THE ADOPTION OF NEW AGRICULTURAL PRACTICES IN NORTHEAST BRAZIL: AN EXAMINATION OF FARMER DECISION-MAKING

Thesis for the Degree of Ph. D.

MICHIGAN STATE UNIVERSITY

DAVID LEWIS PEACOCK

1972

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thesis entitled

The Adoption of New Agricultural Practices in Northeast

Brazil: An examination of Farmer Decision-Making

presented by

David Lewis Peacock

has been accepted towards fulfillment
of the requirements for

Ph.D. degree in Agricultural Economics

Harold M Riley

Major professor

Date Nov 8, 1972

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ABSTRACT

THE ADOPTION OF NEW AGRICULTURAL PRACTICES IN NORTHEAST BRAZIL: AN EXAMINATION OF FARMER DECISION-MAKING

By

David Lewis Peacock

It is generally agreed that farmers' adoption of improved practices is essential for agricultural development, but there are differing views of the process by which farmers adopt these new practices. This study examines the adoption process in terms of individual decision-making under conditions of uncertainty and involving the interaction of social, economic, and personality variables.

Various theoretical concepts, obtained from a review of the relevant literature, were incorporated into a conceptual framework of farmer decision-making with respect to innovations. Based upon this conceptual framework, relationships were hypothesized between the farmer's use of new practices and selected variables amenable to analysis using data collected in a survey of farmers in Northeast Brazil. This survey was one part of a cooperative research project involving Michigan State University and SUDENE (the Northeast Brazil Economic Development Agency) which examined the production and marketing of agricultural commodities in the Recife area.

The Chi-square and analysis of variance techniques were used to test the hypothesized relationships and to examine possible inter-relationships between the independent

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variables. These analyses provided a statistically based view of a system of variables influencing the farmers' decision regarding new agricultural practices. Automatic Interaction Detection was then utilized to determine the relative importance of the variables which appeared to contribute to an explanation of the variation among farmers in their adoption of innovations.

The major findings of this study are that:

1. Although certain attitudes seemed to be related to a greater knowledge of new practices, the effect of attitudes (to the extent they were measured by the variables included in this study) was very small as compared to other variables.
2. Better educated farmers, as expected, were more knowledgeable about yield improving methods and were more likely to use the agronomist or mass media as a source of information about new practices. Surprisingly, the achievement of a very few years of formal education (1 to 3 years) was found to have a substantial impact upon the farmer's level of innovativeness.
3. Farmers who used the agronomist and/or the mass media were significantly more innovative than their counterparts who depended upon neighbors

and relatives as a source of information about farm practices.

4. Lower income farmers were found to be considerably less likely to use new practices than their wealthier counterparts and there was sufficient reason to believe that their reluctance to accept "risks" was importantly involved in this relationship.

5. The local availability of modern inputs was found to be an important predictor of innovativeness, especially among the smaller and more poorly educated farmers.

6. Smaller farmers were more likely than larger farmers to have either not borrowed money or to have borrowed from non-commercial sources (small amounts from relatives, neighbors, landowners, etc.). They very frequently indicated that their unwillingness to use credit was due to the "risk" involved in borrowing. Farmers who had obtained sufficient "credit" (by their own assessment) or had secured loans from banks and credit cooperatives were more innovative than those who either didn't borrow or had obtained loans from non-commercial sources.

7. In general, landlords and tenants seemed to be more innovative than owner-operators. The

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> most reasonable explanation was that the landlords in the sample were better educated and had greater financial resources than owner-operators, while tenants utilized new practices either because landlords furnished the requisite inputs or required their use.

The results of this study suggest that viewing the adoption of new practices as individual decision-making under uncertain conditions and involving the interaction of social, economic and personality variables is a useful approach to gaining a better understanding of technological change. A strategy for securing more rapid adoption of new practices in Northeast Brazil might also be developed on the basis of this research. Important elements of such a strategy would be:

(1) the development of institutional methods for reducing the "risk" involved in trying new methods;

(2) broadening the use of the agronomist and the mass media as sources of information about new agricultural methods;

(3) increasing the availability of commercial agricultural credit (especially to smaller farmers) and reducing the "risk" involved in borrowing, and

(4) over the long run, providing at least a few years of formal education to a greater share of the rural population.

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A very special thanks to my wife Carolyn for her patience and encouragement during the course of my graduate studies at Michigan State University.

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CHAPTER I

INTRODUCTION

The Research Problem

It is generally agreed that farmers' use of new and improved practices is critically important to the advancement of agricultural productivity among the less developed nations.[1] There is considerably less agreement, however, with regard to the process by which farmers adopt new technologies and the strategies that should be employed to secure rapid technological change in the rural sector.

At the moment there seems to exist at least two conceptual viewpoints concerning the process of adoption of new agricultural practices, each having evolved from a different point of view about the behavior of farmers in traditional agriculture. One viewpoint is that farmers in a traditional agriculture behave quite differently from their counterparts in modern agriculture. The reason given for this view is that the traditional farmer is primarily a "social being" and that he lives by attitudes, beliefs, values, and cultural norms which widely diverge from those of the modern farmer. An alternative viewpoint conceives of the farmer in traditional agriculture as no less an "economic man" than farmers in developed countries, being not a prisoner of socio-cultural constraints but the captive of low productivity resulting from a lack of appropriate and

[1] A Report of the President's Science Advisory Committee, The World Food Problem (Report of the Panel on the World Food Supply, Vol. I, The White House, May 1967), pp. 1-6.

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The strategies for increasing the use of improved practices which emerge from these divergent points of view differ greatly in emphasis. Concentration upon the social behavior of traditional farmers leads to strategies, such as those suggested by Niehoff[2] and Rogers,[3] which emphasize the interactions between change agents and members of the traditional community. Such strategies suggest that programs of change should be adapted to fit the socio-cultural environment found in the local communities. This often involves designing change programs to serve what local farmers believe to be their needs and adjusting innovations to fit local cultural patterns. The alternative strategy is to provide the farmer with an increased supply of profitable technologies through investment in the suppliers of these factors of production (such as public agricultural research and extension services), or to increase the profitability of modern inputs through manipulation of the economic environment (through price policies, subsidized inputs, improvements in land tenure, etc.).

Either of these strategies, taken alone, suffers from some inadequacies. While there is no doubt of the need to provide farmers in less developed nations with technically

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[2] Arthur H. Niehoff, A Casebook of Social Change, (Chicago: Aldine Publishing Company, 1966), pp. 11-41.

[3] Everett M. Rogers, Diffusion of Innovations, (New York: The Free Press of Glencoe, 1962), pp. 278-282.

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well-adapted and clearly profitable alternatives to their present practices, it is quite certain that all farmers will not adopt even the most profitable new inputs at exactly the same time. Therefore, it would seem useful to try to determine why rates of adoption vary and utilize the resulting knowledge to develop strategies for increasing the overall pace of adoption.

On the other hand, strategies which emphasize the social interactions involved in the adoption process tend to overlook the relevant economic considerations involved in technological change. Not only are micro-economic phenomena often ignored, but those strategies which insist that innovations must fit the socio-cultural milieu of traditional communities seem to ignore the critical importance of agricultural development. The urgency associated with increasing agricultural productivity in many countries may not permit the modernization of farming communities through a gradual accommodation of the existing culture to modern practices.

Given the shortcomings of the present strategies, it would seem useful to re-examine the adoption process in an attempt to move toward a somewhat more comprehensive understanding of technological change. The frame of reference chosen for this study is to regard the adoption of new agricultural methods as an individual decision-making process conducted under conditions of uncertainty and involving the interaction of social, economic and personality variables.

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The Approach: Adoption of Innovations As Decision-Making Under Uncertain Conditions

Many researchers have recognized that adoption of agricultural innovations is a matter of farmer decision-making and have observed that uncertainty is clearly involved in the process:

> The adoption process is one type of decision-making. The adoption of an innovation requires a decision by an individual. He must begin using a new idea, and in most cases cease using an idea that the innovation replaces. (Rogers: 1962)[4]

> In general, farmers who are limited to traditional agricultural factors are more secure in what they know about factors they use than farmers who are adopting and learning how to use new factors of production. The new types of risk and uncertainty about the yield inherent in factors embodying an advance in knowledge are of real concern to farmers. They could be of critical importance to farmers who are producing so little that there is barely enough production for survival. (Schultz: 1964)[5]

> The subsistence farmers who must execute plans for technological change must weigh the risks and potential probabilities of gains and losses in any change.
> Thus in deciding upon change, we have not only the economics of probabilities of gains and losses, but also of the values of farmers regarding risks and risk-taking. (Mellor: 1969)[6]

> The innovation carries a subjective risk to the individual. He is unsure of its results, ... (Rogers: 1962)[7]

---

[4]*Ibid.*, pp. 77-78.

[5]Theodore W. Schultz, *Transforming Traditional Agriculture*, (New Haven: Yale University Press, 1964).

[6]John W. Mellor, "The Subsistence Farmer in Traditional Economies," Clifton R. Wharton, Jr., (Ed.), *Subsistence Agriculture and Economic Development*, (Chicago: Aldine Publishing Company, 1969), p. 214.

[7]Rogers, *op. cit.*, p. 84.

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Thus, one approach to reexamining the adoption of new agricultural practices would be to view the process in terms of farmer decision-making under conditions of uncertainty. This study will be carried out within this general context. An important advantage of such an approach is that it provides sufficient flexibility to consider a wide range of variables which might be expected to influence the farmer's decisions about new technologies.

The objectives of this study were as follows:

1) To develop a conceptual framework of decision-making under uncertain conditions which can be applied to the process of adoption of new agricultural practices in less developed countries.

2) Within the context of this conceptual framework, to postulate relationships between certain variables and the adoption of innovations, and test these relationships using data provided by a survey of farmers in the Recife area of Northeast Brazil.[8]

3) To examine the relative importance of the postulated relationships as explanations of the variance in the adoption of innovations among the Recife area farmers.

4) Suggest some elements of a strategy to hasten the adoption of more productive agricultural practices

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[8]This data is the result of a farmer survey conducted in a cooperative research project involving researchers from Michigan State University and SUDENE (the Northeast Brazil Economic Development Agency). The research project examined the production and marketing of food and certain other products in the Recife area of Northeast Brazil. See Charles Slater, Harold Riley, et. al., Market Processes in the Recife Area of Northeast Brazil, (Michigan State University, Latin American Studies Center, Research Report No. 2).

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5) Provide an assessment of decision-making under uncertainty as a framework for studying adoption of innovations, and suggest further research which might be conducted utilizing this approach.

Plan of the Thesis

In the pursuit of these objectives, Chapter II provides a foundation for the ensuing research with a review of the literature which focuses upon the behavior of farmers in less developed nations, the diffusion of innovations, and the nature of the decision-making process under conditions of uncertainty. It was believed that from the various ideas presented, certain concepts would emerge that could provide the basis for a theoretical framework of the adoption process as it applies to production-increasing technologies in rural areas still in the early stages of agricultural development.

Chapter III involves the development of a conceptual framework based upon some of the concepts suggested by the literature review. This framework, in turn, provides both testable hypotheses and a theoretical counterpart to later statistically-based models of the adoption process.

Chapter IV briefly describes the agricultural setting in the Northeast of Brazil and examines the characteristics of the farmers included in the MSU/SUDENE survey. This survey, undertaken as a part of a marketing study conducted in 1966-67, questioned the Recife farmers about their personal characteristics (age, education, size of family, etc.), farm tions (size

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operations (size of farm, tenure, use of modern inputs), attitudes and beliefs (fatalism, attitude toward new technology, willingness to defer income), their responsiveness to price changes, use of credit, use of selected inputs, information sources used, income-risk preferences, market behavior, and their perceived availability of certain inputs. Although these data did have certain limitations for the present study, they provided a considerable amount of information which seemed applicable to the problem at hand. Undoubtedly, the greatest limitation was a lack of data about the profitability of new methods.

Chapters V and VI involve an examination of relationships postulated between innovativeness and certain variables which were amenable to analysis using data from the MSU/SUDENE survey of farmers in the Northeast of Brazil. Innovativeness, in this case, can be thought of as the relative rate at which individual farmers adopt new technologies; those who readily accept new practices being regarded as more innovative than those who are more reluctant to change. The specific relationships examined may be generalized into the seven hypotheses which follow:

1. Farmers' attitudes have an influence on their innovativeness.

2. Farmer innovativeness is positively related to educational achievement.

3. Innovativeness is related to the sources used by farmers to learn about new agricultural practices.

4. Farmer innovativeness is positively related to the financial capacity to accept "risks." (Poorer farmers are less innovative because they are

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reluctant to subject their families' well-being to a crisis involving the failure of an innovation. Stated differently, they are unable to accept the "risk" perceived in new methods.)

5. Farmer innovativeness is positively related to his anticipated utility from increased income.

6. Farmer innovativeness is positively related to the availability of inputs and credit.

7. Farmer innovativeness is related to land tenure arrangements.

A more general hypothesis -- to which these seven are subservient -- is that: an <u>interactive system</u> of social, economic and personality variables such as proposed by the conceptual framework developed in Chapter III can be identified empirically, and that the relative importance of these variables to the adoption of an innovation can be established. Identification of such a <u>system</u> would aid in directing attention toward the development of more comprehensive strategies for increasing the pace of technological change within the agricultural sector of developing nations.

Chi-square and analysis of variance techniques were used in these chapters to examine not only the relationship between the variables and the adoption of innovations but the relationships between the independent variables themselves. It was believed that a clearer understanding of the adoption process would be achieved by developing a knowledge of the inter-relationships between the independent variables in addition to discovering their relationship to innovativeness.

Chapter VII examines the relative impact and interaction of variables which, on the basis of relationships discovered in the preceding chapters, appeared to have an effect on farmer

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innovativeness. A statistical technique termed Automatic Interaction Detection was used in the analysis. This technique provides an explanation of the variance in the dependent variable in terms of the interaction of the independent variables. Using either the use/non-use of certain practices or a weighted index of innovations as the dependent variable, the computer was employed to generate several models of the interaction between the independent variables and farmer innovativeness. An examination of these interaction models becomes the focal point of Chapter VII.

Chapter VIII summarizes the research by providing: (1) an evaluation of decision-making under uncertainty as an approach to studying adoption of agricultural innovations; (2) an assessment of the relationship between specific variables and innovativeness; (3) conclusions regarding the generalized hypotheses proposed; (4) a proposal of certain elements to be included in a strategy for hastening the adoption of more productive agricultural practices in the Recife area of Northeast Brazil; and (5) suggestions for further research which might follow this approach.

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CHAPTER II

REVIEW OF THE LITERATURE

Overview

Since this study seeks to examine the adoption of new technologies in the context of an individual decision-making process, a review of the literature should draw upon those concepts which might contribute to an understanding of the behavior of the "decision-maker" and the nature of the decision process employed by the individuals involved. Taking the farmer in less developed countries as the "decision-maker" and the adoption of new agricultural technologies as the decision process, there would seem to be three general areas of the literature which bear investigation: (1) concepts about the behavior of farmers in less developed nations (often under the heading of "subculture of peasantry," "subsistence" or "traditional agriculture"); (2) concepts about the diffusion of innovations; and (3) theories and empirical studies of individual decision-making under uncertainty. It was believed that from the various ideas presented, certain concepts would emerge that can provide the basis for a conceptual framework of the adoption process as decision-making under uncertain conditions.

The Decision-Making Behavior of Farmers in Less Developed Countries

As with so many other important issues in agricultural development, there is less than complete agreement about the

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behavior and motivations of the farmers in traditional agriculture. With respect to the adoption of new agricultural practices, one side of the present controversy argues that:

> Despite all that has been written to show that farmers in poor countries are subject to all manner of cultural restraints that make them unresponsive to normal economic incentives in accepting a new agricultural factor, studies of observed lags in acceptance of particular new agricultural factors show that these lags are explained satisfactorily by profitability. (Schultz: 1964)[9]

While the other side contends that:

> Available evidence seems to indicate that peasant behavior is far from fully oriented toward rational and economic considerations. Undoubtedly, however, the degree to which peasants are efficiency-minded and economically rational depends in a large part on their level of modernization. It does not seem justified to assume that subsistence farmers will be promptly motivated to adopt agricultural innovations merely if the pecuniary advantages of such acceptance are pointed out. (Rogers: 1969)[10]

In general, this controversy has come to be focused upon the behavior of the small farmer within the less developed country -- the "peasant" or "subsistence farmer." There is, of course, a compelling reason to concern ourselves with the behavior of the "peasant." One estimate of their number suggests that they may represent more than 50% of the world's population.[11] If indeed "peasant farmers" are so numerous,

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[9] Schultz, op. cit., p. 164.

[10] Everett M. Rogers, Modernization Among Peasants, (Holt, Rinehart and Winston, Inc., 1969), pp. 31-32.

[11] John D. Rockefeller, 3rd, "The Challenge of Population and Food," Clifton R. Wharton, Jr., (Ed.), Subsistence Agriculture and Economic Development, (Chicago: Aldine Publishing Company, 1969), p. 3.

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they may be expected to represent the major proportion of decision-makers in a traditional agriculture. Consequently, considerable attention will be given in this study to the various views concerning the behavior of the "peasant."

