

BATCH #16

1. SUBJECT CLASSIFICATION	A. PRIMARY Agriculture	AE10-0000-G514
	B. SECONDARY Agricultural economics--Brazil	

2. TITLE AND SUBTITLE  
Farm size and income: an economic study of small farm agriculture in southern Brazil

3. AUTHOR(S)  
Rask, Norman

4. DOCUMENT DATE 1964	5. NUMBER OF PAGES 34p.	6. ARC NUMBER ARC BR339.41.R225a
--------------------------	----------------------------	-------------------------------------

7. REFERENCE ORGANIZATION NAME AND ADDRESS  
Wis.

8. SUPPLEMENTARY NOTES (Sponsoring Organization, Publishers, Availability)  
(In Land Tenure Center research paper no.16)

9. ABSTRACT

10. CONTROL NUMBER PN-RAA-777	11. PRICE OF DOCUMENT
----------------------------------	-----------------------

12. DESCRIPTORS Brazil Farm size Farms, small Income	Productivity	13. PROJECT NUMBER
		14. CONTRACT NUMBER Repas-3 Res,
		15. TYPE OF DOCUMENT

This study is supported in part by the Land Tenure Center, a cooperative research and training program of the American Nations, the Agency for International Development and the University of Wisconsin. The work was done through the cooperation of the Instituto de Estudos e Pesquisas Econômicas, Universidade do Rio Grande do Sul, Pôrto Alegre, Brasil.

At the time of this study, the author was a project associate with the Land Tenure Center.

April 1964

RP No. 16

FARM SIZE AND INCOME: AN ECONOMIC STUDY  
OF SMALL FARM AGRICULTURE  
IN SOUTHERN BRAZIL

By

Norman Rask

This paper is an abbreviated version of the author's Ph.D. thesis of the same title.

All views, interpretations, recommendations and conclusions expressed in this paper are those of the author and not necessarily those of the supporting or cooperating organizations.

THE PROBLEM AND ITS SETTING. The reasons for land or agrarian reform are both economic and social. The gains in productivity and individual income that can result from an organization of agriculture into medium size farms, along with other social concepts such as a more democratic citizenship and a more flexible basis for the changes that have to occur in economic development, form the rationalization in favor of programs of land and agrarian reform. While hopefully all of these results may be achieved, it is more likely that at least in some of the cases one objective will be achieved only at the expense of another.

For example, the division of a large property which has been operated in the traditional latifundia sense (extensive land use) into smaller farm units may very well result in more intensive land use, greater productivity and higher levels of income for the new land owners. On the other hand, if the large property is of the plantation or large commercial farming organization, it is very possible that land division could lead to changes in the form of agricultural production. These changes may or may not result in better income situations for the people or increase productivity.

The crucial question is how large must farms be in order to provide a satisfactory income. To resettle people on land units that are not of sufficient size to give a reasonable expectation of achieving a satisfactory level of income would be self defeating and simply exchanging one form of poverty for another.

The problem to be examined by this study is not one of optimum farm size for greatest economic efficiency, although this question is of great importance to a country in need of expanded food production. The more immediate and practical question is that of minimum farm size--a minimum size that will provide the people with the benefits envisioned in land reform and yet provide for as many people as possible.

The task of this study then is to examine the problem of minimum farm size. The criteria under which farm size performance will be judged is farm income. The examination will be carried out in two parts. First, the actual performance of different farm size groups will be studied in a region of small farms. Second, a more detailed examination of possible levels of income under advanced levels of farm management will be made. The latter levels of management are presently attainable in the area studied.

Income is a result of many factors. A central assumption of this study is that measured differences in the levels of income and productivity may not be a result of size alone. Lack of credit, extension help, or some other factor can be the principal reason limiting farm incomes in a given region. Within the individual farm operation, level of technology, size of family (labor supply), choice and combination of enterprises, and management ability will all affect the income an individual family needs or can expect to receive from a given size of farm.

### Objectives

The general objective of this study is to determine the economic opportunities in owning and operating small land holdings. The more specific objectives are as follows:

1. To determine the income situation which exists on farms of varying sizes.
2. To determine the minimum farm size necessary to support a satisfactory level of income under existing conditions.
3. To determine and evaluate selected paths for improvement in productivity and income.
4. To determine minimum size under advanced levels of productivity and examine the costs and feasibility of changes in farm sizes if suggested by the analysis.

### METHODOLOGY

The data used in the analysis of incomes on existing farms was collected as part of a general survey of the social and economic problems of Santa Cruz do Sul, a municipio situated in the central part of the state of Rio Grande do Sul, Brazil. The survey information is based on a non-proportional stratified sample. The stratification was based on farm size as measured by total land area. A total of 142 questionnaires was taken.

For the purpose of this particular study only farm sizes of less than 100 hectares were considered. This includes 121 of the farms sampled. For the municipio, 99 per cent of the farms are found within this size range. The classification of the data is based on the size categories used in establishing the sample. Six different strata are delineated, with size breaks at 5, 10, 15, 25, 50, and 100 total hectares.

The result of this study of existing incomes is an evaluation of the computed levels of farm labor income in relation to a minimum income standard. This standard is based on the minimum wage in existence at the time of the study. Since farm families do have the use of a house as part of the farm operation, the minimum wage is adjusted to reflect this value. Many farm families have more than one operator, and it can be reasoned that in these situations each operator should receive a minimum return. The computed income levels on farms of various sizes are examined to see if the specific sizes could support one or more adjusted minimum salaries.

The results of the survey conducted in Santa Cruz do Sul demonstrated the need for a more intensive study of the real possibilities and alternative available to the rural people of the municipio. The study demonstrated the inadequate levels of income that presently exist on the small farms and indicated a need for a clear understanding of the available paths to improvement, the levels of income that can be expected from such improvements and the obstacles that must be confronted if the improvements are to be achieved by a significant portion of the rural population.

To effectively deal with this problem, a much deeper understanding of the fundamental structure of the agriculture and of the institutions serving the agriculture of the area was necessary. To this end, a series of personal interviews was conducted with informed people, who through their occupations had intimate knowledge of various aspects of the agricultural life of the municipio.

Banks serving the area were interviewed about credit practices. The major outlets for agricultural products and sources for agricultural inputs were consulted about availability of various items and services, including the prices received and given by farmers. The research and extension departments of ASCAR, the Secretary of Agriculture and the University were asked for research information and current technical recommendations.

The specific questions were framed within the following general outline:

1. A general description of the present situation.
2. The major problems of the small farmers as viewed by the person interviewed, and the steps within his field that were being taken or recommended to remedy the problems.
3. Other improvements within and outside of his profession that would help farmers achieve better levels of living, but including only those that could be reasonably achieved.

4. The chief obstacles to the successful implementation of these improvements.

5. A more specific evaluation of the actual levels of input-output coefficients and other data necessary to quantify these changes.

In all, forty-seven interviews were conducted. Sixteen interviews were conducted in Porto Alegre, 25 in Santa Cruz do Sul, 3 in Santa Rosa, and 3 in São Paulo.

