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9. ABSTRACT
This report presents the results of a study that analyzed the productivities of various forms of capital resources at the farm level. Basic data collected concerning the 1965 farm operations of 821 farmers in Rio Grande do Sul and Santa Catarina, Brazil, were analyzed to determine: (1) how capital resources were being used on the farms; (2) the productivities attributible to the use of those capital resources; (3) variations in resource allocation and productivities among farms with different characteristics; and (4) specific policy implications of the findings. Among the authors' findings and conclusions: The results of the analysis demonstrate rather conclusively that agricultural activity is so diversely organized that broad generalizations are not very useful as policy guides. Possibilities for improving productivity in southern Brazil have been overlooked partly because of lack of understanding of the potentials existing in various types of farm operations. The following findings are discussed in detail: Farm operations with 20 to 30 hectares of productive land, using draft animal power, make relatively full use of available land, labor, and capital resources. Farms with less than 20 hectares of productive land do not adequately use the available family labor resource unless the farm is engaged in a specialized labor-intensive enterprise. Farms with more than 30 hecatres either have a lower percentage of total area cultivated or have additional capital investments for power sources. With all types of farms, the larger the farm size, the more the average returns diminish in terms of yield per hectare. Crop farms and especially mechanized crop farms are making greater use of profitable new crop inputs and credit than are livestock farms. Farms with less than ten hectares of productive land are not generating sufficient income to meet annual production, consumption, and investment needs. The change from traditional livestock farming to mechanized crop farms has resulted in

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a sixfold increase in gross output. Unlike what might be expected, the quantity of labor used on mechanized crop farms, in comparison with livestock farms, is 50 per cent greater. The level of credit use on mechanized crop farms is ten times greater than on traditional livestock farms. Crop expenses per hectare are 2.5 to 8 times greater on mechanized crop farms than on non-mechanized small farms. Amounts of credit used for purchasing these inputs are 8 to 20 times greater on mechanized crop farms. Management performance is a strong indicator of level of productivity. Managers rate higher on livestock practices than on crop practices.

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To Mr. Moulbrogen
Owen

Terminal Report for Research Project

Analysis of Capital Formation and Utilization in Less Developed Countries

by
Norman Rask

December, 1969

Under Research Contract AID/csd-1937

between

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Columbus, Ohio

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Foreword

The Department of Agricultural Economics and Rural Sociology at The Ohio State University entered into subject contract to analyze the principles of capital formation and capital utilization in the agricultural sectors of less developed countries on July 1, 1968. The project, originally designed as a one year effort to terminate on June 30, 1969, was subsequently extended within the original budget to September 30, 1969 and terminated on that date.

The project had as its primary objective a detailed investigation of the productivities of various forms of capital resources at the farm level. The scope of analysis was limited to data already assembled in the Department of Agricultural Economics and Rural Sociology at The Ohio State University. This data had previously been collected in Brazil as part of an agricultural credit research project.*

The report is organized in the following manner. First, a brief summary of the major findings of the research is given. This is followed by a description of the agriculture and type of farming from which the data was collected. A final section contains individual reports of four specific studies from which the summary is drawn. They are: (1) a study of income, investment, and savings patterns, (2) an analysis of resource productivities, (3) a study of the impact of selective price and credit policies on the use of new inputs and mechanization, and (4) a study of the management performance and productivity of capital resources under different levels of management on hog farms.

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The following individuals participated in the analysis of specific segments of the research work: Donald Sorensen, Paulo Araujo, Haralambos Simeonidis, Larry Martin, John Stitzlein, and Bodepudi Rao.

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SUMMARY OF MAJOR RESEARCH FINDINGS

The research results reported here are based on farm level data collected in selected type-of-farming regions in the two southernmost states of Brazil--Rio Grande do Sul and Santa Catarina. Detailed economic data were collected from 821 farmers concerning their 1965 farm operations. The data from these farm observations were organized in various ways for specific analytical studies. The general objectives of these studies were to determine:

1. the manner in which capital resources were being used on the farms,
2. the productivities, both average and marginal, that could be attributed to the utilization of these capital resources,
3. the variation, in both resource allocation and productivities, among farms with different characteristics, and
4. the specific policy implications and suggestions implied by these analyses.

General Comments

A casual acquaintance with the agriculture of developing countries often suggests that broad generalizations are sufficient to categorize agriculture for policy purposes. Generalizations, such as domestic and export agriculture, commercial and non-commercial agriculture, are sometimes used. The results of the analysis reported here, however, demonstrate rather conclusively that broad generalizations are not very satisfactory as policy guides. Within the area studied, a great diversity in the organization and productivity of agriculture was observed. There is great variation in size of farm, type, and combination of enterprises, technology utilized, quality of management, and in returns to factors of production.

This diversity results partly from differences in topography and settlement patterns. More importantly, the dramatic differences in use of technology and productivity also partly result from government policies that implicitly or explicitly include or exclude various segments of agriculture. Policies, such as favorable product pricing, availability of credit in sufficient quantity, and with terms applicable to the type of agriculture in question, allow one group to move ahead rapidly in the acceptance and use of new technology. The contrary policy position in price and credit results in other segments of agriculture being effectively blocked out.

Each of these factors is operative in the development of the agriculture of southern Brazil; the effect of specific policies is apparent in the analysis reported below. In general, substantial gains in the use of technology and productivity increases have occurred in areas which have had favorable physical and economic conditions. In adjacent areas, where some of these conditions are not present, substantial latent benefits are waiting to be realized. It appears that these possibilities have been overlooked largely as a result of lack of understanding of the potential productivities that exist in various types of farm operations within the diverse agriculture found in southern Brazil.

In the past, some agricultural policies have concentrated on specific areas or enterprises and the results have been dramatic and significant. At the same time, other areas or enterprises with substantial opportunities for improvement have been ignored. Thus, these policies have resulted in a less than optimum allocation of scarce capital resources.

Specific Findings

The remainder of this summary is organized around the results of four studies.[1/] For purposes of exposition, the major findings are grouped into general subject matter areas. At the beginning of each subject matter area, the main issues are presented in capsule form. They are followed by brief supporting statements drawn from the specific studies. The four studies are:

1. a study of income, consumption, and investment patterns by farm type and size,

2. an analysis of resource productivity, again by farm type and size,

3. a comparative study that focuses specifically on three types of farms to demonstrate the impact of selective price and credit policy on the use of new inputs and mechanization, and

4. a study focusing on management performance and productivity on hog farms in one of the small farm regions.

Income, Resource Use, and Productivity

1. Resource Use and Farm Size[2/]

   a. As a general guide, farm operations with 20 to 30 hectares of productive land and using draft animal power make relatively full use of available land, labor, and capital resources.

   b. Farms with less than 20 hectares of productive land do not adequately utilize the available family labor resource at their disposal unless specialized, labor intensive enterprises are employed.

   c. Farms with more than 30 hectares of productive land either have a lower percentage of total area cultivated or have additional capital investments for power sources.

   d. Diminishing average returns to farm size (measured in number of hectares) are experienced within all farm types.

1/ Part II of this report contains detailed descriptions of each of the four studies.

2/ Farm size is measured here in hectares of productive land not total land area. Productive land is defined as all land used for cultivated crops and improved pasture plus one-third of the area in permanent unimproved pasture.

There are significant differences in the size of farm operations both within and among farm types. The utilization and productivity of farm resources are affected by the type of enterprise and the size of farm. When farms are grouped on a basis of size, the evidence of diminishing average returns to the land resource is very evident as size of farm increases. Farms with less than four hectares of productive land, for example, experience average output per hectare which is four times that of farms with 50 or more hectares. Between these two extremes, there is a rather uniform decline in output per unit of total land operated as the size of farm increases. The diminishing returns to size are not affected by intensity of land use on farm sizes up to 30 hectares. Farms above 30 hectares demonstrate a somewhat lower percentage of cultivated area, however, the differences are not great. This indicates that within the range of farm sizes studied, land is not being greatly under-utilized and that differences in productivity per unit of land are due more to the nature of the farm enterprise and perhaps partly reflect lack of ability to manage larger units.

Labor was in excess supply on most of the small farms and hired labor became a profitable expenditure only on farms in excess of 20 hectares. Livestock is a profitable alternative on farms with less than 30 hectares; a result that is consistent with the availability of surplus labor. Thus, a livestock feeding enterprise is complementary to a crop enterprise for the use of the labor resource on the smaller farms, but may become competitive on the larger farms. Variations in the level of utilization of power and equipment is important in explaining variations in output only on the larger farms and the estimated marginal returns become significantly higher as farm size increases.

Thus, on farms with 20 to 30 hectares (with existing types of farm enterprises), the labor and land resources are fully utilized. Increases in size beyond 30 hectares will necessitate either lower intensity of land use or capital investment in additional sources of power. Sizes of farms that are considerably smaller than this would result in inefficient use of available family labor unless specialized labor-intensive enterprises are employed, an alternative not available to every farmer.

2. Use and Productivity of Variable Capital

> Crop farms and especially mechanized crop farms are making greater use of profitable new crop inputs and credit than are livestock farms.

Cash crop farms demonstrate a greater intensity of use of operating expenses and credit than do livestock farms producing essentially the same crops, but feeding these crops to livestock. The mechanized crop farms show considerably greater expenditures and credit use than any other farm types. Crop expenses are an important variable in explaining variations in output on the farms studied. The marginal returns are inversely related to the level of utilization, that is, low level of utilization related to high marginal return, and, with the exception of mechanized crop farms, are consistently high.

3. Farm Income

> Farms with less than ten hectares of productive land are not generating sufficient income to meet annual production, consumption, and investment needs.

The average net cash position for each farm group, after allowing for operating costs and family living, was positive. As a general rule, this surplus was sufficient for the larger farms to cover the level of new investment. New investments could not, however, be adequately covered from current income on farms with less than ten hectares. Further, after allowing for net borrowing,

the small farms still displayed a cash deficit situation. Thus, a portion of annual expenditures on these farms had to be met with other funds, presumably from deposits or hoardings; a situation that could not long be maintained without decapitalization.

The Impact of Selective Price and Credit Policy on The Use of New Inputs and Mechanization

The government of Brazil has adopted several measures to increase agricultural productivity which are particularly relevant for some of the farms found in this region. One of these measures is to subsidize the use of modern inputs, primarily fertilizer and farm machinery. Capital constraints have been substantially eased by making credit available to farmers for these purposes. Negative real interest rates have substantially lowered the cost of using these modern inputs. In addition, wheat prices have been supported to induce a greater supply of this commodity. This combination of events resulted in the transformation of extensive cattle grazing farms to intensive mechanized crop production. In the same area, however, farms too small to support a tractor have continued with established methods of cultivation. While fertilizer, hybrid seed, and other modern crop inputs are available to many of these small farmers, they have generally had little access to credit. Thus, within this region, it is possible to contrast the structure and performance of three distinct farm situations in close proximity to one another: (1) an established, traditional, extensive livestock grazing system, (2) a new intensive mechanized crop system that has evolved from the above, and (3) a more or less transitional small farm agriculture that has modern inputs available, but apparently lacks sufficient credit to employ adequate quanitites of these inputs.

1. Comparison Between Traditional Livestock and Mechanized Crop Farms

   a. The change to mechanized crop farms has resulted in a sixfold increase in gross output.

   b. The quantity of labor used has increased 50 percent.

   c. The level of credit use on mechanized crop farms is ten times greater than on traditional livestock farms.

Dramatic changes have taken place on land that has previously been used almost entirely for unimproved pasture. Gross output levels on the mechanized crop farms are six times greater than those found on the traditional livestock farms. Net income differences are four times greater. The net returns to total capital investment increased from three to 12 percent.

Labor utilization actually increased by 50 percent. This is a phenomenon not normally anticipated with introduction of mechanization since it is commonly thought of as a substitute for labor. Undoubtedly, there is also a need for additional as well as different labor skills. Caution should be exercised in projecting this increased labor use to other situations since the increased labor requirement was associated with a change in enterprise as well as a change to mechanization.

Though lacking quantitative data on borrowing in the past, it can be logically inferred that borrowings must have formed a large part of the initial capital assets on the mechanized crop farms. Data available on the purchase of capital items during the year of record show that mechanized crop farms have incurred new investments equal to 18 percent of their reproducible material capital. Credit was used to finance about one-third of these purchases. External financing formed a greater proportion--almost two-thirds--of annual operating expenses. Altogether, more than one-half of the total annual cash outlays on these farms were financed from external credit sources.

Current liabilities on the mechanized crop farms account for about 20 percent of the total value of capital assets. The corresponding figure on the traditional livestock farms is one percent. Further, of the total amount of credit now utilized by mechanized crop farms, 84 percent was for operating expenses. Livestock farms borrow very little in absolute terms and devote a substantial portion of funds borrowed to non-farm purposes.

2. Comparison Between Mechanized Crop Farms and Non-Mechanized Small Farm Agriculture

This analysis focuses specifically on credit availability and crop input use.

a. Crop expenses[3/] per hectare are two-and-a-half to eight times greater on mechanized crop farms than on non-mechanized small farms.

b. Amounts of credit used for purchasing these inputs are eight to 20 times greater on mechanized crop farms.

c. The ratio of marginal returns to costs for the specific crop inputs of seed, fertilizer, and insecticides is near unity for mechanized crop farms indicating maximum utilization of these inputs.

d. This ratio is two to five times greater on small farms indicating a substantial economic potential for increased use of these new inputs on small farms.

Mechanized crop farms with adequate financing have committed approximately $17.00 per hectare for the purchase of seeds, fertilizer, and insecticides. Small crop farms have committed only $5.00 per hectare for those items and other small farms--mostly livestock farms--incurred an expense of only $2.70 per hectare. Marginal productivity estimates for these expenses are consistent with economic logic ranging from a low of approximately one (cost equated to return at the margin) on the mechanized farms to a high of five on the small livestock farms.

3/ Crop expenses include annual expenditures for hired labor, machinery operating costs, seed, fertilizer, and insecticides.

The level of crop expenses per hectare is directly related to the use of credit to purchase these inputs. In addition, a greater percentage of the crop expenses are financed by credit on farms with a high level of input use. Actual credit use for crop expenses ranges from a high of $24.80 per hectare on the mechanized crop farms to a low of about $1.50 on the livestock farms. Considering the level of input use, the amount of credit used for the acquisition of these inputs, and the resulting marginal productivity, it would appear that there has been a failure to recognize or capitalize on the potential for the profitable employment of additional resources on these small farms. Whether this situation results from a lack of credit, technical assistance inputs, or some other factor or is a combination of these was not determined. Mechanized farms with higher incomes, however, have employed considerably greater quantities of the same inputs using both more credit and personal resources to pay for these inputs and have equated the costs and returns at the margin. This would suggest that available resources for the purchase of modern inputs are lacking on small farms and that access to additional credit would result in positive application of new technology and production increases.

Management Performance and Productivity

The analysis of management was carried out on small and medium-sized specialized hog farms.

a. Management performance is a strong indicator of level of productivity.

b. High level managers can generally use increasing quantities of capital productively, but low level managers cannot.

c. Managers rate higher on livestock practices and lower on crop practices, an indication of limitations to spreading the management function over a series of activities.

d. Capital shortgage results in higher adoption for low cost practices and lower adoption of high cost practices regardless of anticipated payoff.

Management performance is a relatively strong indicator of level of productivity. This is especially noticeable at high levels of management performance. High level managers, operating with the same capital use intensity, demonstrate significantly higher levels of productivity than do poorer managers. Further, as the intensity of capital use increases, high level managers continue to experience successively higher levels of productivity. Low level managers do not make effective use of increased quantities of capital and soon reach an output plateau beyond which additional capital inputs are not warranted.

A management performance index based on the accepted technological practices on swine farms reveals that the farmers are giving more consideration to good swine practices than to good crop practices. This would indicate that spreading the management function over several activities results in some loss of effectiveness. In this case, the emphasis is on livestock management at the expense of crop management.

The practices representing the least cash outlay are the first to be adopted. Other more expensive practices, such as protein supplements and fertilizer, are not widely accepted by farmers. Failure to adopt the more costly inputs may be a reflection of insufficient capital resources or price relationships that make them less profitable. High marginal productivity estimates for operating expenses and particularly crop expenses support the capital shortage argument.

Conclusions

Programs to foster modernization of developing agriculture must be based on an understanding of the diversity that exists among farms within any country and be designed to take advantage of the particular opportunities for development

that exist. Reliance on one or two major policy instruments will often lead to overkill in one area and the masking of other profitable investment opportunities. Balanced growth in agriculture and optimum allocation of funds dictate the need for an intimate knowledge of developing agriculture combined with the use of a broad set of policy instruments. The particular example from Brazil used in this analysis has focused on the dual role of credit and technology. This situation undoubtedly has application to many other developing areas. In other situations, credit and technology may not be first priorities. A program of farm level research is needed to form an adequate understanding of the needs and potential of developing agriculture.

Research Issues

The research results reported in this summary have raised some issues concerning the development process at the farm level that merit additional study. They are as follows.

1. Credit Needs With Changing Technology. Studies are needed to determine the role of credit in fostering and sustaining the adoption and use of various forms of technology on a broad range of farm situations. For example:

    a. Mechanization. The investigation of mechanization in the present study focused on a comparative analysis of livestock and crop farms. Additional studies should be undertaken on farm situations that do not involve enterprise changes. Further, each study should include an investigation of tenure and related resource acquisition problems encountered in securing control over the bundle of resources necessary to form a mechanized farm unit. These studies may include: (1) the transition from small and medium size crop farms to medium and large mechanized crop farms, (2) the transition from extensive grazing on natural pastures to the establishment of annual improved pastures, (3) the use of mini tractors on small farm operations, and (4) cooperative ownership or custom operators for key tasks. Most major attempts to introduce mechanization are accompanied by substantial government support. The role of government policy in each of these studies should be carefully documented and evaluated.

b. Fertilizer. Many farmers do not use fertilizer; others use substantial quantities. Productivity analyses suggest that fertilizer is generally an economic investment and when capital restraints are removed farmers generally apply optimum quantities. Studies are needed which focus on the use and productivity of fertilizer including the role of credit as a facilitating factor. These studies could attempt to determine the minimum return necessary to induce farmers to use fertilizer and the credit policies necessary to enable farmers to acquire this input and make repayment from the expected income flow stream. Additional constraints to the adoption and use of fertilizer should also be determined and studied.

2. Savings Capacity in Agriculture

New technology often requires additional capital. It also generates new income. Theoretically, part of this added income is available for new investments in agriculture. These possibilities may exist within the farm firm or in other segments of agriculture. Rural savings institutions with sufficient incentive to attract surplus income would greatly facilitate capital mobilization within the agricultural sector. Savings and investment studies are needed which focus on the capital necessities associated with new technologies. Areas should be studied that have made significant progress in the adoption of new technology as well as control areas that have not. An evaluation of the increase in productivity and income resulting from the use of new inputs and the amount of new savings that might be generated from this income should be included.

3. Size and Role of Non-Institutional Credit Market

Preliminary analysis indicates that non-institutional credit occupies a relatively unimportant role in Latin America. It is not clear what relationship exists between institutional and non-institutional credit, that is, are they complementary or competitive? Also, does non-institutional credit decline or grow in importance with development? Does public policy committed to low interest rates inhibit the formation of capital resources in this area?

4. Capital Formation Process in New Settlement Areas

Studies are needed to evaluate the capital formation process in areas of new settlement. These studies would look at the decapitalization that was taking place in overpopulated areas to serve as sources of financing and capital transfer to new areas. Within the new settlement areas, the capital formation process should be studied both in terms of internally generated capital and capital coming from external sources of support.

5. Constraints on The Use of New Technology--Management Versus Capital

The analysis of the management factor in this study suggested that: (1) capital is more productive under high levels of management and (2) high level managers can generally use increasing quantities of capital productively, but low level managers cannot. Thus, at initial levels of technology use, capital is probably the most limiting or constraining factor. As use of technology increases and larger amounts and more sophisticated forms of capital resources are employed, lack of management ability may become the more important constraint. Studies are needed that focus specifically on the trade-off between capital and management at various levels of technology use.

