implying that the larger the holding, the less the likelihood that farmers are resident on their rural property.
7. A positive correlation between EDLEV and YIELD, although it is very low, possibly implying that the higher the educational level, the higher the yields obtained.
8. A negative correlation between RES and YIELD, although it is very low, possibly implying that the less the likelihood that farmers are resident on their rural property, the higher the yields obtained.
9. A negative correlation between YIELD and YIFA2, implying that the lower the yield, the higher the incidence of crop diseases.
10. A positive correlation between ORG and EXTENS, implying that the higher the membership in agricultural organizations, the greater the use of extension service.

11. A negative correlation between HECTAR and EXTENS, implying that the smaller the landholding size, the greater the use of extension services.
12. A negative correlation between EXTENS and YIFA2, implying that the greater the use of extension service, the lower the incidence of crop diseases.
13. A negative correlation between YIFA1 and IDEAS, implying that the poorer the weather conditions for certain crops (e.g., wheat), the greater the use of new ideas introduced by government.
14. A negative correlation between IDEAS and YIFA2, implying that the greater the use of new ideas, the lower the incidence of crop diseases.
15. A positive correlation between EXPMT and IDEAS, implying that the greater the participation in agricultural experiments, the greater the adoption level of new ideas.
16. A positive correlation between DISTAN and RES, implying that the greater the distance from credit sources, the lower the residency level of rural property.
17. A negative correlation between DISTAN and OWN, implying that the greater the distance from credit sources, the lower the ownership level of land cultivated.

18. A positive correlation between DISTAN and YIFA2, implying that the greater the distance from credit sources, the greater the incidence of crop diseases.

Several points should be clarified regarding these relationships. These include farmer characteristics, organizational membership, weather and innovation, and plant diseases.

Many of the respondents with higher educational levels turned to agriculture with the advent of the lucrative soybean "boom" and have farmed for a shorter period of time than their less educated counterparts. In addition, their properties tend to be larger, more distant from trade centers than those of other farmers, and are often rented rather than owned. Residential proximity to urban amenities and services are important to large-scale producers and therefore many do not live on the land they cultivate. The fact that some farmers are somewhat more productive than others within the sample is accounted for by the higher yields obtained by large-scale rice growers.

Other factors also deserve mention. Farmers that own the land they cultivate are more prevalent among small-scale producers. Likewise small landowners tend to use more extension services than other farmers. This reflects government attempts to reach the small-scale low-income producer and is mainly responsible for the strong negative correlation found between landholding size and use of extension services. Furthermore, large-scale growers tend to use agricultural assistance provided by cooperatives or agri-business firms, which explains the lack of correlation between yields and government extension service use. The positive correlation between poor weather and innovation adoption seems to indicate that within the sample, adverse growing conditions stimulated farmers to seek new methods to resolve their problems. Lastly, the incidence of plant disease is positively correlated with distance from extension centers. Although remoteness may be a factor in this case, many of these properties most affected involve large-scale wet rice plantings using modern technology. No clear explanation is evident and other factors not investigated probably account for the higher crop disease rate.

Prior to the completion of each interview, the respondents were asked two additional questions. The objective was first to determine how farmers perceive the effect of land ownership on the adoption of innovations (Question 32a and 32b) and, second, how they perceive their agricultural progress with respect to the past, present and future (Question 38). Although the two questions were not part of the statistical analysis, the researcher felt the need to know more about farmer attitudes in relation to the adoption of innovations and agricultural progress.

Question 33 dealt specifically with land ownership and productivity. When respondents were asked whether or not they believe there is a relationship between these two variables, twenty-eight responded affirmatively. The same twenty-eight stated that they would adopt more new ideas if they were the owners of the land under cultivation. Only four said that they would adopt fewer innovations. Although all respondents believe that a strong relationship exists between the three variables (OWN, YIELD and IDEAS), the correlation coefficients do not indicate such a relationship (Table 31).

Question 38 focuses on the respondents' views of the past, present and future, respectively, in terms of agricultural progress. For this question, the individuals interviewed were shown a diagram of a step ladder. The steps of the ladder were numbered 1 through 10, each of which represented a different level of agricultural progress. The steps at or near the top of the ladder represented a high level of progress, with the number 10 being the top. The middle steps of the ladder represented a modest level of progress, exemplified by the number 5. The lowest level of progress was indicated by the number 1 at the bottom of the ladder. This technique permitted the respondents to identify their past, present and future levels of progress on the ladder.

In Question 38, "Present Situation," rice producers perceived themselves to be on the lower middle portion of the ladder, between Categories 3 and 5. Six soybean growers rated themselves in Categories 8 and 9, while the remaining soybean growers were in Categories 4 through 6. Wheat producers ranked themselves from Categories 3 through 8, with most being in Category 5. However, the wide range among wheat producers indicates that their opinions vary concerning the amount of progress achieved. Small-scale farmers perceive themselves to be lower on the ladder and selected Categories 3 through 6. Conversely, large-scale farmers saw themselves higher on the ladder and chose Categories 6 through 9.

In Question 38, "Past Situation," six rice farmers indicated their position on the ladder to be in Categories 6 through 10, reflecting a reasonably high level of progress and satisfaction, while five soybean producers saw themselves in Categories 3 through 5. Wheat producers again saw themselves on the lower part of the ladder, from Categories 3 through 5. The most frequent categories chosen among all producers were Categories 5 and 6 (thirteen individuals). Differences in perception of the past were pronounced among producers of different crops, but did not vary significantly among large-scale or small-scale producers. Of interest are the changing perceptions of soybean growers, who ranked themselves lower on the ladder in the "Past Situation" than in the "Present Situation." This could be the result of greatly increased production, higher market prices, and better harvests in 1977 than in the past.