#### Organization of Data

Within a given size of farm, the best method of operation will depend on level of technology, combination of enterprises, size of labor force and management ability. The level of technology is based largely on hand methods of work, and on the use of currently available practices. Two levels of productivity are specified. A high level of productivity is established on the basis of experimental results, knowledge of informed people and the results actually achieved by the better farmers in Santa Cruz do Sul. A medium level of productivity represents a reduction from this established level and is based on poorer management ability. Four situations reflecting variation in enterprise selection possibilities are specified for later analysis. These are based on the common types of farm organization presently used in Santa Cruz do Sul. The farm family is assumed to be the only source of labor. Levels of 2, 3 and 4 man equivalents are considered. The prices used in the analysis are based on those paid by and to farmers in Santa Cruz do Sul as of November 1963.

Five alternative enterprises are specified; tobacco, hogs, dairy, corn and soybeans. Within each enterprise, the following values are developed:

- a) Levels of productivity
- b) Prices
- c) Input requirements
  - land
  - labor
  - investments
  - operating costs
- d) Unit net return to the enterprise

In addition a budget is prepared of all costs and benefits that accrue to the operation independently of what, if any, special enterprise is employed. The items included are:

- a) **Permanently fixed costs** including **land taxes** and **depreciation on land and standard buildings** and **minimum animal power**
- b) **Input requirements for, and value of, production consumed in the household.**

### Analysis of Data

Linear programming is used as the numerical procedure for isolating the best combination of enterprises in each of the situations considered.

The concern is to develop an income value to compare with the established minimum and to outline paths of improvement for small farms. Therefore farm labor income values are specified for each enterprise and optimized subject to land (cultivated hectares), annual labor, and harvest labor restrictions. Seven levels of farm size are considered: 2, 4, 6, 8, 10, 14, and 18 cultivated hectares. The first five land sizes correspond approximately to the levels of land use in the first five strata of the survey. Three labor force sizes are evaluated. They are annual levels of 2, 3 and 4 man equivalents. Each of five enterprises is developed on the basis of two levels of productivity.

A basic farm plan consisting of choices of hogs, corn, and soybean enterprises is established. In addition there are farms and areas that have tobacco, and/or dairy in addition to the basic plan. Thus, four situations of enterprise choice are considered. They are:

- Situation A: Hogs, corn, soybeans
- Situation B: Hogs, corn, soybeans, dairy
- Situation C: Hogs, corn, soybeans, tobacco
- Situation D: Hogs, corn, soybeans, dairy, tobacco

A new minimum income level is established, based on the minimum wage as of November 1963. The size of the labor force was established at three levels, 2, 3 and 4 man equivalents. Therefore, in order to allow a minimum return to each full time worker, the minimum income standards were established at multiples of 2, 3 and 4 times the adjusted minimum salary. Minimum farm sizes are then delineated on the basis of level of productivity, combination of enterprises and labor supply. The basic characteristics of these minimal solutions are described.

Finally, the costs of changing from a small two hectare (cultivated hectares) farm to the minimum size suggested by the analysis is budgeted for one farm situation and the results evaluated in relation to existing credit policies to determine if the income is also sufficiently high to enable financing the necessary changes.

#### GENERAL DESCRIPTION OF THE FARMS STUDIED

Several factors stand out regarding the organization of agricultural units in Santa Cruz. The family farm with a large share of the work performed by family members is by far the dominant type. The system of agriculture is diversified with more emphasis on field crops than on livestock. Tobacco is the principal cash crop and chief source of income. Many of the other crops and livestock enterprises are common, but are operated more on a subsistence basis than as commercial enterprises. The various farm sizes are rather evenly distributed over the 0 - 25 hectare range.

Perhaps the most significant factor is that the agricultural work is performed largely by hand methods, which quickly imposes limitations on the amount of productive work one man can do. One indication is the structure of farm investments, with less than 10 per cent of total investment in machinery. Another is the number of cultivated hectares; as size increases to the last category of 50 - 100 hectares (average 66), the average number of hectares cultivated increases to only 12. It soon becomes physically impossible to cultivate and care for more land without some form of mechanization.

A more significant factor, all the more so because it is combined with small land area, is the low level of efficiency or productivity. The land units are limiting, which also places limits on the livestock units. When a low level of productivity of both land and animal units is added to this, the possibilities of achieving substantial volumes of output are diminished. The fact that more work is performed on the land than with livestock might point to one path of increasing the output per hectare. That is, to use more livestock enterprises or use the present ones more intensively. The low level of labor efficiency (excess of labor) can in some cases be explained by the occurrence of large families on very small farms.

Why is productivity low? The limited use of advanced farming practices is one reason. While fertilizer was used on more than one half of the farms, its use was largely limited to a very small acreage of tobacco. Even then, it was used only because the tobacco companies provided it and insisted on its use. Health and disease preventive methods were used very rarely.

### Credit

With the exception of credit for the purchase of land, there is no real obstacle to the availability of loans for productive purposes. The interest rate is preferential to the small farmer and especially so in a time of inflation. However, credit has not been so readily available in the past. The Banco do Brasil instituted its policy of preferential loans 15 years ago, but did not have facilities to handle a large number of loans until more recently. Also, the present expanded coverage of different types of loans has evolved only slowly in the past fifteen years.

The farmers in the study were asked some specific questions about their attitudes toward credit, their use of credit and their source of funds. About 75 per cent of the farmers indicated that they used some form of agricultural credit. However, the dominant sources of credit were neighbors, friends and tobacco companies. Only 25 per cent listed the Banco do Brasil or other banks as a source of credit. About one quarter of the farmers expressed the opinion that credit was not easily available.

### Technical Assistance

In passing through the stores of the village of Santa Cruz do Sul, one sees fertilizers, hybrid seed, insecticides, feeding rations, etc. These things are available to the people so the natural question is asked, "Why don't they make better use of them?"

Two questions are raised: Is there sufficient extension personnel to serve the area and are there effective ways of getting information to the farmers?

The main tobacco company, Souza Cruz, maintains a staff of specialists to help the farmers in the proper methods of planting, growing and curing tobacco. Each specialist services about 70 families and lives in the immediate area. For this special enterprise, there appears to be little lack of technical personnel. For livestock and crops other than tobacco, the only established sources of information are the extension services of ASCAR and an agronomist and a veterinarian provided by the state department of agriculture.

The extension office, which was established seven years ago, maintains two extension agents (one man and one woman) to serve the needs of over 7,000 farmers. ASCAR feels that one agent can effectively serve less than one hundred families on a personal basis. The actual number will depend on the means of communication available and the type of service the agent is providing. This limits the area the agents can serve to only a small section of the municipio. Radio

broadcasts, the local newspaper and printed leaflets are used in an effort to increase the effectiveness of the extension service.

The farmers in the study were asked if they had heard about technical agricultural assistance. Almost all had. Of these, 25 per cent had not talked to a technician. The remaining 75 per cent had talked to the tobacco company technicians. One-fourth had also consulted other technicians.

They were asked whether they had heard of various new techniques such as pasture rotation, vaccines, insecticides, artificial insemination, and soybeans. They were also asked where they had received their information. On the average, about 30 per cent said they were not aware of these practices. Another 30 per cent had received the news from friends and neighbors. Only 10 per cent had learned from technicians. Radio and newspapers were mentioned by only five per cent.