GENERAL METHODOLOGY AND DATA DESCRIPTION

Introduction

Attainment of economic progress has emerged as a principal objective common to most nations of the world. The predominance of the agricultural sector in most of the underdeveloped nations suggests the assignment to agriculture of a major role in the process. If agriculture is going to fulfill this expected role, increased productivity from resources committed to this sector is required.

The productivity of resources used in basic agricultural production is a function of their quantity and combination within individual farm firms. In underdeveloped nations, the most plentiful resources available for agricultural production are land and labor. Conversely, capital and entrepreneurial resources are severely limited. The institutional, physical, and social considerations related to land and labor imply long-run adjustments in their reallocation. Capital and management, on the other hand, take numerous forms and can be injected into individual farm firms in alternative ways and amounts.

The greater flexibility associated with allocation of capital and management resources leads policymakers to emphasize these factors in the conceptualization and implementation of programs designed to stimulate production of basic agricultural commodities. Public involvement in capital allocation takes two forms: public capital resources channeled to the agricultural sector and public monetary, fiscal, and credit measures designed to induce private capital movement into agriculture.

It is a widely held contention among those concerned with agricultural development that increased injections of capital will significantly increase production. The belief that capital is productive in both the physical and economic sense together with the relative ease of transforming money capital into

various specific forms for use in agriculture gives rise to numerous schemes and techniques for the accomplishment of this task. Thus, some programs provide capital in the form of credit which can be used for purchasing the combination of inputs considered essential by each producer. Other programs provide credit for all aspects of agriculture such as in programs of agrarian reform. Still other programs provide capital inputs in more specific forms such as inorganic fertilizer, hybrid seed, tractors, or mechanized equipment. In many programs of this latter type, credit financing is used to induce participation in the input program. Regardless of the type of program implemented, too little is known about productivities, physical and financial, of the capital inputs. All too often, the mere assumption that capital is scarce, therefore, automatically productive when combined with more plentiful resources provides sufficient grounds for adoption and implementation of programs to inject capital inputs into agriculture.

Others interested in the development process concur that capital inputs are essential to stimulate agricultural output, but contend further that capital inputs can be productively employed only if agricultural producers are provided complementary managerial inputs in the form of technical knowledge and other relevant agricultural information. Programs of supervised or oriented credit in which close supervision and technical guidance by agricultural technicians are a necessary prerequisite for producer participation are examples of this concept. Similar examples exist in action taken by agriculturally related industries which provide requisite inputs including management to agricultural producers.

Generally, capital is the most scarce resource available to a nation; hence, selection of priority allocation programs is essential for maximum results to be attained. All too often, however, adequate information is not available to guide policy decisions related to resource allocation. Superior allocative decisions

are difficult to make when the decision-maker has available only general data concerning capital and management productivity. To provide policymakers information requisite to proper decision-making, empirical research is required on factor productivities in specific agricultural situations.

Purpose

The formulation of meaningful theories, hypotheses, and policies applicable to agricultural development hinges on an intimate knowledge of the structure and processes in the agricultural sector. The general purpose of this study is to examine in depth specific problems at the farm level relating to agricultural development. The setting is the agricultural sector of southern Brazil. The results of four studies are presented.

1. A study of income, consumption, and investment patterns on farms of various types and sizes.
2. An analysis of resource productivity on these same farms.
3. A study of the impact of selective price and credit policies on the use of new inputs and mechanization at the farm level.
4. A study of the management performance and productivity of capital resources under different levels of management on hog farms.

Terms Defined

New Cruzerio (NCr$)	The new cruzerio is the current monetary unit of exchange in Brazil. At the time of the study, the "old cruzerio" was still in use. The financial data reported here has been translated into new cruzeiro equivalents. The exchange value of one new cruzeiro in 1965 would have been approximately 50¢ or alternatively, one dollar would have been equal to two new cruzeiros.
Hectare	A hectare is a land measure qual to 2.47 acres.
Kilogram	A kilogram is a weight measure equal to 2.2 pounds.
Municipio	A municipio is a political subdivision roughly equivalent to a county in the United States.
Land Equivalent	One land equivalent is equal to one hectare of cultivated land, one hectare of improved pasture, or three hectares of native pasture. This measure is used when farms of different types are compared.

Description of Area Studied

The data used in this analysis were collected in the two southernmost states of Brazil for the 1965 calendar year--Rio Grande do Sul and Santa Catarina. Altitude variations combined with a latitude location just within the southern temperate zone allow the cultivation of many tropic and temperate crops in close proximity. For example, within this region are found oranges, bananas, rice, wheat, and soybeans.

Geographically, there are four regions in southern Brazil; all of which are found within these two states. They are: a narrow coastal plain, a coastal mountain range, a high plateau, and an interior low plain. In addition, within each of these geographical regions, one finds differences in agricultural development in terms of farm size, enterprise combinations, and use of technology. Areas of small, intensive mixed enterprise farms in mountain regions using both traditional and modern methods of farming can be contrasted with large, extensive farms on open land grazing or medium size farms with the most modern technological practices.

An important geographical feature of this area is an escarpment located near the Atlantic Ocean with an altitude of approximately 3,000 feet above sea level. This escarpment is prominent along the eastern coast of southern Brazil with the exception of the southern half of Rio Grande do Sul where it turns inland. The escarpment is the beginning of a great plateau which is inclined from the sea to the west. The tilt of the plateau to the west results in almost no major river systems on the east coast of southern Brazil. Rivers, beginning near the escarpment only a few miles from the sea, flow hundreds of miles before entering the Atlantic Ocean as part of the Platte river system in Argentina. The plateau region encompasses by far the greatest area of the four regions of southern

Brazil. In contrast to the high plateau, there are two low level plains in this area. One is the narrow coastal plain along the Atlantic Coast and the other is an interior open range land in the southern half of Rio Grande do Sul.

A fourth geographical area is a mountainous region connecting the escarpment to the lower level plain. Each of these areas has distinctive soil, topographic, vegetation, and climate conditions which have resulted in different patterns of settlement and systems of agriculture. The coastal plain is of limited agricultural significance to this area. It is generally sandy and sometimes swampy. One municipio, Tubarao, was selected from this region. The three remaining areas are described in detail below.

High Plateau

The high plateau is characterized by mixed areas of open plains and pine forest. Forest products have been an important source of income to this area in the past. Where the rivers are cut very deeply into the plateau, topographic situations and settlement patterns similar to those on the coastal mountain range are found. These interior mountain regions were settled in the early 1900's by second and third generation descendants of German, Italian, and other European immigrants moving from the coastal range to these interior valleys. Also, the types of agricultural production found in the interior valleys are similar to those of the coastal mountain range.

The open plain of the plateau was the first area settled for agricultural purposes. It was settled in large estates for the production of beef cattle. The present agricultural production is still predominantly livestock carried on in reasonably large farm situations. In some areas, especially in the southern part of this high plateau, farmers have started to adopt methods of mechanized grain production, principally for wheat and soybeans. The adoption of

mechanization was stimulated by the provision of favorable credit for equipment acquisition and by the guaranteed price of wheat. Because of the high cost of mechanization and reluctance on the part of traditional cattlemen to shift to more intensive land use, different tenure systems have evolved. Initial impetus for the change was given by professional or business people in the city who purchased machinery and then rented land from cattlemen for the production of wheat. The introduction of mechanization for the purpose of wheat production and the result of the cultivation of land has also led to the use of these machines for the establishment of improved pastures for cattle grazing. Due to the transitional nature of the agricultural region, systems of farming run the gamut from traditional to the most modern of mechanized units. Three municipios were selected for study from the plateau region. They are Ibiruba, Carazinho, and Concordia.

Low Land Plain

The low land plain of the southern half of the state of Rio Grande do Sul is an open grass land area which, like the high plateau, was settled by Spanish-Portuguese settlers interested in cattle raising. The type of agriculture is mixed sheep and cattle production on large farms using traditional ranching practices. Farm sizes range from several hundred to several thousand hectares. Some irrigated rice is produced along the principal waterways in this region. The municipio of Alegrete was selected from this region.

Mountain Region

The mountains that extend from the coastal plains to the high escarpment are composed of a series of very steep hills and valleys. The rapid increase in elevation results in substantial annual rainfall. The natural vegetation is tropical forests of deciduous trees. The soils are relatively fertile, but,

because of topographic problems, do not lend themselves well to intensive cultivation or mechanization. This area was settled by European immigrants coming to Brazil in the middle 1800's and later, and many people still retain their native language, principally German and Italian. The immigrants were settled on small farms generally 25 hectares in size. At the present, most of the potentially tillable land has been cleared and is under cultivation. Farm subdivision is resulting in early stages of minifundia in these areas.

Agricultural production is carried on in a part subsistence, part market oriented economy and consists essentially of mixed farming. Corn and beans are the most important crops and hogs are the most important livestock enterprise. In regions close to major cities, a substantial amount of dairy products are produced.

The small farm agriculture that is found in the coastal mountain range, in the interior mountain range that lies between the plateau and the low level plain, and in the interior river valleys within the plateau exhibits characteristics remarkably different from the large farm agriculture of the low level plain and of the plateau. The size of farm ranges to 100 hectares with an average of about 20 hectares per farm. Three quarters of the farms have less than 30 hectares. The tenure situation is almost completely owner-operator. Labor is predominantly family with approximately five percent of the farms using hired labor. The available labor supply is generally three to four man equivalents per farm. While the farms are small, the need for new technology still exists. Fertilizer, hybrid seed, insecticides, purchased supplement feeds, and health control measures for example are not used intensively. Eighty-five percent of the farms have animal power; ten percent of the farms use hand labor only. Two municipios were included from this region. They are Lageado and Timbo. In addition, two of the municipios selected from the plateau region, Ibiruba and Concordia, demonstrate similar farm situations.

In summary, the present form of agriculture of southern Brazil is the result of the distinct geographical and climatic base found in each area and is partly dependent on the settlement patterns which have evolved over time. Three commercially important types of farming can be identified. First, in the open area on the high plateau and on the low grass land areas of Rio Grande do Sul is found an extensive cattle and sheep grazing agriculture based on large farms. A second area, also on the high plateau, is a transitional area from extensive livestock grazing to mechanized grain production. Third, in the mountain regions mixed farming of various kinds with a predominance of corn and hogs is found on the medium and small farms.

Sampling Procedure

The basic objective in establishing the sampling procedure was to provide a sufficient number of observations from each of several distinct types of farming regions to provide a valid basis for comparisons both within and between regions. Further, the primary interest was not limited to using the data for a quantitative description of each particular area, but rather as indicative of the characteristics of a wider region that could be generalized beyond the immediate area studied. Thus, the final sample selection included a careful determination of general regions, selection of small representative areas within each general region, and finally the individual farm selection within the area.

For administrative purposes, the area selection was done on a municipio (county) basis. However, political boundaries do not always coincide with natural or type of farming boundaries. Therefore, when one or more of the districts within a selected municipio was atypical for the general characteristics of the region under study, it was eliminated from the sample population.

A final restriction on the sample population was made by establishing farm size limitations for each of the municipios studied. A maximum limit was established to avoid the inclusion of one or two extreme observations in each area which would be atypical and need to be treated as a special case studies. The lower limit eliminated those farms too small for commercial operation of the particular type of farming under study.

Minimum and maximum size units established for each area were as follows.

	Number of Hectares	
Municipio	Minimum	Maximum
Alegrete	150	5,000
Carazinho	20	1,000
Ibiruba	5	200
Lageado	5	100
Concordia	5	100
Tubarao	3	100
Timbo	5	100

With the sample population so defined, individual observations were chosen on a random cluster sample basis from the property rolls in each municipio. Each farm selected from the roll served to identify a cluster of three farms, the one selected and two additional neighboring farms. The two additional farms were chosen on a predetermined basis, excluding possibility of contiguous borders with properties already selected. Common boundary farms were excluded in order to reduce the possibility of choosing two relatively identical situations resulting from family subdivision of a particular farm unit.

Farm Description

This section presents basic descriptive data on farm size, farm type, land use patterns, and labor supply for the farms included in the analysis.

Size of Farm

Individual farm sizes (owned and rented land) ranged from a low of 3.0 hectares, the lower limit established in the municipio of Tubarao, to a high of 9,528 hectares in the extensive range land area in the municipio of Alegrete. Five of the seven municipios chosen for study were representative of the small farm regions; hence, a majority of the farm sizes are concentrated in the ten to 50 hectare range. However, there are sufficient numbers in all size categories to allow a comparison of the characteristics and performance of farms over a wide range of sizes (Table 1).

Small farm agriculture is adequately represented with farms of five to over 50 hectares. These can also be contrasted with medium size farms of up to 500 hectares in the municipio of Carazinho where cropping systems are somewhat similar. Medium and large farms are found in the municipio of Alegrete, however, systems of open range land grazing represent a substantially different type of agriculture from that predominating in other regions.

Farm Type

The choice of sample areas was based on type of farming regions. However, there was sufficient diversity within most regions, especially in the small farm areas, to warrant type classification of individual farms. Initial classification was made on the basis of the relative importance of various farm enterprises measured in terms of annual farm cash receipts. Three general types of cash receipts were used in the classification: (1) livestock receipts, (2) crop receipts, and (3) other cash receipts (principally from non-farm income.

Table 1

Farm Size Distribution by Municipio,
821 Farms, Southern Brazil, 1965

Number of Hectares	All	State and Municipio						
		Rio Grande do Sul				Santa Catarina		
		Alegrete	Carazinho	Ibiruba	Lageado	Tubarao	Concordia	Timbo
		(Number of Farms)						
3.0 - 4.9	13	-	-	-	1	12	-	-
5.0 - 9.9	75	-	-	2	27	32	5	9
10.0 - 14.9	114	-	-	16	28	23	26	21
15.0 - 19.9	92	-	-	10	20	12	20	30
20.0 - 29.9	180	-	21	37	30	13	37	42
30.0 - 49.9	138	-	23	40	15	12	28	20
50.0 - 99.9	80	1	24	16	5	7	17	10
100.0 - 199.9	29	11	14	3	1	-	-	-
200.0 - 499.9	41	25	16	-	-	-	-	-
500.0 - 1499.9	32	22	10	-	-	-	-	-
1500.0 +	27	26	1	-	-	-	-	-
Total Farms	821	85	109	124	127	111	133	132

The classification was designed to divide the farms into three farm type groups: general, specialized, and other. First, those farms on which the other cash receipts (item 3 aforementioned) were equal to 50 percent or more of the cash receipts originating from livestock and crop sales were classified as "other". The remaining farm operations were classified as either general or specialized farms based on the relative amount of cash receipts from livestock and crop sales. The specialized farms are those receiving 60 percent or more of their cash receipts from one enterprise or group of similar enterprises.

Finally, some additional regrouping was done to further characterize significant differences and similarities within and between specific farm types. Crop farms were divided into mechanized and non-mechanized and extensive cattle and sheep farms under range conditions were combined into one category.

The following nine groupings were used in the final classification (Table 2).

Specialized Livestock Farms

1. Range Livestock Farms--Sixty percent or more of the annual cash receipts from the sale of crops and livestock is from the sale of cattle and sheep including animal products, such as wool. Further, each farm contains 100 or more hectares of pasture land. A total of 73 farms are included in this classification; all but four are located in the large extensive grazing area represented by the municipio of Alegrete in southern Rio Grande do Sul.

2. Hog Farms--Sixty percent or more of the annual cash receipts from the sale of crops and livestock is from the sale of hogs. A total of 218 farms are included in this grouping. This is the largest single type of classification. The farms are located principally in the small farming region in the sampled municipios of Ibiruba, Lageado, and Concordia.

3. Dairy Farms--Sixty percent or more of the annual cash receipts from crops and livestock is from the sale of dairy products. This classification contains 50 farms and is distributed over the geographical areas represented in the study. Dairy farms are listed here as a specialized group on the basis of cash sales. However, it is one of the most diversified groups in terms of organization of the specific dairy enterprise. Almost all farms have some dairy animals and sell some dairy products during the flush production season. Thus, subsistence farms with little cash sales may enter this classification simply because they have no other major source of cash income. The true specialized dairy farms organized for the commercial production of milk are necessarily located near the consumption centers because of problems with adequate refrigeration and transportation facilities in interior areas.

4. General Livestock Farms--Sixty percent or more of the annual cash receipts from crops and livestock is from livestock. However, the farms meet none of the conditions necessary to be included under the three specialized groups mentioned before. There are 107 general livestock farms.

Specialized Crop Farms

5. Mechanized Crop Farms--Sixty percent or more of the annual cash receipts from crops and livestock is from crops and each farm has at least one tractor. There are 42 mechanized crop farms located principally in the municipio of Carazinho. The mechanized crop farms produce primarily wheat, corn, soybeans, and flax. Double-cropping with wheat, a winter crop, and one or more of the other three principal crops mentioned above is a common practice.

6. Extensive Crop Farms--Sixty percent or more of the annual cash receipts from the sale of crops and livestock comes from the specific crops of corn, wheat, soybeans, and flax which are produced with non-mechanized equipment (farms do not have mechanical power). This group contains 38 farms and includes a cross section of geographical areas with principal concentration in the municipios of Carazinho and Ibiruba.

7. General Crop Farms--Sixty percent or more of the annual cash receipts from the sale of crops and livestock comes from the sale of crops. However, the farms meet none of the conditions specified for classifications 5 and 6. There are 112 farms in this group. The principal sources of cash receipts are tobacco, cassava, and rice. They are located primarily in the small farm region in the municipios of Tubarao and Timbo.

Non-Specialized Farms

8. General Farms--More than 40, but less than 60 percent of the annual cash receipts from the sale of crops and livestock is from the sale of livestock. This group contains the farms that are neither specialized crop nor specialized livestock, but are diversified crop and livestock farms. A total of 73 farms in this category are distributed rather evenly over the geographical regions.

9. Other Farms--"Other cash receipts" are equal to 50 percent or more of the annual cash income from the sale of crops and livestock. A total of 108 farms, principally from the municipios of Carazinho and Ibiruba, are included in this category.

A breakdown of farm types by municipios is given in Table 2.

Table 2

Type of Farm Classification by Municipio,
821 Farms, Southern Brazil, 1965

Type of Farm	Total	State and Municipio						
		Rio Grande do Sul				Santa Catarina		
		Alegrete	Carazinho	Ibiruba	Lageado	Tubarao	Concordia	Timbo
		(Number of Farms)						
Specialized Livestock Farms								
Range Livestock	73	69	4	-	-	-	-	-
Hog	218	-	11	60	41	-	99	7
Dairy	50	-	6	3	7	13	-	21
General Livestock	107	-	6	18	41	8	15	19
Specialized Crop Farms								
Mechanized Crop	42	4	27	-	-	7	-	4
Extensive Crop	38	-	18	11	4	3	2	-
General Crop	112	-	-	12	13	33	3	51
Non-Specialized Farms								
General	73	2	15	12	13	14	5	12
Other	108	10	22	8	8	33	9	18
Total	821	85	109	124	127	111	133	132

Land Use

The farms studied display a great diversity in the selection and combination of specific crops grown (Table 3). This is evident both in the differences between and within group averages as well as within many of the individual farm operations. Diversity in cropping patterns results from several basic reasons. First, the great disparity in farm size and technology provides a cross section of farms from substantially subsistence to highly commercial agricultural units. Subsistence farms, in providing for a significant portion of the family's sustenance, must produce a variety of crops both for direct consumption and for animal feed for the various forms of livestock found on these farms. A second reason for lack of specialization in the utilization of crop land is the high degree of uncertainty associated with the production and marketing of agriculture crops. Diversification reduces the risk associated with dependence on a single crop.

Intensity of land use is a third factor. Small farms are able to use the land more intensively by intertilling certain crops and in double-cropping a part of the land by planting crops that mature in different seasons. Double-cropping is also practiced on the larger farms; most notably with wheat which is planted in the fall and harvested in the spring.