In Question 38, "Future Situation," producers of all three crops perceived themselves to be higher on the ladder (Categories 5 through 10) than in the "Present

Situation" or "Past Situation," indicative of general optimism. Rice farmers saw themselves in Categories 8 through 10, while soybean growers saw themselves in Categories 9 and 10. Wheat producers rated themselves lower on the ladder (Categories 6 through 8). The uncertainty of success with wheat, due primarily to unfavorable weather, appears to have a bearing upon their perceptions of future progress. In terms of landholding size, large-scale producers chose Categories 8 through 10, while small-scale producers saw themselves in Categories 5 through 8.

Several generalizations can be made about the perceptions of progress among farmers. Soybean growers are very optimistic about their progress and success, and expect their favorable situation to continue in the future. In contrast, rice producers are more conservative. Some indicated considerable progress and success in the past, but their response was more negative in 1977 (Present Situation). However, most farmers anticipate more progress in the future. Wheat producers generally see themselves as having made little progress in the past, but are more confident regarding their present and future conditions.

CHAPTER IX

CONCLUSION

Included in this chapter is a summary covering the study area, research problem, methodology, and purpose and objectives of the research. The findings of the study and conclusions reached, are also discussed. Implications of the study as related to future research are examined, and recommendations made for the solution of specific problems.

Summary

The economy of Rio Grande do Sul is based largely on agriculture and livestock production. A wide variety of middle latitude and subtropical crops is grown, due largely to the diversity of physical environments and to cultural influences exerted by descendants of nineteenth century European colonists. Cattle ranching has traditionally been rural Rio Grande do Sul's chief pursuit, but it has declined in recent years due to rising production costs and low market prices. Many ranchers have switched to soybean cultivation, or now plant wet rice to supplement their earnings from livestock. The production of soybeans for export now dominates the rural economy, with the Central Plateau or

Planalto Medio accounting for most of the crop. Rio Grande do Sul and Paraná are the nation's principal soybean producing states, and the crop is now second only to coffee in terms of foreign exchange earned. In the colonial highland zones small-scale subsistence and commercial agriculture, as well as dairying, are important. Products not consumed locally are marketed in Porto Alegre, the capital city. The growing of grapes and tobacco is also significant in some colonial agricultural zones.

The advent of large-scale commercial soybean cultivation resulted in major land-use changes, including the expansion and contraction of crop-livestock regions. Farming methods also changed, and the adoption of modern technology, financed by large outlays of capital, was accelerated. Despite the soybean "boom," serious problems remain. Inefficient use of pasture and few innovations typify many ranching operations, due in part to low beef prices. Elsewhere, staple food production, particularly that of black beans, has been curtailed in favor of the more lucrative soybeans. Institutional factors, such as rental agreements which do not stipulate or guarantee tenant farmers cultivation rights for a specified period of time, illiteracy and low farm income, are additional constraints on agricultural development. Thus, Rio Grande do Sul's rural economy is both dynamic and stagnant, while producers are innovative and traditional, affluent and poor. The economy is not dualistic but, rather, heterogeneous in terms of development both within and between the crop-livestock regions.

Rio Grande do Sul is vitally important to Brazil as a producer of soybeans, wheat, rice and specialty crops. Much of the country's export revenue is generated within the state through soybean production, while rice and wheat grown in Rio Grande do Sul provide much of Brazil's food supply. Given this condition, the preparation of an updated agricultural land-use map and the delimitation of current crop-livestock regions was paramount. In turn, the effect of farm technology and government assistance on rural land use was likewise warranted. Such a need formed the basis of this dissertation.

The present study therefore constitutes a geographic appraisal of current agricultural land-use patterns in Rio Grande do Sul, as well as recent changes in those patterns. Innovation and the provision of technical assistance by government organizations were also researched. The investigation is both descriptive and exploratory in nature. Descriptive portions include the reporting of information obtained through land-use mapping, and the crop-livestock regionalization. The review of literature, geographic overview of Rio Grande do Sul, and nonformal interviews with agricultural technicians, university professors, researchers, bankers, farmers and ranchers, were also descriptive in nature. Conversely, the analysis of data obtained from the formal interview schedule and the testing of research hypotheses comprise the exploratory portion of the report.

Conclusions

Conclusions drawn from this study are both general and specific in nature. General conclusions were based on the interpretation of descriptive information, including air photographs, maps and other published materials, field traverses and informal interviews. Conclusions of a more specific nature were based on the tabulation and analysis of data obtained through administration of the formal interview schedule to agriculturalists in the six designated sample areas. Information obtained through formal interviewing was used to test three research hypotheses formulated for this study.

Conclusions regarding land use, innovation, government assistance and data analyses are presented in this section. They include the following:

Major Land-Use Regions

1. The small-scale diversified agriculture region will probably remain stable in terms of area or expand only slightly. Yields per unit area within the region may gradually increase in future years.
2. The focus of the viticulture region has shifted westward from Caxias do Sul to Bento Gonçalves. Experimental vineyards outside the region have not

yet become important on a regional or national scale.