The major question to be examined has been posed by Wharton in the following manner:

> Are subsistence farmers basically different than nonsubsistence farmers? If so, in what way? Or are the differences merely a matter of degree?[12]

The Peasant Farmer as Non-Economic Man

An expansion of Wharton's question, "are subsistence farmers basically different from nonsubsistence farmers?", might be as follows: do peasant farmers behave as if they were "economic men" (at least to the extent that commercial farmers are assumed to do so) by attempting to equate marginal costs and returns, responding to economic incentives and being desirous of obtaining higher incomes; or are they non-economic beings who are constrained in their decisions by the force of the values, attitudes, traditions, and mores of their socio-cultural environment?

Kusum Nair[13] perceives the farmer in less developed countries (at least in India) as not necessarily respondent to economic incentive. Her view can best be illustrated in her own words as she summarizes her study of Indian peasants. Speaking in general terms about the problems of agricultural

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[12]Clifton R. Wharton, Jr., "The Issues and Research Agenda," Clifton R. Wharton, Jr., (Ed.), Subsistence Agriculture and Economic Development, (Chicago: Aldine Publishing Company, 1969), p. 458.

[13]Kusum Nair, Blossoms in the Dust, (New York: Frederick A. Praeger, 1961).

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development in Indian communities, Nair states that:

> After talking to peasants all over the country ... I came to the conclusion that the problem of material resources is only one of several factors that must be taken into consideration and to which any programme designed to raise farm yields must be adjusted. And it is not always the most important. A community's attitude to (sic) work can be a more decisive determinant for raising productivity in Indian agriculture than material resources, or for that matter even technology.[14]

After observing wide variations in the motivations and accomplishments of Indian farmers, Mrs. Nair concludes that:

> In the absence of common valuations, a uniform response to common incentives and stimuli cannot be expected. On the other hand, variations in the value system can make all the difference to the extent of success or failure of a development scheme independently of the material and natural resources.[15]

Focusing her attention on the peasant's attitude toward his standard of living and its improvement, Nair gives the following assessment.

> The upper level they [peasants] are prepared to strive for is limited and it is the floor that is bottomless. This does not mean that the desired standard is always fixed at the subsistence level. It varies with different communities. In some groups it is very much higher than others, and it may be considerably more than the minimum necessary to breed and survive. But whatever the level, it tends to be static, with a ceiling rather than a floor, and it is socially determined. Generally, the lower the level, the more static the aspirations tend to be.
>
> If my observation is correct, it largely invalidates one of the principle assumptions on which present planning for economic development of the rural sector is based.[16]

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[14] Ibid., p. 190.

[15] Ibid., p. 191.

[16] Ibid., pp. 192-193.

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From her observations of peasant farmers in India, Nair reaches the following conclusions about the economics of agricultural development:

> ... It is apparent that there is no economics in isolation from sociology and social psychology. There are many causal relationships and connections between purely economic factors and social and cultural conditions which cannot be ignored or excluded from economic analysis ....[17]

As a result of his basic research in Latin America and supporting work in Asia and Africa, Rogers has also concluded that peasant farmers are basically different from our concept of commercial farmers. He perceives certain behavioral traits as typical of peasants wherever they are found. Further, Rogers argues that these common patterns of behavior constitute a "Subculture of Peasantry" which can be defined in terms of the following characteristics: (1) mutual distrust in interpersonal relations; (2) perceived limited good; (3) dependence and hostility toward government authority; (4) familism; (5) lack of innovativeness; (6) fatalism; (7) limited aspirations; (8) lack of deferred gratification; (9) limited view of the world; and (10) low empathy.[18]

According to Rogers, the "peasant" is the captive of a mentality of mutual distrust, suspiciousness, and evasiveness in interpersonal relations. He appears to be playing life's game by attempting to maximize the shortrun advantage to himself and assuming that others are doing likewise. A

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[17] Ibid., p. 194.

[18] Rogers, Modernization Among Peasants, pp. 24-38.

distrust syndrome of this type seems to preclude cooperative action, casts suspicion upon anyone who advances more rapidly than his neighbor (considering him to have cheated or exploited his fellows), and claims as fraudulent any individual who professes to have altruistic motives.

Closely related to the mutual distrust among peasants is their concept of the world as "having only an absolute quantity of that which is good." The perception of a finite quantity of that which is desirable in life (wealth, health, security, love), these things being always in short supply and beyond the power of the peasant to expand, logically leads the peasant to the conclusion that he must struggle to maintain his share and that anything gained by others is at his expense.

Rogers asserts that the peasant's view toward government is one of ambivalence. He may exhibit suspiciousness, evasiveness, and hostility toward government, yet look to government for the solutions to his problems. While government may seem distant, hypocritical, and exploitative to the peasant, Rogers finds this same peasant to be more strongly imbued with the "help-me" philosophy than with the self-help approach.

Familism is another trait which is assumed to be characteristic of peasants. The individual's goals are subordinated to those of the family. One's own family, or perhaps extended family, may provide the security needed by individuals to cope with these elements of society which he

has learned to distrust. Rogers also notes that familism may be an important contributor to the peasants' lack of innovativeness. Under such a system the decision to accept or reject new ideas must be made jointly by the entire family, often with older members playing dominant roles, the result being a lack of flexibility in decision-making and the likelihood of little innovative behavior.

According to Rogers, peasants are generally not responsive to new ideas. He suggests a few reasons, in addition to familism, why this is the case.

> First of all, his life pattern inclines the peasant to follow those ways he knows will produce positive, even though small scale, results rather than try a new idea that might end in failure and thereby endanger his existence.
>
> It is often said that the lack of peasant innovativeness is a function of scarce economic resources and technology inappropriate for the village setting. Peasants are poor, and a lack of ready capital undoubtedly serves to discourage the adoption of those new ideas which require cash outlay. Peasants are also poor in technological resources and know-how. ... Many agricultural innovations from temperate climates have been introduced in tropical settings without adequate adaptation to new conditions. The result has been failure, and further negative conditioning of peasants' attitudes toward innovation.
>
> Available evidence seems to indicate that peasant behavior is far from fully oriented toward rational and economic considerations.[19]

Rogers finds fatalism widely reported as a characteristic of peasants. Defined as "the degree to which an individual recognizes a lack of ability to control his future," fatalism (often intertwined with his religious beliefs) may serve both as an explanation of the peasants' misery and a barrier to its

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[19]Rogers, Modernization Among Peasants, p. 31.

alleviation.

> If one sees himself in control of his life situation, he can be motivated to improve his existence, but if he resigns himself to the hands of Fate, he cannot be induced to seek a higher standard of living.[20]

Peasants are also thought to possess very low levels of aspiration. Rogers believes that a sense of fatalism, the image of the limited good, authoritarian child-rearing and lack of significant opportunities have conditioned peasants to expect little from life. In addition, the pervasiveness of the view of a limited good is said to result in inconspicuous consumption by those who do manage to improve their level of living. The resultant lack of visible signs of accomplishment would logically have a stagnation effect on the level of aspirations in the community as a whole.

Lack of deferred gratification is the unwillingness to postpone "immediate satisfaction in anticipation of future rewards". Rogers' statement extends somewhat beyond the belief that peasants are reluctant to finance higher earnings in the future by reducing present consumption because of the immediacy of needs at their present low level of living. He suggests that the peasant's lack of deferred gratification can reach a somewhat psychopathic state of preferring the here-and-now to even the immediate future.

Peasants, Rogers continues, view their world in terms of imprecise time periods and a limited geographical perspective. The minutes and hours of a day have little meaning to the

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[20] Ibid., p. 33.

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peasant, who measures time instead by the sun and the moon and the natural seasons of the year. Punctuality and precision are largely foreign to village life. The villager's knowledge of the world outside his own community is also likely to be vague, and the compensating effect of the mass media may remain unrealized because of his limited exposure.

The final trait of the peasant, in his conceptualization by Rogers, is a low degree of empathy. The ability of the peasant to mentally project himself into the role of others (as empathy is defined) is severely circumscribed by his limited exposure to other ways of life and the socio-psychological distance between himself and those individuals in unfamiliar roles -- the urban elite, the extension worker, the governor or the president.

Banfield's[21] examination of a rural community in Southern Italy led him to conclude that cultural constraints were at the center of its continued poverty and lack of social development, although in a somewhat different manner than proposed by Nair and Rogers. Since Banfield begins with the premise that a modern economy and democratic political order depend upon an ability to formulate and maintain a "high degree of formal organization," he attempts to discover why organizations had not developed in this community as they had in rural areas elsewhere. Why, for example, had this particular community not evolved such organizations as a voluntary

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[21]Edward C. Banfield, The Moral Basis of a Backward Society, (The Free Press, Glencoe, Illinois, 1958).

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ambulance service, a local newspaper, a parent-teacher association, or a farmer cooperative which would seem to the outsider to have obvious advantages for everyone concerned.

After rejecting such commonly mentioned factors as ignorance, poverty, class antagonisms, land tenure arrangements, oppression of the State, and despairing fatalism as insufficient to explain the behavior of the peasants and the townspeople; Banfield submits what he believes to be a useable predictive hypothesis. According to this hypothesis, the decisions made by individuals in this particular community were guided by the following principle:

> Maximize the material, short-run advantage of the nuclear family and assume that all others will do likewise.[22]

Naming this principle "amoral familialism," Banfield makes no claim for its universality among backward societies, but does assert that it was useful in explaining the behavior of both peasants and villagers in the community he studied.

There is, of course, no reason to assume that such a decision-making principle would prohibit the adoption of new practices on an individual basis. In fact, Banfield cites the case of peasant farmers continually applying fertilizer in hope of a larger yield. What it does proscribe, which was of greater interest to the author, is organization for the greater good of the community. In contrast to "enlightened self-interest," the practitioner of "amoral familialism"

[22] Ibid., p. 85.

will be expected to contribute nothing to further the interest of the group or community, except as it is to his immediate private advantage. Organizations will be difficult to form and maintain because inducements are often to an important degree unselfish and gains often non-material. Moreover, members of successful organizations must trust each other and have a loyalty to the organization. This is complicated when anyone who professes to be public spirited will be suspected of being a fraud. Thus, Banfield concludes that the community he studied was a prisoner of its family-centered ethos and that their lack of ability to act concertedly for the common good was the fundamental impediment to their economic and social progress. Without a change in the ethos of the people, which according to the author may only be accomplished by outsiders, development will not occur.[23]

The Peasant Farmer as Economic Man

Professor T. W. Schultz, among others, has argued that too much has been made of the social and cultural constraints limiting rural development. On the contrary, he believes that the backwardness of agriculture in less developed nations can best be explained in economic terms.

> The laggardliness of agriculture in poor communities is frequently attributed to particular cultural values. These values relate to work, thrift, industriousness, and aspirations for a higher standard of living. They are then used to explain why there is so little economic progress and why particular economic development programs are unsuccessful in

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[23] *Ibid.*, pp. 163-164.

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> practice. As a rule, however, it is not necessary to appeal to differences in such cultural values, because a simple economic explanation will suffice.[24]

Or, in addressing Wharton's question, Schultz states that:

> Thus, however relevant the cultural attributes are in explaining some important classes of problems, they do not provide a basis for distinguishing between traditional and other types of agriculture.[25]

The crux of Schultz's argument lies with the "state of the arts." The problem is not that farmers in traditional agriculture allocate their efforts and resources badly, in fact he argues that stagnant agricultures are likely to be in better economic adjustment than those exhibiting a pattern of dynamic growth; but that they lack knowledge of new productive inputs or, even worse, that improved locally-adopted technologies are not available to them. A "traditional agriculture", as viewed by Schultz, is one in which any past changes in relative prices and production technologies have been completely adjusted to by the community such that it has long since reached an economic equilibrium -- marginal costs being equal to marginal returns even though incomes are low ("efficient but poor"). What is known about the traditional factors of production -- their costs and their returns -- has been known for some time, and there is little opportunity for showing the farmer how to farm better unless we first introduce technologies with which he has had no

[24] Schultz, op. cit., p. 26.

[25] Ibid., p. 29.

experience.[26]

Within this conceptual framework, of an economic equilibrium uninterrupted by the introduction of improved production factors, Schultz finds the explanation for peasants' attitudes toward work, thrift, and investment:

> Incentives to work more than these people do are weak because the marginal productivity of labor is very low; and the incentives to save more than they do are weak because the marginal productivity of capital is very low.[27]

He emphasizes, particularly, the high costs of gaining additional productivity through the employment of traditional inputs. According to Schultz, the growth of an economy is dependent upon growth in the number of income streams. But new income streams must be purchased through savings and investment, and when costs are high relative to the size of the income stream (low returns to investment in traditional inputs) it is hardly reasonable to expect much in the way of economic growth. To stimulate growth in the agricultural sector, then, it must be provided with lower cost income streams -- more productive inputs.[28]

> Economic growth from the agricultural sector of a poor country depends predominantly upon the availability and price of modern (nontraditional) agricultural factors. The suppliers of these factors in a very real sense hold the key to such growth. When they succeed in producing and distributing

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[26] Ibid., pp. 24-52.

[27] Ibid., p. 28.

[28] Ibid., pp. 71-102.

> these factors cheaply, investment in agriculture becomes profitable, and this then sets the stage for farmers to accept modern factors and learn how to use them. It is also an inducement to increase savings and to develop institutions to provide credit for investment in such factors.[29]

But once new productive factors are available will farmers accept them? If these factors are indeed profitable, Schultz believes they will. Adequate attention must be given, however, to the conditions of profitability. To be profitable the new inputs must increase yields sufficiently to more than offset the (often high) cost of acquiring them. It is absolute increases in yields that pay bills and provide profits, Schultz warns, not relative increases. Further, the matter of risk and uncertainty must be taken into consideration. Variations in yields from traditional inputs are well known from decades of experience. This, of course, is not the case with new factors of production. Uncertainty about possible variations in yield are particularly critical in poor countries where low initial incomes allow very little latitude for experimentation.[30]

The rate of adoption of new inputs in poor countries, given due allowances for risk and uncertainty, concludes Schultz, is dependent upon its profit; and in this respect their response is similar to that observed among the farmers in modern agriculture. Thus, according to Schultz:

> Once there are investment opportunities and efficient incentives, farmers will turn sand into gold.[31]

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[29] Ibid., p. 145.

[30] Ibid., pp. 162-168.

[31] Ibid., p. 5.

There is considerable empirical support for characterizing the farmers in less developed countries as "economic men." The findings of Hopper in North Central India[32], Chennareddy in South India[33], and Welsch in Eastern Nigeria[34] indicate that farmers in these areas allocate their resources efficiently within their traditional technologies. Each of these researchers calculated the marginal value product of traditional inputs (using Cobb-Douglas functions) and compared them with the marginal costs of these inputs. The results were alike in each of these cases, with farmers appearing to do a very adequate job of equilibrating marginal costs and marginal returns.

Welsch found additional reason to believe that farmers in Eastern Nigeria are rational in their response to new technologies. With respect to lack of adoption of fertilizers his assessment is as follows:

> The Abakaliki rice farmers did not use fertilizer in 1963, although they had tried it previously. Crop yield was unpredictable, and lower yields often resulted because of excessive straw growth and consequent lodging and loss of grain. Fertilizer trials on rice at several locations in Eastern Nigeria over the past several years have been inconclusive . . . In addition,

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[32] W. David Hopper, "Allocation Efficiency in Traditional Indian Agriculture," Journal of Farm Economics (August 1965), pp. 611-624.

[33] Venkareddy Chennareddy, "Production Efficiency in South Indian Agriculture," Journal of Farm Economics (November 1967), pp. 817-820.

[34] Delane E. Welsch, "Responses to Economic Incentives by Abakaliki Rice Farmers in Eastern Nigeria," Journal of Farm Economics (November 1965), pp. 900-913.

> the present variety of rice has been selected over the years for its adaptability to the natural environment, rather than for its response to fertilizer.[35]

This observation lends support to Schultz's contention that laggardliness in adopting new technologies can be satisfactorily explained by their profitability (see pages 21-22).

Eicher, in his discussion of Nigerian agricultural development, cites evidence which indicates that the smallholder played a very dynamic role in diffusion and expansion of certain commercial crops. The growth in the production of such crops as oil palm, cocoa, rubber and groundnuts, from 1900 to 1960, was the result of voluntary investments on the part of Nigerian peasants in response to favorable world prices. These significant increases in agricultural productivity, notes Eicher, occurred without the assistance of government directed agricultural programs and the aid of an effective agricultural extension service (often assumed as prerequisites for agricultural change).[36]

In another examination of economic man in Africa, Jones presents evidence against what he believes to be a common misconception by Western observers of the need for a different sort of economics to deal with the behavior of African farmers. His approach was to present historical evidence of

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[35] *Ibid.*, p. 912.

[36] Carl K. Eicher, "Transforming Traditional Agriculture in Southern Nigeria," (paper presented at the Annual Meeting of the African Studies Association, Bloomington, Indiana, October 26-29, 1966).

trade among Africans, or responsiveness to price changes, of rationality in production decisions, and of savings and investment. One example from his study will serve to illustrate how misinterpretation of the facts may lead Western observers to deny the existence of economic man on this largely underdeveloped continent:

> In some parts of Africa . . . manioc farmers present another sort of riddle to the uninformed observer. In their study of food farms in the cocoa belt of Western Nigeria, Galleti and his associates commented on the large amount of manioc that was left in the field unharvested. Harvests yielded only about 45 percent as much as would have been expected on the basis of crop harvesting experiments. . . . Similar figures are reported from an agricultural survey in Southeastern Ghana. . . . In the Ivory Coast, too, an agricultural survey . . . revealed manioc production to be only a small fraction of what it would have been if all the crop were harvested. . . . The general explanation is again economic, and derives from the distribution of costs. . . . It costs little to plant a field of manioc and the crop can be grown with a minimum of care. For manioc even land cost is trivial when the crop is grown in fields that would otherwise be abandoned to bush. By far the largest cost . . . is that assumed in lifting the mature roots from the field and transporting them to market. Many African farmers grow manioc as speculation, to be marketed if the price is high enough . . . to yield a return greater than cost of harvest, to be abandoned if it is not.[37]

Finally, Stern, and Bauer and Yamey provide still more support for the concept of economic responsiveness among farmers in less developed countries. Stern, using relative prices and crop acreages, found that Egyptian cotton producers[38]

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[37] William O. Jones, "Economic Man in Africa," Food Research Institute Studies, (Volume I, 1960), pp. 107-134. [Quotation, pp. 121-122].

