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An Economic Analysis
of the Factors Influencing
the Utilization of Fertilizer
in Southern Brazil

A Research Project Proposal

by

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Background

Traditional agriculture depends primarily on land, labor, draft animals, home-grown seeds, and traditional means of organizing these factors of production in producing crops. According to Schultz and others, the combinations of these inputs have established a rational equilibrium over time, and increasing productivity requires the introduction of new inputs or changing the quality of traditional factors of production. Chemical fertilizers, hybrid or improved seed varieties, herbicides, insecticides, and complex equipment are the factors needed to increase productivity which are most frequently mentioned in the literature. The purpose of this study is to investigate the process of adoption of one of these inputs -- chemical fertilizers. Fertilizer was chosen due to its great potential to increase land and labor productivity and because it involves greater per acre expense and greater knowledge in its application than many of the other new inputs. The assumption made here is that the process of adoption of other inputs would be similar and probably be more rapid due to their lower cost and lesser difficulty in application.

During the present decade, Brazil has made a substantial effort to increase the quantity of fertilizer used by farmers. This effort has been assisted by the Agency for International Development and has involved adjusting price relationships, interest rates, infrastructure, and extension programs. Some research on these programs has been done

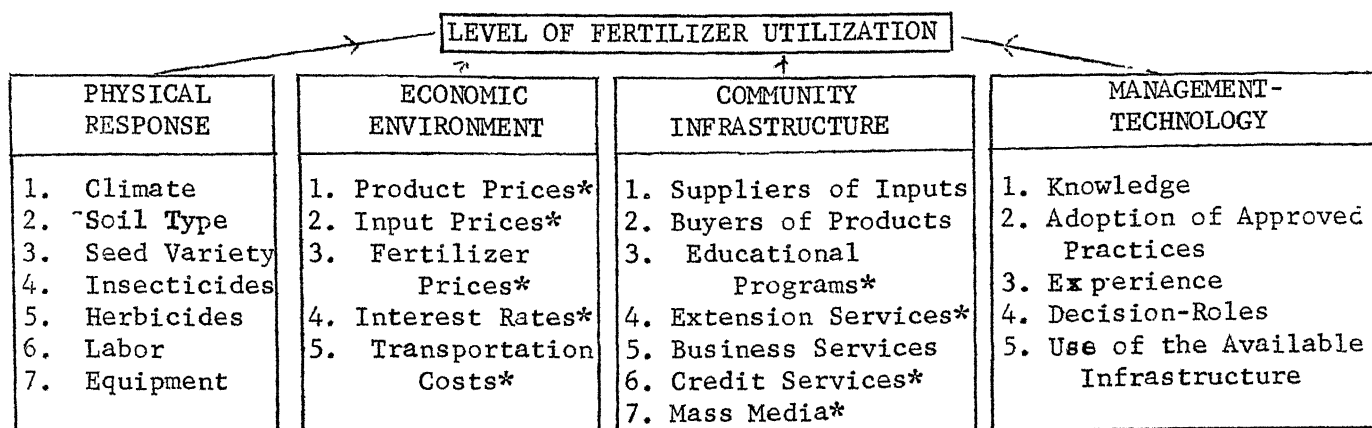
by agricultural economists and by rural sociologists with the economists largely ignoring the process of adoption aspect and the sociologists ignoring the economic aspects. In addition, many of the economic studies have been at an aggregate level. This study will attempt to incorporate most of the factors affecting the adoption process as viewed from the perspective of the farm operator.

The process of introducing chemical fertilizers into the agricultural sector involves the formation of three forms of capital: (1) physical, (2) human, and (3) social. Utilization of fertilizer by farm operators directly changes the quality of land and indirectly increases physical capital through the requirements it places upon transportation systems, production and storage facilities, application equipment, and complementary inputs at the farm level. It involves the formation of human capital at the farm level through requiring operators to add to their management skills if fertilizer is to be used in the most profitable manner. The process of introducing fertilizer may also generate social capital in the form of education and extension services, marketing cooperatives, credit services, and other factors needed for profitable adoption, which can be placed under the heading of community infrastructure. Conversely, the rate of adoption of chemical fertilizers by farm operators will initially be assumed to depend on the present level of the community infrastructure, physical resources, management, technology, and the economic environment, in addition to the actual response of crop yields to fertilizer application. It is hypothesized that the greater the quantity of these forms of capital, the greater the yield

response and the more favorable the price relationships, the higher the level of fertilizer utilization and the faster the rate of adoption will be at the farm level.