3. The tobacco region centered on Santa Cruz do Sul has expanded greatly since 1950 except along its southern margin, which remains important for wet rice production.
4. The sugarcane region of Rio Grande do Sul remains stable in size, despite government attempts to expand the growing area northeastward.
5. The onion region remains stable in size, but is economically stagnant, due to isolation and the lack of all-weather roads. Farm-to-market transportation is especially difficult in production areas along the eastern margin of the Lagoa dos Patos.
6. The soybean-wheat region has expanded greatly in all directions since 1965, but least rapidly on the northeastern margin where lower temperatures mitigate against profitable production. Expansion has been particularly rapid along the southern and western margins of the region, which were formerly devoted to beef cattle. Soybean raising in former wet rice areas of the Depressão Central is also notable. The cultivation of soybeans clearly dominates the economy of the soybean-wheat region, with wheat being a secondary "off-season" crop to make better use of idle land and farm implements.

7. Since 1950 the rice-livestock region has expanded from the Depressão Central to include most of the coastal lowlands, and much of the Rio Uruguai valley lying within Rio Grande do Sul. In 1977 rice production had also become prominent within the extensive livestock ranching region, particularly near Bagé and Dom Pedrito. Shifts from rice to soybeans, and from livestock to rice, have therefore occurred in the rice-livestock and extensive livestock ranching regions, respectively.

Land-Use Subregions

1. The nonspecialized diversified agriculture subregion is stable in area, and remains a traditional zone of subsistence agriculture.
2. The Porto Alegre Market gardening subregion is slowly expanding eastward as population of the urban area increases, and as demand for fresh produce increases.
3. Dairying is expanding into parts of the soybean-wheat region, especially near Ijuí.
4. The pineapple-banana subregion is stable in area and productivity, but modern agricultural technology is essentially absent from the zone.
5. The corn-soybean-swine culture subregion emerged as soybean cultivation expanded southeastward from the Planalto Medio into areas of traditional

subsistence agriculture important for hog and corn production. The subregion may expand southward and southeastward in future years as small-scale farmers become more cash-crop oriented and take advantage of the Estrela soybean export terminal.

6. The black-bean subregion is contracting on its southern and southwestern margins, since many former black bean producers have switched to soybean cultivation. Future land use in the subregion is dependent upon increased government assistance, and whether or not production of the crop is stimulated to a greater extent in diversified agriculture zones closer to major market areas.

7. The corn-black bean subregion of the northwestern Serra do Sudeste remains an isolated zone of traditional subsistence farming. It is characterized by few innovations or technological inputs.

8. The vegetable-fruit-dairying subregion is slowly expanding westward within the southern Serra do Sudeste as fruit and vegetable canning industries in nearby Pelotas develop, and as the urban market for fluid milk expands.

9. The von Thünen model of agricultural land use is less applicable to Rio Grande do Sul than to neighboring Uruguay. Fewer assumptions of the model can be met in the case of Rio Grande do Sul, such as uniform terrain and market accessibility.

Moreover, the model does not account for cultural influences on land use, which in Rio Grande do Sul are highly significant.

Innovation

1. The adoption of innovations in rural Rio Grande do Sul appears to be more dependent upon economic resources than on the communication of new ideas or an awareness of those ideas.
2. Small and large-scale producers are both innovative and noninnovative, depending upon individual circumstances. Small-scale viticulturalists, tobacco growers and some sugarcane producers are generally innovative, as are many large-scale producers of soybeans and wheat. Conversely, many small-scale producers of black beans, manioc, pineapples, bananas and onions are noninnovative, since most lack the necessary financial resources to adopt new technology. By the same token, many large-scale landowners raising beef cattle are traditional, conservative and noninnovative. This is due partly to declining beef prices and competition from agriculture. As a result, many ranchers feel that improvements in pasture lands or beef production systems are not warranted. Some ranchers are also devoting more of their effort to agriculture, which is more profitable.

3. Agricultural innovation adoption in Rio Grande do Sul does not exhibit a distance-decay function from Porto Alegre, i.e., levels of agricultural technology employed do not always decrease as distance from the city increases. Although large-scale soybean-wheat farmers in the Planalto Central are distant from Porto Alegre, they rapidly adopt new technology, and nearly all production is mechanized. High world demand for soybeans stimulated high capital investment in soybean technology so that output could be maximized under favorable market conditions. Second, rural social and economic infrastructure development in Rio Grande do Sul is greater than in many other areas of Brazil or Latin America. Interior agricultural trade centers provide a wide range of goods and services, and have served to reduce the rural-urban innovation dichotomy.

<u>Government Assistance</u>

1. A large number of federal, state and university research and extension centers have been established in the state, and their location relative to producers makes them reasonably accessible. However, the eastern portion of the Alto Uruguai region is deficient in extension centers, considering the

prominence of subsistence agriculture in the zone and the area's high rural population density.

2. Higher interest rates on farm loans as an anti-inflationary measure have been detrimental to small-scale farmers, the producer type most in need of financial assistance.
3. Much useful crop-livestock research has been undertaken at both government and university levels in the state. However, there is need for closer linkage and coordination between researchers and extension agents.

Research Conclusions

The following conclusions were reached regarding the statistical analysis of the three research hypotheses.

Hypothesis I was formulated to ascertain any possible relationship between crop yield and the size of landholding.

I. Yields per unit area of rice, soybeans and wheat are proportional to the size of landholding.

The statistical analysis of this hypothesis was based on three related questions regarding CROP, HECTAR and YIELD. Four analyses were conducted to detect any significance between variables. All analyses indicated that a significant relationship exists between the number of hectares in rural properties and yields per unit area.

On the basis of these findings, the hypothesis was retained.

The second hypothesis was aimed at identifying any relationship between high yields and the use of government extension service.

II. The distribution of high yields is directly related to those areas where the use of government extension service is greatest.