[38] Robert M. Stern, "The Price Responsiveness of Egyptian Cotton Producers," Kyklos (Volume XII, 1959).

and Indian jute producers[39] shifted production patterns with changes in producer prices. Bauer and Yamey found Nigerian primary producers responding to price incentives for higher quality products.[40]

The Behavior of Farmers in Less Developed Countries: A Summary

The question with which this discussion began -- regarding the existence or non-existence of basic behavioral differences between subsistence and modern commercial farmers -- is still unsettled. And universal agreement upon the factors which determine adoption of new agricultural practices has not yet been reached. While Schultz asserts that:

> Since the differences in profitability are a strong explanatory variable, it is not necessary to appeal to differences in personality, education, and social environment.[41]

Rogers argues that:

> Schultz does have a point, even if it is overstated. Economic considerations are one predictor of innovative behavior by peasants, but they certainly do not outweigh socio-cultural variables in all instances.[42]

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[39] Robert M. Stern, "Price Responsiveness of Primary Producers," Review of Economics and Statistics (Volume XLIV, May 1962).

[40] P. T. Bauer and B. S. Yamey, "A Case Study of Responsiveness to Price in an Underdeveloped Country," Economic Journal (Volume 69, December 1959).

[41] Schultz, op. cit., p. 164.

[42] Rogers, Modernization Among Peasants, p. 313.

The question has really emerged (as seen above) as one of the relative weightings that should be given to economic and non-economic variables (if such a line of demarcation could be conveniently drawn) in the adoption process. Economists have shown that in the aggregate farmers in less developed countries are economically responsive. This seems logical, for if one considers only the socio-cultural barriers to adoption it is difficult to conceive of how the farmer would be motivated to try any new practices. On the other hand, if it is only necessary to point out the economic advantages of a new technology to secure its adoption, then why don't all farmers adopt new practices at exactly the same time? Is it not reasonable that both traditionally economic variables and other variables -- such as differences in personality, education and social environment -- could enter into the adoption process? Assuming this to be the case, the approach used in this study will be to examine the explanatory value of a range of variables -- both economic and non-economic -- which might be expected to influence the farmer's decisions toward new agricultural practices.

Different Approaches to Securing Adoption of New Agricultural Practices

An individual's conception of the nature of farmers in less developed nations will have substantial impact on the procedure he would recommend for securing rapid adoption of new agricultural practices.

If profitability is a sufficient factor to secure the adoption of modern practices, a logical strategy is to ensure the availability of profitable new practices to the agricultural sector. Schultz suggests the very direct approach of investing in the production and distribution of modern inputs in order to ensure that a supply of truly profitable nontraditional production factors are provided for the farmer to adopt. It is not adequate, cautions Schultz, to simply transplant those practices used successfully in modern agricultures to less developed nations. At a minimum, adaptive research must be conducted, and it is likely that the development of new inputs should often involve beginning with what is known in the basic agricultural sciences and applying this knowledge to the problems of the area. (Here Schultz alludes to the Rockefeller programs to develop hybrid crop varieties in Mexico.)[43] In addition he notes the importance of investing in the "human resources" of the rural community.

> In sum and substance, the man who is bound by traditional agriculture cannot produce much food no matter how rich the land. Thrift and work are not enough to overcome the niggardliness of this type of agriculture. To produce an abundance of farm products requires that the farmer has access to and has the skill and knowledge to use what science knows about soils, plants, animals, and machines.[44]

But there are other ways to ensure the profitability of modern agricultural inputs and encourage their use. These involve manipulation or restructuring of the agricultural economy in such a way that it favors increased agricultural

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[43] Schultz, op. cit., pp. 145-174.

[44] Ibid., p. 205.

production with the adoption of modern farming methods as a consequence. Agricultural price policy is one possibility which should be included under this heading. Raj Krishna suggests the need for a "positive price policy" in order to stimulate agricultural productivity. He believes that agricultural policies in less developed nations have too often been ruled by considerations of providing cheap food, with the consequence of unfavorable terms of trade toward the agricultural sector ("negative price policy"); and that such policies have been patently unsuccessful in providing sufficient food for these nations.[45] Along with the need for generally favorable product prices, the importance of price stability to growth in agricultural output has been suggested.[46] Further, there may be justification, where the costs of producing agricultural inputs are high and a consumer surplus is likely to result from their use, to subsidize inputs in order to make them profitable for the farmer to use. Changes in tenure arrangements also may present some possibilities for increasing the use of

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[45] Raj Krishna, "Agricultural Price Policy and Economic Development," Herman M. Southworth and Bruce F. Johnston, (Eds.) Agricultural Development and Economic Growth, (Ithaca, New York: Cornell University Press, 1967), p. 540.

[46] See the following for discussions on price stability in developing countries:

FAO, The State of Food and Agriculture (1959), pp. 137-141.

P. T. Bauer and F. W. Paish, "Comment," Kyklos (Volume XI, 1958).

Gerald K. Helleiner, "The Fiscal Role of the Marketing Board in Nigerian Economic Development, 1947-61," Economic Journal (September 1964), pp. 582-610.

H. M. Singer, "Introductory Statement -- Stabilization and Development of Primary Producing Countries, Symposium II," Kyklos, (Volume XII, 1959, Fasc. 3), pp. 269-276.

agricultural inputs.

Fairly recently, the possibility of furthering economic development through improvements in the marketing system has been gaining some attention. This argument assumes that the present marketing processes in less developed nations are not generally efficient, and that changes in the marketing system could both reduce food prices to urban consumers and increase rural incomes. Decreased consumer prices for food products would have a "real income effect," especially on the urban poor who spend a large proportion of their family income on food. Since it is likely that these low income families would spend a considerable amount of any increment of income on additional food, and their numbers are many in the cities of most less developed nations, one could expect a generally increased level of demand for food products. If this increased demand is adequately reflected back through the market system to the farmer, he will be stimulated to increase his production. This may encourage him to purchase improved farm inputs (fertilizer, new seeds, machinery, etc.) whose prices might also be reduced by more efficient marketing systems.[47]

From the contrasting point of view, Rogers has suggested a "strategy for change" which concentrates on the interaction between change agents and their clientele. His strategy focuses upon the following principles: (1) a change program should be tailored to fit cultural values and past

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[47] C. C. Slater, H. M. Riley, et. al., Market Processes, pp. 1/8-1/19.

experiences; (2) clients must perceive a need for the innovation; (3) the change agent should be more concerned with improving their client's competence in evaluating new ideas and less with simply promoting innovations; (4) change agents should concentrate their attention upon opinion leaders in early stages of the diffusion process; and (5) social consequences of innovations should be anticipated and prevented if undesirable.

Since Rogers believes that local beliefs and values have a critical impact upon the success of an innovation, he stresses that change agents should design their programs to be compatible with the local culture. The consequences of not doing so are illustrated by his example of a U.S.-trained irrigation engineer who found that farmers in his Far East homeland were not using the wells he was building. Local farmers believed that water from the irrigation wells was "artificial" in contrast to "natural" rainfall, and refused to utilize them for fear their crops would be damaged.

The potential need for an innovation "must exist in the client system," according to Rogers, although the change agent can help to develop such a need. A useful tactic, then, is for the change agent to select innovations on the basis of those needs perceived by the community.

It has seemed to Rogers that change agents have tended to overemphasize short-run, single-innovation programs as opposed to long-range programs to change the values and evaluation capabilities of their clientele. From the viewpoint that not <u>all</u> innovations should be recommended to <u>all</u>

members of a social system, a "more the better" philosophy is not considered to be as acceptable as a program which seeks to provide a more favorable attitude toward new ideas.

Research in diffusion has found that the opinions of certain individuals in a community are highly valued by other farmers, and that these opinion leaders are a strong legitimizing force for new ideas. Consequently, if the change agent can discover the community's opinion leaders and convince them of the acceptability of an innovation, the rate of adoption by other farmers will be considerably enhanced.

Finally, Rogers notes that well-intentioned innovations can result in unforeseen and undesired social consequences. It should be the task of the change agent to anticipate these effects and initiate action to avoid them.[48]

A Brief Review of "Diffusion"

The elements of "diffusion of innovations," as given by Rogers, are: (1) a new idea; (2) which is communicated through certain channels; (3) among members of a social system; (4) over time.[49] It is within this framework that some of the main concepts of "diffusion" will be briefly considered, although not in the order suggested.

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[48] Everett M. Rogers, Diffusion of Innovations, pp. 278-282. Also see Everett M. Rogers, "Redeveloping a Strategy for Planned Change," (a paper presented at the Symposium on the Application of Systems Analysis and Managerial Techniques to Educational Planning in California, Orange, California, June 12-13, 1967, pp. 1-13).

[49] Ibid., p. 12.

New Idea

> An innovation is an idea perceived as new by the individual. It really matters little, as far as human behavior is concerned, whether or not an idea is "objectively" new ....[50]

According to Rogers, an idea is new if it is perceived to be so by the social system. And, that new ideas are not equivalent units, they have a number of characteristics to greater or lesser degrees. Rogers suggests the following as those characteristics which innovations possess in varying degrees.

1. Relative Advantage--the degree to which an innovation is superior to ideas it supercedes (economic or noneconomic advantage as perceived by the adopter).

2. Compatability--degree to which an innovation is consistent with existing values and past experiences (which ensures greater security to the potential adopter and makes the new idea more meaningful).

3. Complexity--the degree to which an innovation is difficult to understand.

4. Divisibility--degree to which an innovation can be tried on a limited basis.

5. Communicability--degree to which the results of an innovation can be diffused (i.e., obviousness of new haymaking equipment versus farm records).[51]

To these Singh and Warlow added "rate of cost recovery," "operating cost," "initial cost," "amount of labor savings," and "mechanical attraction." They tested the importance of these characteristics on the rate of adoption of new corn production practices by Ontario farmers. The "rate of cost recovery" seemed to be the most highly associated with rates

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50. Ibid., p. 13.

51. Ibid., pp. 121-134.

of adoption, followed by "financial return" (relative advantage), complexity and divisibility in that order. Communicability, operating cost, and initial cost were also significantly related to rate of adoption; while compatability, labor savings, and mechanical attraction were not.[52]

While Rogers alludes to the fact that innovations "carry a subjective risk to the individual,"[53] he has not given attention to amount of perceived risk as a possible explanatory variable for varying rates of adoption. Johan Arndt, however, has studied the relationship between "perceived risk" and innovativeness. He found that New York consumers who perceived less risk involved with a given product tended to be those who had adopted it earliest. Unfortunately, due to the structure of his research, he was unable to determine if consumers had been early adopters because they perceived less risk associated with the product, or whether they now perceived less risk because they had adopted earlier and thus had greater experience with the product by the time of the survey.[54]

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[52] Ram N. Singh and G. S. Warlow, Characteristics of Farm Innovations Associated with the Rate of Adaptation, (University of Guelph, Department of Extension Education, Report # 14, October, 1966).

[53] Rogers, Diffusion, p. 84.

[54] Johan Arndt, "New Product Diffusion: The Interplay of Innovativeness, Learning, Opinion Leadership, Perceived Risk, and Product Characteristics," (Unpublished paper, Columbia University, New York).

Time

Diffusion of innovation has come to be regarded as a process which occurs over time. Rogers found that if the number of members of a community who had adopted an innovation by certain dates were plotted over time it resembled an S-shaped (cumulative frequency) curve. He believes that the shape of such a curve is caused by an "interaction effect" among the members of the social system. The "interaction effect" results from the influence of those who already adopted on the remainder of the community. At first the pace of innovation is sluggish, but as the number of adopters increases it quickens until only the most recalcitrant members of the community are left. Empirical evidence of this S-shaped adoption curve, according to Rogers, is one of the reasons why adoption of innovations should be regarded as a social process rather than a purely economic phenomenon.[55]

The individual's adoption process may also be thought of as having a time dimension. Rogers initially believed this process to be divided into five stages:

1. Awareness--exposure to a new idea, but lacking "complete" information about it. (Often thought of as a random or non-purposeful occurrence.)

2. Interest--favors the innovation in a general way, although he has not yet determined its utility to him--actively seeking information.

3. Evaluation--mentally applies the innovation to his present or future situation and decides whether to try it or not--seeks reinforcement at this stage.

4. Trial--use on a small scale to determine its utility in the individual's particular situation.

[55] Rogers, Diffusion, pp. 136-141.

5. Adoption--decision to continue use of the innovation on a full scale.[56]

Empirical evidence, however, did not seem to support this conceptualization of the adoption process. Diffusion researchers found that stages were often misplaced and sometimes omitted altogether. This caused Rogers to reformulate the adoption process in terms of four functions he believes describe the mental activities of the individual as he adopts or rejects a new idea:

Knowledge function--in this subprocess the individual gains knowledge of an innovation but is not yet motivated to seek additional information.
Persuasion function--in this subprocess the individual increases his information level to the extent that he can form an opinion toward the idea.
Decision function--includes those activities an individual goes through in choosing among alternatives.
Confirmation function--information seeking activities following adoption or rejection of an innovation. (This is explained by Rogers as an effort to reduce post-decision cognitive dissonance.)[57]

Members of a Social System

As noted before, not all members of a social system adopt an innovation at the same time. Rogers has consequently divided the whole of the community into groups of individuals on the basis of their relative earliness or lateness of adoption. Rogers and others believe that different attributes can be assigned to these various adopter categories. The following chart describes some of the personal characteristics

[56] Rogers, Diffusion, pp. 76-93.

[57] Everett M. Rogers, with F. Floyd Shoemaker, Diffusion of Innovations: A Cross-Cultural and Communication Approach (New York: Free Press of Glencoe, forthcoming).

assumed to be typical of these different categories as applied to farm operators.

Adopter Category	Personal Characteristics
Innovator	Youngest age, highest social status, largest and most specialized operation, wealthy, willing to take risks.
Early Adopter	High social status, large and specialized operations.
Early Majority	Above average social status, average-sized operation.
Late Majority	Below average social status, small operation, little specialization, small income, skeptical.
Laggard	Little specialization, lowest social status, smallest operation, smallest income, oldest, tradition-oriented.

Source: Rogers, Diffusion, p. 185.

There are several concepts (in addition to those in the above chart) which are basic to the diffusion researcher's choice of variables. Below are listed some of the concepts which the diffusion researcher frequently uses to explain an individual's innovativeness -- willingness to accept new ideas.

Literacy--degree of mastery over symbols in a written form.

Education--usually highest grade attained in school.

Cosmopoliteness--degree to which an individual is oriented outside his immediate social system (opposite is localism).

Extension Worker Contact--amount of interaction with extension workers.

<u>Interpersonal Trust</u>--willingness of individuals to trust others.

<u>Fatalism</u>--degree to which an individual perceives a lack of ability to control his future.

<u>Source Creditability</u>--degree of trust one places in particular sources of information.

<u>Achievement Motivation</u>--a desire for excellence in order to achieve a feeling of personal accomplishment.

<u>Empathy</u>--ability to see oneself in another person's situation.[58]

<u>Communication</u>

> The essence of the diffusion process is the human interaction in which one person communicates a new idea to another person. (Rogers: 1962).[59]

Information about a new idea may be communicated to an individual from a variety of sources. Rogers has suggested a dual classification of these sources on the basis of the means used to communicate the message and the origin of the message. The dichotomy based upon means involves the division between mass media messages and interpersonal ("face-to-face" or "word-of-mouth") communication. While the mass media is an extremely rapid method of disseminating information about new ideas, to large audiences, in an unaltered form, it has certain limitations as an instrument of social change. The one-way characteristic of mass media often results in uncorrected misunderstandings of the message, where the feedback possibilities in interpersonal

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[58]Rogers, <u>Peasants</u>, pp. 302-303.

[59]Rogers, <u>Diffusion</u>, p. 13.

communication permits the communicator to adjust his message to the beliefs and level of understanding of the recipient. Mass media also encounters the problem of "selectivity" to a greater extent than interpersonal communications. "Selectivity" is the psychological principle that individuals tend to select and recall those messages which are congruent with their beliefs and values, and ignore those messages which are not. Mass media messages are subject to considerable "selectivity" (such as turning off the radio), while a face-to-face interaction between individuals has a greater probability of overcoming this difficulty. The consequence of these differences, according to Rogers, is that the mass media can be an effective method of increasing knowledge of innovations, but interpersonal communication is more successful in securing changes in attitudes.

The second division is between "cosmopolite" and "localite" sources of information. "Cosmopolite" messages originate from outside the immediate social system, while "localite" messages emanate from within the community. "Localiteness" and "cosmopoliteness" may be combined with mass media and interpersonal means of communication to form a two-way classification of information sources as shown below.

Nature of the Channel	Point of Origin: Localite	Point of Origin: Cosmpolite
Interpersonal	Neighbor Relative	Extension Agent Wandering Storytellers
Mass Media	Local Newspaper Wall Posters	Radio T.V. Magazines

Source: Rogers, Peasants, p. 128.