Corn is the most important crop both in terms of number of farms planting corn and in the acreage devoted to it. On the livestock farms, it occupies more than one-half of the total land cultivated. It is used for both human and animal consumption on the farm and serves as an important source of cash income for many farms. It is the principal feed for the fattening of hogs.

Wheat and soybeans are both commercially important as sources of cash receipts on many of the farms studied, especially in the mechanized crop areas where they are well suited to modern production methods. They are not important sources of animal feed though soybean oil meal is repurchased by some hog farmers as a protein supplement.

Rice production in the regions studied is limited to areas where irrigation facilities are readily available. Thus, its production is important locally, but not throughout the regions studied. Mandioca (cassava) is an important animal feed on most farms and is grown commercially on some farms, especially in the areas of poorer soils.

Labor Supply

The computed values for labor availability are composed of two forms of agricultural labor, farm family labor and hired labor. The value attributed to farm family labor represents the amount of productive labor available to work on the farm. It does not measure the amount of productive work performed by members of the family. On some small farms, there is a redundant labor supply for most if not all periods of the year and this measure reflects this abundance of family labor. The estimated value is a composite of family size, age, sex, place of residence, and type of farming. For example, the wife was considered to contribute one-half a man equivalent to the farm labor force on certain farm types and children were considered at various fractions of a man equivalent. One man equivalent was defined as 300 days of productive labor. Hired labor was measured on the basis of days worked. A full-time hired man or 300 days of temporary hired labor were considered equal to one man equivalent.

Table 3

Land Ownership and Use by Farm Type,
448 Specialized Livestock Farms, Southern Brazil, 1965

Land Use	Farm Type			
	Range Livestock Farms	Hog Farms	Dairy Farms	General Livestock Farms
	(Number of Hectares)			
Land Owned	995	31	23	24
Land Operated	1,408	30	24	24
Land Cultivated[a/]	16.5	11.6	6.0	8.7
Pasture Land	1,330	7	9	10
Cropping Pattern				
Corn	7.9	6.9	2.3	4.1
Wheat	.7	1.4	.2	.7
Soybeans	----	1.2	.4	1.7
Rice	6.4	.2	.1	.1
Cassava	.2	1.6	1.2	1.3
Other	1.0	.1	.1	.2
Forage	.1	.7	.6	.6
Home Use	1.1	.8	.8	.9
Total Crops[a/]	17.4	12.9	6.2	9.6

a/ Differences in the average values between hectares of land cultivated and hectares of land in specific crops are due to the practice of double-cropping, especially with wheat which is a winter crop.

Table 3 (Cont'd.)

Land Ownership and Use by Farm Type,
192 Specialized Crop Farms, Southern Brazil, 1965

Land Use	Farm Type		
	Mechanized Crop Farms	Extensive Crop Farms	General Crop Farms
		(Number of Hectares)	
Land Owned	219	37.4	22
Land Operated	365	37.4	22
Land Cultivated[a/]	146.9	18.6	8.0
Land in Pasture	166	8	4
Cropping Pattern			
Corn	35.1	9.5	2.2
Wheat	77.9	5.4	.3
Soybeans	36.1	5.1	.4
Rice	9.3	.1	1.6
Cassava	.8	.8	1.1
Other	46.1	2.5	1.4
Forage	.7	.4	.8
Home Use	1.5	.7	.4
Total Crops[a/]	207.5	24.5	8.2

a/ Differences in the average values between hectares of land cultivated and hectares of land in specific crops are due to the practice of double-cropping, especially with wheat which is a winter crop.

Table 3 (Cont'd.)

Land Ownership and Use by Farm Type,
181 Non-Specialized Farms, Southern Brazil, 1965

Land Use	Farm Type	
	General Farms	Other Farms
	(Number of Hectares)	
Land Owned	37.9	76
Land Operated	69.1	89
Land Cultivated[a/]	16.1	8.0
Pasture Land	42	64
Cropping Pattern		
Corn	7.6	5.2
Wheat	4.1	.9
Soybeans	2.5	1.5
Rice	1.2	.2
Cassava	1.4	1.0
Other	.8	7.1
Forage	.5	.4
Home Use	.7	.8
Total Crops[a/]	18.8	17.1

a/ Differences in the average values between hectares of land cultivated and hectares of land in specific crops are due to the practice of double-cropping, especially with wheat which is a winter crop.

Available family labor accounts for nearly all the labor supply with all farm types except for the range livestock and mechanized crop farms (Table 4). The greater use of hired labor on these two farm types results from the nature of the tasks to be performed and less available family labor because many of the families live off the farm. Only one-third of the families in the range livestock group lived on the ranch while the comparable value for the mechanized crop farms was 58 percent. All other specialized farms had from 93 to 100 percent of the families living on the farm property.

One of the reasons for establishing a place of residence in urban rather than rural areas is to have secondary schooling available for the children. The substantially higher level of educational achievement by the operators of the range livestock and mechanized crop farms is indicative of this situation.

Table 4

Labor Availability by Farm Type,
821 Farms, Southern Brazil, 1965

Farm Type	Labor Source			
	Total	Family Labor	Hired Labor	
			Permanent	Temporary
	(Man Equivalents)[a]			
Specialized Livestock Farms				
Range Livestock	5.4	1.7	2.7	1.0
Hog	3.1	3.0	.1	---
Dairy	3.1	3.0	---	.1
General Livestock	3.1	2.9	.2	---
Specialized Crop Farms				
Mechanized Crop	5.0	2.3	1.7	1.0
Extensive Crop	3.4	3.2	.1	.1
General Crop	3.8	3.6	.1	.1
Non-Specialized Farms				
General	4.1	3.4	---	.7
Other	3.2	2.8	.2	.2

a/ One man equivalent is equal to one permanent hired employee or 300 days of temporary hired labor.

DATA ANALYSIS

In this section, four specific studies are presented utilizing various segments of the farm level data described in the previous section. In some instances, all of the farm observations are used. At other times, particular subsamples of the farms are selected for specific types of analysis. First, a study of income, savings, and investment is presented using all farms divided into type of farm groups with a subsample analysis by farm size for the small and medium size farms. The second study is a resource productivity analysis using the same data groupings as the first study.

The third study is more restrictive in data use and focuses specifically on three types of farms: range livestock farms, mechanized crop farms, and small farm agriculture. This study is concerned with a comparative analysis of the productivity and use of resources between the mechanized grain farms and the range livestock farms from which they evolved and the use of comparable inputs in the small farm region. This study emphasizes the role of agricultural credit in the introduction and maintenance of new technology.

The fourth study focuses on the productivity of management and is restricted to a study of hog farms in the small farm region.

Income, Savings, and Investment Analysis

The purpose of this section is to present a summary of the income, savings, and investment experience for the farms studied. The data are presented in the form of a cash flow analysis demonstrating the availability and disposition of internal funds and their relation to the need for and the utilization of external credit. This cash flow analysis is presented by farm type and farm size.

The data are organized and presented at three different levels. First, the data from all 821 farms are presented by type of farm. The second farm classification is by farm size. Size is measured in terms of land equivalents which is a weighted measure of the amount of productive land available on each farm. In order to maintain some uniformity in the farm size groups, the municipios of Tubarao and Alegrete were omitted from this analysis and further, only farms of less than 50 hectares of land equivalents were considered. Five-hundred and eighty-three farms are included in the general farm size analysis. The final organization of the farm data is by size within general farm types. In this analysis, 351 specialized livestock farms and 118 specialized crop farms were selected from the 583 farms used in the farm size analysis.

The data for each of the three levels of analysis mentioned above are presented in two forms. First, the annual cash flow components for both income flows and expense flows are presented. The income cash flow components are composed of cash farm receipts from production items, capital sales, non-farm income, and new borrowing during the year.[4/] The cash expense flow components are composed of annual operating expenses, new farm investments, family living expenses, and principal payments on outstanding debts.

4/ An additional potential source of cash income flow would be deposits or hoardings. However, data were not available on this particular component. Also, on the expense flow side, the possibility of deposits or hoardings is not supported by data.

The second level of analysis combines these various components into several income, savings, and investment measures. The first measure shown is net farm cash income.[5/] This figure includes the cash receipts from production items and capital sales minus operating expenses. The second measure is non-farm income to show the relationship between the on-farm and the non-farm sources of disposable cash income. The third item is called savings potential. This is a value composed of both net farm cash income and non-farm income minus family living expenses. It is a measure of the amount of cash available from the farm and non-farm operations and net of necessary family living expenses and, therefore, available for new investments. This value is then compared with the level of new investments and the difference between the amount of money spent for new investments and that available is listed as the savings investment gap. A positive value in the column for savings investment gap indicates that the savings potential was not sufficient to meet the level of new investments. A negative figure indicates that sufficient savings were available from current operating budgets to meet the level of investment incurred during the year.

5/ Income is a nebulous concept that can be measured in many ways. This is especially true when considering farm operations that are closely tied to family considerations in terms of financial management. Thus, it is possible to manipulate the cash flow components in various ways depending on which measure is desired. In this analysis, these components have been combined to show as best possible the residuals that are available from various sources and for various uses both within the farm operation and within the larger family financial picture. The emphasis here is on the cash position rather than on some of the more traditional income measurements which take into account inventory changes.

The sixth measure is net borrowing and this is composed of new borrowings minus principal payments made during the year and is a measure of the net increase in indebtedness incurred during the year. The final value shown is a cash surplus or deficit and is merely the difference between the savings investment gap and the level of net borrowing. This final figure can be interpreted several ways. A negative value may indicate that to meet current levels of investment and operating expenses, funds had to be withdrawn from deposits or hoardings. If the value is positive, it may indicate that funds were available for additional retirement of debt for for hoarding or off-farm investments and finally, it may also indicate a margin of error in the compilation of the income statement for each individual farmer.

Each of these values, then, is compared between farm types, by farm size, and for general farm types within the farm size groupings. Organizing financial farm data on an annual basis obscures one important aspect of financial management--the timing of the cash flow throughout the year. The data as presented here accurately indicate the necessity for external funds to maintain a given level of new investments. However, they do not indicate the need for credit to cover operating costs that may occur in advance of production sales. This qualification should be noted when evaluating the quantity of credit utilized in relation to the savings investment gap.

Farm Type

Data are presented on the income, expense, credit, and other cash flow components and their compilation into income measures by farm type in Tables 5 and 6. The data presented in Table 5 are based on average farm figures for each of the farm types. While it is evident in this table that there are substantial differences between the various farm types, the magnitude of these differences is

not readily apparent since the average farm size varies greatly between the farm types. To gain a better perspective of the differences between types of farms, key data in Table 5 are alternatively presented in parentheses on a land equivalent basis. This allows a direct comparison between farm types on the intensity of the income and expense flow items per unit of productive land.

When the cash flow components are compared on a per hectare basis, several important differences are apparent. First, within the specialized livestock farms, those types of livestock farms which are generally found in the small farm area--dairy, hog, and general livestock--show rather consistent values with respect to average farm cash receipts, new credit, level of operating expenses, and level of new investments. The range livestock farms, which are considerably larger, show reduced value on a per hectare basis for each of the categories. Within the specialized crop farms, there are rather significant differences apparent. The large value of cash receipts per hectare shown on the general crop farms is primarily the result of high intensity land use crops, such as tobacco.

Mechanized crop farms and extensive crop farms essentially have the same cropping patterns, however, significant difference in farm cash receipts per hectare is noted. The mechanized crop farms, though being considerably larger, experience almost double the level of farm cash receipts per hectare of land equivalent. This results largely from the application of new technology, such as fertilizers, seed, and pesticides, and is apparent in the level of operating expenses per hectare which are three times that of the extensive crop and the largest of any type of farm in the analysis.

Table 5

Income, Expense, Credit, and Other Cash Flow Components by Farm Type, 821 Farms, Southern Brazil, 1965

Farm Type	Average Farm Size	Number of Farms	Income Flow: Farm Cash Receipts	Income Flow: Non-Farm Income	Income Flow: Capital Sales	Income Flow: New Credit	Expense Flow: Operating Expenses	Expense Flow: Family Living Expenses	Expense Flow: New Investments	Expense Flow: Principal Payments
	(Land Equivalent)a/		(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
			(New Cruzeiros)							
Specialized Livestock Farms										
Range Livestock	474.6	73	24,748(52)	259	570	3,525(7)	11,723(25)	3,805	9,292(20)	2,689
Hog	14.1	218	1,704(121)	37	40	237(17)	580(41)	643	499(35)	95
Dairy	9.4	50	1,059(112)	60	49	141(15)	407(48)	625	413(44)	23
General Livestock	11.1	107	1,170(105)	31	77	148(13)	349(31)	647	433(39)	98
Specialized Crop Farms										
Mechanized Crop	221.7	42	22,778(103)	928	360	11,373(51)	13,611(61)	2,172	5,638(25)	2,989
Extensive Crop	21.4	38	1,223(57)	26	63	599(28)	400(19)	579	712(33)	50
General Crop	9.5	112	1,215(128)	60	61	180(19)	368(39)	661	321(34)	136
Non-Specialized Farms										
General	30.9	73	2,262(73)	67	61	556(18)	1,077(35)	819	719(23)	276
Other	33.6	108	1,833(55)	947	27	391(12)	925(28)	1,065	943(28)	116

a/ One land equivalent is equal to one hectare of cultivated land, one hectare of improved pasture, or three hectares of unimproved pasture.

Values in ( ) are expressed on a per hectare of land equivalent basis.

Table 6

Annual Cash Flow Analysis by Farm Type,
821 Farms, Southern Brazil, 1965

Farm Type	Net Farm Cash Income	Non-Farm Income	Saving Potential	New Investment	Savings Investment Gap	Net Borrowing	Cash Surplus or Deficit
	(9)	(10)	(11)	(12)	(13)	(14)	(15)
	(1 + 3 - 5)	(2)	(9 + 10 - 6)	(7)	(12 - 11)	(4 - 8)	(14 - 13)
	(New Cruzeiros)						
Specialized Livestock Farms							
Range Livestock	13,595(29)	259	10,049(21)	9,292	- 757	836	+ 1,593
Hog	1,164(83)	37	558(40)	499	- 59	142	+ 201
Dairy	701(75)	60	136(14)	413	277	118	- 159
General Livestock	898(81)	31	282(25)	433	151	50	- 101
Specialized Crop Farms							
Mechanized Crop	9,527(43)	928	8,283(37)	5,638	-2,645	8,384	+11,029
Extensive Crop	886(41)	26	333(16)	712	379	549	+ 170
General Crop	908(96)	60	307(32)	321	14	44	+ 30
Non-Specialized Farms							
General	1,246(40)	67	494(16)	719	225	280	+ 55
Other	935(28)	947	817(24)	943	126	275	+ 149

There are also some interesting general differences between the specialized livestock farms and the specialized crop farms. For instance, on level of new investments, the livestock farms show a slightly larger investment per hectare, however, there is general uniformity both within and between the groups. In terms of operating expenses, one would expect that given more or less equal utilization of new technology, livestock farms would have a greater operating expense input per hectare as a result of the livestock expenses in addition to crop expenses. However, this is not apparent in a comparison between these two types of farms; in fact, the mechanized farms, while being considerably larger than most of the livestock farms and all of the other crop farms, still demonstrate the greatest intensity of operating expenses per hectare.

Utilization of credit is heavily weighted in favor of the crop farms. Though, as noted above, the level of investment is slightly greater on the livestock farms. Within the crop farms again, the mechanized crop farms maintain by far the greatest intensity of use of credit. Several factors are operative here and are also noted in other parts of this report. Essentially, they relate to the availability of credit for specific purposes and to the duration of farm operation loans. For example, credit for crop production loans that are repayable immediately following the harvest of the crop is not compatible with the income flow situation on livestock farms where they must wait for some period of time following harvest before the sale of the livestock. Also, special credit programs that have been introduced to foster the utilization of fertilizer and to increase the production of basic crops such as wheat have further contributed to the greater utilization of credit on crop farms. These factors are probably responsible for the relatively high level of farm cash receipts on crop farms in relation to that experienced on the livestock farms.

When the cash flow components are combined into income, savings, and investment values, relatively consistent savings and investment patterns are noted. For example, in almost all instances, the savings potential is more than utilized in new investments; the exceptions being the larger livestock and crop farms where new investments did not use up all of the savings potential.

Farm Size

The farm size analysis is carried out on a smaller, more homogeneous sample of farms as explained earlier. As farm size increases, the level of farm cash receipts per hectare decreases very rapidly at first then decreases more slowly with the larger farm sizes (Tables 7 and 8). However, in spite of this declining return per unit of productive land, the level of borrowing per unit of land and the level of new investments remain quite consistent over farm size with the exception of the very small farms. When this particular group of farms is divided into two subgroups, that is, specialized livestock farms and specialized crop farms, some exceptions to this general trend are noted. In the case of farm cash receipts, the trend remains the same though, for given size units, specialized livestock farms experience somewhat higher farm cash receipts.

In terms of credit use, the level of new borrowing per farm for livestock farms is rather consistent; therefore, the borrowing per hectare, as farm size increases, diminishes very rapidly. Differences in new borrowings on the specialized crop farms more closely approximate differences in farm size.

Table 7

Income, Expense, Credit, and Other Cash Flow Components for Selected Farm Size Groups, 583 Farms, Southern Brazil, 1965

Size Group	Average Size Per Farm	Number of Farms	Income Flow: Farm Cash Receipts	Income Flow: Non-Farm Income	Income Flow: Capital Sales	Income Flow: New Borrowing	Expense Flow: Operating Expenses	Expense Flow: Family Living Expenses	Expense Flow: New Investments	Expense Flow: Principal Payments
(Land Equivalents)a/			(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
			(New Cruzeiros)							
			All Farms							
1.0 - 3.9	2.9	35	814(280)	87	29	185(64)	346	496	257(89)	62
4.0 - 6.9	5.5	111	703(128)	61	9	91(17)	205	451	180(32)	35
7.0 - 9.9	8.3	124	997(120)	69	78	118(14)	292	528	376(45)	70
10.0 - 14.9	12.1	139	1,345(111)	79	64	134(11)	382	679	369(30)	87
15.0 - 19.9	17.6	75	1,814(103)	109	41	218(12)	613	770	453(26)	84
20.0 - 29.9	24.4	71	2,149(88)	151	22	368(15)	815	811	650(27)	127
30.0 - 49.9	37.3	28	2,363(63)	243	68	797(21)	1,193	1,007	1,086(29)	137
			Specialized Livestock Farms Only							
1.0 - 3.9	2.9	19	1,041(359)	13	1	235(81)	523	493	216	73
4.0 - 6.9	5.6	64	688(123)	31	10	73(13)	196	424	178	31
7.0 - 9.9	8.2	77	1,094(133)	37	125	137(17)	321	541	503	65
10.0 - 14.9	12.2	94	1,449(119)	45	58	145(12)	410	659	394	81
15.0 - 19.9	17.5	51	2,017(115)	51	36	245(14)	708	762	496	96
20.0 - 29.9	24.5	33	2,444(100)	16	0	202(8)	877	821	611	121
30.0 - 49.9	37.4	13	2,857(76)	33	0	222(6)	1,324	1,081	498	213
			Specialized Crop Farms Only							
1.0 - 3.9	3.2	11	545(170)	1	91	120(38)	121	411	254	63
4.0 - 6.9	5.6	25	760(136)	38	0	65(12)	247	474	128	61
7.0 - 9.9	8.5	24	845(99)	75	0	89(10)	230	506	222	80
10.0 - 14.9	11.9	25	1,251(105)	25	140	123(10)	342	722	306	129
15.0 - 19.9	17.7	12	1,696(96)	17	0	133(8)	357	824	208	55
20.0 - 29.9	24.1	15	1,709(71)	11	0	442(18)	711	686	607	152
30.0 - 49.9	38.1	6	2,325(61)	67	317	2,779(73)	1,237	793	3,322	92

a/ One land equivalent is equal to one hectare of cultivated land, one hectare of improved pasture, or three hectares of unimproved pasture.