Other factors that can affect the ability to communicate and receive new ideas are education and use of radio and newspapers. Eighty per cent of the people responded affirmatively to the simple question of "Can you read and write?" This was true of both wife and husband. The average amount of schooling was four years. However, only one-half of the people who could read and write read a newspaper. About half of the farmers owned a radio, but very few listened to farm programs. Finally, one-fifth of the people interviewed did not speak Portuguese, but still retained the German language in the home.

Various authors have described the traditional stages in the adoption of new ideas, and the various communications media most effective in each stage. For example, in the beginning or awareness stage, when a person is first introduced to a new concept or idea, mass communications are traditionally most effective. However, this has to assume that a majority of the rural people have access to and use radio, television and newspapers.

In Santa Cruz the means of mass communication are available. However, its effectiveness is hampered by lack of use and/or lack of ability of the rural people to receive the information. Many of the people simply lack the facilities of a radio or daily paper, or barriers of language or education prevent them from making effective use of them. This means that much of the introduction to new ideas must come through personal contacts, principally friends and neighbors.

This adds to the work of an extension person and limits his area of influence, for he must also work at the local level, not only to convince people to use new methods, but also to just make them properly aware of the existence of these ideas.

The various other stages in the adoption of new practices from the seeking of information through experimentation and final adoption are accompanied by a greater need for personal contact. It is unlikely that a process that begins within the influence of friends and neighbors will move outside of this sphere for more detailed information on specific application of the practices. Therefore, an extension agent must project himself into the local situation as a good source of ideas and information if people are ever to receive the best and most up-to-date information.

In this context, it is evident that what has been achieved by the tobacco company technicians is significant but unfortunately limited to the production of tobacco. The concept of innovation does not seem to carry over to other crops. Perhaps this is a result of the system in which the use of fertilizer, fungicides and other special practices are just part of a package plan handed to the farmers with ingredients included. The tobacco farmer is not forced to think about whether to use fertilizer or not, or how much to use. In general, these decisions are made for him.

#### SURVEY INVESTIGATION OF MINIMUM FARM SIZE

The minimum industrial wage in existence at the time of the survey (July 1961 to June 1962) was chosen as the standard of comparison for the delineation of a minimum size producing unit that will provide the farm operator and his family with an acceptable level of living. During the year of record this minimum salary was 134,000 cruzeiros per year. One adjustment must be made to this standard since an industrial worker must pay for habitation. A study by IEPE has determined this value as equal to just under 20 per cent of the wage earnings. This leaves the annual adjusted standard of 110,000 cruzeiros.

It is now possible to make a first estimate of a minimum size farm on the basis of the incomes presently existing in Santa Cruz. Farm labor income is the best measure for comparison with the standard established above, for it accounts for all charges except labor and management. While farm labor income increases with size it does not meet the minimum standard of 110,000 cruzeiros until the fifth strata, which has an average farm size of 31.8 hectares with 11.3 cultivated hectares. The income in the sixth strata is only slightly higher than the income in the fifth strata. Thus using one minimum salary as the measure, a first approximation to a minimum size would be about 30 hectares or more (11 or more hectares tillable), with little expectation of receiving much more than the minimum acceptable return for one person.

**Table 1. Cash, Net Farm, and Farm Labor Income By Size of Farm  
(121 Farms - Santa Cruz do Sul - 1962)**

Strata number	Income		
	Cash	Net farm	Farm labor
(In Cr\$1,000.00)			
1	9	31	16
2	36	70	42
3	27	78	44
4	88	145	93
5	110	197	130
6	100	216	137
Município average	65	122	76

However, the labor necessary to generate the amount of income shown in strata five was equal to three man equivalents. Thus, while the income levels in the fifth and sixth strata would support a family on the basis of one minimum salary, they would not provide minimum salaries on a per man basis. It could be readily argued that a farm operation requiring more than two full-time men should be classified as a two-man farm, and thus require a return of more than one minimum salary. With this interpretation, it is not possible to delineate a minimum size of farm from the survey data.

It is important to note that in no instance do the first three strata show any reasonable possibility of offering a minimum acceptable level of living under the current level of land use and technology. Furthermore, within the first four strata are found three fourths of all the farms in Santa Cruz do Sul, and the trend is toward lower farm size.

It would appear then, that size in terms of land area is not the limiting factor on these small farms. Further, in order to measure accurately the relationship of size to possible income, a study must be made in which the conditions for the effective use of all resources including labor, are assured in order that the true effects of size can be isolated.

The survey results indicate that, on the average, farm labor income rises as size of farm is increased. However, the value of this return to labor on a per man basis has not been sufficient to allow

an estimate of the necessary minimum size farm. For a country short in resources, it is also very important to know if efficiency increases along with the opportunity for increased income or whether one is achieved at the expense of the other.

The usual concept of returns to size is that efficiency increases but generally at a decreasing rate as farm size is increased. At some point the problems of management-labor-owner separation cause efficiency to level off or decline. Again this is based on a mechanized agriculture where the input of some items of mechanization are non-divisible.

Intensity of land use, measured in terms of the amount of cultivated land relative to total land is greatest on the small farms and steadily declines as farm size increases. However, when cultivated land is used as the size criteria, a different relationship exists. That is, when the value of total production is measured on a cultivated hectare basis, the value shows little relationship to size (Table 2). Except for strata three, the average value of production per hectare is almost identical in all strata. Value of total production, however, does not account for possible differences in costs. When farm labor income is considered in terms of cultivated hectares, the similarity between farm sizes is again evident.

Table 2. Returns Per Cultivated Hectare. (121 Farms - Santa Cruz do Sul - 1962).

Strata number	Value of total production	Farm labor income
	(In CR\$1,000.00)	
1	26	8
2	25	10
3	18	7
4	27	11
5	24	12
6	27	11
Municipio average	24	10

Within the size range that has special importance for this study, there is no apparent size relationship to productivity per cultivated hectare. It would appear that the limited use of technology and largely hand methods allow a rather uniform rate of productivity to emerge on the average, even though there is the usual variation between individual observations.

#### BUDGET ANALYSIS

Five specific enterprises were chosen for evaluation. They are: tobacco, hogs, dairy, corn, and soybeans. Each is discussed separately. First, the manner in which the enterprise is commonly operated was determined and an improved method for operating the specific enterprise was delineated, including the necessary quantitative information needed for budgeting. Finally, a net per unit return was developed. In addition to the five enterprises, a budget for the overall farm operation is constructed. This includes only those costs and returns that occur regardless of the type of enterprise used.

It is not possible to include in one analysis all of the possible alternative means of combining the given resources at the disposal of a farm operator. In this study, the limitation of considered alternative paths to improved income resulted in the choice of only one principal method for each of the five selected enterprises. Some additional alternatives were allowed for the methods of acquisition and disposition of some inputs and products.

In choosing one particular procedure for operating an enterprise one must make advance decisions as to the better way of organizing the individual enterprise. It is quite possible that what is best for an enterprise in isolation is not best for that particular enterprise in combination with others, especially in the use of by-products and in competition for scarce resources.

In arriving at the final selections of particular enterprises and the manner in which each was to be operated, three criteria were used.

1. The levels of management were established well within the capability of achievement by a significant portion of the farm population.
2. The particular practices are those presently in use by the better farmers and/or are current recommendations of knowledgeable people in the profession.