Rogers has characterized the various adopter categories on the basis of their communication behavior. The most innovative are assumed to use mass media/cosmopolite sources to a greater extent than other members of their community, while the least innovative farmers tend to depend upon interpersonal/localite sources.[60]

Adopter Category	Communications Characterists
Innovator	Closest contact with scientific information sources; interactions with other sources; relatively greatest use of impersonal sources.
Early Adopters	Greatest contact with local change agents.
Early Majority	Considerable contact with change agents and early adopters.
Late Majority	Secure ideas from peers who are mainly late majority and early majority; less use of mass media.
Laggards	Neighbors, friends, and relatives with similar values are main information source.

Source: Rogers, Diffusion, p. 185.

[60]Rogers, Peasants, pp. 124-133.

Deutschmann and Fals Borda utilized a slightly different classification of information sources in their study of communication in an Andean village. Their classification is based upon "a kind of psychological-sociological distance dimension" hypothesizing that channels nearer to "self" would produce later information than the channels farther from "self" and that the more distant channels would result in earlier adoption:

1. Egocentric or intra-personal (see-for-myself)
2. Intra-community personal (my neighbor said)
3. Extra-community personal (some stranger said)
4. Impersonal (radio, pamphlet, etc.)

These researchers found a greater dependence among laggards upon interpersonal and intra-community channels and less dependence upon extra-community and impersonal channels as opposed to their more innovative colleagues.[61]

Although this review is, without doubt, rather incomplete, it should be useful in outlining some of the notions used by diffusion researchers which will be applicable to the present study.

A Review of Risk, Uncertainty, and Decision-Making

> The variables affecting the decision-making process of farm managers have only relatively lately become a subject of serious interest in the study of agricultural economics. One of the reasons for this development is that traditionally price-oriented economic theory of the firm does not shed light on such questions as the

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[61] Paul J. Deutschmann and Orlando Fals Borda, "Communication in an Andean Village" (a paper presented to the Association for Education in Journalism Convention, University of North Carolina, Chapel Hill, August 27, 1962).

> following: Why do some farmers adopt new technology more rapidly than others? Why do some farmers prefer risky undertakings . . . (Halter and Beringer: 1960).[62]

However much they may disagree on other matters, most researchers who are interested in agricultural development have acknowledged that the adoption of new farming practices involves an element of subjective risk to the farmer. As a consequence, this section is devoted to examining several views of decision-making under uncertainty in order to identify concepts which might be applicable to the problem of adoption of new agricultural practices in less developed nations.

Decision-Making with Incomplete Knowledge

Risk, Uncertainty, and Profit

Mention of Frank H. Knight's 1921 publication, Risk, Uncertainty and Profit, usually brings to mind the definitions expressed in the following paragraph:

> The practical difference between the two categories, risk and uncertainty, is that in the former the distribution of the outcome in a group of instances is known (either through calculation a priori or from statistics of past experience), while in the case of uncertainty that is not true, the reason being in general that it is impossible to form a group of instances, because the situation dealt with is in a high degree unique.[63]

It is indeed unfortunate that such great emphasis has been placed, in the usual interpretation of Knight's work, upon this particular dichotomy. First of all, it contributes

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[62] A. N. Halter and Christopher Beringer, "Cardinal Utility Functions and Managerial Behavior," Journal of Farm Economics (February, 1960), p. 118.

[63] Frank H. Knight, Risk, Uncertainty and Profit (Hart, Schaffner & Marx, 1921, Reprint: Harper Torchbooks), p. 233.

to the tendency to overlook Knight's efforts to understand the process of decision-making under conditions of less than perfect knowledge. Secondly, there is considerable evidence that Knight intended his definitions of risk and uncertainty to be illustrative rather than categorical.

Knight was concerned with the inadequacies of abstract economic theory, especially the notion of omniscience among the members of the economic system. In reference to this assumption he comments that:

> The facts of life in this regard are in a sense obtrusively obvious and are a matter of common observation. It is a world of change in which we live, and a world of uncertainty. We live only by knowing _something_ about the future; while the problems of life, or of conduct at least, arise from the fact that we know so little. This is as true of business as of other spheres of activity. The essence of the situation is action according to opinion, of greater or less foundation and value, neither entire ignorance nor perfect information, but partial knowledge.[64]

Clearly, Knight considered it very unlikely that decision-makers either behave randomly in a vacuum of complete ignorance or that they possess complete information. Instead he suggests that they operate under conditions of imperfect knowledge; choosing among alternative actions on the basis of some "_image_ of the future state of affairs." For Knight, the mechanics of formulating this _image_ remained an enigma.

> The ultimate logic, or psychology, of these deliberations is obscure, a part of the scientifically unfathomable mystery of life and the mind. We must simply fall back upon a "capacity" in the intelligent

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[64] _Ibid._, p. 199.

> animal to form more or less correct judgements about things, and intuitive sense of values. We are so built that what seems to us reasonable is likely to be confirmed by experience, or we could not live in the world at all.[65]

He maintains, however, that there is at best a tenuous connection between scientific inquiry and the process of forming expectations and making decisions regarding everyday affairs.

> So when we try to decide what to expect in a certain situation, and how to behave ourselves accordingly, we are likely to do a lot of irrelevant rambling, and first thing we know we have made up our minds, that our course of action is settled. There seems to be very little meaning in what has gone on in our minds, and certainly little kinship with the formal processes of logic which the scientist uses in an investigation. We contrast the two processes by recognizing that the former is not reasoned knowledge, but "judgement," "common sense" or "intuition." There is doubtless some analysis of a crude type involved, but in the main it seems that we "infer" largely from our experience of the past as a whole, somewhat in the same way that we deal with intrinsically simple (unanalyzable) problems like estimating distances, weights, or other physical magnitudes, when measuring instruments are not at hand.[66]

In the case of business decisions (such as expanding a factory) and most other human conduct (choosing a career, marriage, etc.), Knight suggests that the problems faced by decision-makers are usually highly unique. It is therefore quite unlikely that he will have experienced a sufficiently large number of homogeneous (almost identical events from which to establish the probability of success or failure in the present venture). As a consequence he is forced to decide within the state of knowledge defined by Knight as

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[65] Ibid., p. 227.

[66] Ibid., p. 211.

uncertainty (where it is not possible to calculate the probability of various outcomes).

> The essential and outstanding fact is that the "instance" in question is so entirely unique that there are no others or not a sufficient number to make it possible to tabulate enough like it to form a basis for any inference of the value about any real probability in the case we are interested in.[67]

This does not mean that the decision-maker has no idea of what to expect from various actions:

> He "figures" more or less on the proposition, taking account as well as possible of the various factors more or less susceptible of measurement, but the final result is an "estimate" of the probable outcome of any proposed course of action.[68]

In addition to generating an "estimate" of the expected outcome of a given action (through the "obscure process" of consciousness), the individual decision-maker also assigns some degree of belief (probability) to the correctness of his "estimate." Knight insists that this procedure involves "two separate exercises of judgement; the formation of an estimate and an estimation of its value [probability]."

> The businessman himself not merely forms the best estimate he can of the outcome of his actions, but he is likely also to estimate the probability that his estimate is correct. The "degree" of certainty or of confidence felt in the conclusion after it is reached cannot be ignored, for it is of the greatest practical significance. The action which follows upon an opinion depends as much upon the amount of confidence in that opinion as it does upon the favorableness of the opinion itself.[69]

Knight suggests an important relationship between the

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[67] _Ibid._, p. 226.

[68] _Ibid._, p. 226.

[69] _Ibid._, p. 227.

degree of certainty about the outcome and the gain necessary to secure a positive response to a particular venture. In his view the size of the possible rewards from any given enterprise must increase in some "proportion" to the uncertainty related to these rewards or the decision-maker will be unwilling to engage in the venture.

> We shall assume, then, that if a man is undergoing a sacrifice for the sake of a future benefit, the reward must be larger to evoke the sacrifice if it is viewed as contingent than if it is considered certain, and that it will have to be larger in at least some general proportion to the degree of felt uncertainty in anticipation. It is clearly the subjective uncertainty which is decisive in such a case, what the man believes the chances to be, whether his degree of confidence is based upon objective probability in the situation itself or in an estimate of his own powers of prediction.[70]

Knight suggests that there are at least three methods by which the individual may form estimates, or degrees of belief [a term not used by Knight] in his estimates, even in seemingly quite unique cases: (1) by observing the outcome of "similar" ventures undertaken by others; (2) from the amount of success the given decision-maker has had with dissimilar cases; and (3) on the basis of an intuitive feeling or "hunch" regarding the perspective outcome.[71]

Knight, unlike some of his interpreters, hedges his distinction between risk and uncertainty by acknowledging that there are considerable gradations of the states of

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[70] Ibid., p. 242.

[71] Ibid., p. 237.

knowledge within which a decision-maker may find himself.

> All gradations, we should say, except the ideal extremes themselves [risk and uncertainty]; for as we can never in practice secure completely homogeneous classes in one case [identical events for which probability distributions might be calculated *a priori* such as throws of a fair die], so in the other it probably never happens that there is *no* basis of comparison for determining probability . . . .[72]

Or:

> . . . Nothing in the universe of experience is absolutely unique any more than any two things are absolutely alike.[73]

Finally, Knight believes that for various reasons decision-makers are not a homogeneous group of individuals. They vary in their capacity to form "correct judgements" due to differences in the ability to perceive and infer the course of future events. They differ in their capacity to plan and execute "adjustments necessary to meet the anticipated future situation." They do not all hold the same degree of confidence in their own judgements, nor are they presumed to be equally willing to "take chances."

This brief review of Knight's work will provide a background for the remaining discussion of decision-making under uncertain conditions. Additional attention will be given to the mental process of decision-making, the state of knowledge within which decision-making occurs, the effect of uncertainty upon individual choices, and the differences among decision-makers.

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[72] *Ibid.*, p. 227.

[73] *Ibid.*, p. 226.

The Image

Some three and one-half decades after Knight's work, another economist, Kenneth Boulding, set about the task of elaborating the concept of an image which would guide human conduct. All of man's behavior, according to Boulding, depends upon his subjective knowledge; his image of the world.[74] This image is a product of all the individual's past experiences. It, perhaps, begins as an "undifferentiated blur" and increases in differentiation and complexity as a result of a constant stream of messages being admitted through the senses. There is a necessity, argues Boulding, to carefully distinguish between the image and the messages that reach it:

> The message consists of information in the sense that it is structured experience. The meaning of a message is the change which it produces in the image.[75]

A message may have differing impacts upon the image. A large proportion of messages are simply ignored (i.e., the ticking of a clock). A second type of message may change the image in a "regular or well-defined way that might be described as simple addition" (i.e., learning more about price theory, which would hardly reorganize the economist's image of the economic system). Still another effect of messages may be a "revolutionary change" [the term used by Boulding] in which some portion of the image is completely reorganized.

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[74]Kenneth E. Boulding, The Image (Ann Arbor: Ann Arbor Paperback, 1956), pp. 1-49.

[75]Ibid., p. 6.

(Perhaps an example would be Schultz's suggestion of "efficient but poor" peasants which is said to have reorganized a number of economists' ideas about peasant agriculture.) One additional impact is possible. A message may have the effect of increasing (or decreasing) the certainty, probability, or clarity with which certain portions of the image are held (i.e., the Cobb-Douglas studies undertaken by several authors in less developed countries -- as cited earlier -- may have increased the certainty with which economists hold the concept of "efficient but poor" peasants).

Not all messages, in Boulding's view, have equal access to the image. Messages which are congruent with the existing image are readily admitted, and result in either a simple accretion in an image or no impact at all. Messages which are contrary to the image tend to be rejected, unless they are extremely forceful or are repeated too often to be ignored. The acceptance of such a message may result in a major reorganization of the image. Boulding suggests that there are two reasons why messages receive unequal access to the image. First, the image tends to have a built-in stability or resistance to change. Boulding is rather vague as to the basis of this stability, asserting only that it is the result of an internal consistency or arrangement and that "some kind of principle of minimization of internal strain" is at work. Secondly, the image, in total, is said to consist of both an image of <u>fact</u> (loosely defined) and an image of value. The messages received by the image are, according to Boulding, "mediated" through the individual's value system (hence there are no "facts" as such). The value system, therefore, has considerable impact upon the interpretation of incoming messages. But still further, the value system contributes to a resistance to such messages as might be considered "bad" or "hostile" given the existing image.

To describe the effect of the image on organizing behavior (the reason for its existence), Boulding begins with a discussion of the thermostat, which he believes expresses the concept of an image in its most rudimentary form:

> The thermostat has an image of the outside world in the shape of the information regarding its temperature. It also has a value system in the sense of the ideal temperature at which it is set. Its behavior is directed toward the receipt of information which will bring its image and value system together. When its image of the outside world is "right," that is, conforms to its value system, it ceases to act. As long as the image, as confirmed by messages received, does not conform to its value system, it acts to bring the other two together.[76]

This, in the simplest possible form, describes the essence of the image's effect on behavior. Boulding believes that all biological systems possess images, of lesser and greater complexity, and, like the thermostat, attempt to organize themselves in response to messages received from outside the system. Man stands at the top of the biological ladder, not because of improved sensory perception, but because of his capacity to organize information into "large

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[76]Ibid., p. 22.

and complex images." He has the ability to locate himself in the world temporally and spatially (as a result of his ability to communicate and record information). He is able to observe various relationships and to infer cause and effect from them. His image is characterized by greater degree of self-consciousness and self-awareness than the lower animals. There is also a reflective character to man's image: not only does he know, he knows what he knows. Finally, man's image has the capacity for internal growth quite independent of external messages. His image, therefore, contains not only what is, but what might be. This power of "imagination" allows him to contemplate the world of potentialities, evaluate them according to his value system, and choose the "best" from among them.

The economist, criticizes Boulding, has not given sufficient attention to man's image and its effect upon economic behavior:

> The economists have badly neglected the impact of information and knowledge structures on economic behavior and processes. There are good reasons, or perhaps one should say excuses, for this neglect. With deft analytical fingers the economist abstracts from the untidy complexities of social life a neat world of commodities. It is the behavior of commodities, not the behavior of men which is the prime focus of interest in economic studies.
>
> He is aware, of course, at the back of his mind, that prices, outputs, etc., are in fact the result of human decisions. He likes to reduce these decisions, however, to a form as abstract and manageable as possible. Commodities are simpleminded creatures.[77]

Even so, Boulding finds an <u>implied</u> concept of man's

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[77] <u>Ibid.</u>, p. 82.

image even in the simplest of economic theories.

> Economic behavior is conceived as the process of "maximization." Economic man is supposed to be capable of at least three processes involving an image. In the first place he is supposed to be conscious of the alternatives which lie before him . . . Or in the simplest form, we suppose his mind to be much like a department store full of images of commodities, each with a convenient price tag attached.
>
> In addition to the image of alternatives economic man is also supposed to be able to give a value ordering to all relevant alternatives, that is all parts of the image. Not only do the combinations of his mental department store have price tags, they have utility tags . . . .
>
> His final task after imagination has performed these labors of Hercules is a simple one. All he needs to do is scan all possible combinations which are open to him and all his alternative acts, rank them in order on the parade ground of value, and pick out the top of the class.[78]

When we introduce the difficulties of uncertain outcomes into the problem, Boulding perceives the economists' usual assumptions of the image on economic man as even more incredulous:

> The economists have tried to deal with the problem of uncertainty by supposing that each of the alternatives in our image presents to mind not only with utility tags attached but also with whole probability distributions. Economic man, clever fellow that he is, now maximizes the expected value of his acts, a feat of mathematical agility which would take centuries of experience and enormous electronic calculators to perfect.[79]

Having poked some good-natured fun at the traditional constructs of economic man, Boulding submits his "revised laws of economic behavior" (which as will be seen are not a great improvement over the originals). According to Boulding,

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[78] Ibid., p. 83.

[79] Ibid., p. 85.

man carries on his economic activities of today much as he did yesterday, for in doing so he can be reasonably certain of the outcome. (Although he doesn't indicate what made us do what we did yesterday.) The further one diverges from his habitual behavior the less certain he will be about the outcome. The larger the negative value he attaches to uncertainty "in his value orientation," the less likely that he will abandon the familiar and known; the more likely that he will do today as he did yesterday. At this point Boulding suggests his first revised law of economic behavior: "we will do today what we did yesterday unless there is very good reason for doing otherwise."[80]

The second revised law is "that the good reasons which are necessary if we do not do today what we did yesterday are derived mainly from dissatisfaction with what we did yesterday or what happened yesterday." Boulding contends that changes can occur in the value structure during the course of repetitions of habitual behavior (although he is unclear how) until a point is reached where the misery of contemplating present behavior overcomes the uncertainty associated with a different behavior, and suddenly a reorganization of economic activity is undertaken (i.e., a new job, a new business, a new location, etc.). Another possibility is that messages we receive (from the ticker tape, the Wall Street Journal and, perhaps more importantly, by word-of-mouth) may cause us to revise our images of the

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[80] Ibid., p. 86.

alternatives and consequently select a different course of behavior.[81]

This, unfortunately, is the extent of Boulding's reformulation of economic behavior. It would seem that the major contribution of his discussion is an insistence upon the decision-making process as an interaction of the individual's knowledge structure, value structure, and the information entering this system. Thus, economic decision-making is not simply a choice between alternatives -- of which the outcomes are either perfectly or imperfectly known -- but instead is a choice of a new pattern of behavior over the habitual pattern of the past as a result of an altered perception of the alternatives.