There are three major purposes of this study. First, the actual levels of fertilizer application by crop, area, and operator must be determined and compared to recommended levels in order that an index of actual to recommended levels can be established. The second purpose is to relate this adoption index to the current levels of physical, social, and human capital, and the economic environment faced by each operator. Emphasis will be placed on identifying those factors which can be manipulated by government action, such as interest rates, prices, education-extension programs, and mass media. Third, to investigate the cost-effectiveness implications of various government actions designed to stimulate the adoption of fertilizer. A number of the variables to be analyzed are presented below in Figure 1.

Figure 1. Factors Influencing the Level of Fertilization



*Factors which can be controlled by government action.

Objectives

- A. To determine the actual and the recommended levels of fertilizer application for selected crops by area.
- B. To identify the critical factors affecting the utilization of fertilizer and to determine the degree of their effect.
- C. To determine the interrelationships between the critical factor's rates of substitution.
- E. To estimate the cost-effectiveness ratios of various governmental policies designed to stimulate fertilizer utilization.
- F. To make policy recommendations with respect to: (1) Should an effort be made to encourage fertilizer utilization? (2) What crops and what areas should be emphasized? and (3) What are the most efficient strategies to use to stimulate utilization?

Derived from these objectives are the following hypotheses:

- 1. There are no differences in crop yields with or without fertilizer application.
- 2. There are no differences between the actual and recommended levels of fertilizer utilization.
- 3. Differences in the level of management-technology have no effect on the level of fertilizer application.
- 4. Differences in the infrastructure have no effect on the level of fertilizer application
- 5. Differences in the economic environment (price ratios, interest rates) have no effect on the level of fertilizer application.
- 6. There is no relationship (complements or substitutes) between the infrastructure, management-technology, or economic environment.

7. There are no differences in the cost-effectiveness ratios, the quantitative change in fertilizer utilization due to the strategy divided by the cost of the strategy, of the various strategies designed to stimulate fertilization utilization such as price manipulation, credit subsidies, education-extension programs, and marketing projects.
8. There is no relationship between levels of credit usage and rates of fertilizer application.

Methodology

Objective A will be accomplished through a production function analysis of questionnaire data and through a synthesis of previous research on fertilizer application and experiment station recommendations.

Objectives B, C, and D will be fulfilled by estimating and testing coefficients for the following function and sub-functions:

$$Y_{ijk} = f(P, I, M, R)$$

Y_{ijk} = Ratio of actual/optimum fertilizer usage by crop i , area j , operator k .

P_{ij} = Ratio of fertilizer price to product price i , area j .

I_j = Infrastructure Index, area j .

M_{jk} = Management index, area j , operator k

R_{ij} = Real interest rate, ratio of interest rate, area j to rate of change in product price i , area j .

The infrastructure index will contain factors pertaining to: (1) credit availability, (2) availability of fertilizer, (3) marketing facilities for the product, and (4) education-extension programs. The management index will contain factors pertaining to level of technology adoption, knowledge of environment, use of infrastructure, and decision processes.

Objective E will be accomplished by estimating costs of various strategies for a representative municipio or for several types of municipios and comparing this to the relative effectiveness of these strategies found in the achievement of objective B. Policy recommendations, objective F, would be made on the basis of all results found in the accomplishment of objectives A through E.

Information Sources

Three major sources of data will be used in the study. A farm operator questionnaire will be the source of data on the actual levels of fertilization, management, technology, on-farm prices and interest rates, and the basis for developing production functions. A municipio questionnaire will provide data concerning the community infrastructure and additional information on prices, interest rates, and transportation costs. Previous studies and public data sources will provide information on the response to fertilization, recommended levels of fertilization, cost and effectiveness of alternative fertilizer stimulation strategies, and the relative importance of infrastructure components and management practices.

In addition, a second questionnaire may be developed for a subsample of the farm operators interviewed in the initial survey. This questionnaire would be aimed at gathering detailed information on farm management procedures, and on factors which influence his management ability such as formal or adult education, extension, business and peer contacts, and mass media.