Values in ( ) are expressed on a per hectare of land equivalent basis.

Table 8

Annual Cash Flow Analysis for Selected Farm Size Groups,
583 Farms, Southern Brazil, 1965

Size Group (Land Equivalents)a/	Net Farm Cash Receipts (9) (1 + 3 - 5)	Non-Farm Income (10) (2)	Saving Potential (11) (9 + 10 - 6)	New Investment (12) (7)	Savings Investment Gap (13) (12 - 11)	Net Borrowing (14) (4 - 8)	Cash Surplus or Deficit (15) (14 - 13)
			(New Cruzeiros)				
			All Farms				
1.0 - 3.9	497(171)	87	88(30)	257	169	123	- 46
4.0 - 6.9	507(92)	61	117(21)	180	63	56	- 7
7.0 - 9.9	783(94)	69	324(39)	376	52	48	- 4
10.0 - 14.9	1,027(85)	79	427(35)	369	- 58	47	+105
15.0 - 19.9	1,242(71)	109	581(33)	453	- 128	134	+262
20.0 - 29.9	1,356(56)	151	696(29)	650	- 46	241	+287
30.0 - 49.9	1,238(33)	243	474(13)	1,086	612	660	+ 48
			Specialized Livestock Farms Only				
1.0 - 3.9	519	13	39	216	177	162	- 15
4.0 - 6.9	502	31	109	178	69	42	- 27
7.0 - 9.9	898	37	394	503	109	72	- 37
10.0 - 14.9	1,097	45	483	394	- 89	64	153
15.0 - 19.9	1,345	51	634	496	- 138	149	287
20.0 - 29.9	1,567	16	762	611	- 151	81	232
30.0 - 49.9	1,533	33	485	498	13	9	- 4
			Specialized Crop Farms Only				
1.0 - 3.9	515	1	105	254	149	57	- 92
4.0 - 6.9	513	38	77	128	51	4	- 47
7.0 - 9.9	615	75	184	222	38	9	- 29
10.0 - 14.9	1,049	25	352	306	- 46	- 6	40
15.0 - 19.9	1,339	17	532	308	- 224	78	302
20.0 - 29.9	998	11	323	607	284	290	6
30.0 - 49.9	1,405	67	679	3,322	2,643	2,687	44

a/ One land equivalent is equal to one hectare of cultivated land, one hectare of improved pasture, or three hectares of unimproved pasture.

Values in ( ) are expressed on a per hectare of land equivalent basis.

Differences in net farm income as size of farm increases demonstrate the same diminishing returns to size as noted with the farm cash receipts. The savings potential, however, on a per hectare basis remains fairly consistent except on the very large size farms. The savings investment gap for the smaller size farms is positive indicating that savings potential was not sufficient to cover the level of investment during the year. On the larger farms, the savings investment gap was generally negative indicating that investments did not exceed the level of savings potential. On the average for all farms, net borrowing was positive indicating that new credit exceeded retirement of debt during the year. However, the savings and investment gap was sufficiently large on the smaller farms that even though net borrowings were positive, there still was not sufficient cash available to cover all of the expenses on these small farms; thus, a portion of annual expenditures had to be met with other funds, presumably from deposits or hoardings. On the larger size farms, the cash situation was positive indicating a surplus was available for hoarding, retirement of additional debt, or perhaps for non-farm investments. The same general trends hold true when these farms are divided into livestock and crop farms with one or two exceptions. The savings potential appears to be a little bit greater on the livestock farms. The savings investment gap relationship to net borrowing holds for both groups. The level of net farm cash income is remarkably consistent.

Capital Productivity Analysis

The method of analysis used to study value productivity of capital at the farm level is production function estimation. The estimated production coefficients are derived by the use of least squares regression technique fitted to cross sectional data using a stepwise regression program. With this program, variables are inserted until a satisfactory regression equation is obtained. The variables which were free to enter each model were selected on the basis of economic theory and/or a priori information.

In the stepwise regression program, the first independent variable to enter is that one which is most highly correlated with the dependent variable. Each successive dependent variable to enter is selected on the basis of its partial correlation coefficient (the proportion of the previously unexplained variation which is explained by the entry of the dependent variable). The procedure continues until the specified minimum F-level for the variables to be included in the regression is reached or until all the variables free to enter are incorporated in the equation. Additionally, any previously entered variable whose F-level falls below a specified minimum will be removed from the equation. The above minimum F-levels were set at 0.01 and 0.005, respectively.

However, the equations shown in this report are taken from that point where the last variable to enter was significant at the five percent level, but the succeeding variable was not. The regression coefficients (and the intercepts), which are not significant at the .10 level, are so specified in the tabular presentation.

Two methods of grouping the data were used--farm type and farm size. Nine farm type classifications were used.[6/] They are:

Specialized Livestock Farms

1. Range Livestock
2. Hog
3. Dairy
4. General Livestock

Specialized Crop Farms

5. Mechanized Crop
6. Extensive Crop
7. General Crop

Non-Specialized Farms

8. General
9. Other

The data were also divided into eight size ranges on the basis of total land equivalents.[7/] The ranges are:

1.0 - 3.9 land equivalents,

4.0 - 6.9 land equivalents,

7.0 - 9.9 land equivalents,

10.0 - 14.9 land equivalents,

15.0 - 19.9 land equivalents,

20.0 - 29.9 land equivalents,

30.0 - 49.9 land equivalents, and

50.0 & above land equivalents.

6/ See page 24 for explanation of farm type classification.

7/ One land equivalent is equal to one hectare of cultivated land, one hectare of improved pasture, or three hectares of native pasture.

The data for the farm size analysis were taken from the municipios of Ibiruba, Lageado, and Carazinho in Rio Grande do Sul and from Concordia and Timbo in Santa Catarina. Analysis by farm type utilized data from the municipios of Alegrete and Tubarao in addition to the above five municipios.

The following tables serve to present the arithmetic means, standard deviations, and order of entry for each of the variables free to enter the equations; the regression coefficients (marginal productivities) and net effects[8/] of the entered variables; and the multiple correlation coefficients (R^2), standard errors, intercept values, and numbers of observations for each model. These various values are presented for 17 models.

In Appendix A, the reader will find the correlation coefficients of the variables which were free to enter the nine farm type models and the eight farm size models.

8/ The net effect of an entered variable is the summation of its direct and indirect effects. The net effects of the entered variables are equal to the unadjusted R^2 (multiple correlation coefficient). The values of the net effects give an indication of the relative importance of the various variables.

Table 9

Arithmetic Means, Standard Deviations, and Orders of Entry of Variables Free to Enter Stepwise Regression Models, Specialized Livestock Farms, Southern Brazil, 1965

Variable	Range Livestock Farms			Hog Farms			Dairy Farms			General Livestock Farms		
	Mean	Standard Deviation	Order	Mean	Standard Deviation	Order	Mean	Standard Deviation	Order	Mean	Standard Deviation	Order
Gross Farm Output (NCr$)	16218	18830		2184	1504		1209	853.9		1558	722.3	
Land (Hectares)												
Land Equivalents	434.3	423.6	1									
Cultivated				11.53	8.31	3	6.07	4.58	8	8.18	4.97	3
Improved Pasture				.17	.52	8	.33	1.03	9	.47	3.56	9
Permanent Pasture				6.85	11.17	4	9.57	19.09	4	6.16	10.24	4
Labor (Man Equivalents)												
Family	1.66	.99	8	3.00	1.33	7	3.08	1.35	6	2.80	1.30	5
Capital - Assets (NCr$)												
Productive Livestock	67821	65537	7	1783	974.5	1	1390	870.7	1	1646	906.0	1
Work Stock	2363	2370	3	356.3	188.5	9	231.3	175.6	5	275.2	198.2	8
Tractor + All Equipment	5938	10019	2	794.7	1679	6	269.3	219.3	3	399.6	710.1	10
Capital - Expenses (NCr$)												
Crop Expenses	380.0	1170	5	44.29	106.1	10	33.09	73.05	2	35.54	93.05	7
Livestock Expenses	2898	3241	6	295.6	461.5	2	110.5	298.1	7	112.4	121.2	2
Machinery Expenses	1216	1931	4									
Labor Expenses	1619	1922	9	22.14	63.14	5	10.91	42.93	10	25.78	120.5	6

Table 9 (Cont'd.)

Arithmetic Means, Standard Deviations, and Orders of Entry of Variables Free to Enter Stepwise Regression Models, Specialized Crop Farms, Southern Brazil, 1965

Variable	Mechanized Crop Farms			Extensive Crop Farms			General Crop Farms		
	Mean	Standard Deviation	Order	Mean	Standard Deviation	Order	Mean	Standard Deviation	Order
Gross Farm Output (NCr$)	21670	17905		1938	854.2		1616	904.7	
Land (Hectares)									
Land Equivalents				16.80	9.39	7			
Cultivated	150.5	123.7	1				7.67	5.47	5
Improved Pasture							.15	.53	9
Permanent Pasture							3.54	4.12	6
Labor (Man Equivalents)									
Hired + Family				3.29	1.59	6			
Family	2.29	1.40	7				3.56	1.59	2
Capital - Assets (NCr$)									
Productive Livestock	7347	10537	5	1236	630.6	1	884.7	541.7	7
Work Stock				328.0	159.1	3	228.3	180.8	10
Tractor + All Equipment				280.7	510.6	5	356.6	593.6	3
Tractor + Mechanized Equipment	22278	17938	6						
Work Stock + Animal Equipment	420.9	348.3	4						
Manual & Other Equipment	11.52	2119	2						
Capital - Expenses (NCr$)									
Crop Expenses	5954	7107	3	132.7	266.9	2	86.44	131.3	1
Livestock Expenses				44.69	73.43	4	41.28	87.65	4
Machinery Expenses	3763	3468	8						
Labor Expenses	1357	1470	9				33.87	72.56	8

Table 9 (Cont'd.)

Arithmetic Means, Standard Deviations, and Orders of Entry of Variables Free to Enter Stepwise Regression Models, Non-Specialized Farms, Southern Brazil, 1965

Variable	General Farms			Other Farms		
	Mean	Standard Deviation	Order	Mean	Standard Deviation	Order
Gross Farm Output (NCr$)	2165	1707		1282	1413	
Land (Hectares)						
Cultivated	13.81	13.76	7	11.01	27.66	12
Improved Pasture	.40	2.19	4	1.53	6.72	7
Permanent Pasture	9.60	19.58	6	10.13	17.62	5
Labor (Man Equivalents)						
Family	3.21	1.27	9	3.03	1.64	2
Capital - Assets (NCr$)						
Productive Livestock	1649	1109	1	1408	1791	6
Work Stock	341.1	238.3	10	276.1	224.6	9
Tractor + All Equipment	991.6	2037	3			
Tractor + Mechanized Equipment				495.4	3157	11
Non-Mechanized Equipment				415.2	1201	10
Capital - Expenses (NCr$)						
Crop Expenses	116.3	288.3	2	66.90	173.5	1
Livestock Expenses	109.4	168.1	8	120.8	247.3	3
Machinery Expenses				136.1	430.0	4
Labor Expenses	36.55	96.09	5	89.95	260.7	8

Table 10

Regression Coefficients, Net Effects, and Related Statistics for The Models, Specialized Livestock Farms, Southern Brazil, 1965

Variable	Range Livestock Farms		Hog Farms		Dairy Farms		General Livestock Farms	
	Coefficient	Effect	Coefficient	Effect	Coefficient	Effect	Coefficient	Effect
Land (Hectares)								
Land Equivalents	20.60	.388						
Cultivated			72.79	.259			36.53	.097
Labor (Man Equivalents)								
Capital - Assets (NCr$)								
Productive Livestock			.35	.159	.51	.387	.35	.228
Work Stock	1.67	.167						
Tractor + All Equipment	.67	.240						
Capital - Expenses (NCr$)								
Crop Expenses					4.42	.259		
Livestock Expenses			1.30	.250			1.86	.132
Intercept Value	-643		339		351		470	
Total R^2		.795		.668		.646		.457
Standard Error of Y	18830		1504		854		772	
Standard Error of Estimate	8707		872		519		578	
Number of Observations	72		217		47		102	

Table 10 (Cont'd.)

Regression Coefficients, Net Effects, and Related Statistics for The Models, Specialized Crop and Non-Specialized Farms, Southern Brazil, 1965

Variable	Mechanized Crop Farms		Extensive Crop Farms		General Crop Farms		General Farms		Other Farms	
	Coefficient	Effect	Coefficient	Effect	Coefficient	Effect	Coefficient	Effect	Coefficient	Effect
Land (Hectares)										
Cultivated	105.8	.670								
Labor (Man Equivalents)										
Family					163.5	.127			160.6	.038
Capital - Assets (NCr$)										
Productive Livestock			.41	.157			.85	.486		
Work Stock			2.19	.175						
Tractor + All Equipment					.48	.122	.19	.154		
Manual & Other Equipment	1.80	.039								
Capital - Expenses (NCr$)										
Crop Expenses	.57	.191	1.79	.277	2.31	.158	1.80	.248	5.69	.554
Livestock Expenses					3.20	.142			1.06	.086
Machinery Expenses									.43	.067
Intercept Value	NS 258.8		469.3		530.4		359.2		227.7	
Total R^2		.900		.609		.549		.888		.745
Standard Error of Y	18898		854.2		904.7		1707		1413	
Standard Error of Estimate	5907		558.4		619.2		584.7		729.0	
Number of Observations	38		36		109		71		96	

NS = Not significant at .10 level.

Table 11

Arithmetic Means, Standard Deviations, and Orders of Entry of Variables Free to Enter Stepwise Regression Models, by Farm Size Breakdown, Southern Brazil, 1965

Variable	Farms of 1.0-3.9 Land Equivalents			Farms of 4.0-6.9 Land Equivalents			Farms of 7.0-9.9 Land Equivalents			Farms of 10.0-14.9 Land Equivalents		
	Mean	Standard Deviation	Order	Mean	Standard Deviation	Order	Mean	Standard Deviation	Order	Mean	Standard Deviation	Order
Gross Farm Output (NCr$)	841	461		1074	528		1525	637		1920	890	
Land Equivalents (Hectares)	2.94	.70	2	5.48	.89	6	8.30	.86	6	12.1	1.5	6
Productive Livestock (NCr$)	840	445	6	965	428	1	1294	587	2	1573	586	1
Work Stock + Tractor + All Equipment (NCr$)	308	352	4	447	341	4	738	750	5	920	1012	4
Crop Expense (NCr$)	30.4	93.1	3	25.2	52.9	2	30.4	41.6	3	37.5	63.9	3
Livestock Expense (NCr$)	63.0	102	1	78.2	122	3	119	154	1	158	216	2
Labor Expense (NCr$)	10.3	26.0	5	15.3	40.0	5	34.8	44.6	4	48.2	71.5	5

Includes data from the municipios of Ibiruba, Lageado, Carazinho, Concordia, and Timbo only.

Table 11 (Cont'd.)

Arithmetic Means, Standard Deviations, and Orders of Entry of Variables Free to Enter Stepwise Regression Models, by Farm Size Breakdown, Southern Brazil, 1965

Variable	Farms of 15.0-19.9 Land Equivalents			Farms of 20.0-29.9 Land Equivalents			Farms of 30.0-49.9 Land Equivalents			Farms of 50.0 & Above Land Equivalents		
	Mean	Standard Deviation	Order	Mean	Standard Deviation	Order	Mean	Standard Deviation	Order	Mean	Standard Deviation	Order
Gross Farm Output (NCr$)	2419	1318		2833	1626		3833	3532		20892	17525	
Land Equivalents (Hectares)	17.6	1.4	5	24.4	2.8	4	37.2	5.9	6	235	177	3
Productive Livestock (NCr$)	1870	883	2	2145	1015	3	2983	1930	4	8849	9928	4
Work Stock + Tractor + All Equipment (NCr$)	1206	1409	4	1628	2103	6	4125	5943	3	22567	18809	1
Crop Expense (NCr$)	57.4	112	3	133	192	5	333	361	5	5654	6926	2
Livestock Expense (NCr$)	290	587	1	342	508	1	378	895	2	552	611	5
Labor Expense (NCr$)	43.9	121	6	27.8	55.5	2	385	994	1	1151	1313	6

Includes data from the municipios of Ibiruba, Lageado, Carazinho, Concordia, and Timbo only.

Table 12

Regression Coefficients, Net Effects, and Related Statistics for The Models, by Farm Size Breakdown, Southern Brazil, 1965

Variable	Farms of 1.0-3.9 Land Equivalents		Farms of 4.0-6.9 Land Equivalents		Farms of 7.0-9.9 Land Equivalents		Farms of 10.0-14.9 Land Equivalents	
	Coefficient	Effect	Coefficient	Effect	Coefficient	Effect	Coefficient	Effect
Land Equivalents (Hectares)	262.5	.162						
Productive Livestock (NCr$)			.41	.171	.42	.207	.64	.215
Work Stock + Tractor + All Equipment (NCr$)								
Crop Expense (NCr$)			3.29	.113	4.21	.069	3.08	.055
Livestock Expense (NCr$)	2.55	.319	1.46	.165	1.61	.210	1.41	.161
Labor Expense (NCr$)								
Intercept Value	NS -90.8		477		660		575	
Total R^2		.481		.449		.486		.431
Standard Error of Y	461		528		637		890	
Standard Error of Estimate	342		397		463		679	
Number of Observations	34		111		121		138	

NS = Not Significant at .10 level.

Includes data from the municipios of Ibiruba, Lageado, Carazinho, Concordia, and Timbo only.

Table 12 (Cont'd.)

Regression Coefficients, Net Effects, and Related Statistics for The Models, by Farm Size Breakdown, Southern Brazil, 1965

Variable	Farms of 15.0-19.9 Land Equivalents		Farms of 20.0-29.9 Land Equivalents		Farms of 30.0-49.9 Land Equivalents		Farms of 50.0 & Above Land Equivalents	
	Coefficient	Effect	Coefficient	Effect	Coefficient	Effect	Coefficient	Effect
Land Equivalents (Hectares)							23.3	.167
Productive Livestock (NCr$)	.52	.211	.45	.140				
Work Stock + Tractor + All Equipment (NCr$)	.19	.069			.25	.302	.39	.362
Crop Expense (NCr$)	3.04	.056					.89	.296
Livestock Expense (NCr$)	.78	.210	1.55	.301	1.99	.248		
Labor Expense (NCr$)			7.42	.050	1.49	.308		
Intercept Value	815		1140		1478		1592	
Total R^2		.546		.491		.858		.825
Standard Error of Y	1318		1626		3532		17525	
Standard Error of Estimate	912		1186		1401		7625	
Number of Observations	76		68		31		41	

Includes data from the municipios of Ibiruba, Lageado, Carazinho, Concordia, and Timbo only.

Table 13

Selected Ratios,
by Farm Type, Southern Brazil, 1965

Item	Range Livestock Farms	Hog Farms	Dairy Farms	General Livestock Farms	Mechanized Crop Farms	Extensive Crop Farms	General Crop Farms	General Farms	Other Farms
Gross Farm Output ÷ Total Land	13.6	118	75.6	105	69.3	85.8	144	90.9	56.5
Gross Farm Output ÷ Family Labor	9540	728	390	556	9422	606	449	677	427
Gross Farm Output ÷ Capital Assets[a/]	.21	.75	.64	.67	.69	1.05	1.10	.72	.49
Gross Farm Output ÷ Cash Expenditures[b/]	1.5	4.0	4.3	5.0	1.7	5.1	5.0	4.7	2.2
Capital Assets ÷ Family Labor	44778	977	610	829	13563	577	408	934	865
Capital Assets ÷ Total Land	61.9	158	118	159	99.8	89.6	131	126	114
Total Land ÷ Family Labor	724	6.2	5.2	5.3	136	6.4	3.1	7.4	7.6
Crop Expenses ÷ Cultivated Land + Improved Pasture	12.0	3.8	5.2	4.1	37.2	9.1	11.1	8.2	5.3
Cultivated Land + Improved Pasture ÷ Total Land	.026	.63	.40	.58	.50	.70	.69	.60	.55
Work Stock + Tractor + All Equipment ÷ Cultivated Land + Improved Pasture	246	98	78	78	147	42	75	94	94

a/ Capital assets include productive livestock, work stock, tractors, and all equipment.

b/ Cash expenditures include crop expenses, machinery expenses, labor expenses, and livestock expenses.