The testing of this hypothesis was based on analysis of the following variables: YIELD, EXTENS, AGVISI and VISAS. Two Chi-Square analyses were conducted regarding this hypothesis. The first was designed to identify any possible relationship between yields and the use of extension services. The second focused upon the relationship between yields and farmer visits to extension centers. The Chi-Square results for both analyses were above the required significance level. This indicates that a significant relationship exists between the variables under study, i.e., that higher yields were obtained through greater use of extension services. On the basis of these findings the hypothesis was retained.

The objective of the third hypothesis was to identify the factors influencing the adoption of innovations.

III. Innovation is directly related to (a) use and accessibility to sources of agricultural assistance, (b) land tenure, and (c) information sources.

Variables included in this analysis were those which had been previously identified in other studies regarding the adoption of innovations in agriculture. The variables were: the adoption of innovations, use of extension services, visits to ASCAR or similar extension centers, participation in agricultural experiments, accessibility to sources of agricultural assistance, land tenure, and information sources. The Chi-Square analyses to test this hypothesis indicated that there is no significant relationship between the variables examined when controlling by IDEAS.

Three Pearson Correlation analyses were conducted to determine the proportion of variation in IDEAS that could be explained by all the variables considered in the Chi-Square analysis. Only 26 percent of the variation in IDEAS could be explained. On the basis of this finding, the hypothesis was rejected.

To identify any other significant relationship, an additional Chi-Square analysis was conducted, this time using CROP as the dependent variable while the remaining independent variables were retained. This analysis showed that nine variables, out of a total of sixteen, were statistically significant, indicating that many other variables seem to influence the adoption of innovations including the type of crop being cultivated.

The last analysis undertaken was a Pearson Correlation Coefficients routine in which twelve variables were examined in relationship to each other. The most significant relationships found were (1) a negative correlation between EDLEV and AGTIME, i.e., the higher the educational level, the less time in agriculture; (2) a positive correlation between EDLEV and YIELD, i.e., the higher the educational level the higher the crop yields; (3) a negative correlation between EDLEV and OWN, i.e., the higher the educational level, the lower the level of ownership; (4) a positive correlation between ORG and OWN, i.e., the greater the organizational membership, the higher the ownership level; (5) a positive correlation between ORG and EXTENS, i.e., the higher the membership in farm organizations, the greater the use of extension centers; (6) a negative correlation between HECTAR and EXTENS, i.e., the smaller the landholding, the greater the use of extension services; (7) a negative correlation between EXTENS and YIFA2, i.e., the greater the use of extension services, the lower the incidence of crop disease; and (8) a positive correlation between EXPMT and IDEAS, i.e., the greater the participation in agricultural experiments, the greater the adoption of new ideas.

Implications

Significant changes have occurred in the rural land-use pattern of Rio Grande do Sul. Foremost is the changing amount of land devoted to the production of specific crops. Soybean cultivation has expanded rapidly from its core area in the Planalto Medio and encroached on areas traditionally devoted to wet rice cultivation and cattle ranching. Meanwhile, the southeastern Atlantic littoral, Rio Uruguai valley and parts of the Campanha ranching zone have become centers of rice cultivation. Elsewhere, other land use has declined in importance, such as black bean production in northern Rio Grande do Sul and hog raising in the far northwest.

Equally noteworthy has been the increase of mechanized agriculture, the adoption of pesticides and the introduction of soil sampling in some parts of the state, while other areas remain technologically stagnant. An increasing government concern for agricultural development is exemplified by the creation of federal crop-livestock research centers and the consolidation of state extension services to eliminate organizational inefficiency and duplication of effort.

These findings have implications for future development planning in Rio Grande do Sul. The study could therefore serve as a planning tool in future assessments of agricultural land use, innovation adoption and government assistance. The findings could be applied in the following cases:

I. Land-Use Assessment: the study can serve as a useful tool for assessing current agricultural land use in the state. The land-use map prepared for this study depicts five zones of crop-livestock land use and, in 1977, was the most recent map available. The map has particular value when used with earlier land-use maps for comparative study in the following ways:

A. Evaluating the spatial aspects of expanded soybean production, particularly the penetration of the crop into zones formerly devoted to wet rice cultivation or livestock raising.

B. Studying the expansion of wet rice cultivation in traditional livestock ranching areas.

C. Identifying subsistence agriculture regions of which the boundaries have remained stable over time, for long range development programs designed to boost productivity and increase rural income.

D. As a planning document when highly detailed land-use information is needed.

II. Regional Land-Use Planning: the map of crop-livestock regions prepared for this study is based largely on information shown on the agricultural land-use map. However, specific regions and subregions are delimited which show the crop-livestock production complexes in any given area of Rio Grande do Sul, and are discussed in the accompanying text. The study is therefore useful for regional planning, including the location of infrastructure projects where they can best meet the needs of farmers. Specific examples include:

A. The comparative study of crop-livestock regions on a temporal-spatial basis.

B. The identification of land-use problem areas for which alternative land-use strategies may be considered.

C. Locational planning of new cooperatives or agribusiness firms relative to production zones, major markets and trade centers.

D. Transportation planning, including new farm-to-market roads, crop storage facilities, shipping terminals, and waterway development to better serve producers.

III. Innovation and Government Assistance to Agriculture: the study has applicability for both innovation diffusion research and agricultural assistance planning in the following cases:

A. As a general source of information indicating the level of crop-livestock technology employed in the various regions and subregions examined.

B. The locational planning of new research and/or extension centers.

C. The determination of specific services to be provided by extension or research centers in relation to agricultural land-use zones.