3. There presently exist the necessary kinds of institutions to service the types of farm organization studied. These include technical help, market outlets, input sources, and credit availability for annual operation and for the necessary initial capital improvements. That is, to service a greater number of people, these institutions need only be expanded, not created.

Four specific farm situations are then evaluated, each representing a different possible combination of enterprise. Each specific situation is budgeted for seven size categories, three levels of labor input, two levels of management and two alternative methods of acquiring corn to be used as a feed input for the livestock enterprises. The total number of possible farm organizations is 336. However, since all the enterprises considered in each situation are not always part of the final solution, only 177 distinct farm organizations were found.

The four situations isolated for study have been designated situations A, B, C, and D. Situation A is the basic farm organization of hogs, corn, and soybeans. These three enterprises appear in all the other situations as well. Situation B considers possible combinations of these three plus dairy. Situation C adds tobacco as an alternative to the basic plan, and situation D adds both tobacco and dairy. When the option of buying corn is included, the situations are designated as A(1), B(1), C(1), and D(1).

Linear programming is the procedure used for determining the best combination of enterprises in each situation. The concern in this study is farm income. Thus, linear programming is well suited as a numerical procedure, for it automatically isolates the optimum (maximum profit) combination of enterprises within the given situations.

Linear programming assumes that the processes considered are divisible and thus the optimum solutions display partial units of each process. This creates no problem with crops, for land area is easily divisible. However, livestock, when part of the solution, must be converted to whole numbers. Thus the budgets presented in this study represent feasible adaptations of the optimum solutions given by the program. In the optimum solutions land was never in surplus supply, therefore the feasible adaptations make full use of available land. When livestock enterprises were the only enterprises in the final solution and converting to whole numbers resulted in a small reduction in the amount of land utilized, soybeans were entered to make use of the extra land area.

### Budgeted Situations

Each of the individual situations will be examined in turn. However, there are some general observations that can be made about all of the situations. First, corn as a cash crop is dominated by soybeans. That is, the return per unit of scarce resource for soybeans is greater in all instances than for corn. Thus corn does not enter the final solutions as a cash crop. It is used as a home produced feed input for many of the livestock combinations. When home produced corn and purchased corn appear in the same situation, the tendency is to buy corn for the small farm sizes and to produce corn on the larger farm sizes.

Whenever tobacco was considered it entered the final solution and for the smallest farm size was always the only enterprise in the final solution. Soybeans, except when used to complete a feasible solution, appear only on the larger farm sizes. Finally, when all five enterprises are considered the general rule is for tobacco to dominate land use on the small sizes, the livestock enterprises on the medium farm sizes and soybeans on the larger. This is a logical sequence, starting with tobacco which requires little land and much labor, following with livestock which balances labor and land use, and ending with soybeans which require a large amount of land and relatively little labor.

### Situation A

A summary of the income levels by size of farm, labor supply and level of productivity for situation A are presented in Table 3.

Combination of enterprises. The enterprises considered under Situation A are hogs, corn and soybeans. In the first size category of two cultivated hectares, sufficient land is not available for commercial enterprises to support one unit of a hog operation. Therefore, in this size category only soybeans are used. However, when the corn purchase option is allowed, this same category will support two units of hog operation and the resulting income is almost two times as great as for soybeans alone.

Hogs are prevalent in the small and medium size farms but their numbers gradually diminish in favor of soybeans at the larger farm sizes. When labor supply is increased the hogs stay in longer and reach higher levels of use. The maximum sizes of the hog enterprise are 5, 8, and 11 sows, respectively, for each of the three labor supplies. These maximum levels appear at farm sizes of 8, 10, and 14 cultivated hectares. It is profitable to buy corn as long as labor is in surplus supply. However, when labor becomes the restricting factor, it is more profitable to produce corn for the hogs and use soybeans as a cash crop on the extra land.

Table 3. Farm Labor Income For Situation A by Level of Productivity, Labor Supply and Size of Farm (Santa Cruz do Sul - 1963-64).

Situation*	Level of Productivity	Man Equivalents	Number of cultivated hectares						
			2	4	6	8	10	14	18
(In 1,000 cruzeiros)									
A	High	2	105	324	541	706	767	935	1060
A	High	3	105	324	541	756	968	1136	1260
A	High	4	105	324	541	756	968	1337	1461
A(1)	High	2	202	516	590	706	767	935	1060
A(1)	High	3	202	610	779	899	968	1136	1260
A(1)	High	4	202	610	1017	1089	1157	1337	1461
A	Medium	2	95	249	401	523	612	729	881
A	Medium	3	95	249	401	552	670	874	1026
A	Medium	4	95	249	401	552	670	960	1141
A(1)	Medium	2	144	361	445	523	612	729	881
A(1)	Medium	3	144	361	533	639	719	874	1026
A(1)	Medium	4	144	361	577	748	829	1007	1141

\*Enterprise possibilities for Situation A are hogs, corn and soybeans. A(1) refers to Situation A with the option to purchase corn.

Use of labor. In the absence of a heavy labor-using enterprise, the small sizes cannot make use of additional labor. For example, the basic plan of hogs, corn, and soybeans does not fully utilize the two man labor supply until a size of eight hectares is reached. The third man cannot contribute fully productive labor until a size of 10 hectares is attained and only at 14 hectares is the fourth labor unit utilized.

Purchasing corn allows a greater concentration of labor on a given land size and the respective limits for the full use of labor are 4, 6, and 8 hectares.

Income. Incomes increase steadily as farm size increases. The higher levels of income show a somewhat lower rate of increase, but in all cases the increase is a significant amount. Situation A displays the lowest levels of income of the four situations studied. This is as should be expected, for the other situations contain enterprises with only limited applicability. Farms favored by location, such as proximity to market in the case of dairy production, would be expected to achieve higher levels of income.

The medium levels of productivity show a lower income but display similar patterns of labor use, enterprise combination, and income trends.

### Situation B

A summary of the income levels by size of farm, labor supply, and level of productivity are presented in Table 4.

Combination of enterprises. The enterprises considered in Situation B are hogs, corn, soybeans, and dairy. Dairy cows replace hogs in all size categories as a more profitable livestock enterprise. Soybeans appear at some small size levels to make use of the extra land released when dairy cow levels are adjusted to whole numbers. They appear as part of the optimum solution only when labor becomes limiting. This is at 8, 10, and 14 hectares for the respective size labor forces. As soybeans enter the optimum farm plan, cow numbers gradually diminish. The maximum herd sizes appear at each of the above mentioned size categories and are 9, 14, and 22 cows respectively.

When the corn buying option is allowed, it again enters the solution until labor is fully utilized. Hogs are the more profitable livestock enterprise for the small farms as it is possible to purchase a greater part of the total ration in the form of corn for hogs than for dairy cows. There are three stages of enterprise combination as size of farm increases. The first involves hog production with corn purchased. Then a gradual shift from hogs to dairy releases enough

Table 4. Farm Labor Income for Situation B by Level of Productivity, Labor Supply and Size of Farm (Santa Cruz do Sul - 1963-64).