<u>Aspirations and Satisficing</u>

In Simon's view, economic behavior can be conceptualized in the same framework as used by psychologists to understand other forms of human behavior: the motivating force of certain drives and their ultimate satisfaction.

> In most psychological theories the motive to act stems from drives, and the action terminates when the drive is satisfied. Moreover, the conditions for satisfying a drive are not necessarily fixed, but may be specified by an aspiration level that itself adjusts upward and downward on the basis of experience.[82]

Applying these concepts to a firm, he suggests that a certain level of profit might be set as a goal and that the firm

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[81] *Ibid.*, p. 93.

[82] Herbert R. Simon, "Theories of Decision-Making in Economics and Behavioral Science," *American Economic Review*, (June, 1959), p. 263.

would select an action, from among known alternatives, which would fulfill this goal ("level of aspiration"). The concept of profit "maximization" is replaced by a concept of "satisficing" since the firm is not examining all of the possible alternatives in order to choose the "most" profitable action, but instead selects one from among known alternatives providing it either meets or exceeds the minimum profit criterion set as its goal. If none of the known alternatives is "satisfactory" (meets or exceeds the firm's goals), two possible actions may be taken: (1) a search is initiated for a "satisfactory" alternative; or (2) the level of aspiration is adjusted downward. If the process of locating a "satisfactory" alternative or the downward adjustment of the aspirational level to coincide with actual performance proceeds too slowly, Simon believes that emotional behavior (apathy or aggression) will very likely replace "rational behavior."[83]

Katona generalizes that an individual's level of aspiration is the product of his past experiences and his reference group. Past successes act as a stimulus to aspiration levels, while "failure, disappointment, frustration tend to lower the level of aspiration." Katona continues by noting that not only our own successes and failure, but the success or failures of our reference group impinge upon our aspiration level:

> If a person grows up in a small mining town in which his father, brothers, friends also grew up, he will be strongly influenced to accept being a miner

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[83] *Ibid.*, pp. 253-283.

> as his lot, and not aspire further. Thus his expectations and aspirations will be limited, not by any failure on his part, but by the limits of his group.[84]

While accomplishment is assumed to breed striving toward higher levels of accomplishment, Katona extends his argument to hold that "apparent lack of motivation or absence of striving toward a goal is usually the result of frustration." Failure and disappointment may cause a person to be convinced that his income and advancement is dependent upon others, or upon luck, and not the result of his own effort and activities [fatalism].

Knowledge Situations

Knight's definitions of risk and uncertainty are viewed by Glenn L. Johnson as an unsatisfactory categorization of the actual states of knowledge encountered by decision-makers.[85] Believing, as did Hardy[86], that the conditions of risk and uncertainty differ largely in the amount of information at hand, Johnson proposes a classification of "knowledge situations" which emphasizes the importance of learning. He suggests an analogy between the process of

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[84] George Katona, Psychological Analysis of Economic Behavior (New York: McGraw-Hill Book Co., Inc., 1963), p. 92.

[85] Glenn L. Johnson and Curtis F. Lard, "Knowledge Situations," Managerial Processes of Midwestern Farmers (Ames: Iowa State University Press), pp. 41-51.

[86] Johnson and Lard cite Hardy in their discussion: C. O. Hardy, Risk and Risk Bearing (University of Chicago Press, 1923), p. 54.

decision-making under uncertainty and the statistical technique of sequential analysis. Using the sequential analysis procedure the analyst draws a small sample and from this sample determines whether to accept or reject the hypothesis, or, as a third alternative, he may decide that it is necessary (profitable) to gather additional information before a decision is made. Johnson's scheme of classification assumes that decision-makers behave in much this same manner, deciding on the basis of the subjective costs and returns of additional information whether to commit themselves to acceptance or rejection of a proposal or to seek still more information. The knowledge situations defined by Johnson are as follows:

I. Subjective Certainty--"the manager regards his information as so good that he need not take precautions against being wrong."

II. Subjective Uncertainty

A. Risk action, a situation in which a manager regards present knowledge as adequate for making a decision and in which the cost of additional knowledge is exactly equal to its value. Risk actions may be either:
(a) positive, or
(b) negative.

B. Learning, a situation in which a manager considers his present knowledge inadequate for action in the sense that he is subjectively unwilling to decide and take the consequences for his errors which he might make and in which the costs of acquiring more knowledge is less than its value.

C. Inaction, a situation in which a manager regards his present knowledge as inadequate for action and in which the cost of more knowledge exceeds its value. In this situation, no action is taken and no learning occurs.

D. Forced action, a situation in which a manager's information is inadequate for him to be ready, willing and able to make a decision subject to the errors involved but in which some outside force makes it necessary for him to act. Forced action decisions were regarded as either:
(a) positive, or
(b) negative.[87]

In the course of empirically examining these knowledge situations, researchers "uncovered" what they believed to be still another classification, involuntary learning. Involuntary learning was proposed to cover those situations in which farmers indicated that they continued to learn even after a terminal decision had been made:

E. Involuntary learning, a situation wherein the manager is subjectively unwilling to learn more since the costs of additional information equals or exceeds its value to him, but in which some outside force makes it necessary to learn or for some learning to occur regardless of the volition of the manager.[88]

Johnson's contribution is that it directs our attention toward the importance of learning in altering the states of knowledge within which the decision-makers select their actions.

Cardinal Utility

While Boulding has been arguing that "maximization of utility" is a much too formidable task for the decision-maker to ever accomplish, other economists have been investigating the usefulness of the concept of "cardinal utility" in explaining economic behavior. The renewed interest in this

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[87] Johnson and Lard, op. cit., pp. 44-45.

[88] Ibid., p. 53.

concept is usually attributed to Von Neumann and Morgenstern's development (in the mid-forties) of a method for numerically measuring utility.[89] The word "renewed" is appropriate since, historically, the first expressions of utility were in cardinal terms. Between then and the recent past, the concept of utility as a number was largely displaced, within the economist's theoretical constructs, by an elaborately developed theory of ordinal measurement -- analysis of indifference curves. The reason behind this change in emphasis was the problems involved in quantifying a concept which has at its basis the human sensation of preference -- desire for one item "more" than another. While it was difficult to devise an intuitively satisfactory method of assigning numbers to "how much" one item was preferred to another, it was quite obvious that preferences could be observed by directly ranking items (and groups of items). Von Neumann and Morgenstern contend that "under the conditions on which indifference curve analysis is based, very little extra effort is needed to reach numerical utility."

Von Neumann and Morgenstern propose a situation in which an individual has preferences among A, B, and C. By a "very natural extension of this picture" they permit the individual to not only compare events, but to compare combinations of events with certain probabilities attached. If the individual prefers A to B and also to C, he will

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[89] John Van Neumann and Oskar Morgenstern, Theory of Games and Economic Behavior (New York: John Wiley and Sons, Inc., 1944).

clearly prefer A to a 50% probability of B and a 50% probability of C. (A, B, and C must be considered exhaustive in order to avoid the possibility of complementarity between them.) But if he prefers C to A and A to B, a preference of A over a 50-50 combination of B and C contains some "fundamentally new information." This would indicate that his preference for C over A is less than his preference for A over B, or, more generally, the differences between utilities have now become measurable. It is from this modest intuitive argument that Von Neumann and Morgenstern develop their method of numerically measuring utility.

The Von Neumann-Morgenstern scheme can be operationalized by asking an individual to state the probability level "μ" at which he would be indifferent between the uncertain outcome $\mu X_1 + (1 - \mu) X_2$ and a certain outcome X_3 (where $X_1 > X_3 > X_2$). Arbitrarily setting numerical utility values for X_1 and X_2 permits the computation of a numerical utility for any given level of X_3.

There are two common criticisms of this approach: (1) a real-world individual may not understand the concepts of probability; and (2) he may have an aversion to gambling framework utilized in this line of questioning. These problems, however, can be largely circumvented by slight modifications in the Von Neumann-Morgenstern approach.[90]

[90] R. R. Officer and A. N. Halter, "Utility Analysis in a Practical Setting," American Journal of Agricultural Economics, (May, 1968), pp. 257-277.

In a 1960 article, Halter and Beringer suggest "that the Von Neumann-Morgenstern index for measuring cardinal utility may explain certain aspects of managerial behavior which are largely ignored by the traditional product-type and factor-cost oriented theory of the firm." They derived, using a method which did not require the respondent to have a knowledge of probabilities, utility indexes for a number of farmers. Halter and Beringer discovered a strong relationship between the farmer's utility for increased income and the type of farming he was engaged in, with higher utilities for income being associated with those operations which are commonly considered to be more risky (cash crops and fat-stock feeding). Farmers with a high utility for increases in income were also more likely to incur large debts than farmers with a lower marginal utility for wealth. Low-risk enterprises (dairying, general farming) were found to be highly correlated with a large marginal disutility for losses. It was also found that farmers with lower net worth positions and lower gross incomes tended to have a greater disutility for losses than their wealthier counterparts. Finally, it was discovered that the size of gains sufficient to induce the acceptance of unfair odds was at least 26 times the losses necessary to induce acceptance of insurance schemes at unfair odds.[91]

Somewhat later, Officer and Halter examined the

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[91] Albert W. Halter and Christoph Beringer, "Utility Functions and Managerial Behavior," Journal of Farm Economics (February, 1960), pp. 118-132.

contribution of cardinal utility functions in predicting the decisions made by Australian wool producers. The main hypothesis of their study was "that farmers' operational decisions are more consistent with a criteria of minimizing expected disutility than with a criteria of minimizing costs."

In addition they were interested in determining if useful utility functions could be derived under field conditions and whether or not these functions were stable over time. In pursuit of their objectives, Officer and Halter conducted two experiments, separated by a year, involving five farmers. They derived utility functions for each of these farmers and then asked them to choose alternatives (fodder reserve levels) within several programmed situations. Predictions of the farmer's choice, on the basis of his expressed utility functions, were next compared with his actual choices. Officer and Halter, using a rather crude method of analysis, found that cardinal utility functions were somewhat helpful in predicting farmer decisions. In addition, they found that over a period of one year the farmers' decisions (confronting them with the same situations) and utility functions did not change radically.[92]

Friedman-Savage Utility Function

Friedman and Savage believe that decision-makers behave *as if* they were maximizing expected utility provided that "a rather special shape is given to the total utility curve

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[92]R. R. Officer and A. N. Halter, *op. cit.*, pp. 257-277.

for money."[93] They consider the question of whether or not individuals _actually_ calculate and compare expected utilities as largely irrelevant. What is important, according to these authors, is whether or not a particular hypothesis is a "sufficiently good approximation to reality for the purpose at hand."

The "purpose at hand" in the present discussion is an explanation of the apparent tendency for individuals to both, and at the same time, insure against losses and engage in games of chance. Gambling and insuring are the focal points of their discussion because of the obvious influence of risk on these forms of behavior. Friedman and Savage believe that the model they have developed to understand these phenomena may also be applicable to other forms of decision-making such as occupational and business choices.

The "special shape" of the Friedman-Savage utility function is based upon a (graphical) proposal of the necessary conditions underlying an individual's desire to either avoid or accept risks. To examine these conditions let us imagine the curve CDE (in Figure 1a and 1b below) as representing an individual's utility for all certain incomes between I_1 and I_2. Next assume that our decision-maker is presented with the chance $A=[\mu I_1 + (1-\mu)I_2]$ where the probability μ is set such that acturial value is $\bar{I}$. The expected utility of A, $\bar{U} = [\mu U(I_1) + (1-\mu)\ U(I_2)]$, is equal

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[93] Milton Friedman and L. V. Savage, "The Utility Analysis of Choices Involving Risk," _Journal of Political Economy_ (Volume 56, 1948), pp. 279-304.

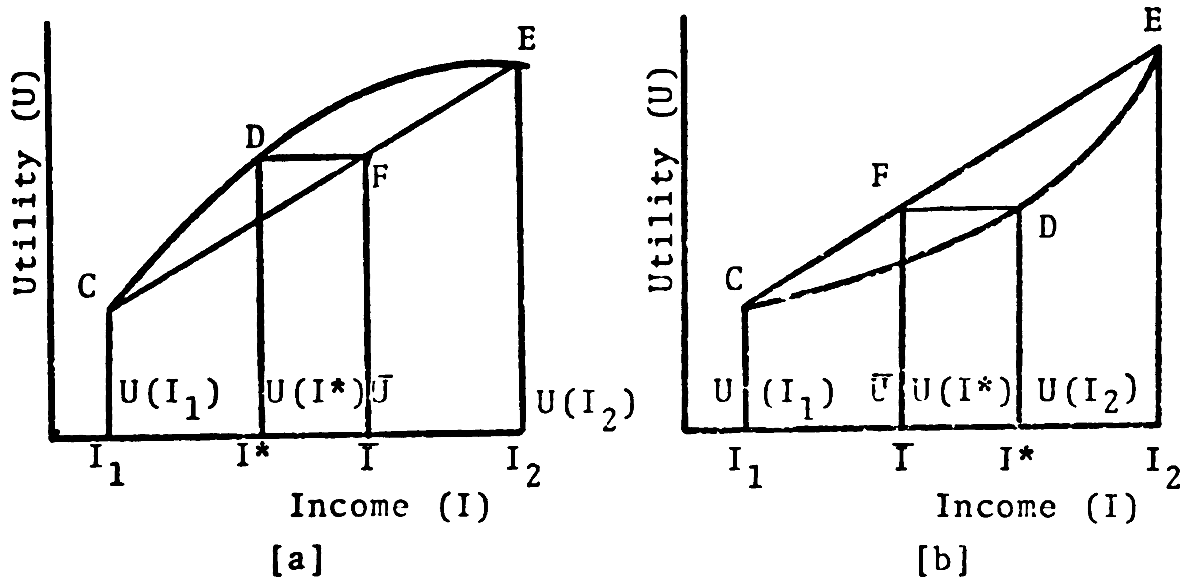

Figure 1.--Illustration of Utility Analysis in Choices Involving Risk. (Friedman and Savage, p. 290.)

to F [on the chord CFE drawn from $U(I_2)$ to $U(I_1)$]. I* is defined as the level of certain income which has the same utility as the uncertain situation A, $U(I^*) = \bar{U}$. It should become obvious at this point that [a] describes a situation in which the individual is willing to pay something for certainty (buy insurance), since his utility for a lower certain income (I*) is equal to his utility for the greater expected (acturarial) income ($\bar{I}$). In fact, he would be willing to pay a maximum amount of $\bar{I}$-I* in order to be assured of the income I* rather than take his chances on either I_1 or I_2. The reverse is true of [b]. Here the individual prefers the chance of either I_1 or I_2 to any certain income less than I* (which is larger than the expected income $\bar{I}$). The premium he would be willing to pay for the gamble (A) is a maximum of $I^*-\bar{I}$.

In order to rationalize both gambling and insuring by the same individual, Friedman and Savage suggest that the shape of the utility function should be a combination of the types discussed above (see Figure 2). Note that the lower range of the utility function is convex from above while the upper range is concave from above. Locating the individual's present income at I_0 (upper part of the convex segment), we find that he would be inclined to insure against losses since a chord drawn from $U(I_0)$, at D, to the utility of a lower income would lie below his utility function (for certain income). On the other hand, a chance of I_1 or I_2 with an expected value of $\bar{I}$ is equally as acceptable on a certainty of I_0. If the expected value were any amount greater than $\bar{I}$, say $\bar{I}'$, the individual would be willing to pay the difference between I_0 and $\bar{I}'$ for the privilege of gambling. Given a utility function of the form presented, individual behavior involving both gambling and insuring (at the same time) can be visualized as consistent with utility maximization.

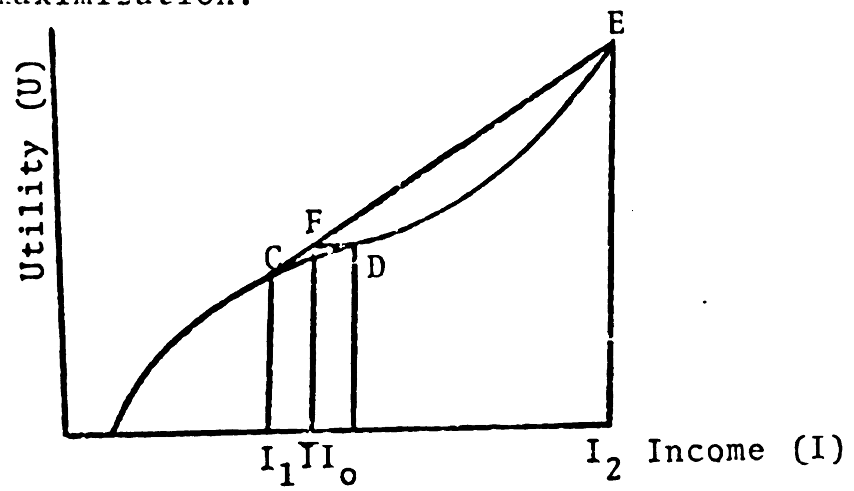

Figure 2.--Friedman-Savage Utility Function. (Friedman and Savage, p. 295.)

Friedman and Savage have presented a seemingly useful way of viewing utility functions for income. However, they had little to say about the minimum income levels applicable to the utility function, except that all values of U(I) will not be described since the minimum income an individual can have is a negative income equal to the amount he can lose in any period. Other authors have had more to say about utility and minimum incomes.