Recommendations

It is hoped that the information, maps and analyses presented in this study have fulfilled the stated research objectives. Yet, during the course of the research it became apparent that improvements in methodology could be made, and that some related topics merit study of a more specific nature. Second, much valuable information was obtained that could be used by government for future decision making. Specific recommendations intended for future researchers and government personnel charged with agricultural planning follow.

Future Research

During the course of field work it was noted that certain changes in research objectives and methodology might facilitate the task of persons engaged in future studies of this type:

1. Future studies of this type should be narrower in scope, with a specific focus on either crop-livestock land use, spatial aspects of innovation diffusion, or locational assessment of extension centers.
2. Cluster sampling should be avoided when interviewing large-scale landowners, since in most cases their properties are noncontiguous and distant from each other. A stratified areal sample may be used in

this situation. However, the use of cluster sampling is desirable in areas of small holdings.

3. Flexibility in sampling techniques must be maintained, since even the best conceived research plans are subject to the economic, transportation and time constraints of government organizations assisting the researcher.

Several potential research topics were identified during field work in Rio Grande do Sul. All are timely and worthy of study, given the extreme importance of agriculture in the state's economy. Future research should include the following themes:

1. The spatial diffusion of soybean production in Rio Grande do Sul and concomitant decrease in the area devoted to staple food crops.
2. A geographic appraisal of alternative wheat production locations in Rio Grande do Sul.
3. A locational study for optimizing extension service effectiveness and innovation delivery to small-scale farmers.
4. Variations in innovation adoption over geographic space, emphasizing the role of cooperatives as change agents.

Recommendations to Government

The following recommendations are made to the government of Rio Grande do Sul based on the findings of this study:

1. Agricultural land-use maps prepared by the government should be updated periodically to serve as useful planning tools. This is especially important because of the expansion of soybean production since 1970.
2. Linkages between government-university research groups and extension centers should be strengthened. This would accelerate information and technology delivery, while acquainting researchers with the specific needs and problems of crop-livestock producers.
3. Soybean cultivation should be encouraged, but not at the expense of staple food crops. Additional credit should be provided, particularly to small-scale black bean producers. This would increase self-sufficiency in food production and promote development in low-income farming zones.
4. The possibilities for wheat production in areas of Rio Grande do Sul better suited environmentally than the Planalto Medio should be explored. Special attention should be given to the potential for wheat in the high <u>campos</u> of the state's northeast and in the Bagé area, both of which have higher average wheat yields than does the Planalto Medio.

It is hoped that these recommendations will stimulate further thought on the study topic among scholars and government planners. The importance of ranching and agriculture in Rio Grande do Sul cannot be overstated, considering the state's role in Brazilian agriculture and Brazil's position as the second largest provider of foodstuffs for a hungry planet.

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APPENDICES

APPENDIX A

FORMAL INTERVIEW SCHEDULE

APPENDIX A

FORMAL INTERVIEW SCHEDULE

Data____________________

Capa Do Questionário

Numero de respondente_______

Município__________________________

Localização da propriedade____________________________________

____

____

Tipo de cultura: arroz_____
soja______
trigo_____

Tipo fundiário da propriedade: grande propriedade_____
pequena propriedade____

Topografia geral na zona
e da propriedade: plano ____
undulada ____
acidentada____

Comentários gerais:

Questionário Formal

1. Quantos anos possue? _________ anos

1.	_____	15-20 anos	7.	_____	46-50 anos
2.	_____	21-25 anos	8.	_____	51-55 anos
3.	_____	26-30 anos	9.	_____	56-60 anos
4.	_____	31-35 anos	10.	_____	61-65 anos
5.	_____	36-40 anos	11.	_____	mais de 65 anos
6.	_____	41-45 anos			

2. Qual é seu estado civil?

   1. _____ casado
   2. _____ soltero
   3. _____ outro

3. Onde nasceu? ____

4. Onde nasceram seus avôs? ______________________________

5. Quantos membros possue sua familia? ___________

1.	_____	2	7.	_____	8
2.	_____	3	8.	_____	9
3.	_____	4	9.	_____	10
4.	_____	5	10.	_____	11
5.	_____	6	11.	_____	12
6.	_____	7	12.	_____	mais de 12

5a. Quantas crianças? _________

1.	_____	1	8.	_____	8
2.	_____	2	9.	_____	9
3.	_____	3	10.	_____	10
4.	_____	4	11.	_____	11
5.	_____	5	12.	_____	12
6.	_____	6	13.	_____	mais de 12
7.	_____	7			

6. Qual é seu grau de escolarização?

   1. _____ escola primária
   2. _____ ginásio
   3. _____ segundo grau
   4. _____ universidade
   5. _____ nenhum

7. É membro de organização (organizações) agrícola(s)?

1. _____ Sim Siga a #7a.
2. _____ Não Siga a #8.

7a. Se Sim, que tipo de organização (organizações)?

1. _____ cooperativa agrícola
2. _____ cooperativa de criadores
3. _____ associação de produtores para cultura específica
4. _____ outra

8. Quanto tempo vôce é agricultor? __________

1. _____ 1 ano ou menos
2. _____ 2 anos
3. _____ 3 anos
4. _____ 4 anos
5. _____ 5 anos
6. _____ 6 anos
7. _____ 7 anos
8. _____ 8 anos
9. _____ 9-10 anos
10. _____ 11-12 anos
11. _____ 13-14 anos
12. _____ 15-16 anos
13. _____ 17-20 anos
14. _____ 21-25 anos
15. _____ mais de 25 anos

8a. Sempre no Rio Grande do Sul?