Table 14

Selected Ratios,
Farm Size Breakdown, Southern Brazil, 1965

Item	Farms of 1.0-3.9 Land Equivalents	Farms of 4.0-6.9 Land Equivalents	Farms of 7.0-9.9 Land Equivalents	Farms of 10.0-14.9 Land Equivalents	Farms of 15.0-19.9 Land Equivalents	Farms of 20.0-29.9 Land Equivalents	Farms of 30.0-49.9 Land Equivalents	Farms of 50.0 & Above Land Equivalents
Gross Farm Output ÷ Total Land	205	153	146	120	107	85	69	50
Crop Expenses ÷ Cultivated Land + Improved Pasture	12.9	5.34	4.21	3.68	3.80	6.68	11.9	29.6
Cultivated Land + Improved Pasture ÷ Total Land	.58	.67	.69	.64	.67	.60	.51	.45
Farm Income[a/] ÷ Total Land	168	128	115	95.9	79.9	59.6	31	16
Tractor + Work Stock + All Equipment ÷ Cultivated Land + Improved Pasture	131	94.8	102	90.4	79.8	81.5	147	118
Cultivated Land + Improved Pasture ÷ Hired Labor + Family Labor	1.08	1.79	2.50	3.04	4.16	5.64	6.73	42.8

a/ Farm income is equal to net cash income minus machinery and equipment depreciation plus livestock inventory change plus farm production consumed by the farm family.

Land

Four different variables have been used as a means of incorporating land as a factor of production into the models. These include: (1) cultivated land, (2) improved pasture, (3) permanent pasture (unimproved), and (4) land equivalents. All except the latter are specified in number of hectares. The land equivalent variable is a weighted summation of the other three. One land equivalent consists of either one hectare of cultivated land, one hectare of improved pasture, or three hectares of permanent pasture.

There are significant differences in the size of farm operation both within and between farm types; therefore, it is interesting to observe how the utilization and productivity of the land variable is affected by the type of enterprise and size of farm. First, between farm size groups, the evidence of diminishing average returns to the land resource are very evident as size of farm increases. For example, farms with land equivalents from one to 3.9 have an average output per unit of total land operated which is four times that of the farms with 50 or more hectares (Table 14). Between these two extremes, there is a rather uniform decline in output per unit of total land operated as the size of farm increases.

It could be hypothesized that diminishing returns to total land may be indicative of the intensity with which the land is utilized. Intensity of land use in turn can be determined in one of two ways: either by the percentage of land that is under cultivation and/or by the manner in which the land is utilized, that is, the type of enterprise.

Percentage of total land utilized for crops may be indicative of the amount of land that is available for cultivation or it may indicate a system in which the land resource is in abundance and there is not sufficient capital and labor to utilize all that is cultivatable. Output differences related to type of

farming would include a different intensity of crop enterprises which may yield different levels of output per unit of land and/or the effect of a livestock enterprise either through raising crops to a higher form of product for sale or through the very extensive use of land for pasture. All of these factors are operative in determining the rather substantial differences in output per unit of total land when farms are grouped on the basis of farm enterprise. However, when one looks at the level of land utilization, that is, the percentage of land that is devoted to cultivated crops and improved pasture, there is very little difference between type of farm and among different sizes of farms. The one exception being the range livestock farms and, to some extent, the dairy farms where a considerable amount of the land is used for pasture.

The percent of land utilized for cultivation and improved pasture when the farms are grouped according to size is remarkably consistent up to about 30 hectares. Farms above 30 hectares demonstrate a somewhat lower level of utilization of land. However, the differences are not great. This would seem to indicate that within the range of the farm sizes studied here, that land is not necessarily being under-utilized and that differences in productivity per unit of land are largely due to the nature of the farm enterprise which is carried out on the farm and perhaps a result of the ability to effectively manage a given size of enterprise.

The data coefficients (marginal productivities) are all positive and range from a low of 20.6 new cruzeiros per land equivalent for range livestock farms to 105.8 per cultivated hectare for mechanized crop farms (Table 10) and by size category, range from 23.3 new cruzeiros per land equivalent for the larger size category to 262.5 for the smaller size category (Table 12).

The importance of land in the models (as indicated by the net effects) appears to be the largest in the case of range livestock, mechanized crop, and dairy farms.

Labor

The variables representing labor as a factor of production are: (1) family labor and (2) family labor plus hired labor. Both of these variables are measured in terms of man equivalents. One man equivalent is equal to one permanent hired employee or 300 days of temporary labor. Family labor was rated according to age, sex, and days available to work on the farm.

Hired labor was most generally incorporated into the models as labor expense and not as a measure of man equivalents.

The average number of man equivalents of family labor available by farm type varies slightly. Two farm types, range livestock farms and mechanized crop farms, show the lowest values for available family labor. They are 1.66 and 2.29, respectively. These two farm sizes are characterized by large farms and, in many cases, two residences, one on the farm and the major residence in a nearby town. This dual residence is maintained primarily for access to higher education. Thus, during most of the year, school age children will be living away from the farm and, therefore, are not available for work. This is primarily responsible for this lower level of availability of family labor.

The remainder of the farm types are characterized by the farm family living on the farm and display a rather uniform level of available family labor averaging slightly below to slightly above three man equivalents per farm.

In terms of size categories, man equivalent of family plus hired labor per farm increases twofold from the smallest to the largest size category. Thus, as farm size increases, there is a substantial increase in the number of hectares per man equivalent ranging from about one hectare of cultivated land per man equivalent on a smaller farm to over 42 hectares of cultivated land per man equivalent on the largest farms.

It could be logically assumed that on many of these farms available family labor is in fact in surplus supply and, therefore, that labor would not have a strong influence on volume of output. In looking at the farms according to farm type, family labor entered in only two of the nine equations and in each case, the marginal productivity associated with family labor is considerably below the minimum wage.

Alternatively, it might be argued that where expense is actually incurred, there is a necessity for additional labor and that labor might then be productive. Labor expense entered the equations for the farms between 20 and 29.9 hectares and those between 30 and 49.9 hectares and in each case, the marginal productivities indicate that hired labor can be profitably employed on farms of this size.

Capital

The primary focus of the productivity analysis was on capital items. The capital inputs have been divided into two major types: (1) capital flows and (2) capital stocks and then each of these subdivided into various categories.

Capital Flows

Capital flows are reoccurring farm expenditures. In this analysis, they take the form of crop, livestock, labor, and machinery expenses. One or more of these capital flows is important in explaining differences in productivity in each of the farm types and farm size categories.

Crop expenses are perhaps the most universal of the capital flow items since crop production is a major activity on most types of livestock farms as well as on cash crop farms. Also, the items which make up crop expenses, that is, fertilizer, hybrid seed, insecticides, and pesticides, are those items of technology which are currently receiving considerable emphasis in development plans in underdeveloped countries.

When crop expenses are expressed on a per hectare of cultivated land basis, several very interesting contrasts are apparent. First, for those types of farms (both livestock and crop) that have a significant percentage of land in cultivation, the livestock farms demonstrated a considerably lower level of crop expenses per hectare than the specialized crop farms. Also, within crop farms, there are significant differences. The non-mechanized crop farms incur an average crop expense cost per cultivated hectare that is two to three times greater than the specialized livestock farms whereas the mechanized crop farms use considerably more of these inputs experiencing an average crop expense per cultivated acre that is eight to ten times greater than the specialized livestock farms.9/

When the same measure, crop expenses per cultivated hectare, is compared across farm sizes, it is interesting to note that the very small and the very large farms exhibit the greatest intensity of use. This again probably reflects a concentration of specialized crop farms in the larger farms and in the very small farms with a majority of the livestock farms being of more medium size.

9/ It is interesting to contrast this rather sharp difference in the utilization of crop expenses between specialized crop farms and specialized livestock farms with the observation noted in the management study on page 96, that is, that when looking at the components of the management index that are related to livestock and crop practices respectively, the hog farmers chose to concentrate more on livestock practices and not on crop practices. It is also interesting to compare this with the observation on page 82 where the hypothesis was put forward that the low use of crop expenses (though high returns were indicated) was related to the level of credit utilization. The indication being that short-term credit for crop expenses that had to be repaid at the end of the harvest season was not consistent with the credit needs of livestock farmers where the sources of income for repaying these loans were delayed until the sale of the livestock.

Crop expenses appear as an important variable in terms of explaining variations in output on all of the crop farms and on dairy farms. On other livestock farms, it does not enter as an important explanatory variable. This is probably partly due to its low level of utilization. The marginal returns are inversely related to the level of utilization, that is, low level of utilization related to high marginal return, and, with the exception of mechanized crop farms, are consistently high. The other specialized crop farms show that a return of about 200 percent could be realized from additional investments for crop expenses. For other farms and dairy farms, this rate of return would increase to 400 to 500 percent indicating that in general on these farms, there is still considerable opportunity for increased utilization of the components of the crop expenses; namely fertilizer, hybrid seed, insecticides, and pesticides.

Mechanized crop farms which had experienced levels of investment in crop expenses more than three times greater than the other specialized crop farms, show a return of less than unity for additional expenditures indicating that they have already reached or passed the point of maximum utilization.10/ When returns to crop expenses are viewed across farm size, the rather significant differences noted betwen the farm types largely disappear. Returns of additional investments in the area of 300 to 400 percent are rather consistent up to the very large farms where they again drop down to near unity. Again, the larger farms are largely composed of mechanized crop farms so this is consistent with the earlier results.

10/ On several alternative models, this particular coefficient varied between the low value noted here of .57 and a high of about 1.5. This variation is caused by high collinearity between some of the explanatory variables. However, it is reasonably certain that the level of investment on the mechanized crop farms is approaching the point of maximum economic returns.

Livestock expenses are an important explanatory variable in several of the models including both livestock and specialized crop farms and where they appear, the resulting estimated marginal productivities for additional expenditures are positive. It is a stronger variable in the farm size classification than it is by farm type. In most cases, it appears that a return of around 50 percent above the expenditure could be expected for additional investments in livestock expenses.

Labor Expenses and Machinery Expenses--Labor expenses were discussed under the returns to labor earlier. However, in summary, it appears that they are profitable on the farms above 20 hectares where surplus family labor is no longer in evidence. Machinery expenditures were incorporated in only one of the models and were not very important as an explanatory variable. The marginal return was less than one.

Capital Stocks

Capital stocks refer to moveable productive items. Included in this classification are productive livestock, work stock, all types of equipment, and tractors.

In one form or another, capital stock appears in all but two of the 17 models. The models which do not include some form of the variable are other farms and the 1.0-3.9 category in the farm size breakdowns.

Unlike the capital flows, the capital stocks do not exhibit the dramatic degree of variation within and between the categories. This is not to say that variation does not exist, but merely that it is much less. The variation encountered within and between the categories based on farm type is much greater than that found in the categories based on farm size. The within category variation is greatest in the case of the variable depicting tractors and equipment.

When the capital stock investment is compared to gross farm output by farm type, the values of output per unit of investment range from .21 for range livestock farms to 1.1 for general crop farms. Capital stock per unit of land extends from a low of 61.9 for range livestock farms to 158 and 159 for hog and general livestock farms, respectively.

To get a clear indication of the trade off between capital and labor, productive livestock was removed from the capital stock values. The remainder, power and equipment, was divided by hectares of cultivated land and improved pasture.[11/] These values can then be compared to similar measures of land use per unit of labor. The values of power plus equipment employed per hectare of cultivated land and improved pasture approximate each other very closely throughout most of the size ranges (Table 14). Only at the two extremes are the values somewhat higher. This probably indicates an inability to reduce some capital items to a sufficiently small size for the very small farms meaning that there would be some excess capital stock on the very small farms. On the other extreme, the increased investment in capital stock is indicative of a substitution of mechanical equipment for labor in some of the operations carried out on the farm. This observation would be consistent with the amount of labor available on these larger farms.

Within the capital stock variables, the one appearing in most of the models is productive livestock. It, however, does not enter on the farm sizes greater than 30 hectares, a result that is also consistent with an earlier observation of surplus labor on the smaller size farms. Thus, a livestock enterprise would be complementary to a crop enterprise on the smaller farms, but may in fact become competitive on the larger farms for use of the labor resource.

11/ Power includes both animal and motorized sources.

The variations in the level of utilization of power and equipment are important in explaining variations in output only on the larger farms--those above 15 hectares--and the estimated marginal returns become progressively higher as farm size increases.

The Impact of Selective Price and Credit Policies on The Use of New Inputs and Mechanization at The Farm Level

The growing understanding of the nature of agriculture in developing countries strongly suggests that diversity in the structure of agriculture is the rule and homogeneity the exception. As a consequence of this diversity of developing agriculture, major segments are often scattered along the continuum between undeveloped and developed. Movement along this continuum is not uniform. Various barriers to further development will periodically present themselves and these are not necessarily the same at various levels of development. Lack of appropriate technology, suitable credit services, management and labor skills, tenure arrangements, farm size, and other factors, individually or in combinations, can all serve to slow the orderly development of agriculture. Further, within geographical areas, all farms do not necessarily conform to the same stage of development nor face the same barriers to modernization. There are substantial differences between farms both in terms of existing capital structure, enterprise combination, crop inputs, and in terms of production possibilities available to them.

If policies to hasten the development process are to be effective, they must recognize this diversity in agriculture and identify the priority needs of various groups of farmers. Empirical studies documenting the diverse needs of developing agriculture should be the basis for policy formulation. Broad generalizations are likely to lead to unrealistic policies.

The focus of this particular study is on the role of credit in fostering rapid productivity changes. Three points are stressed: (1) the diversity of agriculture within one region, (2) the major structural and productivity changes on a particular farm type resulting from a package program of mechanization and other complementary technological inputs including the use of agricultural credit as a facilitating service, and (3) the unrealized potential for productivity gains on neighboring farms of a different type.

Background

Southern Brazil offers great contrasts in the structure and organization of its agriculture. Individual farm holdings run the gamut from small (several hectares) diversified subsistence agriculture to the most modern of large (several hundred to thousands of hectares) crop and livestock farms. Between these two extremes are found many farm situations displaying different combinations of size, enterprise, and technology use.

The government of Brazil has adopted several measures to increase agricultural productivity that are particularly relevant for some of the farm types found in this region. One of these measures is to subsidize the use of modern inputs, primarily fertilizer and farm machinery, through agricultural credit at negative real interest rates. Capital constraints have been reduced by making credit available to farmers for these purposes. Subsidized interest rates have been used to foster adoption and increased use thus lowering the real cost of using these modern inputs. In addition, wheat prices have been supported to induce a greater domestic supply of this commodity.

Encouraged by the incentives offered, farmers have introduced tractors on their farms. However, the tractors available until 1965 were large and only substantial operations could justify the adoption of mechanization. This combination of events--the availability of large tractors only, favorable credit

terms for the acquisition of farm machinery and modern crop inputs, and the desire to increase substantially the domestic production of wheat--resulted in a package application in the transformation of extensive cattle grazing farms to intensive mechanized crop production. This change has occurred largely in the central plateau area of the state of Rio Grande do Sul where the climatic conditions and land resources are conducive to either system of production. In the same area, small farms with holdings not large enough to support a tractor have continued with established methods of cultivation. While fertilizer, hybri seed, and other modern crop inputs are also available to many of these small farmers, credit availability, in practice, has been restricted. Thus, within this region, it is possible to contrast the structure and performance of three distinct farm situations in close proximity to one another: (1) an established ("traditional") extensive livestock grazing system, (2) a new intensive mechanized crop system that has evolved from the above, and (3) a more or less transitional small farm agriculture that has modern inputs available, but apparently lacks sufficient credit or other operating capital sources to employ adequate quantities of these inputs.

Modernization Through Mechanization

Dramatic changes have taken place on land that has previously been used almost entirely for unimproved pasture. The process of transition, though relatively swift, has not been accomplished without some major shifts in farm operator and tenure situations. Many traditional cattlemen have been reluctant to participate in the early stages of transition because of the substantial capital structural changes, the reorientation of production activities, and the high cost involved in this transformation. Business and other professional

people with some previous interest in farming and some progressive ranch operators have given the initial impetus to this change. They have expanded their land base by renting land and increased their capital base by borrowing heavily from official credit agencies.

Since many of the present mechanized farm operations have not evolved from a previously established ranch operation (units have been somewhat recombined through renting), it is not possible to make direct before and after comparisons. The method chosen to compare the two systems of farming in this analysis was to select farm operations of similar sizes in each category.[12/] A range of farm size from 100 to 1,000 hectares was used. This includes most of the possibilities for mechanized crops. A few extensive livestock farms will substantially exceed 1,000 hectares.[13/]

Summary data on the resource situation for each type of farm, including both physical and financial measures, is given in Tables 15 and 16. The overall resource base is similar for the two types of operations, however, the composition of their capital is radically different. The average land area per farm is similar (about 380 hectares) since farm observations of similar sizes were selected for each group. Labor utilization actually increased by 50

12/ Observations for the mechanized crop farms were selected from a county where the transition is now almost complete. The control group of extensive livestock farms was selected from another county where ranching is still the major agricultural activity.

13/ It could be argued that perhaps size considerations would make livestock farms in excess of 1,000 hectares more efficient. However, traditional livestock farms in which 99 percent of the resource inputs are made up of land and range livestock have little opportunity to take advantage of size economies.

Table 15

Land, Labor, and Power Resource Utilization Per Farm,
56 Farms, Southern Brazil, 1965

Items	Mechanized Crop Farms	Range Livestock Farms
Total Land Operated (Hectares)	382	379
Owned	206	273
Rented	176	106
Cultivated[a]	224	10
Total Labor Units[b]	4.3	2.9
Family Labor	2.2	1.9
Hired Labor	2.1	1.0
Total Power Units[c]	21	20
Mechanical	21	1
Animal	0	19
Number of Farms	25	31

a/ Includes improved pasture.

b/ One labor unit equals one full-time worker or 300 days of temporary labor.

c/ One power unit equals one horse, two oxen, or five horsepower of mechanical power.

Table 16

Capital Assets, Operating Expenses, and Credit Use Per Farm,[a/]
56 Farms, Southern Brazil, 1965

Item	Mechanized Crop Farms				Range Livestock Farms			
	Asset Value	New Purchases	New Credit	Outstanding Liabilities	Asset Value	New Purchases	New Credit	Liabilities
	(United States Dollar Equivalents)							
Land and Buildings[b/]	$18,470	$ 622	$ 163	$ 143	$25,204	$ 410	$ 92	$ 62
Livestock	3,833	221	82	55	10,567	210	13	20
Machinery and Equipment	14,770	2,506	849	879	362	17	0	0
Total Assets	37,073	3,349	1,094	1,077	36,133	637	105	82
Operating Expenses	------	8,550	5,576	5,938[c/]	------	1,295	24	18
Total	$37,073	$11,899	$6,670	$7,015	$36,133	$1,932	$129	$100

a/ In addition to the loans for agricultural purposes, new credit for personal and other uses amounts to an average of $34.00 per farm for the mechanized crop farms and $293.00 per farm for the range livestock. In addition, average interest rates for all new loans were 13.8 percent and 24.4 percent for mechanized crop and range livestock farms, respectively.

b/ Value of rented land not included.

c/ At the time of interview, wheat harvest was just terminating and current operating loans had not yet been retired. This value also includes some carry over credit from the previous year.

percent, a phenomenon not normally anticipated with introduction of mechanization which is commonly thought of as a substitute for labor. Undoubtedly, the need for additional and different labor skills was also required. Power unit equivalents did not change, however, the nature and utilization of the available power was completely different moving from predominantly range horses to tractors. The combined investment for livestock and machinery on the mechanized farms is almost twice as great as on the livestock farms demonstrating the need for additional capital investments if this transformation is to take place.