Focus-Loss

Focus-loss might be described as some minimum level of outcome which constitutes the borderline between tolerable and intolerable outcomes. The decision-maker, according to this concept, will not willingly accept alternatives which might result in outcomes falling below this minimal level. This idea has been used to conceptualize farmer decision-making in both modern and peasant agriculture. Schickele utilized just such a premise in his discussion of the Great Plain's farmer's adaptation to income uncertainty.[94] He describes the motivations of farmers in the following way:

> The farmer's end is not simply to "maximize net income" as it is usually assumed in analyses of the firm. Let us break down the general goal of income maximization into two more specific ones: (a) to assure the farmer's survival in the case of heavy risk losses (whenever they might hit) and (b) to maximize income over time subject to (a). They are not coordinate; the survival end has priority over the maximization end.[95]

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[94] Rainer Schickele, "Farmer Adaptations to Income Uncertainty," Journal of Farm Economics, (August, 1950), pp. 356-374.

[95] Ibid., p. 362.

In short, Schickele assumes that farmers will manage their operations in such a way as to minimize the possibility that their incomes would fall so low as to cause discontinuance of the enterprise. He reasoned that farms with a low level of assets were less capable of withstanding risk losses than their larger counterparts. In support of this reasoning Schickele found that small farmers organized their operations in a way that did not maximize expected (long-run) profits, but did provide for continued survival (diversification, off-farm employment, etc.). Large farmers, by contrast, more often specialized in the riskier high profit activities in a manner consistent with maximization of expected profits.

Wharton observed that the concept of focus-loss could be very useful in developing a "neglected" explanation of the peasant farmer's reluctance to accept new agricultural practices.[96] He believes that the low levels of income associated with subsistence and semi-subsistence farmers produce a much stronger "survival element" in decision-making than would be found among their commercial counterparts. Each community, according to Wharton, has a socially-prescribed minimum standard of living -- S_{ms} -- which farmers are unwilling to fall below. (This minimum income level is usually above the physiological minimum, but it may

[96]Clifton R. Wharton, Jr., "Risk, Uncertainty and the Subsistence Farmer: Technological Innovation and Resistance to Change in the Context of Survival," (Paper presented at the Joint Session American Economic and Association for Comparative Economics, Chicago, Illinois, December 28, 1968), pp. 1-53.

nonetheless be insufficient for adequate diets in the poorer communities.) The typical peasant family will strive to reach some communal or societal achievement standard (of living)-- S_{as} -- but more importantly it will struggle to avoid the minimum subsistence standard -- S_{ms}. Because actual levels of living -- L_a -- are often in such close proximity to the minimum acceptable standard (S_{ms}), the peasant farmer is particularly vulnerable to variations in income (due to variations in costs, physical output, and prices).

The very survival of subsistence farmers, in Wharton's view, has been the result of their ability to select traditional technologies which have a small variability. From considerable experience, sometimes handed down from generation to generation, the subsistence farmer has learned what to expect from traditional technologies. This is not so with new technologies, implying that the peasant must base his decisions upon <u>subjective expectations</u>. If the <u>subjectively evaluated</u> variance associated with a new technology is sufficiently large to result in incomes below the minimum subsistence standard, the peasant will reject the new method (as too risky) despite its superiority in average returns. Wharton illustrates this situation with the diagram in Figure 3. Note that while the expected outcome -- $E(O_T)$ -- for the traditional method is less than the expected outcome -- $E(O_N)$ -- for the new technology, one standard deviation from mean outcome would still permit a level of living above the minimum standard. At the same time, a standard deviation from the expected outcome of the new

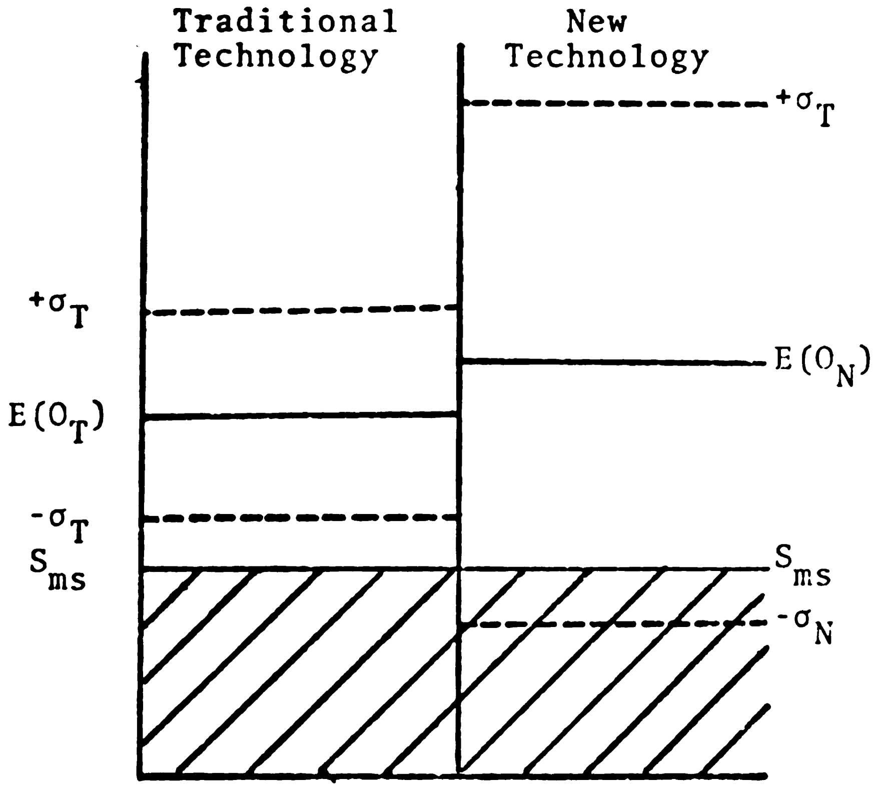

Figure 3.-- Wharton's Diagram Representing the Differences in "Expected" Outcomes from Traditional and New Technologies. (Wharton, Risk, Uncertainty, and the Subsistence Farmer, p. 40.)

practice (based upon the individual's subjective estimate of variance) would result in the "intolerable" circumstance of an income below the minimum standard. If somewhat less variance were expected from the new technology, it would stand a much better chance of being accepted, according to Wharton.

The focus-loss concept has also been applied in empirical research. In an attempt to study vegetable production in Southern France, Boussard and Petit soon discovered that it "was impossible to neglect farmers' reactions to extreme price uncertainty." Confronted with this problem, they developed a technique to include consideration of the farmer's aversion to risk in their linear programming model. At the foundation of their method was the assumption "that farmers choose, among various actions, the one which will maximize the expected gain, provided that the possibility of ruin is so small that it can be neglected." Boussard and Petit defined ruin in terms of income, at a level below which the farmer would not risk having his income reduced. The largest acceptable loss was, in turn, derived from the minimum income level. Next the researchers asked extension personnel to indicate the level of loss, for various crops that they would be "very surprised" to see occur. Having obtained a concensus of the amount of such losses (which is an expression of the riskiness of various crops), Boussard and Petit added the constraint to their linear programming model that the maximum loss from the $i^{\underline{th}}$ crop (the amount of loss for a given crop which would be considered "very surprising" times the acreage devoted to that crop) could never exceed one-third of the largest acceptable loss. (In other words, the "worst" conceivable outcome for a particular crop could not amount to more than one-third of the difference between the expected and minimum income levels.) With this addition to their model the authors were able to nearly duplicate the cropping patterns of farmers in the area studied.[97]

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[97] Jean Marc Boussard and Michel Petit, "Representation of Farmer's Behavior Under Uncertainty with a Focus-Loss Constraint," Journal of Farm Economics, (November, 1967), pp. 869-880.

Sturt concluded from his study of 200 West Pakistani farmers that "the capacity for risk-bearing appeared to be a major factor affecting change." "Smaller cultivators," among those studied, failed to make as many changes in their farm operations as "larger cultivators." (Recall Schickele's explanation of this same phenomenon among Great Plains farmers.) In addition, Sturt found that the amount of change undertaken by these farmers was also related to the availability of irrigated land, the lack of credit and the unavailability of new inputs.[98]

Schematic Model of the Farm Manager

Nielson has prepared a schematic representation of the farm manager.[99] Nielson's model is almost self-explanatory. The items subsumed by V symbolize the manager as an *individual* with a certain configuration of background experiences -- V_1 -- directed by certain drives and motivations -- V_2 -- which are monitored by the value system (an effort to bring "values" and "fact" together) and, who possesses a particular endowment of talent and capabilities (a critical item that Boulding omitted from his model) -- V_3. P signifies the entirety of the complex mental processes involved in decision-making. Past

[98] Daniel Sturt, "Response to Change in Pakistan," *Journal of Farm Economics*, (August, 1965), pp. 625-633.

[99] James Nielson, Aspects of Management of Concern to Basic Researchers (Denver, Colorado: Farm Management Research Committee of the Western Agricultural Economics Research Council, 1962).

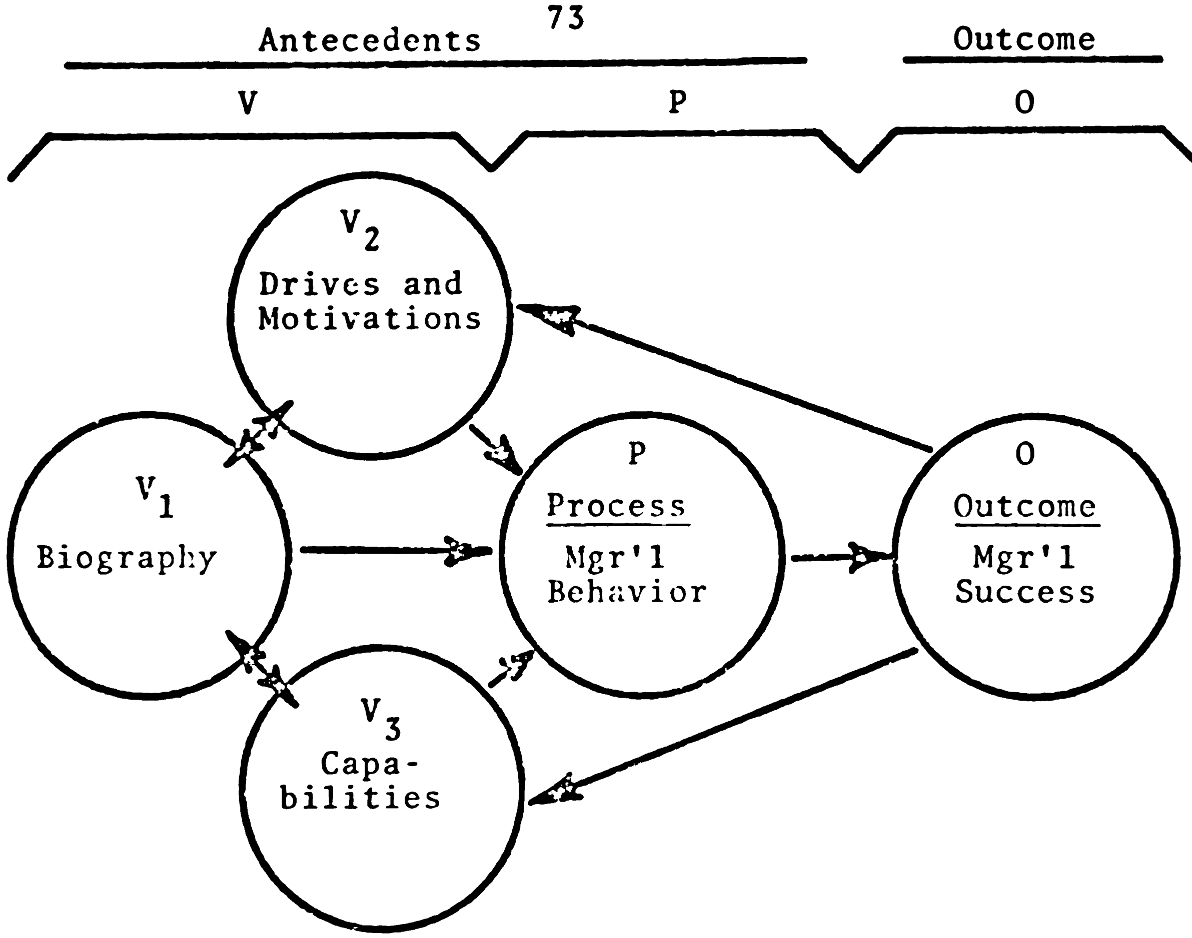

Figure 4.--Nielson's Model of the Farm Manager. (Nielson, *Aspects of Management of Concern to Basic Researchers*)

experiences, motivations, and capabilities all have an impact upon these processes, which -- as evidenced by Knight, Boulding, and Nielson's reluctance to elaborate in greater detail -- are apparently very difficult to conceptualize. The outcome of economic decision-making, O, is connected by "feedback" linkages to both capabilities and drives and motivations. It is unclear as to why feedback is not also included between outcome and biography (the set of past experiences). Still another omission, in Nielson's schematic view of management, is provision for messages from outside the system.

Summary

This chapter has examined various segments of the literature for ideas which would be useful in conceptualizing the adoption of new agricultural practices as decision-making under conditions of uncertainty. A review of the controversy over the importance of non-economic as opposed to economic factors in determining peasant behavior has led to the conclusion that both should be examined in a comprehensive view of the adoption process. The question of greater interest seems to be the relative weightings that should be given to economic and non-economic variables as they interact within the decision-making process.

Also included was a brief discussion of some of the main concepts which have emerged from "diffusion research." Of particular interest in this study were the distinguishing characteristics of innovative individuals, the categorization of channels of communication, and the characteristics of an innovation. Variations of these concepts will provide part of the complement of notions integrated into a conceptualization of the adoption process as it evolves in later chapters.

Finally, a search of the literature on economic behavior under uncertainty has provided several ideas which will serve as a basis of a conceptualization of the adoption process. Decision-making is viewed as taking place under varying states of incomplete knowledge, the exact degree of incompleteness depending upon the amount of knowledge the decision-maker has been able to gather about the proposed action. The views of several authors regarding the decision-making process suggests that it involves an interaction of the individual's knowledge from past experiences, his value system, messages received from his environment, and his own intellectual and managerial capabilities.

Knight has argued that a relationship exists between the uncertainty perceived by the decision-maker and the return necessary to induce him to accept the risks involved. Friedman and Savage elaborated this relationship in terms of a utility function which was designed to explain the individual's willingness to accept certain risks and reject others. Meanwhile, Schickele and Wharton have proposed explanations of the unwillingness of poorer farmers to accept the risks readily taken by relatively wealthier farmers. These notions will be observed as the underlying arguments in the conceptualization of the adoption process as presented in the following chapters.

CHAPTER III

A CONCEPTUALIZATION OF FARMER ADOPTION OF NEW TECHNOLOGIES UNDER CONDITIONS OF UNCERTAINTY

> A discussion of uncertainty is not "theoretical and impractical;" the major decisions of individual persons and nations fall in this framework.
> [E. O. Heady][100]

This chapter will attempt to evolve a conceptual framework capable of bringing the study of adoption of agricultural innovations under the umbrella of decision-making in an uncertain environment. The forthcoming proposal is basically an open and interactive model of an individual decision-maker in an environment of uncertain outcomes. Within this environment, the decision-maker is exposed to both information which is useful in decision-making and circumstances which impose constraints on the final form that his decisions can take. The general framework of this conceptualization is outlined in the succeeding sections, while subsequent chapters examine its implications.

Sources of Uncertainty

Although it might appear sufficient to simply consider the subjective risk involved in adopting new agricultural practices as the product of uncertainty about their eventual outcomes, an interactive model would seem to suggest a closer examination of the uncertain environment in which the decision-maker operates. Since several factors are

[100]Earl O. Heady, Economics of Agricultural Production and Resource Use (Englewood Cliffs, New Jersey: Prentice Hall, Inc., 1952), p. 439.

presumably given consideration in the farmer's decision process, several sources of uncertainty are likely -- in one form or another -- to have an impact upon his ultimate decisions. The Interstate Managerial Study, conducted in 1956, suggested that farmers in a modern agriculture required five types of information to engage in decision-making: information about (1) production methods (current technology), (2) new technology, (3) human relations, (4) the institutional setting, and (5) prices.[101] By implication, these areas are sources of uncertainty in United States agriculture. It seems reasonable that these could also be sources of uncertainty in developing agricultures.

Current Technology

It can be argued, following Schultz[102] and Wharton[103], that farmers in a traditional agriculture have very well developed expectations about the outcomes of their present methods. Yet in the most traditional conditions conceivable, uncertainty will surely exist; if for no other reason than the vagary of nature. For even though farmers may possess accurate expectations (as the result of years of experience), the outcome of any given year remains uncertain due to weather and biological factors such as insects and disease.

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[101] Managerial Processes of Midwestern Farmers, op. cit., pp. 26-27.

[102] Schultz, op. cit., pp. 30-31.

[103] Wharton, "Risk, Uncertainty and the Subsistence Farmer," p. 38.

While the uncertainties imposed by weather variations and other natural hazards vary from region to region, it would be difficult to name an area where they are not an important consideration. Within a changing, and hopefully modernizing agriculture, the uncertainties of the marketplace and new technologies will likely be added to those of nature.