1. _____ Sim
2. _____ Não

9. Mora em sua propio propriedade rural?

1. _____ Sim Siga a #10.
2. _____ Não Siga a #9a.

9a. Onde mora?

1. _____ outra propriedade rural
2. _____ cidade vizinha, que cidade? __________
3. _____ Porto Alegre
4. _____ outro lugar

10. E proprietário vôce das terra cultivadas?

1. _____ Sim Siga a #10a.
2. _____ Não Siga a #10b.

10a. Está arrendando terras a outros agricultores?

1. _____ Sim
2. _____ Não ou não aplicável

10b. É

1. _____ arrendatário
2. _____ parceiro
3. _____ posseiro
4. _____ empresa de socios
5. _____ nenhum de istos

11. Que é sua cultura principal?

1. _____ arroz
2. _____ soja
3. _____ trigo

12. Está usando as suas terras para outras atividades além das culturas (arroz-soja-trigo) mencionada na pergunta anterior?

1. _____ Sim Siga a #12a.
2. _____ Não Siga a #13.

12a. Que culturas ou atividades?

1. _____ sorgo
2. _____ milho
3. _____ soja
4. _____ arroz
5. _____ feijão preto
6. _____ uva
7. _____ batata inglêsa
8. _____ batata dôce
9. _____ mandioca
10. _____ trigo
11. _____ avicultura
12. _____ suinicultura
13. _____ pastagen para gado de corte
14. _____ pastagen para gado de leite
15. _____ pastagen para ovinos
16. _____ outra

13. Quantos hectares tem em sua propriedade?

1. _____ 0-10 hectares
2. _____ 11-20 hectares
3. _____ 21-40 hectares
4. _____ 41-60 hectares
5. _____ 61-100 hectares
6. _____ 101-200 hectares
7. _____ 201-500 hectares
8. _____ 501-1,000 hectares
9. _____ 1,001-2,000 hectares
10. _____ 2,001-5,000 hectares
11. _____ mais que 5,000 hectares

14. Quantos hectares approximadamente está <u>cultivando</u> em total (incluyendo pastagen artificial)?

1. _____ 0-10 hectares
2. _____ 11-20 hectares
3. _____ 21-40 hectares
4. _____ 41-60 hectares
5. _____ 61-100 hectares
6. _____ 101-200 hectares
7. _____ 201-500 hectares
8. _____ 501-1,000 hectares
9. _____ 1,001-2,000 hectares
10. _____ 2,001-5,000 hectares
11. _____ mais que 5,000 hectares

15. Quantos hectares tem em sua cultura principal?

1. _____ 0-10 hectares
2. _____ 11-20 hectares
3. _____ 21-40 hectares
4. _____ 41-60 hectares
5. _____ 61-100 hectares
6. _____ 101-200 hectares
7. _____ 201-500 hectares
8. _____ 501-1,000 hectares
9. _____ 1,001-2,000 hectares
10. _____ 2,001-5,000 hectares
11. _____ mais que 5,000 hectares

16. Está fazendo rotação em suas lavouras?

1. _____ Sim Siga a #16a.
2. _____ Não Siga a #17.

16a. Quais culturas ou atividades pecuárias?

1. _____ milho
2. _____ soja
3. _____ trigo
4. _____ ovinos (pastagen) e arroz
5. _____ gado de corte (pastagen)
6. _____ gado de leite (pastagen)
7. _____ arroz
8. _____ centeio
9. _____ cevada
10. _____ mandioca
11. _____ feijão preto
12. _____ batata inglêsa
13. _____ batata dôce
14. _____ sorgo
15. _____ outra

17. Que foi seu rendimento em quilos por hectare para sua última colheita do produto principal (arroz, soja, ou trigo)?

___________________ quilos/hectare

18. O que aconteceu na ultima colheita do produto principal (arroz, soja, ou trigo)?

1. _____ aumentou o rendimento
2. _____ ficou o mesmo o rendimento
3. _____ diminuiú o rendimento

19. Quais são os fatores responsáveis para seu rendimento do produto principal (arroz, soja, ou trigo) na última colheita?

1. _____ condições de tempo
2. _____ doenças
3. _____ consultas com técnicos do governo
4. _____ sementes diferentes
5. _____ adubação diferente
6. _____ correção dos solos
7. _____ temporada de aplicação de insumos
8. _____ mais crédito rural
9. _____ menos crédito rural
10. _____ assistência técnica melhorada
11. _____ assistência técnica insuficente
12. _____ mecanização/novos implementos agrícolas
13. _____ outras causas

20. Está cultivando ou pretende a cultivar outra cultura que não foi feita no ano pasado em sua propriedade?

1. _____ Sim Siga a #20a.
2. _____ Não Siga a #21.

20a. O que é a nova cultura?

1. _____ milho
2. _____ soja
3. _____ trigo
4. _____ arroz
5. _____ pastagen artificial
6. _____ feijão preto
7. _____ batata inglêsa
8. _____ batata dôce
9. _____ sorgo
10. _____ hortaliças
11. _____ outra

21. Pretende a abandonar ou reduzir no ano que vem alguma cultura ou atividade pecuária que tem agora?

1. _____ Sim Siga a #21a e #22.
2. _____ Não Siga a #23.

21a. Que cultura ou atividade pecuária pretende a abandonar ou reduzir?