Thus, mechanization induced through a supply of credit at concessional rates has been associated with two major structural changes within the farm operations: (1) in the enterprise combination and (2) in the composition of capital assets. Consequent productivity differences are substantial. Gross output on mechanized crop farms is six times higher than on traditional livestock farms and net farm income is four times higher (Table 17). These differences are particularly significant in view of the equal amounts of capital invested on both types of farms.[14/] If average net farm income values are expressed as a percentage of capital investment, returns to capital of 12 and three percent are obtained.

This transition and consequent productivity improvement have been rendered possible in part by the substantial amounts of credit made available to farmers. Individual farm data is not available on credit use during early stages of the transition, however, the borrowing situation as it appeared in 1965 shows that

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14/ It should be noted that a greater proportion of land is rented on mechanized crop farms. Therefore, if capital controlled is used as a measure of assets, the mechanized farms commit approximately 15 percent more capital assets to production than do intensive livestock farms of comparable acreage. Further, if the additional operating expenses on mechanized crop farms are also included, a total additional capital need of 28 percent may be assumed. However, regardless of which value is used, productivity changes of sixfold and income changes of fourfold remain largely unchanged.

Table 17

Measures of Output and Income Per Farm,
56 Farms, Southern Brazil, 1965

Item	Mechanized Crop Farms	Range Livestock Farms
	(Value in United States Dollar Equivalents)	
Gross Output	$14,019	$2,283
Marketable Output	13,604	1,904
Operating Expenses	8,550	1,295
Net Farm Income	4,326	931
Net Farm Income/Capital Assets	.12	.03

liabilities constitute about 20 percent and one percent of the total value of capital assets on mechanized crop farms and livestock farms, respectively. An analysis of credit use by purpose (Table 16) shows that about 84 percent of the credit on mechanized farms was for working expenses and about 13 percent for the purchase of machinery and equipment. Not only did livestock farms borrow very little in absolute terms, but also they devoted a substantial portion of those funds to "other purposes" which include personal and household expenses.

The inferences are quite obvious. Given the enterprises on the more traditional farms, there is neither the scope for profitable investments nor the need for outside funds whereas in modern farming, substantial amounts of credit have been used. Though lacking quantitative data on borrowing in the past, it can be logically inferred that borrowings must have formed a considerably large part of the initial capital assets on the mechanized crop farms. Data available on purchases of capital items during the year of record show that mechanized crop farms have invested $3,349 per farm or 18 percent of their reproducible material capital. Credit was used to finance about one-third of these purchases. External financing formed a greater portion (almost two-thirds) of annual operating expenses. Altogether, more than one-half of total annual cash outlays on these farms were financed from external credit sources.

On the basis of this particular comparison, several hypotheses concerning developing agriculture can be given additional support. (1) Modernization of traditional agriculture can greatly improve the productivity of resources assuming a "hospitable climate" in the overall economy and availability of

suitable inputs. (2) Modernization may require substantial and increasing amounts of credit to flow into agriculture. (3) Without some major change, traditional farming cannot absorb productive credit on any considerable scale.[15/]

Credit Availability and Input Use

A comparison of use of new crop inputs, credit, and resulting levels of productivity between the large mechanized crop farms and adjacent small farm agriculture was made. While the existence (previous to the study period) of large tractors only precluded mechanization (to any substantial degree) on the small farms, these farms did have reasonable access to other modern inputs such as hybrid seed, fertilizer, and insecticides. Credit was also available, but in practice, use of both credit and modern inputs was considerably less than on the mechanized farms. Further, factor productivity studies based on regression analysis indicate that the marginal productivity of specific crop inputs on the small farms is considerably in excess of the factor cost (two to five times greater). Similar studies of the mechanized crop farms demonstrate a more economically rational utilization of these inputs (Table 18).

Mechanized crop farms with adequate financing have committed approximately $17.00 per hectare for specific crop inputs (seed, fertilizer, and insecticides). Small crop farms have committed only $5.00 per hectare for this item and small livestock farms have incurred an expense of only $2.50 per hectare. Marginal productivity estimates for these crop inputs are consistent with economic logic

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15/ These inferences appear to have some support in the experience of United States agriculture. "It appears that farmers most heavily in debt are making the greatest gains in both equities and income."(74) Concern is being expressed about the position of the banking system in the United States as a prospective source of funds if the current debt-to-asset ratio of 17 percent goes up, as estimated, to 28 percent by 1980.(4)

Table 18

Level of Annual Crop Expenses Per Hectare,
Amount Financed by Credit, and Marginal Value Product
of Specific Crop Input Costs,
by Type of Farm,[a] Southern Brazil, 1965

Type of Farm	Number of Observations	Annual Crop Expense Per Hectare		Specific Crop Input Costs Per Hectare	
		Actual Level	Financed by Credit	Actual Level	Marginal Value Product
		(Value in United States Dollar Equivalents)			
Mechanized Crop	38	$32.00	$24.80	$16.57	0.57[b]
Small Crop Farms					
Extensive Crop	36	6.81	3.23	4.29	1.79
General Crop	109	8.40	2.81	6.34	2.31
General Farms	71	4.88	3.58	4.09	1.80
Small Livestock Farms					
Dairy	47	3.70	0.66	2.74	4.42
Hogs	216	3.41	1.58	1.87	----[c]

a/ Specific crop inputs refer to seed, fertilizer, and insecticides only whereas annual crop expenses in addition include hired labor and machinery expenses.

b/ Different models have given a range of MVP from 0.57 in the selected model to a high of 0.85 in other alternative models.

c/ Specific crop input costs did not enter the equation as an explanatory variable for hog farms.

ranging from a low of approximately one (cost at the margin equated with returns) on the mechanized farm to a high of four and one-half on the small livestock farms. In each case, the different farm types are located in close proximity to one another, the factor inputs are the same, and the basic crop production similar. The source of cash receipt is similar for the crop farms, however, the timing of receipts on the livestock farms would be somewhat delayed causing repayment problems for short time crop loans.

Again, one can only hypothesize that lack of credit is the dominant factor resulting in the low level of usage of modern crop inputs on the small farms. However, several factors support this belief. (1) The relationship between credit used for crop expenses and the actual level of crop expenses per hectare is quite consistent for each group (slightly greater than fifty percent). (2) Short-term credit, repayable immediately following crop harvest, is more compatible with cash crop farms than with livestock farms (hogs) where income is delayed for several months after harvest. (3) A preliminary report of a pilot credit project in one of the municipios from which small farm data was collected indicates that merely making additional credit available resulted in a significant increase in the number of farm loans.(67)[16/]

Thus, it would appear that there has been a failure to recognize or capitalize on the potential for the profitable employment of additional resources on these small farms. Whether this situation results from a lack of suitable credit, technical assistance, inputs, or some other factors or is a combination

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16/ The purpose of this special project was to test the effect of "unlimited" credit availability on the use of credit and modern inputs. During the first three months of this special project, 45 percent of the loans given were to farmers who had not received credit during the previous three years. The existing banking facilities were not sufficient to attend to the large number of requests for loans during this initial period.

of these cannot be precisely determined. However, the fact that mechanized farms, with higher incomes, have employed considerably greater quantities of the same inputs using both more credit and personal resources to pay for these inputs and have equated the costs and returns at the margin would strongly suggest that available resources for the purchase of modern inputs were lacking on small farms and that additional credit would result in positive application of new technology and production increases on them.

Programs to foster modernization of developing agriculture must be based on an understanding of the diversity that exists between farms and regions within any country and be designed to take advantage of the particular opportunities for development that exist. Reliance on one or two major policy instruments will often lead to overkill in one area and the masking of some very profitable investment opportunities in other areas. Balanced growth in agriculture and optimum allocation of development funds dictate the need for an intimate knowledge of the nature of developing agriculture combined with a broad set of policy instruments. The particular example from Brazil used in this presentation focused on the dual role of credit and technology. This situation undoubtedly has application to many other developing areas. In other situations, credit and technology may not be first priorities. A broadly based program of research at the farm level is imperative to an adequate understanding of the needs and potential of developing agriculture.

The Management Factor[17/]

The specification error conceded most often in production function analysis is the omission of entrepreneurial or managerial services. The major reason for failure to include the management factor in production function analysis is that a well defined concept of management has not been developed.

Various research attempts have consistently indicated that some portion of inter-farm variation in production cannot be explained by variation in the quantity and quality of physical resources used in production.(7, 25, 41, 59) Farms with essentially similar physical resource patterns vary widely in production and efficiency. Some consensus exists that the variation which cannot be explained by differences in resources is due to differences in the managerial level of farm operators. While it is generally recognized that managerial levels vary among farmers, no satisfactory conceptualization or direct quantification of the management factor has been developed. After more than a six year endeavor by the North Central Regional Committee (North Central Regional Project 59), the conceptual problem related to the identification of management remains unresolved. Thomas, in a paper presented to the NC59 Committee, stated that "...to the best of my knowledge, there exists no research within the field of agricultural economics that we would be willing to accept as having directly

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17/ For a more detailed description of this study, see Donald M. Sorensen, "Capital Productivity and Management Performance in Small Farm Agriculture in Southern Brazil", unpublished Ph. D. Dissertation, Department of Agricultural Economics, Ohio State University, 1968.

measured the managerial ability of farmers".[18/] In essence, there is no satisfactory measure of the one variable which occupies the crucial role in allocation and utilization of farm resources. While it is difficult to identify quantitatively the phenomenon known as management, the importance of the management factor is recognized by those concerned with problems of stimulating agricultural production in developing nations.(43, 63) Moreover, policymakers have made various attempts to improve the managerial level of farmers through programs of supervised or oriented credit which combine technical assistance with capital inputs.(14) The underlying philosophy of such schemes holds that management is the constraining factor to the adoption and profitable use of additional (and improved) capital inputs. It is contended that additional capital inputs can be productively employed only when accompanied by complementary managerial inputs.

On the other hand, implicit attention is granted the management factor in programs designed to encourage use of additional inputs to stimulate production of a greater social agricultural product. The assumption underlying programs promoting mechanization, fertilizer, and hybrid seed use is that farmers who acquire these technological inputs presently possess sufficient managerial resources to productively utilize the inputs. In either case, the managerial factor is recognized as being essential to the profitable use of additional capital and technological inputs. The increased attention being given to the management factor and the critical role it occupies in development planning

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18/ D. Woods Thomas, "Agricultural Economics Research Related to The Measurement of Managerial Ability" in a symposium on measuring managerial ability of farmers. Mimeo report NCR Research Committee (NC59) on The Management Resource in Farming and The Farm Foundation, pages 3-11.

suggests that an attempt to develop some measurement be undertaken. Thus, while giving recognition to the conceptual difficulties and identification problems related to management, the present study constitutes an effort to identify empirically characteristics thought to be indicative of management performance. The management variable developed for this study is an index composed of a number of recommended and improved practices which are weighted to reflect their relative importance as determined by professional farm management personnel.[19/]

The sample entrepreneurs (all specialized hog farmers) were objectively rated on the basis of their use of recommended agricultural practices and physical output performance. The management index represents an attempt to include a composite factor which, while not entirely independent of other input categories, does serve as a measure to indicate the level of management performance on the swine farms studied. Realizing that use of the index may be subject to the criticism of arbitrariness, it, nevertheless, represents a point of departure for sharpening the focus on the management factor in Brazilian agriculture and provides a technique for making some allowance for management as an explicit factor in production analysis.

Management Index

The management index developed for this study consists of two parts: the first relates to recommended swine practices and the second relates to recommended crop practices. A composite of 12 factors, each weighted to reflect their relative importance as determined by professional extension and farm management personnel in southern Brazil, is used to rate the sample

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19/ Professional personnel include members of Brazilian Rural Extension Service (ASCAR), Ministries of Agriculture, universities, and researchers in southern Brazil.

entrepreneurs. Eight of the factors apply to swine production and four relate to crop production. Total points possible are 30 with two-thirds of this total assigned to recommended swine practices. The component factors of the swine practices portion of the index are: raising of meat-type hogs, number of pigs weaned per sow per year, a composite of age and weight at which hogs are marketed, clipping of needle teeth, use of feed supplements, vaccination, and internal parasite control. Included in the crop portion of the index are: use of improved seed, application of fertilizer, use of insecticides, and an index of crop yields. The components, weights, and total possible points for swine and crop practices used in the index are presented in Appendix B with a description of the manner in which the index is applied.

Each producer is rated according to 12 components of the index and the sum of points actually earned is divided by the total number of points possible (30). For example, if 15 points are earned, the percentage or value of the index for the producer is 50. The possible value of the index ranged from zero to 100. The average value of the management index for all 217 producers is 48. The value of the index ranges from a low of three to a high of 87. The average value increases as farm size increases; for small farms, the index is 44; the index averages 47 for medium farms and 57 for large farms. The value of the index is taken to be the measurement of management performance.

Build Up of Management Index

To analyze the relative importance of the individual components making up the composite index, the farms are arrayed in order of the value of the management index then divided into eight subgroups to reflect different levels of management. The breakdown according to index value is done to reveal the order in which individual components of the index become a part of management practices. The number of farmers receiving some points for each of the

components of the index and total number of farms in each subgroup is shown in Table 19. The only component in the lowest index subgroup for which more than one-half of the farmers received some points is the scale of pigs weaned per sow per year. As the value of the index increases from the lowest level, a majority of the farmers soon begin earning some points for clipping needle teeth of pigs and internal parasite control. At the 40-49 index subgroup level, only the use of feed supplements from all swine practice components fails to earn some points for a majority of farmers. However, none of the crop practice components are contributing to the composite index for the greater number of farmers in this subgroup. As the index level increases beyond 50, selected seeds, fertilizer, and insecticides in that order achieve higher levels of usage. The majority of farmers in the highest index value group (80+ points) received some points for all items in the composite index.

Although the number of farmers earning points for the respective index components reveals, in a general way, the order in which the individual items became important, a better understanding of the index build up is possible by taking into account the absolute amount of points earned as the management index increases. Since the individual components are weighted, computation of the average absolute points earned per item reveals the magnitude of the contribution of each to the composite score for each index subgroup (Tables 20, 21).[20/]

20/ The average points earned per item are calculated by summing the points earned for all farmers in the respective subgroups and dividing the sum by the number of farmers. The results are shown in Table 20. To compute the average percentage of points earned relative to total possible points per item (Table 21), the weighted value of each component is multiplied by the number of farmers in the subgroup. This value is then divided into total points actually earned for the component to give average percentage of possible points earned.

Table 19

Number of Farmers Receiving Some Points for Each of 12 (11) Component Factors of Management Index as Value of Index Increases From Minimum to Maximum Value, 217 Swine Farms, Southern Brazil, 1965

Index Component	Value of Index 0-19	20-29	30-39	40-49	50-59	60-69	70-79	80-89	Possible Points
	(Number of Farmers)								
Swine Practices									
1 Raise Improved Breeds	--	4	18	28	29	26	19	11	1
2 Pigs Weaned Per Sow Per Year	5	7	22	27	26	22	13	12	3
3 Age and Weight Marketed	10	12	36	42	42	29	19	12	10
4 Clipping Needle Teeth	7	9	25	21	36	22	16	12	1
5 Use Feed Supplements	1	2	9	15	24	17	11	6	1
6 Vaccination	2	7	15	24	34	24	15	8	2
7 Internal Parasite Control	3	10	31	34	39	29	19	12	2
Crop Practices									
8 Use Selected Seed	3	5	24	19	31	24	15	8	2
9 Apply Fertilizer	--	2	5	4	9	5	11	9	3
10 Use Insecticides	2	5	7	3	4	15	2	7	1
11 Crop Yield Index	4	9	15	21	20	24	12	9	4
Number of Farms in Each Index Range	16	17	39	42	42	29	20	12	30
Average Index Value	13	26	35	43	55	64	71	82	48

Table 20

Average Points Earned by Each Farmer for Each Component of The Management Index for Different Levels of Index Value, 217 Swine Farms, Southern Brazil, 1965

Index Component	Value of Index 0-19	20-29	30-39	40-49	50-59	60-69	70-79	80+		Possible Points
	(Number of Points Earned)									
Swine Practices										
Raise Improved Breeds	0	.24	.46	.67	.69	.90	.95	.92		1
Pigs Weaned Per Sow Per Year	.75	.82	1.00	1.45	1.31	1.48	1.55	2.50		3
Age and Weight Marketed	1.01	1.71	3.36	4.36	6.12	6.90	8.80	9.00		10
Clipping Needle Teeth	.44	.53	.64	.74	.86	.76	.80	1.00		1
Use Feed Supplements	.06	.12	.23	.36	.57	.59	.55	.50		1
Vaccination	.25	.82	.77	1.14	1.62	1.66	1.50	1.33		2
Internal Parasite Control	.38	1.18	1.59	1.71	1.86	2.00	1.90	2.00		2
Crop Practices										
Use Selected Seed	.38	.58	1.23	.90	1.48	1.66	1.50	1.33		2
Apply Fertilizer	0	.35	.38	.29	.64	.52	1.65	2.25		3
Use Insecticides	.13	.29	.18	.07	.10	.52	.10	.58		1
Crop Yield Index	.38	1.29	.74	1.26	1.14	2.10	1.90	3.22		4
Average Total Points Earned	3.78	7.83	10.58	12.95	16.39	19.09	21.20	24.63		30
Total Possible Points	30	30	30	30	30	30	30	30	=	100%
Average Index Value	13	26	35	43	55	64	71	82		

Table 21

Average Percentage of Points Earned Relative to Total Possible Points for Each Item by Index Level, 217 Swine Farms, Southern Brazil, 1965

Index Component	Value of Index							
	0-19	20-29	30-39	40-49	50-59	60-69	70-79	80+
	(Percent of Points Earned)							
Swine Practices								
Raise Improved Breeds	0	24	46	67	69	90	95	92
Pigs Weaned Per Sow Per Year	25	27	33	48	43	49	52	83
Age and Weight Marketed	10	17	34	44	61	69	88	90
Clipping Needle Teeth	44	53	64	74	86	76	80	100
Use Feed Supplements	6	12	23	36	57	59	55	67
Vaccination	13	41	39	57	81	83	75	67
Internal Parasite Control	19	59	80	86	93	100	95	100
Crop Practices								
Use Selected Seed	19	29	62	45	74	83	75	67
Apply Fertilizer	0	12	13	10	21	17	55	75
Use Insecticides	13	29	18	7	10	52	10	58
Crop Yield Index	10	32	18	32	28	52	48	81

The lowest index subgroup (0-19 points) does not have a single component of the composite index for which one-half of the possible points are earned. At this level of management, a given farmer may be following one practice and another does something else. In sum, no single recommended practice is being followed by a majority of farmers. In the 20-29 point group, two components, both of which involve insignificant cash outlays, are the first to be important for a majority of farmers in the subgroup. Clipping needle teeth and internal parasite control are important components for this group and continue to be followed by farmers at all higher levels of the index. To these components are added the use of selected seed in the 30-39 index subgroup. However, selected seed declines in importance for the 40-49 point range while the raising of improved breeds of swine and pig vaccination provide points for a majority of farmers. In the 50-59 index subgroup, the scale of pigs weaned per sow per year is the only component of swine practices which remains below one-half of possible points earned. Selected seed again assumes importance while other crop components average below half of possible points. Only three items fail to average more than one-half possible points for farmers in the upper three subgroups (60-69, 70-79, and 80+ points). These items are pigs weaned per sow per year for the first, fertilizer application for the second, and use of insecticides for the latter subgroup.