New Technologies

New technology is a much greater source of uncertainty than traditional technology (current production methods). Accurate expectations of outcomes from its use cannot be immediately established. The farmer will question whether the results obtained at experiment stations -- domestic or foreign -- can be duplicated with his soils, climate, and farm organization. Initially, he will lack sufficient information to confidently evaluate a new technology. Heady notes that extension of new technologies has usually emphasized the improvement in the mean outcome over current methods.[104] He asserts, as does Wharton[105], that the variance of outcomes is also critical to decision-making. Reduction of uncertainty about the performance of suggested new technologies requires time for learning on the part of the farmer.

Human Relations

Uncertainty about a new technology can result from a quite different source, uncertainty in the area of human

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[104]Heady, op. cit., p. 445.

[105]Wharton, "Risk, Uncertainty and the Subsistence Farmer," p. 36.

relations. Byrnes isolates farmer uncertainty regarding the competency and motives of change agents as an important reason for failure of certain innovations.[106] It is also conceivable that concern about peer group acceptance may cause potential innovators to be reluctant to try "something different." Rogers believes those less encumbered by concerns of group acceptance have a tendency to accept new ideas more rapidly.[107]

Institutional Arrangements

Institutional arrangements can be a source of uncertainty whether the farmer uses traditional or new technologies. No nation seems to be without some government program which affects agriculture. Farmers may have incomplete knowledge of these programs, and probably of greater importance, they may be unsure of what programs to expect in the future. How directly uncertainties regarding government programs -- present and future -- affect producer decision-making is a matter of individual cases. Specific government programs are not, however, the only institutional arrangements which may be important sources of uncertainty. The institutional framework governing land tenure, specifically landlord-tenant relationships, is often identified as a source of considerable uncertainty. The structure of the credit system might be thought of as a possible source of

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[106] Francis C. Byrnes, Some Missing Variables in Diffusion Research and Innovation Strategy, (New York, Agricultural Development Council, Inc.).

[107] Rogers, Diffusion of Innovations, pp. 193-207.

uncertainty ("life and death" power of local money-lenders, land as collateral on small loans, refinancing practices), just as the risks of agricultural production are thought of as limiting credit usage. Still another source of uncertainty is the availability of new inputs. Untimely availability and insufficient quantities of new inputs is often given as a reason for their lack of use.

Prices

The uncertainty of producer prices is of considerable importance to those farmers participating in the market economy. In addition to causing difficulties in organizing production, widely varying prices will likely have an inhibiting effect on the innovativeness of farmers. Variations in prices can be classified into three categories: (1) uncertainty about the price level of a given product for particular years (inter-year variations in average prices), (2) price fluctuations within a given season (intra-year variability), and (3) price differentials between areas. It seems almost too obvious to mention that the accuracy of farmers' price expectations depend upon the functioning of the relevant market system (market organization and "market rules") and the variation in quantities supplied and demanded.

Expectations

> By expectation I mean the act of creating imaginary situations, of associating them with named future dates, and of assigning to each of the hypotheses thus formed a place on a scale measuring the degree

> of our belief that a specified course of action on our part will make this hypothesis come true.
> (G. L. S. Shackle)[108]

As noted already, there are several sources of uncertainty facing the farmer. Consequently, he often has no way of knowing exactly some future outcome, and must conjecture what will occur. The farmer is guided in estimating future events by a set of expectations based upon his judgment and his knowledge of the factors affecting given outcomes. The formation and characteristics of such expectations will be of major concern in this section. At least momentarily, we will set aside the complexities of dealing with several sources of uncertainty and concentrate on a more abstract model.

For the purposes of this study, uncertainty will be considered as any situation where the farmer does not know for certain (probability equal to one) what outcome will occur.[109] It also seems reasonable to consider expectations

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[108] G. L. S. Shackle, Expectations in Economics, (Cambridge: Cambridge University Press, 1949), p. 10.

[109] It is the contention here that nothing is added to our knowledge by attempting to separate uncertainty into different categories such as those suggested by Knight and elaborated by Heady. It will be recalled that Knight has proposed a conceptual division of uncertainty into "risk" -- where the probability distribution of outcomes is known -- and "uncertainty" -- where probability distributions do not exist (Knight, p. 333). Heady bases his classification on Knight's proposal, asserting that "risk" is the product of a large number of independent observations such that the probability function is empirically derived and that "uncertainty refers to future events where the parameters of the probability distribution cannot be determined empirically" (Heady, pp. 441-442). Heady reaches the conclusion that uncertainty "is a purely subjective

as being formed by an individual mental process (problem-solving behavior) utilizing whatever information is at hand. Such information can range from many observations on his own farm -- akin to scientific investigation and statistical analysis -- to the expectations of someone whose advice he respects.

The information used by farmers could possibly be classified into three types: (1) empirically derived information, (2) a priori associative knowledge, and (3) communicated knowledge. Since such a breakdown is probably unique to this study, some explanation of these terms is necessary. Empirically derived information will be defined as that information which was obtained by observation of a given phenomenon. It need not be thought of as a complete empirical experiment. In addition, no claim can be made regarding any one-to-one correspondence between the information generated by these observations and some "absolute" reality. The senses provide only data which must be transformed into meaningful information within the context of the second type of information: a priori associative knowledge.

A priori associative knowledge, in turn, can be defined as that information, developed over time and residing with the individual, which aids him in associating various relationships and reasoning toward certain conclusions. Under this

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phenomenon and is peculiar to the mind of the individual." This view involves an unwarranted division of types of information used in forming expectations, and suggests arguments about the meaning of "objectivity" and "subjectivity" as they apply to information sources.

heading are collected the individual's attitudes, beliefs, and conceptual structures (i.e., concepts of plant nutrition, weights and measures, mechanical concepts). They are the product of his past learning experiences -- both formal and informal -- and provide him with the capabilities for interpreting situations and formulating expectations.

Finally, communicated information is the information which passes between individuals through the various channels of communication. It too is subject to the interpretation provided for by a priori associative knowledge. The farmer's expectations are the product of some combination of these types of information.

Let us take a typical example of the diffusion of an agricultural innovation. Presume that a new variety of corn has been developed and the intention is to extend this innovation to farmers. The researchers at the experiment station have evidence that the new variety is superior to present varieties. This evidence might consist of field trials where the new variety was observed to produce higher yields than current varieties -- empirical information. The extension agents learn about the variety from the experiment station personnel -- communicated information. They also may have a priori associative information which permits them to see the researcher's evidence as reasonable. And they have a priori information that the researchers are usually correct in their evaluation of new technologies. The expectations that they form are established on this basis.

When the extension agent presents the variety to farmers, they are receiving communicated information based initially on empirical information. They, too, have a priori associative information with which to evaluate both the source and the message. Presume that from experience the farmer has a priori information that his extension agent is competent and well intentioned. Suppose also he believes that researchers can improve upon present practices. Consider as well that he has some a priori information which allows him to believe that better seeds will make better crops. Finally presume that experience has shown him that on his soils varieties produce about a third less than at the experiment station. He now has information that can be used to develop a set of expectations about the variety for his own farm. In an intuitive way he assigns "degrees of belief" for a set of outcomes which might be expected if he were to adopt the new technology. As he observes the variety growing on his own farm or his neighbor's farm he can revise the probabilities of different outcomes on the basis of additional empirical information. In retrospect it makes very little sense to pursue arguments about the conditions within which expectations are either "subjectively" or "objectively" formed.

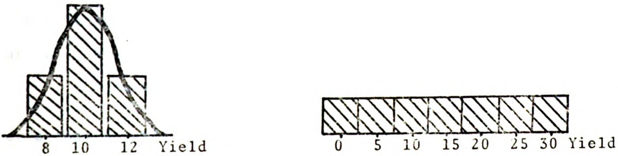
We have now reached the point of discussing the "degrees of belief" that the farmer attaches to various outcomes. Clearly we are suggesting that a Bayesian view of statistics is applicable to expectations, that probabilities can be established by other than measuring the frequency of given outcomes over large numbers. The farmer contemplating buying a farm has hardly enough observations to establish the probability of his success or failure in a frequency sense. Yet he must formulate some expectations in order to make a reasonable decision. As a result, the information at hand is processed by the individual and he is guided by his expectations as to what action should be taken. The action taken may, of course, be to postpone the decision and to gather more information.

His expectations are essentially a set of associated outcomes and "degrees of belief" that these outcomes will occur. If one has reservations about using probabilities as "degrees of belief," they can possibly be dispelled by the following representation. The scientist with his statistically valid probability distributions developed from his empirical observations undertakes the same mental calculations as the farmer; <u>only</u> his mix of information sources is different. He expects a given outcome because of <u>empirical information</u> from his experiments and <u>a priori associative information</u> that is formalized in his knowledge of statistics. The scientist's set of expectations are then essentially "degrees of belief" based upon a different emphasis in the information sources used.

If the farmer can establish a priori probabilities regarding forthcoming outcomes, then how can uncertainty be taken into consideration? This is somewhat of a conceptual problem which deserves a careful examination. Since we have downgraded the possibility of a "true" probability distribution that exists apart from human understanding we can hardly say that as the farmer's probability distribution approaches the true distribution uncertainty is reduced.

The fact of the matter is that we can theoretically conceive of an analogous chain of events within the mental processes of the individual. With little knowledge to the contrary, the farmer may assign equal "degrees of belief" to every plausible outcome -- nearly complete lack of information and the highest degree of uncertainty possible. With more and more information he begins to restructure his "degrees of belief" in line with his increased understanding of which outcomes appear most likely. Eventually, with all of the information available that he is capable of processing (or willing to accumulate) he will have reached some final revision of his expectations. He is, nonetheless, uncertain about what outcome will occur in a given year, but he has been able to rule out those outcomes which at this present level of knowledge are extremely unlikely.

Let us examine this sequence of events with a hypothetical example. What we are expressing is a learning process where additional information permits the decision-maker to assign new "degrees of belief" that certain outcomes will occur. Suppose that an extension agent is attempting to introduce chemical fertilizer to a given group of farmers who have had no experience with this practice. The range of outcomes to which farmers might give consideration could vary from fertilizer "burning up" their crops -- no yield -- to more than a tripling of present yields. They may consider decreases in yields for any given year equally as likely as yields above the present levels. Assume for simplification that the usual yield with present technology is ten units in average years (six out of ten years), and eight units in poor years (two out of ten years), and twelve units in good years (also two out of ten years). The farmers' expectations for traditional technology would probably closely reflect these frequencies. If he has little information about the new technology he might expect any outcome between zero and thirty units as equally likely yields. Figures 5a and 5b illustrate these respective expectations at a given point in time (t_1).



-a- Present Technology -b- New Technology (t_1)

Figure 5 -- Frequency Distributions Representing the "Degree of Belief" (Probability) a Farmer Might Assign to Various Crop Yields Under Present and New Technologies.

If the extension agent tells the farmer that the average yield on the experimental farm with the use of chemical fertilizer was twenty units and that fertilization would not "burn up" his crop, he might consider zero yield as unlikely and expect an average (mean) yield somewhat below the extension agent's claims (discounting for slight distrust in the extension agent or differences in soils that he presumes to exist between his farm and the research farm). At this point in time (t_2) he may have expectations approaching figure 6a. If his neighbors try the practice and even in a bad year their crop yields ten units he will begin to attach fewer degrees of belief in yields below this level. If, in a very good year, the practice yields only twenty-five, this information will influence his expectations. At this juncture (t_3) his expectations might be represented by figure 6b.

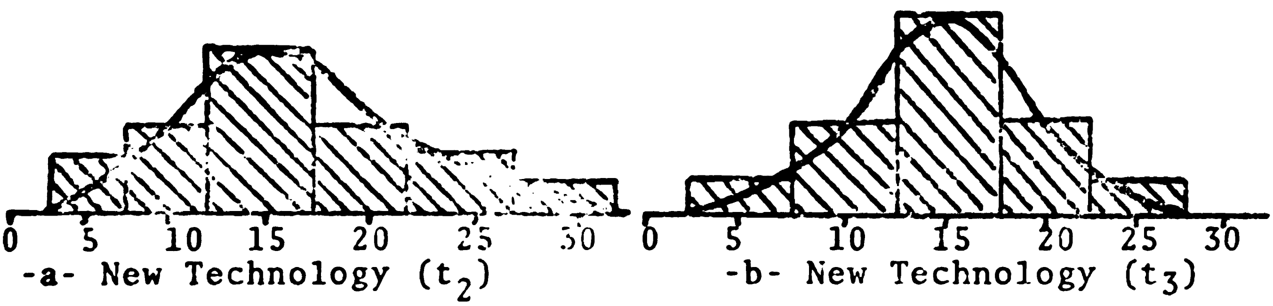


Figure 6 -- Frequency Distributions Representing a Farmer's Expectations of Various Yields with Increased Accumulation of Information.

After a considerable amount of information-gathering (actively or passively), our hypothetical farmer still is not certain what yield will occur in a given year, but he is reasonably certain that zero and thirty unit yields will not occur and he attaches a high "degree of belief" to the possibility of yields at fifteen units.

Note that the example is based on discrete probabilities at arbitrarily set levels. This is probably a reasonable approximation of the type of expectations that farmers have. They certainly will not, in their expectations, approach a continuous distribution of "degrees of belief." Our assurance of this lies in the limitation of outcomes that it is humanly possible to consider at one time. It is thus likely that farmers focus their attention at certain points over the range of possible outcomes and concentrate upon the "degrees of belief" which should be associated with these points. Other points hold less interest to the decision-maker or are subsumed within a range centered about the points of interest.

Utility for Income

Now that we are equipped with some ideas of how expectations are formulated, to continue our conceptual framework we will need some notions about the farmer's utility for income. The concept of utility for income is notably troublesome, yet it is crucial that we use some concept to measure the value attached to various levels of income in order that we may understand decision-making under uncertainty.

Our concern here is to conceptualize a "typical" utility function for farmers in less developed countries. The Friedman-Savage utility function[110], which attempts to explain gambling and insurance, can be a useful starting point. The relevance of this type of function is that it places the individual at some level of income and explains his utility for gains and losses. The shortcoming of the Friedman-Savage analysis is that they did not deal with a

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[110] Friedman-Savage, op. cit., pp. 279-303.

situation applicable to business decisions. They examined situations with a small probability of a large gain and a large probability of a small loss, or the reverse in the case of insuring. Most farm production decisions are hardly a gamble in the Friedman-Savage sense. In short, the losses associated with gains are not necessarily so small that their disutility is negligible. We are, instead, interested in the utility of a wider range of associated gains and losses.

To consider the case of the farmer in a less developed country we will begin with his present income and speculate on his utility for given levels of income other than present. With respect to his utility for higher incomes, we can find several positions represented in the literature. An upper limit on aspirations, as visualized by Mrs. Nair[111], would suggest that the upper range of the (Friedman-Savage) utility curve soon becomes parallel to the horizontal axis. Katona's[112] assertion that the desire for additional income is a function of the individual's past successes and the incomes of his peer group would direct us toward a rather individualistic interpretation of the shape of the utility curve for increased incomes. A positively sloping utility curve is the least that may be implied by Schultz's[113] view of the peasant farmer as an "economic man." Finally, we have Friedman and

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[111]Nair, op. cit., pp. 192-193. Also see p.13 of this text.

[112]Katona, op. cit., pp. 86-106. Also see pp. 56-57 of this text.

[113]Schultz, op. cit., pp. 24-52. Also see pp. 20-24 of this text.

Savage's[114] contention that the upper range of a "poor person's" utility function is concave from above. Perhaps the best position to take, until better information is available, is that the upper range will be assumed to have a positive slope with the derivative of the curve depending upon the individual and his particular situation (i.e., past successes and failures, the income levels of peer groups and other members of the community).

At the opposite end of the utility function, we have somewhat sounder theoretical notions on which to postulate the shape of the curve. Wharton[115] has recently related the concept of focus-loss to subsistence agriculture. In Wharton's view, those farmers living on the edge of a subsistence income, whether physiologically or socially prescribed, are extemely fearful of taking actions which have any likelihood of forcing them below the subsistence level of income. (If money must be borrowed to take the action under consideration it seems reasonable that the critical level of income will be the subsistence level plus the amount that must be paid back.) Any prospects of falling below this critical level are intolerable to the farmer (as starvation of his family would be conceived to be). The closer a farmer's present income lies to this critical income the more hesitant he is to accept losses. This implies that

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[114] Friedman-Savage, op. cit., pp. 294-295. Also see pp. 63-67 of this text.

[115] Wharton, "Risk, Uncertainty and the Subsistence Farmer," pp. 1-53. Also see pp. 68-70 of this text.

the utility function for income in the lower range becomes discontinuous at the critical income level.

A representation of an income-utility function which fits the specifications presented in this section could serve as a useful summary.