Situation*	Level of Productivity	Man Equivalents	Number of cultivated hectares						
			2	4	6	8	10	14	18
(In Cr\$1,000)									
B	High	2	139	394	612	761	838	955	1,112
B	High	3	139	394	612	863	1,077	1,261	1,384
B	High	4	139	394	612	863	1,077	1,534	1,657
B(1)	High	2	202	519	692	761	839	955	1,112
B(1)	High	3	202	610	852	989	1,111	1,262	1,384
B(1)	High	4	202	610	1,017	1,128	1,285	1,535	1,657
B	Medium	2	123	302	507	627	689	809	934
B	Medium	3	123	302	507	683	855	1,030	1,155
B	Medium	4	123	302	507	683	855	1,223	1,349
B(1)	Medium	2	144	361	530	627	689	809	934
B(1)	Medium	3	144	361	559	750	907	1,030	1,155
B(1)	Medium	4	144	361	577	777	936	1,223	1,349

\*Enterprise possibilities for Situation B are hogs, corn, soybeans, and dairy. B(1) refers to Situation B with the option to purchase corn.

labor to move one or two size categories higher. When hogs leave the optimum solution soybeans enter as a cash crop. Therefore, the plans at the larger land sizes are combinations of dairy cows and soybeans.

Use of labor. The pattern of labor use is the same as for Situation A. Labor is not fully utilized until land sizes of 8, 10, and 14 hectares are reached. The corn option allows greater concentration of enterprises and the levels are reduced to 4, 6, and 8 hectares for the respective size labor forces.

Income. Situation B displays higher levels of income than Situation A, except in the first farm sizes under the corn purchasing option when they are the same. In an operation that produces the majority of the livestock feed, dairy cows are a more profitable enterprise than hogs. However, for the extremely small farm, it would pay to buy corn and feed hogs. Additional labor cannot be productively used on the smaller farm sizes and is therefore unrewarded. As with Situation A, the four man labor supply does not receive additional income over the three man supply until a size of 14 hectares is reached.

The medium level of productivity for Situation B displays only one difference to the trends in enterprise combination, labor use and income described above for the high level of productivity. At the large farm sizes, the corn purchasing option is not accepted. For these larger sizes it is more profitable to use scarce labor producing corn for livestock feed and soybeans for sale than to add more cows and buy corn under the medium level of productivity.

### Situation C

A summary of the income levels by size of farm, labor supply, and level of productivity for Situation C is presented in Table 5.

Combination of enterprises. The enterprises considered in Situation C are hogs, corn, soybeans, and tobacco. This is an addition of tobacco to the basic plan presented in Situation A. Tobacco requires little land but has a heavy labor requirement. This makes it ideally suited for the small farms. It is the only enterprise appearing in the optimum plan on the two hectare size farm for all sizes of labor force.

In addition, when a four man labor supply is available it is also the only enterprise appearing on the four hectare farm. Available harvest labor soon restricts the tobacco enterprise and hogs enter the solution until total labor is exhausted. Then soybeans enter the optimum plan and hogs diminish. Tobacco remains as part of the organization throughout all farm sizes.

Table 5. Farm Labor Income for Situation C by Level of Productivity, Labor Supply and Size of Farm (Santa Cruz do Sul - 1963-64).

Situation*	Level of Productivity	Man Equivalents	Number of cultivated hectares						
			2	4	6	8	10	14	18
(In Cr\$1,000)									
C	High	2	309	555	689	776	866	1,029	1,131
C	High	3	309	727	876	1,010	1,110	1,279	1,451
C	High	4	309	880	1,049	1,181	1,313	1,510	1,695
C(1)	High	2	309	595	689	776	866	1,029	1,131
C(1)	High	3	309	767	913	1,010	1,110	1,279	1,451
C(1)	High	4	309	880	1,143	1,240	1,337	1,510	1,695
C	Medium	2	273	473	562	642	722	871	989
C	Medium	3	273	633	723	794	891	1,042	1,200
C	Medium	4	273	764	883	971	1,054	1,212	1,369
C(1)	Medium	2	273	473	562	642	722	871	989
C(1)	Medium	3	273	633	723	794	891	1,042	1,200
C(1)	Medium	4	273	764	883	971	1,054	1,212	1,369

\*Enterprise possibilities for Situation C are hogs, corn, soybeans, and tobacco. C(1) refers to Situation C with the option to purchase corn.

While it is an important part of the solution in all cases, tobacco displays an interesting pattern of level of usage. It comes into the solution at a maximum level. However, as size of farm increases, the livestock enterprise takes away some of the labor and tobacco production diminishes. When the higher levels of farm size are reached, livestock production diminishes and soybean production increases. Since soybeans use little labor, tobacco once more increases in level of usage. Finally, at very high land levels, soybeans bid away tobacco labor and it once more reduces in level.

Hogs show the same pattern as in Situations A and B. They increase until total labor is used up and then gradually decrease in numbers as soybeans enter. The levels of usage are slightly more than half as great as when tobacco is not included, as in Situation A. For example, the peak levels are 3, 5, and 6 sows. In Situation A the corresponding levels are 5, 8, and 11 sows.

When the corn purchasing option is allowed, corn is purchased until the full labor supply is utilized. Thereafter home produced corn, soybeans, and tobacco compete more effectively for the scarce labor. However, when corn purchasing is accepted, it reduces substantially the level of operation of the tobacco enterprise (in some cases by about 50 per cent).

Use of labor. Tobacco does not have an even labor distribution during the year and its intensity of operation is therefore limited by harvest labor. This limit is rapidly reached, but the full use of annual labor still follows the same pattern established in the two previous situations.

Income. The income levels of Situation C are substantially higher than either A or B in the small farm sizes. In the larger sizes the differences are less pronounced. Additional labor can always be used productively except in the two hectare size category where land is the limiting factor. For the two hectare size farm the increase in income of Situation C over Situation A is almost 200 per cent.

For the medium level of productivity the corn buying option was rejected in all cases.

#### Situation D

A summary of the income levels by size of farm, labor supply, and level of productivity are presented in Table 6.

**Table 6. Farm Labor Income For Situation D by Level of Productivity, Labor Supply and Size of Farm (Santa Cruz do Sul - 1963-64).**

Situation*	Level of Productivity	Man Equivalents	Number of cultivated hectares						
			2	4	6	8	10	14	18
(In Cr\$1,000)									
D	High	2	309	598	758	826	903	1,029	1,131
D	High	3	309	746	927	1,105	1,202	1,341	1,489
D	High	4	309	880	1,070	1,260	1,442	1,643	1,788
D(1)	High	2	309	628	758	826	904	1,029	1,131
D(1)	High	3	309	767	959	1,141	1,202	1,342	1,489
D(1)	High	4	309	880	1,143	1,308	1,474	1,652	1,788
D	Medium	2	273	512	641	706	773	885	989
D	Medium	3	273	642	787	925	1,007	1,133	1,221
D	Medium	4	273	764	921	1,058	1,195	1,379	1,501
D(1)	Medium	2	273	512	641	706	773	885	989
D(1)	Medium	3	273	645	789	927	1,007	1,133	1,221
D(1)	Medium	4	273	764	929	1,072	1,207	1,379	1,501

\*Enterprise possibilities for Situation D are hogs, corn, soybeans, dairy, and tobacco. D(1) refers to Situation D with the option to purchase corn.