Taken together, the three tables presented in this section reveal the composition of the management index as the value increases from subgroup to subgroup. At the lowest index levels (0-19, 20-29, and 30-39), the practices that are most important involve very little cash expenditure. Within the intermediate index ranges (40-49 and 50-59), practices involving small cash outlays continue to be important, but the quality of livestock is beginning to be improved. In addition, practices that require some cash expense, that is,

vaccination and feed supplements, are important components of the index. The cumulative effect of the use of a number of recommended practices begins to emerge as the selling age and weight scale increases for the average farmer. The three highest subgroups continue to utilize nearly all recommended practices and the overall manner in which the component factors exercise a cumulative effect is revealed by the continued increase in the selling age and weight scale for swine and crop yield index.

Presentation of the data from Table 21 in graphical form in Figures 1 and 2 serves to illustrate the contribution of each index component to the build up of the composite index from lower to higher values. The 45 degree line coming from the origin of each figure represents the contribution each component would have to make at all levels of the index to be exactly equal to all other components. The average percent of points earned by management level is measured on the ordinate and total possible points are measured on the abscissa. Any point lying above the diagonal line means that the particular component in question is contributed more than its normal share to index value whereas points below the line denote failure of the subject component to contribute its share to the given index value.

The most costly item, feed supplement, persistently remains below the line indicating that at all levels of management as measured by the index (except 50-59 index range), use of feed supplements is limited. The most important components at low index values are those practices which require minimal cash outlays, that is, parasite control, vaccination, and weaning an above average number of pigs per sow throughout the year.

The second part of the composite index consists of three crop practices and the crop yield index which are represented graphically in Figure 2. (The ordinate and abscissa measurements are defined as before). The one component

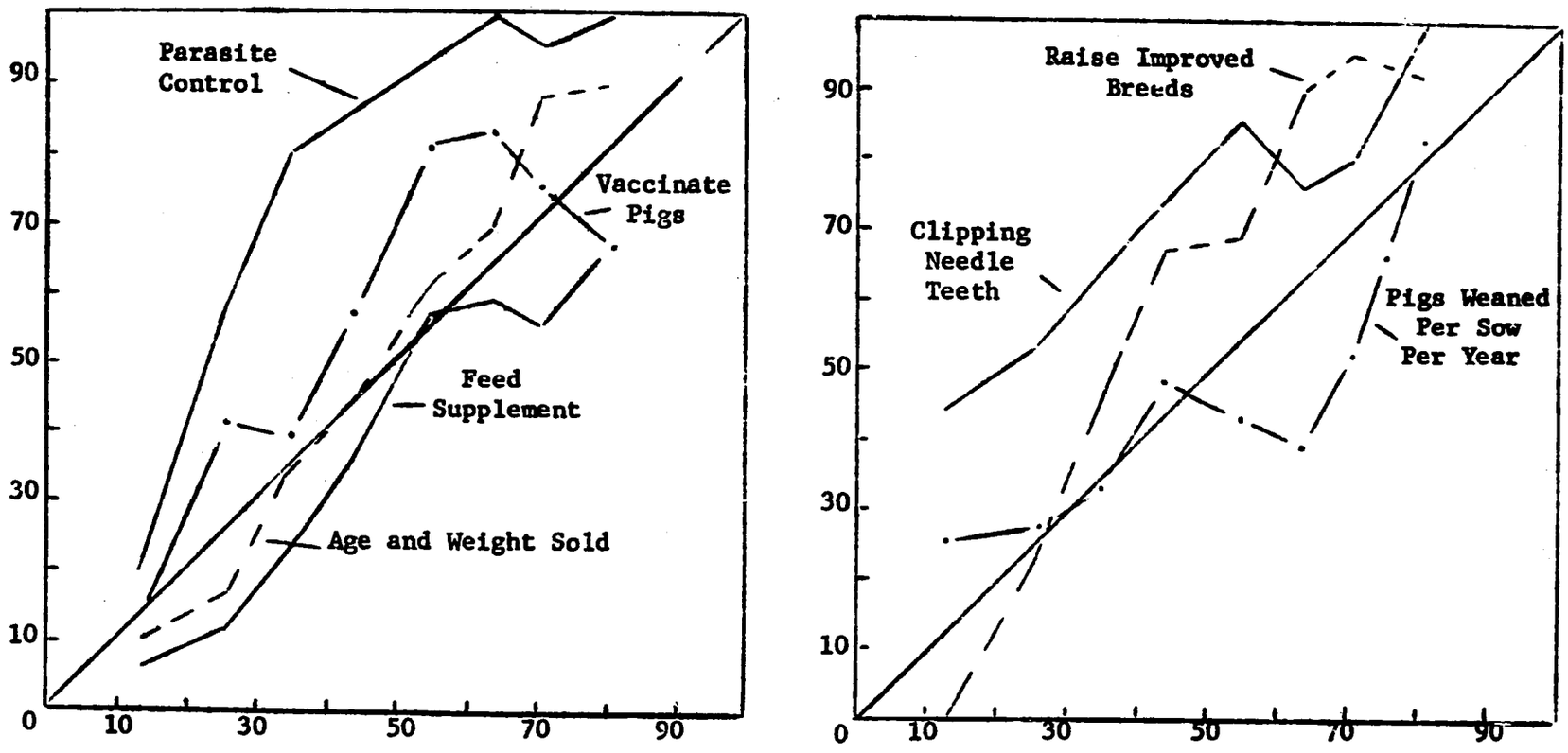

Figure 1. Average percentage of points earned relative to total possible points for each item by index level, swine practices (see data in top part of Table 21).

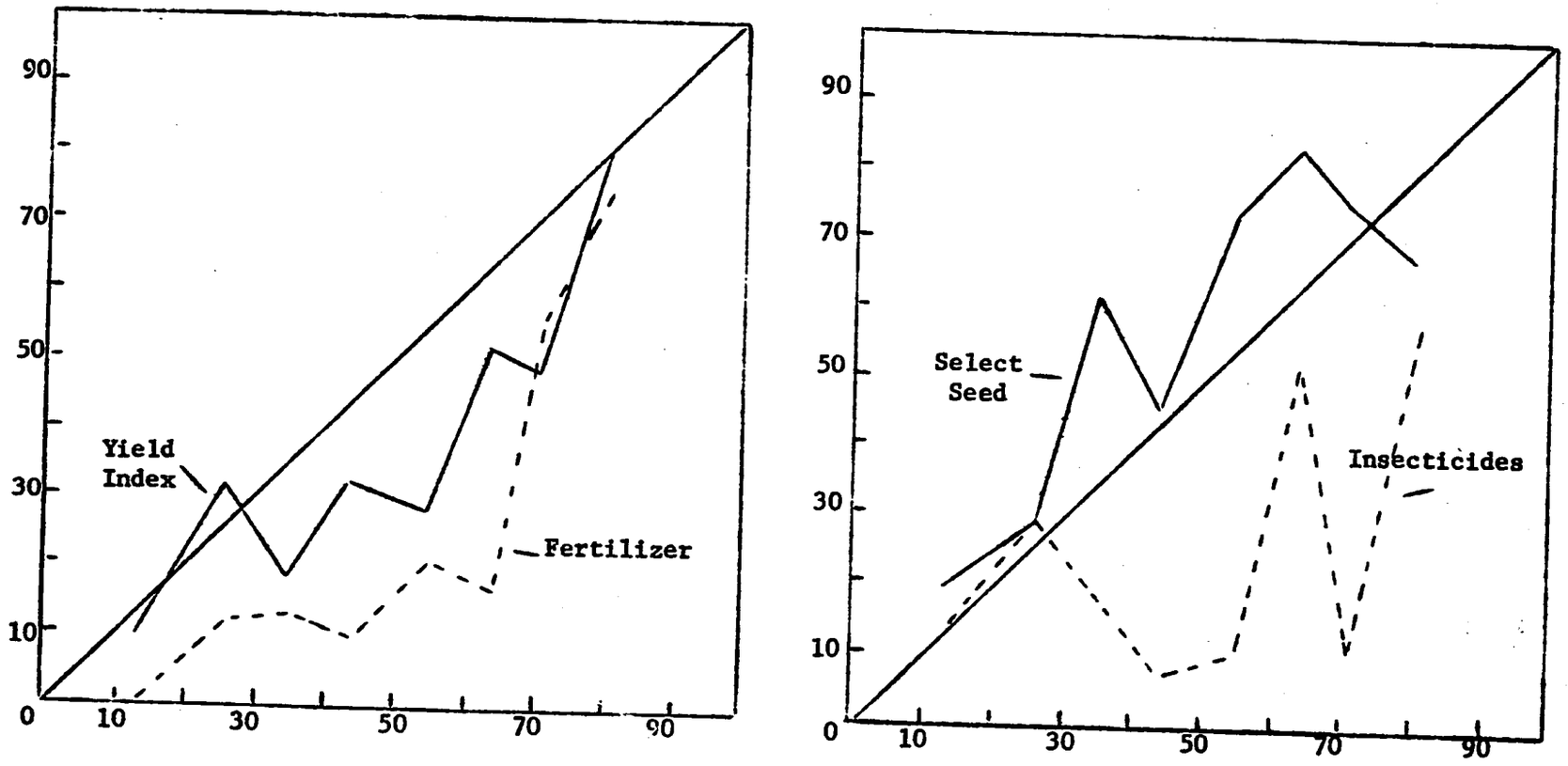

Figure 2. Average percentage of points earned relative to total possible points for each item by index level, crop practices (see data in bottom part of Table 21).

which contributes more than a proportional share to the index value up to the 70-79 level is use of selected seeds. The yield index and use of insecticide components are above the line only for the 20-29 index level. Throughout the remaining range of the index, the yield index and insecticide components are on or below the line. For crop components as with swine components, the most costly recommended practice is persistently below its proportionate contribution to composite index value. An interesting parallel is evident between crop yield index and contribution of the fertilizer component to the composite value.

Taken together, the two figures reveal some important characteristics of the swine farms sampled. First, it is apparent that farmers on the average swine farm are giving more consideration to good swine practices than to good crop practices. Second, the components representing the greatest cash outlay, feed supplement and fertilizer, are not used by a majority of the producers at any level of management except at the 50-59 level for feed supplement.

Effect of Management Performance on Capital Productivity

The effect of management on gross farm output and capital productivity was studied using average productivity analysis. Examination of the build up of the management index from lower to higher values demonstrates that, on the average, management performance has a cumulative effect on agricultural production as evidenced by continual improvement in physical production of crops and swine. At very low levels of the index, a given component of the index can be outweighed by other components, that is, when one or two recommended cultural practices are followed, their effect may be offset by failure to follow through in other recommended practices. The nature of swine production in Brazil is such that a broad spectrum of factors influence the generation of final product. In the first place, the general practice of producing the bulk of livestock feed

supplies on the farms means that cultivation practices are an important aspect of the integrated crop swine operation. Unsatisfactory performance in this respect, even though recommended swine practices are followed carefully, means that the quantity of hogs produced will be limited. Conversely, poor performance on the livestock part of the business may cancel out advantages gained by doing a good job in crop cultivation. In essence, management is a cumulative process that exerts the most dramatic effect on gross farm output when all facets of the integrated crop swine operation are handled well.

The cumulative effect of following the majority of recommended practices begins to emerge as the index value reaches the 60-69 range. Not only are the producers, on the average, following improved practices, but the yield indices for swine and crop physical output are noticeably improved. With the index score of 60 serving as the dividing point, the producers are classified into low and high level managers. All producers rated up to and including 59 are classified in the low level management group and all producers rated 60 or above are considered high level managers. In all, there are 156 farmers rated as low level managers and 61 farmers rated as high level managers.

Separation of farm size groups on the basis of management level reveals that producers rated as high level managers are also managers whose investment in operating expense and working asset capital exceeds, by a considerable amount, the investment made by low level managers. Better managers not only employ greater total amounts of operating expense and working asset capital, but also use it at higher levels of intensity than do lower level managers. For all farms taken together, superior managers are utilizing two and one-half times as much operating expense capital per hectare as the low level managers. In addition, the better managers use 25 percent more working asset capital on a per hectare basis. The comparison between high and low manager capital investment, land resources, and gross farm output is made in Table 22.

Table 22

Comparison of Average Input and Output Data for High and Low Level Managers
Rated by Management Index, by Farm Size,
217 Swine Farms, Southern Brazil, 1965

Farm Size Group and Level of Management	Inputs					Outputs	
	Farm Size	Total Operating Expense	Total Working Assets	Per Hectare Operating Expense	Per Hectare Working Assets	Total Gross Output	Per Hectare Gross Output
	Hectares	NCr$	NCr$	NCr$	NCr$	NCr$	NCr$
All 217 Swine Farms							
Low Managers (156)	12.9	362	2,511	31	219	1,711	150
High Managers (61)	16.9	1,085	4,036	70	272	3,540	240
Small Farms							
Low Managers (63)	6.8	264	1,780	39	276	1,207	180
High Managers (18)	6.9	542	2,522	88	380	1,872	299
Medium Farms							
Low Managers (73)	13.9	350	2,626	26	191	1,963	143
High Managers (27)	15.0	970	3,454	62	235	3,351	225
Large Farms							
Low Managers (20)	28.7	714	4,401	25	153	2,381	83
High Managers (16)	32.0	1,889	6,721	64	213	5,736	201

Average gross output per hectare produced by high level managers exceeds the lower management group output by 60 percent. The importance of management as farm size becomes larger and capital use increases is brought out rather dramatically by comparison of average productivities for the two management levels on the large farms. Average per hectare production on well managed farms is 144 percent greater than the output from the low rated farms.

However, careful examination of information contained in Table 22 reveals that the differential return between management groups cannot be attributed entirely to differences in level of management. The superior managers have slightly larger farms, use greater total quantities of capital, and use it more intensively.

In order to evaluate more precisely the effect of management on capital productivity and gross farm output, the influence of different intensities of capital and farm size should be neutralized. The analysis of average productivity of capital is done by sorting the swine farms into seven groups on the basis of operating expense intensity then each of these intensity groups is divided into high and low management subgroups. In this manner, differences in intensity are removed to permit examination of the effect of management on gross output and capital productivity at successive levels of capital use.

To neutralize differences in farm size between management levels and among intensity groups, an adjustment factor is used to put all farms on an equivalent output basis with that achieved on average size farms (14 hectares). This adjustment allows direct comparison of average productivity of capital at alternative intensity levels between the two management groups.

The data shown in the last column of Table 23 reveal the differential in per hectare gross output between high and low managers at different levels of operating expense intensity. The differential representing the amount by which

Table 23

Comparison of Average Input and Output Data for High and Low Level Managers Rated by Management Index for Operating Expense Intensity Groups, 217 Swine Farms, Southern Brazil, 1965

Intensity Group (In NCr$ Per Hectare)	Inputs[a]					Outputs		
	Farm Size	Total Operating Expense	Total Working Assets	Per Hectare Operating Expense	Per Hectare Working Assets	Total Gross Output	Gross Output Per Hectare	Adjusted Gross Output Per Hectare
	Hectares	NCr$	NCr$	NCr$	NCr$	NCr$	NCr$	NCr$
0-9.9 NCr$								
Low Managers (35)	14.2	78	175	5	12	1,091	77	78
High Managers (-)	----	-----	-----	---	---	-----	---	---
10-19.9 NCr$								
Low Managers (32)	13.6	211	407	16	30	1,776	131	127
High Managers (6)	15.1	182	622	12	41	2,473	163	173
20-29.9 NCr$								
Low Managers (28)	13.0	314	385	24	30	1,865	143	135
High Managers (7)	17.6	447	1,557	25	89	3,285	187	223
30-39.9 NCr$								
Low Managers (20)	11.7	397	456	35	40	1,797	156	137
High Managers (11)	28.0	1,027	2,613	37	93	4,214	150	264
High Managers (10)[b]	20.6	734	726	36	35	3,722	181	246

Table 23 (Cont'd.)

Intensity Group (In NCr$ Per Hectare)	Inputs[a]					Outputs		
	Farm Size	Total Operating Expense	Total Working Assets	Per Hectare Operating Expense	Per Hectare Working Assets	Total Gross Output	Gross Output Per Hectare	Adjusted Gross Output Per Hectare
40-49 NCr$								
Low Managers (15)	12.5	566	935	45	75	2,106	168	155
High Managers (10)	14.9	684	1,383	46	93	2,980	200	210
50-79 NCr$								
Low Managers (18)	13.1	830	1,491	64	114	2,151	164	156
High Managers (10)	14.0	925	1,145	66	82	2,935	211	211
80+ NCr$								
Low Managers (8)	7.1	859	732	121	103	1,677	236	150
High Managers (17)	13.0	2,034	1,064	156	82	4,272	328	310

a/ All data are given in new cruzeiros except farm size (given in hectare equivalents of cultivable land).

b/ Averages for this row are computed without one extreme observation (101.9 hectare farm).

better managers out-produce the other managers ranges from 26 percent for the NCr$40-49 intensity level to 107 percent for the highest level. Although operating expense intensity for both management groups is nearly equal for all except the highest level, there are some differences in working asset intensity which can be expected to account for a portion of differential per hectare output.

An alternative presentation of the unadjusted and adjusted data is made graphically in Figure 3. The dashed lines trace out unadjusted per hectare output for both management groups at successive levels of operating expense use. The dashed lines are plotted from data taken from the next to last column of Table 23. The two lines retain a rather constant relationship to each other throughout the range of the data. The most notable exception is the dip in the high level management line at the intensity level of NCr$30-39 per hectare. The farms in that particular subgroup average twice the size of all farms in the sample.