1. _____ milho
2. _____ soja
3. _____ trigo
4. _____ arroz
5. _____ pastagen artificial
6. _____ feijão preto
7. _____ batata inglêsa
8. _____ batata dôce
9. _____ outra

22. Que cultura vai a plantar a substituir para a cultura abandonada na mencionada pergunta anterior?

1. _____ milho
2. _____ soja
3. _____ trigo
4. _____ arroz
5. _____ pastagen artificial
6. _____ feijão preto
7. _____ batata inglêsa
8. _____ batata dôce
9. _____ sorgo
10. _____ hortaliças
11. _____ outra
12. _____ nenhum

23. O área que tem suas lavouras do produto principal (arroz, soja, ou trigo) está

    1. _____ mais grande que o ano pasado
    2. _____ o mesmo que o ano pasado
    3. _____ menos grande que o ano pasado

24. Quais fatores foram responsáveis para esta situação em sua propriedade mencionada na pergunta anterior?

    1. _____ mudança do preço do mercado
    2. _____ mudança do preço mínimo
    3. _____ consulta (s) com extensionistas ou técnicos do governo
    4. _____ tempo
    5. _____ tecnologia nova
    6. _____ adquisação de novos implementos agrícolas
    7. _____ topografia desfavorável
    8. _____ enfraquecimento dos solos
    9. _____ erosão dos solos
    10. _____ desejo a diversificar a produção
    11. _____ mais pastagen
    12. _____ outro fator

25. Utiliza os serviços de extensão rural (técnicos, etc.) fornecido pelo governo?

    1. _____ Sim Siga a #26.
    2. _____ Não Siga a #25a.

    25a. Se não, que?

        1. _____ conhecimento insuficiênte
        2. _____ carencia de fé com istos serviços
        3. _____ longe demais de escritório de extensão rural (ASCAR) ou Delegacia Agrícola
        4. _____ problemas de transporte
        5. _____ falta de necessidade
        6. _____ outra razão, o que é? _______________

26. O agrônomo, técnico rural, ou extensionista do governo, ele ou ela fazem visitas a sua propriedade?

    1. _____ Sim Siga a #26a.
    2. _____ Não Siga a #27.

    26a. Qual escritório de ASCAR, Delegacia Agrícola, ou IRGA ele ou ela pertenece?

    ________________________________ (cidade)

27. Faz visitas ao escritório de extensão e assistência rural (ASCAR) ou outra entidade similar?

    1. _____ Sim Siga a #27a.
    2. _____ Não Siga a #28.

    27a. Se Sim, onde fica esta escritório?

    ________________________ (cidade)

28. Quais sugestões tem recibido dos técnicos do governo?

    1. _____ informações sôbre sementes novos
    2. _____ informações sôbre adubação
    3. _____ informações sôbre pragas, doenças, etc.
    4. _____ informações sôbre defensivos agrícolas
    5. _____ novas técnicas agrícolas
    6. _____ informações sôbre terraceamento
    7. _____ informações sôbre implementos agrícolas
    8. _____ informações sôbre rotação das lavouras
    9. _____ informações sôbre erosão dos solos e problemas relatadas
    10. _____ informações sôbre como fazer uma amostragem de solo
    11. _____ publicações agrícolas
    12. _____ outra

29. Está usando alguma idéia nova introduzido pelo governo em suas culturas que não usou no ano pasado?

    1. _____ Sim Siga a #29a.
    2. _____ Não Siga a #29b.

    29a. Qual é a nova idéia que vôce experimentou?

        1. _____ sementes novos
        2. _____ conservação dos solos
        3. _____ adubação
        4. _____ controle de pragas/uso de defensivos agrícolas
        5. _____ mudança de época para plantar
        6. _____ novo método para plantar
        7. _____ pastagen artificial
        8. _____ uso de implementos agrícolas/mecanização
        9. _____ outra, o que foi?

        ____

29b. Por que não?

1. _____ custoso demais a implementar estas novas idéias de eles
2. _____ discorda com os técnicos do governo
3. _____ não tem confiança em técnicos
4. _____ grande risco econômico para vôce como produtor
5. _____ falta de necessidade para os conselhos do governo
6. _____ outra razão

30. Quais outros fontes de informações sôbre agricultura (novas idéias) alem do governo pretende aproveitar ou já aproveitou?

1. _____ amigos ou parentes
2. _____ radio
3. _____ televisão
4. _____ cooperativas agrícolas
5. _____ centros de inseminação artificial, associações de criadores de gado, ovinos, etc.
6. _____ revistas agrárias
7. _____ associações agrícolas
8. _____ representantes de empresas agrícolas particulares
9. _____ jornais
10. _____ outros fontes
11. _____ nenhum

31. Os amigos com quem vôce conversa sôbre problemas de agricultura/pecuária moram a que distancia (mais ou menos)?

1. _____ 1 quilômetro
2. _____ 2 quilômetros
3. _____ 3 quilômetros
4. _____ 5 quilômetros
5. _____ 8 quilômetros
6. _____ 10 quilômetros
7. _____ 15 quilômetros
8. _____ 25 quilômetros
9. _____ 50 quilômetros
10. _____ 100 quilômetros
11. _____ mais de 100 quilômetros

31a. Eles (seus amigos) moram em

1. _____ Santa Rosa
2. _____ Três do Maio
3. _____ Santo Ângelo
4. _____ Ijuí, Chiapeta, ou Catuípe

5. _____ Cachoeira do Sul
6. _____ Santa Vitória do Palmar
7. _____ zona rural afora do-sede do município
8. _____ outro lugar

32. Como produtor, está participando em algumos experimentações agropecuárias em cooperação com o governo?

1. _____ Sim
2. _____ Não

32a. _____ Se Sim, adotaría mais novas idéias agrícolas se fosse proprietário?

32b. _____ Se Sim, adotaría menos novas idéias agrícolas se fosse proprietário?