Combination of enterprises. The enterprises considered in Situation D are hogs, corn, soybeans, dairy, and tobacco. This includes all the enterprises used in each of the three previous combinations. When corn is home produced, dairy appears as a superior alternative to hogs as a livestock enterprise and soybeans dominate corn as a cash crop. Therefore, only tobacco, dairy, and soybeans appear in the optimum plans.

Under the corn purchasing option, hogs appear at the small farm sizes and give way to dairy as the point of full labor use is reached. Soybeans then begin to enter the solution and dairy decreases. Tobacco again remains in the optimum plan at all levels. In the two hectare farm size it is the only enterprise. As farm size increases the level of use of the tobacco enterprise displays the same cycling effect noted in Situation C as the livestock enterprises come in and then go out in favor of soybeans.

Use of labor. The pattern of labor use is similar to Situation C.

Income. Situation D displays income levels equal to or higher than other combinations studied. The differences are most notable in the small and medium farm sizes. The combination of buying corn for the livestock enterprise and the use of tobacco allows a fuller use of labor at the small farm sizes and thus a greater level of productivity. This results in a rapid increase in the level of income as farm size increases. At the larger farm sizes, the livestock enterprises diminish in importance and soybeans increase, due to a shortage of labor. This last trend has occurred in all combinations. Therefore, the differences in income at large farm sizes are not as pronounced.

Under medium levels of productivity, the benefits from buying corn are practically negligible and the income difference not sufficient to warrant a firm recommendation.

#### Price Stability

The various solutions were tested to find the price range over which they would remain optimal. Price in this instance refers to the net income value for each enterprise and is thus composed of both product and input prices. A minimum net income value was derived for each enterprise in the final solutions. This value is that which must be attained or exceeded if the enterprise is to remain in the optimal solution. This minimum value was then expressed as a percentage of the computed enterprise net income used in the budgeting analysis. This percentage figure then represents the maximum amount by which the net income could decrease and still have the enterprise remain in the final solution. The decrease in net income could be composed of any

combination of changes in product or input prices. A summary of these values is presented in Table 7.

When several different values appeared for one enterprise in a given situation, only the smallest allowable change was selected for inclusion in Table 7.

Table 7. Minimum Allowable Change in Net Income if Specific Enterprises are to Remain in Optimal Solutions, Under Various Enterprise Combinations (Santa Cruz do Sul - 1963-64).

Enterprise	A	B	C	D	A(1)	B(1)	C(1)	D(1)
(Per cent)								
<b>High productivity</b>								
Hogs	43	--	13	--	45	45	24	17
Soybeans	65	47	45	45	65	8	45	3
Dairy	*	10	*	14	*	1	*	1
Tobacco	*	*	37	21	*	*	30	20
<b>Medium productivity</b>								
Hogs	32	--	2	--	31	10	--	--
Soybeans	61	54	63	49	60	64	--	49
Dairy	*	19	*	22	*	3	*	2
Tobacco	*	*	31	29	*	*	--	29

\*Enterprise not considered in specific combination.

In general, tobacco and soybeans are the most price stable enterprises. Under the A, B, C, and D situations, soybeans can have a net income variation of as much as 45 to 65 per cent and still remain in the optimum solutions of which they are a part. In the A(1) through D(1) situations (corn purchased) the hog enterprise is very strong, especially in the high productivity situations. The low values for the dairy enterprise indicate only that dairy uses very little corn and thus any substantial change in the net income of this enterprise would cause it to be replaced by the dairy enterprise which uses home produced corn. Thus the low value does not indicate that dairy would

drop out of the final solution, but only that the form of organization of the dairy enterprise would change from buying corn to producing corn. On the other hand, if the change in net income was due to a factor common to both dairy enterprises, say the price of milk, then the original enterprise would remain a part of the solution until it is limited by a third enterprise such as hogs.

The lack of values under C(1) medium productivity is because the option of buying corn was not accepted and therefore the results of these budgets are identical to C, medium productivity.

### Determining Minimum Farm Size

#### Minimum Income Level

It was decided to use the minimum salary presently in existence as the basis for determining an adequate return to the productive labor in agriculture. Certain modifications are necessary when a minimum salary intended primarily for industrial workers is used as a guide for farm income. Farmers receive certain benefits from the farm business that are not enjoyed by city dwellers. Home produced food and shelter are the most important. Values for home consumption have already been added to farm income. It is not as easy to determine a value for the use of the farm home. However, data is available on the cost of housing for industrial workers in Porto Alegre. Therefore, this value is subtracted from the minimum salary before it is used as a guideline for determining minimum farm size. Its value amounts to about 20 per cent of the minimum wage.

The use of the minimum wage is further complicated since the time period chosen for establishing values for this study, November 1963, occurred at a time when a new minimum wage was about to go into effect. The old minimum wage of Cr\$18,300 per month was established toward the end of 1962, and in the intervening time the cost of living increased about 100 per cent. Therefore, the new wage which was to go into effect in January or February of 1964 was expected to be about Cr\$36,000 per month, the increase matching the rise in the cost of living. By November of 1963, 80 to 85 per cent of the increase had already occurred.

The minimum income standard was arrived at in the following way. The minimum salary in existence during November of 1963 was increased by 85 per cent in order to bring the wage level in line with the level of prices used to determine income in the study. This value was then decreased by 20 per cent to allow for free housing for the farm workers. The resulting value of 325,008 cruzeiros per year was rounded to Cr\$325,000 and used as the standard for one full time man. For the three labor categories of 2, 3, and 4 men respectively, minimum values of farm labor income of Cr\$650,000, 975,000, and 1,300,000 are necessary to provide an equal income on a per man basis.

**Minimum Farm Size**

Based on these minimum values for farm labor income, a series of minimum size units was delineated by level of productivity and combination of enterprises (Table 8). The enterprise combination considered to have the greatest applicability is Situation A: a combination of hogs, corn, and soybeans. All others would have regional or other limitations to widespread adoption. In Situation A, under levels of high productivity, the minimum size that a farm could be and still return the minimum salary to farm labor is 7.3 cultivated hectares for the two man labor force. For three men it is 10.0 cultivated hectares and for four men, 13.7 cultivated hectares.

**Table 8. Computed Minimum Farm Sizes\* by Level of Productivity, Combination of Enterprises and Labor Supply (Santa Cruz do Sul - 1963-64).**

Situation	Labor supply in man equivalents		
	2	3	4
<b>(Cultivated Hectares)</b>			
<b>High productivity</b>			
A	7.3	10.0	13.7
A(1)	6.8	10.0	13.1
B	6.5	9.0	11.9
B(1)	5.5	7.8	10.3
C	5.4	7.6	9.9
C(1)	5.1	7.3	9.2
D	4.6	6.5	8.1
D(1)	4.4	6.2	7.4
<b>Medium productivity</b>			
A	11.2	16.6	--
A(1)	11.2	16.6	--
B	8.7	12.8	16.4
B(1)	8.7	12.3	16.4
C	8.3	12.2	16.4
C(1)	8.3	12.2	16.4
D	6.2	9.1	12.2
D(1)	6.2	9.1	12.1

\*Minimum farm size was determined on the basis of farm labor income values of Cr\$650,000, 975,000, and 1,300,000 for the 2, 3, and 4 man equivalent labor supplies respectively. Cultivated hectares are used as the measure of farm size.