The adjusted per hectare data depicted by the solid lines in Figure 3 bring into sharp relief the differences in average output after farm size has been taken into account. There are two points at which over-adjustment may take place. First, the extent to which the NCr$30-39 per hectare intensity level farms diverge from overall average may accentuate the amount of adjustment. The second point is at the highest intensity level for low level managers where average farm size (7.1) is only half that of all 217 farms taken together. For this subgroup of farms, any over-adjustment is likely to be in a downward direction. Although caution is used in interpreting the magnitude of adjustment for these extreme subgroups, the general trend appears to be unaffected. Indeed, the curve representing low managers has nearly flattened out at the NCr$40-49 intensity level and there is no reason to suspect that an upward trend would follow at

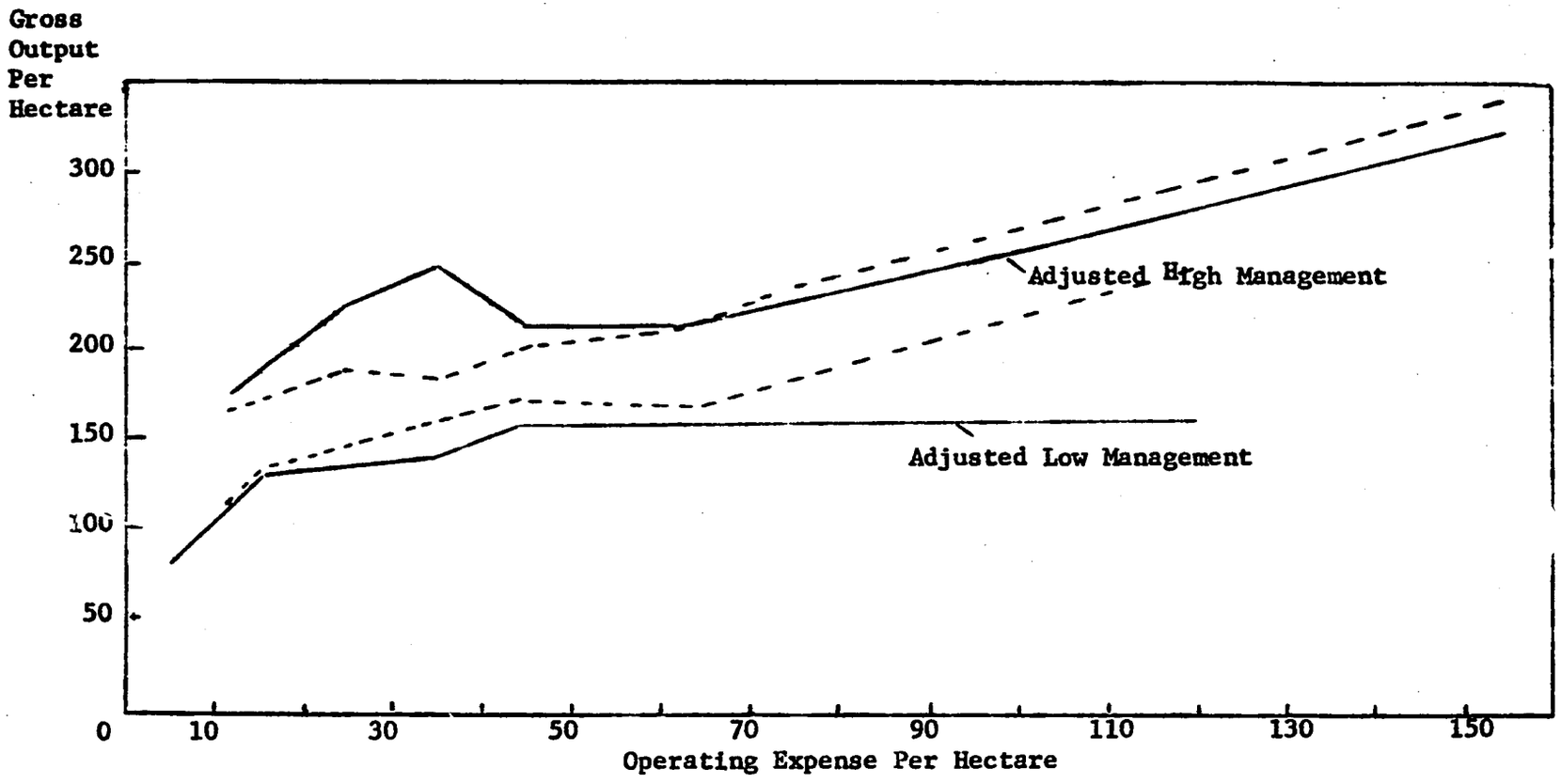

Figure 3. Adjusted and unadjusted average gross output per hectare by intensity of operating expense at two levels of management (see data in Table 23).

successively higher intensity levels. The low level managers are able to increase average per hectare output substantially from the lowest to the second intensity group. However, beyond this level, the average return to additional capital is sharply reduced. After a slight increase in the average up to the NCr$40-49 intensity group, no additional output is forthcoming from further injections of operating expense. The tendency of average output to rise rapidly at low capital intensity levels then remain practically constant may be indicative that a capital saturation point is reached very soon by low level managers. While a little capital can be productively employed, the capacity of a low level manager to profitably utilize successive amounts may be limited. Beyond a certain point, additional capital is merely absorbed in the operation without making a determinable impact on gross output.

The line representative of high level managers lies above and diverges considerably from the previously discussed solid line. At all levels of operating expense, better managers generate a greater quantity of per hectare product than the low level managers. Whereas production for the lower management group tends to flatten out at a rather low intensity level, on well managed farms, the general trend throughout the range of the data is for average gross output to increase. The combined differential and divergence of the two adjusted per hectare output lines show that at all levels of intensity, a superior manager can transform a given amount of operating expense into a relatively greater amount of agricultural product.

In summary, analysis presented in this and the previous sections points out some of the interrelationships between management performance and capital productivity. In the analysis of capital productivity, operating expense capital together with the unmechanized equipment component of working asset capital are shown to be highly productive inputs on the average swine farm surveyed. The

high return to these inputs indicates that their use in swine production is limited. Indeed, in this section, examination of the management index as its value becomes successively higher reveals that the more costly of recommended agricultural practices tends to lag behind those involving little, if any, cash outlay.

Disaggregation of sample farms into three size groups by level of management demonstrates that high level managers in all farm size groups utilize greater amounts of capital more intensively than do low level managers. In all cases, high level managers generate a greater gross output per hectare. By disaggregation of the data according to operating expense intensity for both levels of management then adjusting for farm size, the effect of management performance on average capital productivity is demonstrated. The high level managers are shown to achieve substantially greater average product than are the low level managers. Implicit in the relationships that emerge between management performance and capital productivity is the underlying complementarity of the two factors of production, management and capital. At relatively low intensities of capital, the proportionate increase in average product is similar for both levels of management although absolute amount of average product on high management farms exceeds that of low management farms. However, as capital is applied at higher and higher levels of intensity, the constraint imposed by the management becomes more important as intensity and quantity of capital resources increase. Low level managers soon reach a limit as to the amount of capital they can productively employ and beyond rather low intensity levels, average productivity per hectare remains relatively unchanged. On the other hand, average productivity is higher at comparable intensity levels and continues to rise throughout the range of intensities for the high level managers.

Appendix A

Appendix A contains the correlation coefficients between gross farm output and the independent variables free to enter the regression models. These models are described and evaluated in the capital productivity analysis study, pages 49 to 70.

Code for correlation coefficient tables (Tables A_1 through A_7):

Y_1 = gross farm output

N_1 = land equivalents

N_2 = cultivated land

N_3 = improved pasture

N_4 = permanent pasture

L_1 = hired and family labor

L_2 = family labor

A_1 = productive livestock

A_2 = work stock

A_3 = tractor + all equipment

A_4 = tractor + mechanized equipment

A_5 = non-mechanized equipment

A_6 = work stock + animal equipment

A_7 = manual and other equipment

E_1 = crop expenses

E_2 = livestock expenses

E_3 = machinery expenses

E_4 = labor expenses

Table A_1

Correlation Coefficients Between Gross Farm Output and The Independent Variables Free to Enter The Regression Models, by Farm Type

	Range Livestock Farms								
	N_1	L_2	A_1	A_2	A_3	E_1	E_2	E_3	E_4
Y_1	.84	-.04	.84	.71	.68	.38	.65	.52	.71
N_1		.02	.96	.78	.54	.33	.79	.65	.83
N_2									
N_3									
N_4									
L_2			-.02	.07	-.14	-.11	.05	.13	-.01
A_1				.76	.57	.26	.83	.59	.83
A_2					.30	.06	.55	.51	.65
A_3						.51	.59	.52	.56
E_1							.37	.53	.43
E_2								.67	.86
E_3									.68

	Hog Farms									
	N_2	N_3	N_4	L_2	A_1	A_2	A_3	E_1	E_2	E_4
Y_1	.64	.12	.11	.24	.70	.38	.51	.46	.63	.45
N_1										
N_2		.12	.23	.30	.63	.47	.63	.73	.25	.26
N_3			-.07	-.01	.12	.13	.15	.18	.21	.04
N_4				.15	.41	.24	.16	.17	.05	.04
L_2					.33	.36	.11	.18	.04	-.14
A_1						.48	.48	.42	.56	.35
A_2							.16	.31	.23	.00
A_3								.61	.21	.24
E_1									.19	.22
E_2										.46
E_3										

Table A_2

Correlation Coefficients Between Gross Farm Output and The Independent Variables Free to Enter The Regression Models, by Farm Type

	Dairy Farms									
	N_2	N_3	N_4	L_2	A_1	A_2	A_3	E_1	E_2	E_4
Y_1	.51	.29	.29	.19	.74	.01	.39	.68	.54	.14
N_2		.45	.31	.09	.55	.21	.26	.56	.39	.18
N_3			-.05	-.16	.37	.35	-.01	.36	.39	.49
N_4				.18	.41	.01	.42	.48	.73	-.07
L_2					.36	.40	.09	.00	-.01	-.05
A_1						.30	.32	.59	.52	.29
A_2							.08	-.11	-.06	.37
A_3								.27	.41	.03
E_1									.75	-.03
E_2										.00

	General Livestock Farms									
	N_2	N_3	N_4	L_2	A_1	A_2	A_3	E_1	E_2	E_4
Y_1	.41	.08	.54	.33	.55	.40	.19	.31	.45	.21
N_2		-.02	.18	.15	.26	.29	.30	.20	.23	-.15
N_3			.00	-.11	.32	.00	-.04	.04	.03	.09
N_4				-.04	.38	.11	.22	.50	.49	.33
L_2					.28	.35	.03	-.04	.05	-.16
A_1						.52	.27	.10	.26	.37
A_2							-.02	-.02	.15	-.01
A_3								.16	.17	-.03
E_1									.36	.01
E_2										.06

Table A_3

Correlation Coefficients Between Gross Farm Output and The Independent Variables Free to Enter The Regression Models, by Farm Type

	Mechanized Crop Farms								
	N_2	L_2	A_1	A_4	A_6	A_7	E_1	E_3	E_4
Y_1	.92	-.34	.35	.87	.01	.18	.84	.80	.45
N_1									
N_2		-.35	.38	.86	.12	-.03	.84	.82	.41
L_1									
L_2			-.23	-.19	.00	-.28	-.16	-.21	-.37
A_1				.26	.72	.03	.24	.19	.45
A_2									
A_3									
A_4					.05	.16	.87	.84	.37
A_6						.00	-.09	-.01	.18
A_7							-.03	.03	.33
E_1								.83	.37
E_2									
E_3									.50

	Extensive Crop Farms						
	N_1	L_1	A_1	A_2	A_3	E_1	E_2
Y_1	.50	-.33	.51	.43	.20	.50	.10
N_1		-.67	.21	.24	.32	.64	.28
N_2							
L_1			-.10	-.21	-.14	-.36	-.16
L_2							
A_1				.42	.30	.06	.48
A_2					.17	-.20	.20
A_3						-.02	.43
A_4							
A_6							
A_7							
E_1							.01
E_2							
E_3							

Table A_4

Correlation Coefficients Between Gross Farm Output and The Independent Variables Free to Enter The Regression Models, by Farm Type

	General Crop Farms									
	N_2	N_3	N_4	L_2	A_1	A_2	A_3	E_1	E_2	E_4
Y_1	.38	.13	.12	.44	.37	.17	.39	.47	.46	.12
N_2		.01	.33	.26	.31	.30	.22	.24	.22	.08
N_3			.11	.12	.11	-.10	.07	.03	.06	-.07
N_4				.18	.58	.23	.05	.28	.09	-.05
L_2					.18	.24	.14	.14	.20	.03
A_1						.23	.19	.22	.36	.06
A_2							.14	.00	.10	.04
A_3								.07	.03	.35
E_1									.25	.05
E_2										.12

	General Farms									
	N_2	N_3	N_4	L_2	A_1	A_2	A_3	E_1	E_2	E_4
Y_1	.82	.72	.70	.11	.87	.25	.69	.82	.56	.58
N_2		.69	.71	.03	.71	.25	.66	.77	.49	.46
N_3			.66	.02	.55	-.01	.58	.75	.48	.32
N_4				.16	.62	.45	.42	.69	.35	.26
L_2					.21	.34	.11	-.06	.07	-.06
A_1						.41	.51	.67	.53	.48
A_2							-.06	.10	.13	-.01
A_3								.63	.45	.46
E_1									.40	.64
E_2										.30

Table A_5

Correlation Coefficients Between Gross Farm Output and The Independent Variables Free to Enter The Regression Models, by Farm Type

	Other Farms											
	N_2	N_3	N_4	L_2	A_1	A_2	A_4	A_5	E_1	E_2	E_3	E_4
Y_1	.32	.15	.02	.21	.28	.18	.69	.10	.79	.47	.51	.09
N_2		.78	.41	-.08	.78	.12	.40	.14	.38	.23	.20	.45
N_3			.61	-.26	.69	.08	.20	.03	.34	.04	.11	.38
N_4				-.29	.67	.22	.05	.11	.20	.13	-.03	.20
L_2					-.06	.06	-.03	-.05	-.08	.18	.29	-.08
A_1						.33	.22	.19	.27	.36	.09	.34
A_2							.01	.30	.08	.24	.03	.10
A_4								.11	.83	.38	.36	.00
A_5									.13	.22	.07	.04
E_1										.30	.39	.03
E_2											.27	.03
E_3												.22

Table A_6

Correlation Coefficients Between Gross Farm Output and The Independent Variables Free to Enter The Regression Models, by Farm Size Breakdown

	1.0-3.9 Land Equivalent Farms					
	N_1	A_1	A_2+A_3	E_1	E_2	E_4
Y_1	.41	.36	.04	.50	.57	.21
N_1		.18	.01	.23	.01	.14
A_1			.37	.46	.50	.06
A_2+A_3				.31	.11	.11
E_1					.48	.62
E_2						.20

	4.0-6.9 Land Equivalent Farms					
	N_1	A_1	A_2+A_3	E_1	E_2	E_4
Y_1	.23	.51	.47	.34	.49	.31
N_1		.30	.14	.08	.23	.08
A_1			.42	.05	.47	.21
A_2+A_3				.50	.23	.22
E_1					.00	.29
E_2						.32

	7.0-9.9 Land Equivalent Farms					
	N_1	A_1	A_2+A_3	E_1	E_2	E_4
Y_1	-.01	.53	.18	.25	.54	.21
N_1		.06	.03	-.05	-.29	-.05
A_1			.12	-.05	.41	-.10
A_2+A_3				-.05	.12	.07
E_1					-.02	.12
E_2						.26

	10.0-14.9 Land Equivalent Farms					
	N_1	A_1	A_2+A_3	E_1	E_2	E_4
Y_1	.23	.51	.29	.25	.47	.07
N_1		.33	.15	.08	.07	-.01
A_1			.08	.00	.26	-.07
A_2+A_3				.33	.19	.14
E_1					.08	.08
E_2						.02

Table A_7

Correlation Coefficients Between Gross Farm Output and The Independent Variables Free to Enter The Regression Models, by Farm Size Breakdown

	15.0-19.9 Land Equivalent Farms					
	N_1	A_1	A_2+A_3	E_1	E_2	E_4
Y_1	.08	.61	.33	.22	.61	.31
N_1		-.01	-.02	-.09	.03	-.13
A_1			.22	-.09	.68	.34
A_2+A_3				.00	.14	.08
E_1					-.01	.01
E_2						.34

	20.0-29.9 Land Equivalent Farms					
	N_1	A_1	A_2+A_3	E_1	E_2	E_4
Y_1	.20	.50	.20	.14	.62	.20
N_1		.09	.22	.08	-.01	.21
A_1			.27	.06	.53	-.12
A_2+A_3				-.10	.06	.21
E_1					-.01	.07
E_2						-.05

	30.0-49.9 Land Equivalent Farms					
	N_1	A_1	A_2+A_3	E_1	E_2	E_4
Y_1	.21	.32	.72	.53	.49	.73
N_1		.33	.37	.17	-.20	.22
A_1			-.01	-.16	.44	.02
A_2+A_3				.67	.28	.75
E_1					-.06	.52
E_2						.00

	50.0 & Above Land Equivalent Farms					
	N_1	A_1	A_2+A_3	E_1	E_2	E_4
Y_1	.71	.23	.86	.84	.13	.55
N_1		.77	.64	.60	.38	.66
A_1			.17	.13	.42	.49
A_2+A_3				.83	.18	.50
E_1					.22	.49
E_2						.44

Appendix B

Appendix B contains a description of the construction and application of the management index. This index is developed and evaluated in the study entitled the management factor, pages 84 to 104.

The Management Index

The management index developed for this study consists of two parts: the first relates to recommended swine practices and the second relates to recommended crop practices. A composite of 12 factors, each weighted to reflect their relative importance as determined by professional extension and farm management personnel in southern Brazil, is used to rate the sample entrepreneurs. Eight of the factors apply to swine production and four relate to crop production. Total points possible are 30 with two-thirds of this total assigned to recommended swine practices. The component factors of the swine practices portion of the index are: raising of meat-type hogs, number of pigs weaned per sow per year, a composite of age and weight at which hogs are marketed, clipping of needle teeth, use of feed supplements, vaccination, and internal parasite control. Included in the crop portion of the index are: use of improved seed, application of fertilizer, use of insecticides, and an index of crop yields.

Taking the various components in order: the first, improved breeds, reflects the type of stock raised by the producer. The meat-type hog is in greater demand and the raising of improved swine provides an indication of managerial responsiveness to economic incentives. If no improved swine are raised, no points are given the producer for this component of the index. The second component is the number of pigs weaned per sow per year. This component is weighted by a sliding scale from zero to three to reflect number of pigs weaned. For this measure, the values are arrayed with all farms in the same array. All producers below the median are given zero points for this value. The fifty percent of farms above the median are divided into three groups to which the

Table B_1

Component Factors, Weighting Scale, and Total Points Possible for Management Index of Recommended Production Practices, 217 Swine Farms, Southern Brazil, 1965

Index Component	Weight	Total Points
	Recommended Swine Practices	
(1) Raise Improved Breeds (Meat-Type Hogs)	1	1
(2) Pigs Weaned Per Sow Per Year	0 = If Less Than 7.2 1 = 7.3 to 8.5 2 = 8.6 to 10.7 3 = 10.8 or More	3
(3 and 4) Age and Weight of Hogs Marketed	Kilograms Months ≤79 80-99 ≥100 ≤ 10 5 7 10 11-13 1 3 5 14-16 0 1 2	10
(5) Clipping Needle Teeth	1	1
(6) Use Feed Supplements	1	1
(7) Vaccination	2	2
(8) Internal Parasite Control	2	2
Total Swine Practices		20
	Recommended Crop Practices	
(9) Use Improved Seed (Hybrid)	2	2
(10) Apply Fertilizer	3	3
(11) Use Insecticides and Fungicides	1	1
(12) Crop Yield Index	0-4[a]	4
Total Crop Practices		10
Total Swine and Crop Practices		30

a/ The index of crop yield depended upon the average yield in each of the municipios in which interviews were taken. Explanation of the index is given in the text.

sliding weight from one to three points applies. For example, the three points possible for this value means that out of 108 swine farms above the median, the first 36 producers receive three points, 36 receive two points, and the remaining 36 producers receive one point.

The third and fourth components, age and weight, are considered simultaneously in determining number of points for this value. The sliding scale of points to be earned reflects the efficiency in achieving alternative weights within given time periods. This component is included as a measure of the managers' performance in terms of the many factors that cannot be directly observed such as timeliness of practices followed. If needle teeth are clipped, a single point is given the producer; if he does not, no points are given. Also, one point is given for feeding supplements or mixed livestock feed. Two points are possible for each of the components of swine practices, vaccination, and internal parasite control. Combined, the available points for swine practices total 20.

The crop portion of the management index consists of four components worth 10 possible points. If improved or selected seed is planted, two points are given; otherwise no points are given. Producers applying commercial fertilizer receive three points while those not using this input receive no points. The use of insecticides is assigned a single point. The final component, crop yield index, is rated on a sliding scale from zero to four points. The same basic procedure used for the sliding scale for pigs weaned per sow per year is used for crop yield except a separate point system is used for each municipio.

The crop yield index weighted by crop area is calculated for each farm. Five major crops: corn, wheat, soybeans, cassava, and tobacco are included in computation of per hectare yield. A five year state average of the five crops is

calculated. Then the individual farm per hectare yield of each crop is divided by the state average of that crop. These values are converted to percentages which are multiplied by their respective crop areas and summed. This sum is divided by total farm crop area to get the weighted crop yield index. For each municipio, the farms are arrayed in order of the yield index computed for each farm. All farms below the median (one-half of total) are given zero points. The remaining one-half of all farmers are divided into four groups on the basis of the crop yield index computed. The highest one-fourth of the farms above the median are given four points, the second quartile is given three points, the third is given two points, and one point is given for farms in the lowest quartile.

Table B_2

Crop Yield Index Distribution and Associated Points by Municipio, 217 Swine Farms, Southern Brazil, 1965

Points	Municipio				
	Ibiruba	Lageado	Carazinho	Concordia	Timbo
0	$\leq$ 108	$\leq$ 110	$\leq$ 99	$\leq$ 124	$\leq$ 93
1	109-123	111-129	100-108	125-136	94-111
2	124-139	130-157	109-130	137-152	112-125
3	140-169	158-181	131-160	153-182	126-149
4	$>$ 169	$>$ 181	$>$ 160	$>$ 182	$>$ 149

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