34. Que distancia mais ou menos viaja para procurar crédito agrícola ou assistência financeira?

1. _____ 0-5 quilômetros
2. _____ 6-10 quilômetros
3. _____ 11-15 quilômetros
4. _____ 16-25 quilômetros A onde? ______________
5. _____ 26-50 quilômetros
6. _____ 51-100 quilômetros
7. _____ mais de 100 quilômetros

35. Quanto tempo precisa para transportar seu(s) produto(s) agrícola(s) ao mercado para comercialização?

1. _____ 10 minutos
2. _____ 20 minutos
3. _____ 30 minutos
4. _____ 45 minutos
5. _____ 1 hora
6. _____ 2 horas
7. _____ 4 horas
8. _____ mais que 4 horas

36. Qual modo ou tipo de transporte usa para levar estos produtos ao mercado?

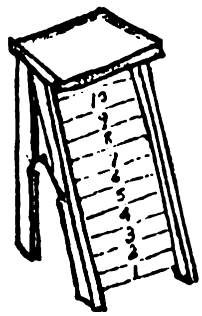
1. _____ caminhão privado
2. _____ caminhão coletivo
3. _____ caminhão de outro agricultor
4. _____ caminhão de camionhero
5. _____ caminhão de empresa de transporte
6. _____ estrada de ferro
7. _____ transporte fluvial

37. Como faz comercialização dos produtos agrícolas (também produtos pecuários se aplicável)?

1. _____ cooperativa agropecuária
2. _____ empresa particular
3. _____ venta direta ao governo
4. _____ mercado local
5. _____ outra entidade

38. Na escada, a parte acima representa a realização de suas metas e aspirações como produtor. Em sua opinião,

1. _____ onde está vôce na escada atualmente?
2. _____ onde foi vôce na escada ha dois anos?
3. _____ onde vôce pretende estar na escada daqui a dois anos?



APPENDIX B

INFORMAL INTERVIEW SCHEDULE

APPENDIX B

INFORMAL INTERVIEW SCHEDULE

<u>QUESTIONÁRIO INFORMAL</u> Lugar________
Data________

1. Tipo de produção agropecuária

2. Tamanho meio das lavouras

3. Estrutura fundiária

4. Donos da terra residentes em outras cidades - a onde?

5. Mudança de uso da terra agrícola - se sim, porque?

6. Mercado(s) principais para a produção agropecuária

7. Rutas de transporte para a produção agrária - estradas primárias

8. Tipo(s) de transporte utilizado

9. Inovações agrícolas - como funciona a entrega de tecnologia e idéias novas ao produtor

10. Receptividade das agricultores em respeito a inovação na agricultura

11. Relação com tenência de terra e melhoramento das tecnícas agropecuárias

12. Novos projetos introduzidos, implementados ou em andamento em relação o desenvolvimento agrário

13. Rotação das lavouras - tipo de lavoura

14. Tipos de solos na zona - ventagens ou problemas particulares

15. Uso de fertilizantes, correção de solos, uso de defensivos - outros insumos

16. Colheita das lavouras - mecanizada ou manual

17. Vinculação de técnico com pesquisas agropecuárias do governo

18. Vinculação de técnico com pesquisas agropecuárias universitarias

19. Vinculação de técnico com cooperativas agrícolas e instituções bancárias

20. Problemas vôce pode notar que são obstáculos para o desenvolvimento agrário em sua zona

Comentários


57°
55°
53°
51°
28°
30°
32°
Rio Uruguai
ARGENTINA
Santa Catarina
URUGUAY
ATLANTIC OCEAN
Uruguai
Rio
Santa Rosa
Palmeira das Missões
Erechim
Barragem Passo Fundo
Santo Ângelo
Passo Fundo
Vacaria
São Borja
Cruz Alta
Barragem Ernestina
Caxias do Sul
Lajeado
Santa Cruz do Sul
Novo Hamburgo
Santa Maria
Uruguaiana
Alegrete
Cachoeira do Sul
GREATER PORTO ALEGRE
Santana do Livramento
Lagoa dos Patos
Bagé
Pelotas
Rio Grande
Lagoa Mirim
Lagoa Mangueira
RIO GRANDE DO SUL
AGRICULTURAL LAND USE/
USO DA TERRA AGRÍCOLA 1977
AGRICULTURAL LAND USE
(Uso da Terra Agrícola)
Livestock Raising
(Pecuária)
Wet Rice — Livestock
(Arroz Irrigado — Pecuária)
Soybean — Wheat Double Cropping
(Successão Soja — Trigo)
Small-Scale Diversified Agriculture
(Policultura em Pequenas Propriedades)
NON—AGRICULTURAL LAND
(Terras sim Atividades Agropecuárias)
Forest Areas
(Áreas Forestais)
Marsh and Mud Flats
(Áreas de Banhado e Restinga)
Sand and Eolian Beach Features
(Áreas e Formações Eolianais da Praia)
Major Urban Land Use Areas
(Zonas Importantes de Uso da Terra Urbana)
0
50
100
KILOMETERS
N
Based on 1:110,000 Scale 1975 Air Photos.
(Com base em fotos aéreas (1975) de escala de 1:110,000)
Compiled by David R. Hicks with assistance provided by the Central de Comandos Mecanizados de Apoio à Agricultura (CEMAPA) of the Secretaria da Agricultura of Rio Grande do Sul, 1977.
(Compilado por David R. Hicks com assistência prestado pelo Central de Comandos Mecanizados de Apoio à Agricultura (CEMAPA) da Secretaria da Agricultura do Rio Grande do Sul, 1977.)