Situation A displays the largest minimum sizes in each category. If the other enterprises could be successfully adopted, the necessary minimum farm size would decrease. For instance, adding dairy (Situation B), which generally replaces hogs as the livestock enterprise, would lower the requirement from one to two hectares. If tobacco were added instead of dairy the reduction would be greater still (Situation C), and finally when all the enterprises are considered together, the minimum sizes range from just under five hectares to a little more than eight.

Under medium levels of productivity the minimum sizes are greater. In Situation A it was not possible to delineate a minimum size for the four man labor supply within the size range studied, two to eighteen cultivated hectares. The relationships between the various situations remained the same as for the high productivity levels.

The option of buying corn resulted in lower minimum sizes for all but one situation in the high productivity levels. In contrast, it appeared to have very little effect with medium productivity. This has two causes. First, corn purchasing was not as profitable an alternative under medium productivity as it was under high productivity. Also, when the option was accepted it was at small farm sizes when labor was still in excess. Most of the minimum sizes in the medium productivity situations occur at larger farm sizes.

#### Characteristics of Minimum Size Farms

While the minimum size units display a considerable range in size, depending on the combination of enterprises, labor supply, and level of productivity, certain aspects of the minimal solutions in regard to enterprise concentration and labor use are quite uniform.

All of the solutions, in the high productivity level, occurred at or just before the maximum concentration of the livestock enterprises. This was equally true for the Situation D, 2 man equivalent (which has a minimum farm size of 4.6 hectares) as for the A, 4 man situation (which shows a minimum size of 13.7 hectares). Furthermore, the point of maximum concentration of the livestock enterprises is also the first point at which labor is fully utilized. This means that under the budgeted levels of high productivity, labor must be fully employed in order to earn the minimum return. Further increases in income are only possible through a shift to more land extensive enterprises (in this case, soybeans).

Under medium levels of productivity the minimum sizes are slightly greater than the point of maximum concentration of livestock production. They involve the use of more land in extensive crops and occur somewhat after the point of full labor use is first reached.

Thus, under medium levels of productivity the livestock enterprises do not give a sufficient return to reach the minimum income level unless combined with an enterprise that requires little labor but much land.

Situation A appears as the most logical choice for determining minimum farm size, not only because it has general applicability, but also because it assumes that a major portion of the livestock feed is home produced. While the corn buying option would lower the minimum size a little, its use would have to assume that somewhere near the conditions for a more extensive type of agriculture existed and that this area would have a man-land ratio sufficiently low to encourage field crop production such as corn. Also, since the real gains from buying corn are at the very small farm sizes where a fuller use of labor is possible on given land areas, it appears to be a more valuable alternative for those who must adjust to small farm situations.

The minimum size selected in this study then would range from 7.3 to 13.7 cultivated hectares, depending on how large the labor force is. The total farm size would be somewhat larger depending on the ratio of cultivatable to non-cultivatable land. In specific situations, the introduction of dairy and/or tobacco would allow a smaller size farm to give the minimum income. If conditions of high productivity are not achievable, the minimum size would increase to 11.2 tillable hectares for small labor supplies, and it is doubtful that large labor supplies could be adequately rewarded on small farms. Again, specific situations would allow a smaller minimum size where dairy and/or tobacco could be used.

The conditions for returns to labor in excess of the minimum standard are not encouraging under present possible levels of labor productivity. It appears that making full use of present technology on small farms would allow agricultural labor to receive a minimum salary. Any greater increase in income must await a basic change in the nature of technology, probably for an increase in the use of mechanization in order to make agricultural labor more productive.

However, at the present time, the majority of the farmers are not using the technology available to them. To achieve the levels of productivity used in this analysis, many farms must make significant capital changes both in equipment and animals for the specific enterprise, and in some cases for the acquisition of more land.

#### Capital Changes

The final objective of this study was to examine the feasibility of changing to different land sizes and/or adding other capital improvements in order to achieve minimum levels of income. The analysis of existing incomes on the small farms of the region indicated that on

the average no farm size would provide a reasonable expectation of re- turning a minimum salary to the agricultural labor. Thus capital changes in the form of better animals and housing are necessary at all sizes of farms. The introduction of new enterprises or existing enterprises at higher levels would also require additional inputs.

When higher levels of productivity were budgeted many of the smaller farm sizes were still not of sufficient size to allow the amount of productive output necessary to provide a minimum salary. Thus two types of analysis are necessary. First, the farms that are already large enough require an analysis of the feasibility of introducing capital changes. For the farms that are too small, a supplementary analysis for the acquisition of more land is also needed. The cost of maintaining the capital improvements is already included in the budgeted farm plans. Therefore all that need be examined is the cost of financing the improvements in relation to the amount of income available to pay for them.

The cost of borrowed funds and repayment schedules are based on the preferential policies of the Banco do Brasil presently in use in Santa Cruz do Sul. For capital improvements the interest rate is 7 per cent per year on the unpaid balance, with a repayment schedule of up to three years. The actual timing of repayment is adjusted to the expected income flow. For land purchases, a period of up to 15 years is allowed for repayment. However, the eligibility requirements for land purchase loans are such that very few are given by the bank.

Annual cash income is used as the value from which to determine the feasibility of repayment schedules. A value equal to five times the monthly minimum wage is subtracted as necessary for annual personal living expenses. The remainder is assumed to be available for debt and interest payments. For the 2, 3, and 4 man equivalents the values subtracted are 340,000, 510,000, and 680,000 cruzeiros.

It was assumed that added land would likely come from consolidation of small properties. Therefore a ratio of cultivated to total land of 2:3 was assumed. Thus in order to gain two hectares of cultivatable land, three must be purchased. A land value of Cr\$45,000 per hectare is used for purchased land.

The capital changes for situation A were then budgeted. The determined minimum farm sizes of 7.3, 10.0, and 13.7 hectares are changed to 8, 10, and 14 hectares in order to use data from the specific solutions. In addition to an allowance for annual living expenses, an interest value was subtracted from cash income to account for borrowed money used to finance annual crop expenses.

The remaining value is that amount which the farmer is free to apply against capital debts and interest payments. The costs of housing, necessary equipment and breeding stock is then computed for a repayment schedule of three years. In all three cases, the income is sufficient to allow complete repayment of both principal and interest in three years.

Assuming that the farmer started with two cultivated hectares, the cost of purchasing enough additional land to reach the minimum size was then computed. The principal and interest payments for this purchase could also be made within the first three years. Thus it would appear that there is no serious repayment restriction to the implementation of the capital and land changes.

However, if the preferential rates for the purchase of land were not available (and for most of the present land transactions they are not), the conditions of repayment would be much more difficult to assume. The legal limit on interest charges is 1 per cent per month. However, service charges from commercial sources raise the actual rate paid to about 30 per cent per year. The repayment schedule of about three years is much shorter. If funds to acquire land were borrowed under these conditions, the amount of land any one person could purchase with a minimum level of income would be restricted.

The actual conditions of credit availability from commercial sources--including interest rates, loan duration, quantity of credit available and loan servicing in rural areas--are sufficiently unstable to make any analysis based on this credit source highly speculative. Rather, it seems that if a serious effort is initiated to facilitate the consolidation of small properties, a liberalization of the conditions under which the Banco do Brasil could finance land purchases, would be a more realistic approach.

#### CONCLUSIONS

The results of this study demonstrate that it is possible to achieve acceptable levels of income on small farms. However, there are many prerequisites to satisfy before this point can be reached. First, the combination of enterprises must be such that the labor can be fully utilized in a productive capacity. With the given enterprises and assumed labor supply, a size of about 10 cultivated hectares is essential though specific situations would allow smaller sizes.

It is necessary for the farmers to attain the improved levels of productivity. This will involve a much greater effort in the fields of agricultural credit and technical assistance than is now in force. A substantial reorganization of land units is necessary. The present

trend toward smaller farms in this area has resulted in the establishment of many farm operations on land units too small to provide a minimum income, even under advanced levels of productivity. Presently, more than 25 per cent of the farms have less than five cultivated hectares, 75 per cent have less than 10. Consolidation of these small farms would necessitate an exodus of many people from the rural areas.

When the results of this analysis are interpreted as guides for directed changes in farm size, they should be treated as absolute minima. The intent of land reform is to substitute a new form of farm organization for another which has not yielded to the forces of change. Among other things, it is an attempt to put an economic basis under agricultural production. It seems very apparent that the new established system should be constructed on the basis of being able to not only endure, but to advance under the pressures of change.

The incomes developed in this study indicate that, even under high levels of productivity, hand methods soon limit the amount of productive work one man can do. Therefore, in looking at farm size requirements over time, it is significant that while the farmers are not presently using the production methods necessary to provide a minimum income standard, use of presently available methods would do little more than provide this standard. Any greater increase in income must be accompanied by basic changes in the nature of technology in order to make agricultural labor more productive.

These anticipated changes would undoubtedly include a substitution of at least limited mechanization for hand methods of work. With mechanization, one man can care for many more productive units. Therefore the size of farm needed to fully employ the labor supply would increase. When directed changes in farm size are undertaken, this possibility of future needs should be considered in the program either by giving units of land somewhat in excess of the present minimum size or by making adequate provisions for the acquisition of more land in the future.

#### EPILOGUE

The analysis of minimum farm size has been based on the present ratio of tillable to non-tillable hectares on farms of various sizes in Santa Cruz do Sul. It has been helpful to use the existing land use patterns as a basis for projecting the budget analysis, for it is this structure within which the individual adjustments must be made. Many specific farm organizational patterns were evaluated for it is recognized that some farmers must adjust to the present situation without the possibility of acquiring more land.

However, it is possible to arrive more directly at minimum size units if some of these assumptions are altered. For example, if it is assumed that there will be an effort to consolidate small farms into economically feasible units, the assumption of a constant ratio of tillable to non-tillable hectares can be employed. Under this assumption it is possible to allocate fixed costs on land (taxes, interest, and maintenance) to each enterprise and include this charge in the enterprise net return value. The enterprise land requirements can then be expressed as the objective function and minimized subject to the restraint that net revenue must equal or exceed the minimum income standard. The solution will give the minimum size directly.

The analysis of minimum farm size was reevaluated under the assumption that small farms would be consolidated to allow the formation of economic units. It was assumed that the ratio of tillable to non-tillable land was 2:1 (for each three hectares of total land, two would be tillable). Fixed costs associated with land were added to the net income compilation of each enterprise on the basis of the land requirement of the enterprise. The value of perquisites minus other overhead costs (a net value of Cr\$50,000) was subtracted from the minimum income standard.

Thus, for the 2, 3, and 4 man farms, the number of tillable hectares was minimized subject to the restriction that the net revenue equal or exceed 600,000, 925,000, and 1,250,000 cruzeiros. The determined farm sizes were increased by 1.1 hectares (subsistence crops) to arrive at the minimum size units under the new assumptions (Table 9).

In general the minimum sizes are slightly less under the new assumptions, particularly for situations requiring larger tillable land areas. Under medium productivity levels the decrease in minimum size is more apparent. Both of these trends are to be expected since the ratio of tillable to non-tillable land rapidly decreases as farm size increases under current land use in Santa Cruz do Sul. Moreover, the levels of return under medium productivity are not able to support overhead costs as well as with high levels of productivity.

This procedure not only provides a check against the method used in the study, but also demonstrates a new procedure for determining minimum size farm units. This procedure has the advantage of requiring much less computational effort and at the same time gives the answer directly. However, information about farm organization and potential income levels for farms of various sizes, which is very useful for planning farm adjustments, must be sacrificed. The two methods provide similar solutions to the question of minimum farm size both in terms of land area and enterprise organization.

**Table 9. Computed Minimum Farm Sizes by Level of Productivity, Combination of Enterprises and Labor Supply. (Epilogue Analysis). (Santa Cruz do Sul - 1963-64).**

Situation	Labor supply in man equivalents		
	2	3	4
	(cultivated hectares)		
<b>High productivity</b>			
A	6.9	9.6	12.6
A(1)	6.9	9.6	12.4
B	6.1	8.8	11.5
B(1)	5.4	7.5	9.7
C	5.1	7.2	9.3
C(1)	5.0	6.8	8.7
D	4.5	6.3	8.2
D(1)	4.3	6.0	7.6
<b>Medium productivity</b>			
A	10.5	15.3	20.1
A(1)	10.5	15.3	20.1
B	7.8	10.8	14.1
B(1)	7.7	10.6	13.6
C	7.9	11.5	15.1
C(1)	7.9	11.5	15.1
D	5.9	8.4	11.0
D(1)	5.9	8.3	10.8

## LTC RESEARCH PAPERS

- No. 1 Out of print.
- No. 2 Ronald L. Tinnermeier, "The Role of the National Institute of Tobacco in Increasing Tobacco Production in Colombia." November 1964.
- No. 3 Bernard L. Erven, "Farm Loan Repayment Policy Needs in Rio Grande do Sul, Brazil--A Framework for Investigation." November 1964.
- No. 4 Out of print--now Reprint No. 8.
- No. 5 A. Eugene Havens, "Social Factors in Economic Development." May 1965.
- No. 6 John Strasma, "Market-Enforced Self-Assessment for Real Estate Taxes." August 1965.
- No. 7 Bryant E. Kearl, "Communications in Economic Development." September 1965.
- No. 8 A. Eugene Havens, "Education in Rural Colombia: An Investment in Human Resources." February 1965.
- No. 9 John D. Powell, "Preliminary Report on the Federación Campesina de Venezuela: Origins, Organization, Leadership and Role in the Agrarian Reform Program." September 1965.
- No. 10 William C. Thiesenhusen, "Chile's Experiments in Agrarian Reform." November 1965.
- No. 11 John Strasma, "Reform Finance and a Latin American Common Market: Some 'Harmonization' Problems in Tax Policy." June 1965.
- No. 12 Belden H. Paulson, "Local Political Patterns in Northeast Brazil: A Community Case Study." August 1964.
- No. 13 Ronald L. Tinnermeier, "New Land Settlement in the Eastern Lowlands of Colombia." December 1964.
- No. 14 Robert E. Price, "Rural Unionization in Brazil." August 1964.
- No. 15 Robert E. Price, "The Brazilian Land Reform Statute." April 1965.
- No. 16 Norman Rask, "Farm Size and Income: An Economic Study of Small Farm Agriculture in Southern Brazil." April 1964.