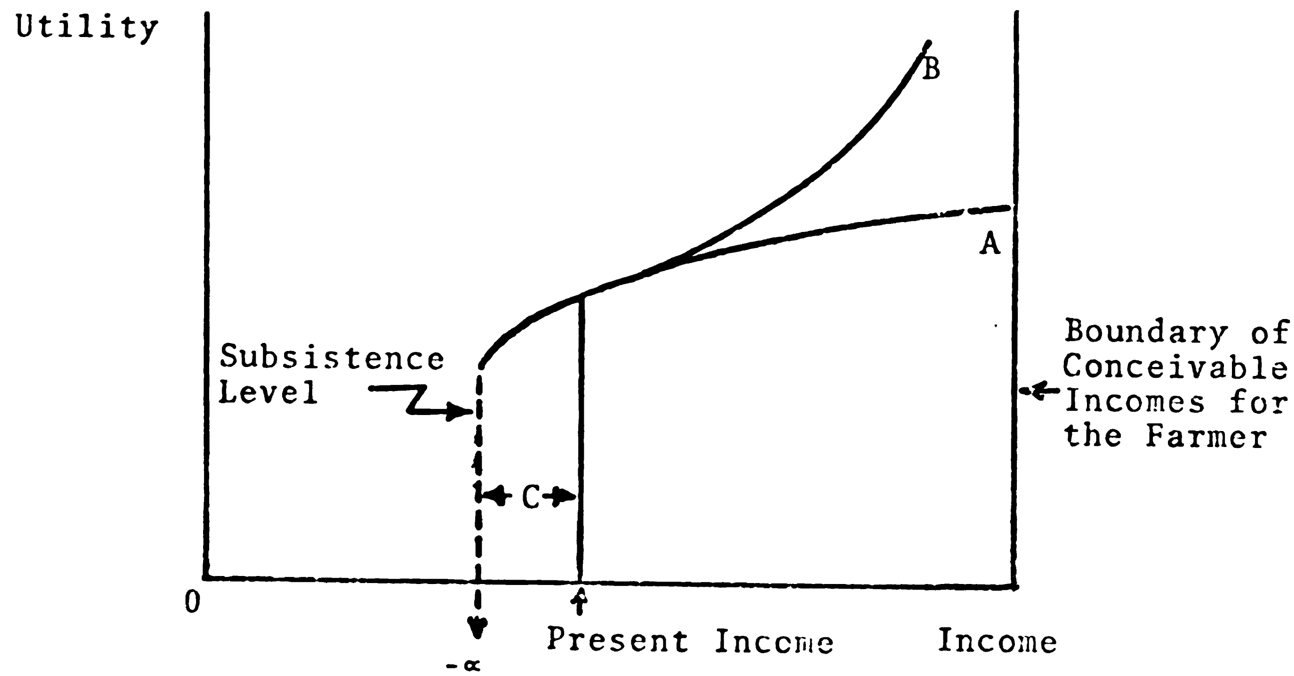

Figure 7.--Suggested Income-Utility Function.

The line labeled A represents an income-utility function rising at a decreasing rate to the outer range of outcomes conceivable to the farmer. Line B gives the function as rising at an increasing rate. At the lower end utility falls off more rapidly than it increases for gains in incomes, as suggested by empirical work by Halter[116] who examined farmers in the United States. The curve becomes discontinuous at the subsistence level and goes to infinite disutility. The segment "c" is smaller for farmers nearer the subsistence level.

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[116]Halter and Beringer, op. cit., pp. 118-132.

Constraints Upon the Implementation of New Agricultural Practices

Before we examine the interaction of the farmer's expectations and utility for income, it is necessary to consider those factors which limit his capacity to employ new practices. Since new methods usually involve purchased inputs, the most obvious limitation on the farmer's innovativeness would be the availability of these inputs. Not only must inputs be available in the absolute sense, they need to be provided at convenient locations. This is necessitated by limitations on the distance that farmers in less developed areas can travel to secure the items needed on their farms. The supply of these products also should be timely and in sufficient quantities so that farmers can be certain that they can acquire inputs when they need them.

The availability of credit can also be a determining factor in the implementation of new practices. Cash outlays for purchased inputs may be beyond the immediate financial capabilities of many of the farmers concerned. Without credit they might be unable to cover both current family living expenses and the cost of purchased inputs. The availability of loans is not by itself a solution to this problem. Loans must be large enough to adequately finance new practices, and the terms of these loans must be such that they encourage rather than discourage the use of credit. Unduly stringent collateral and repayment requirements may deter farmers from using credit. As an example, a relatively small loan requiring land as security and insisting upon repayment at harvest time -- when prices are lowest -- would probably be unattractive to farmers, despite the benefits they might derive from using new methods.

Another possible limitation on the farmer's capacity to utilize new practices is land tenure. When the farmer is a tenant rather than a landowner, he may be justifiably unwilling to use new practices. If he must bear all the costs and receive only a portion of the benefits, many otherwise attractive innovations would become unattractive. Secondly, he may be most unwilling to participate in improvements in the farm -- irrigation facilities, building soil fertility through fertilization, improved crop storage facilities -- if he is uncertain that he will have continued access to these resources.

Thus a favorable disposition toward a new technology is not a sufficient condition for its adoption. The farmer must also have available the resources -- inputs, credit, land resources -- necessary for implementing his decision in a form that does not discourage their use.

The Adoption Process: Decision-Making Involving the Interaction of Many Variables

"Rationality"

A basic assumption of the present theory is that farmers -- peasants and commercial farmers -- behave "rationally." The problem with this assumption is that opinions differ regarding the definition that should be given "rationality." Economists tend to have a very specialized meaning for this term which

usually involves the maximization of profits (in production) or utility (in consumption). Criticism of the "maximization" approach has given rise to the concept of "satisficing" -- choosing a satisfactory although not necessarily the "best" alternative. Among non-economists "rationality" usually receives a more general interpretation, meaning a choice of alternatives which conforms to the individual's value and belief systems. They normally emphasize the non-economic variables which influence individuals' choices.

We need not argue for or against the need for including "differences in personality, education, and social environment" since the impact of a large number of variables can be encompassed by our decision-making model. Differences in attitudes, beliefs, and educational achievement can influence decision-making through the impact of a priori associative knowledge on the process of formulating expectations. As an example, a fatalistic attitude might result in generally negative evaluations of new methods, while a higher level of education might permit a better understanding of the relationship between chemical fertilizer and crop yields through a clearer concept of plant nutrition. Since we have allowed for a flexible and individualistic interpretation of the shape of the utility function for increased incomes, variations in individual aspirations can be considered. Attention has also been given to empirical and communicated information which allows us to consider the impact of different sources of information. Finally, we have given

consideration to the farmer's capacity to implement his decisions, by including the availability of inputs, credit and land tenure. With these possibilities for the interaction of non-economic variables with economic variables, an assumption of "rationality" must, by necessity, take on a rather general character. Thus the "rationality" assumption is that farmers, given (1) their state of knowledge about various alternatives and the resulting expectations about possible outcomes and (2) their individual aspirations for economic gains and desire to avoid losses, choose the alternative actions that they believe to be "best" and attempt to implement them within the constraints of their particular situations.

Decision-Making: An Interactive System

The schema on the following page is a representation of the decision-making process relating those concepts which have been developed in the previous sections. This conceptualization involves the interaction of various kinds of information in the formulation of expectations, a comparison of the expected utility from new and current methods, and an implementation of the "best" alternative given the constraints imposed by the availability of certain resources -- credit, tenure, and inputs.

Let us examine this conceptualization in somewhat greater detail. The composition of the farmer's expectations, at any point in time, is the product of the information used in formulating these evaluations Initially he may have little more than *a priori information* with which

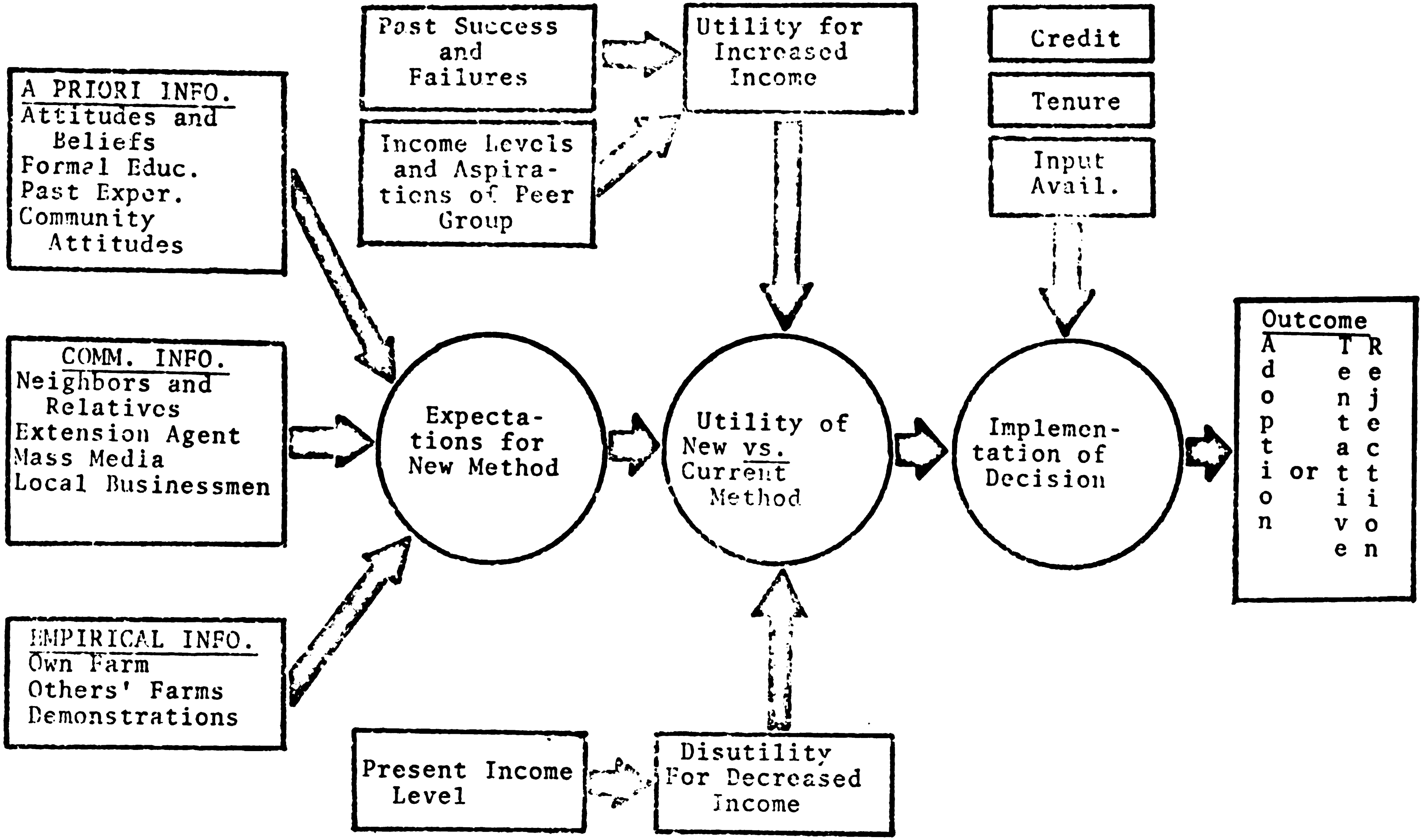

Figure 8.--Schematic View of Farmer Decision-Making With Respect to New Agricultural Practices.

to evaluate the possibility of various outcomes from an innovation, and consequently his expectations may reflect a great deal of uncertainty. If they include the possibility of outcomes consistent with returns below the minimum acceptable income level, he will tentatively reject the innovation and continue to use those practices which from experience he has learned to expect at least the minimally acceptable results.

Even expectations at this early stage will vary from farmer to farmer due to differences in the attitides and beliefs held by these individuals, variations in their past experiences and formal education, and differences in their perception of community attitudes. Farmers may hold attitudes, such as a fatalistic outlook, which affect their assessment of a new method in a negative manner. Or they may hold attitudes, such as a generally favorable view toward technological change, which would positively influence their expectations toward new practices. Favorable experiences with somewhat similar innovations in the past could stimulate a rather positive view of a new technology, while the past failures of poorly adapted innovations would justifiably cause the farmer to regard a new practice with considerable skepticism. The amount of formal education possessed by the farmer may also influence his evaluations of new methods, since especially in the case of technically complex innovations the better educated individuals would be assumed to reason toward a more technically accurate set of

expectations in a shorter period of time and with less empirical information than their poorly educated colleagues. Finally, a farmer who perceives his community's attitude as favorable toward technological advance may be more favorably disposed toward new methods than the farmer who believes his neighborhood would resist change. Thus, a number of hypothesized relationships between a priori information and the adoption of new technologies would be consistent with this conceptual framework.

As the farmers gather additional information (actively or passively), they will differ in their choice of sources of communicated ideas about new practices. Farmers who value information from extension agents (agronomists) or the mass media will conceivably be exposed to "messages" about a new technology at an earlier point in time than those who obtain their ideas from discussions with relatives and neighbors. The content of the respective "messages" will probably also be quite different. We might call "messages" from the extension agent and the mass media "direct" information, as opposed to "indirect" information from relatives and neighbors. The reason for this particular terminology is that "messages" from the extension agent and mass media would seem to pass through fewer intermediaries in their flow from the source of the innovation (perhaps the experiment station) to the ultimate recipient. Since each intermediary probably incorporates his own expectations into the message he presents to others, a message from a

"direct" source of information will include fewer modifications than the ideas received from such "indirect" sources as relatives and neighbors. In terms of the farmer's own expectations, we would expect those who utilize "direct" sources of information to formulate favorable expectations toward new methods more rapidly than farmers who depend heavily upon "indirect" information sources.

Still another form of information is observation of a new method in use. Farmers who have an opportunity to observe demonstrations of new practices may form favorable expectations relatively early. But those farmers whose desire for empirical information causes them to wait until new practices can be observed on their neighbors' farms will consequently be relatively late in formulating expectations favorable to the adoption of these methods. There is, of course, the possibility of limited trials on the farmer's own farm when an innovation lends itself to this practice and the farmer is financially able to engage in such experimentation. It should also be noted that the reformulation of expectations is not discontinued with the adoption of a new method as the farmer continues to assimilate information about the practices currently being applied.

At the same time that the farmer is formulating and reformulating his expectations about new methods he is contrasting the expected utility from the new method with that of the current practice. The relative attractiveness of the new method versus the current practice depends both upon

the expectations held by the farmer and his particular utility function. Two farmers with the same set of expectations may respond quite differently to an innovation depending upon their initial level of income. The larger and wealthier farmer may be willing to accept risks in pursuit of higher earnings that his smaller and poorer counterpart would find intolerable. The possibility of a 50 percent reduction in crop yields, as an example, might not reduce the wealthier farmer's income below an acceptable level, but for the poorer farmer such an outcome would represent considerable suffering for his family. Thus the poorer farmer may need to be more certain in his expectations and quite sure that untolerable outcomes will not be forthcoming before he adopts a new practice.

In addition to considering the disutility from possible decreases in income, the farmer evaluates the utility from possible increases in earnings. Differences in the motivation for additional earnings will vary the attractiveness of new methods as perceived by different farmers. Past successes or failures and the income levels and aspirations of a farmer's peer group may influence his desire for additional earnings. The income aspirations of the individual farmer, therefore, may affect his willingness to adopt new methods and accept the risks inherent in his expectations about the innovation. Farmers who are highly motivated to obtain increased earnings may consequently be willing to act upon less certain expectations than their less motivated colleagues.

A favorable disposition toward a new practice can be conceptualized as involving the interaction of a farmer's expectations and his utility for income, but this still does not imply adoption. The farmer must be able to implement what he believes to be the "best" alternative. He may find that sufficient credit is not available or that the terms of a needed loan involve too much "risk" to be acceptable despite the benefits that might be derived from a new practice. If the farmer is unsure that he will benefit fully from a new practice, because of his status as a tenant, he may be justifiably unwilling to employ a new method. Finally, he may not find the needed inputs available at a time and place that make it possible for him to utilize a new practice.

In summary, the adoption process has been conceptualized as the interaction of a number of variables which might be expected to affect the formulation of expectations, the shape of the farmer's utility function and his ability to implement what he considers to be his "best" alternative. This conceptualization of the adoption process will be examined empirically in the following chapters utilizing data from the MSU/SUDENE survey of farmers in the Recife area of Northeast Brazil.

CHAPTER IV

AGRICULTURE IN THE RECIFE AREA OF NORTHEAST BRAZIL: THE SOURCE AND CHARACTERISTICS OF THE DATA

Introduction

The empirical examination of the adoption process presented in the following chapters is based upon data generated by a survey of farmers in the Recife area of Northeast Brazil. This chapter provides an overview of agriculture in Brazil's Northeast and a description of the MSU/SUDENE Farmer Survey from which data used in the later chapters was taken. In addition, selected characteristics of the farms and farmers included in this survey will be presented.

An Overview of the Agricultural Economy in Northeast Brazil

The Northeast of Brazil is a large and populous area. Robock describes it in the following way:

> If the Brazilian Northeast were a separate nation, it would rank second in population and third in area within South America. With its present population [1963] of about 25 million, Brazil's "bulge" has as many people as Thailand, more than Argentina, and almost three times the number of people in the New England region of the United States. In area, the Northeast is larger than Italy, Spain, and Portugal combined.[117]

Climatic Sub-Regions of the Northeast

Four relatively distinct sub-regions are encompassed by the Northeast (see Map 1, page 118). A narrow humid strip,

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[117] Stefan H. Robock, Brazil's Developing Northeast: A Study of Regional Planning and Foreign Aid (Washington, D.C.: Brookings Institution, September 1963), p. 2.

called the Zona da Mata or "Forest Zone," lies along the coast between the city of Salvador to the upper edge of the state of Pernambuco. This area, ranging from thirty to sixty miles in width, has ample and dependable rainfall averaging over fifty inches per year. The southern portion of the Forest Zone in Pernambuco is very hilly, with an interspersion of relatively flat, shallow valleys. The northern part of the Forest Zone and the portion lying below Pernambuco consist of extensive flatlands cut irregularly by deep stream beds. Sugar cane production has been the principal economic activity in this area since the initial colonization of the region.

Lying to the west of the Forest Zone is the second major sub-region of the Northeast, the Agreste. The Agreste is a transitional zone separating the low-lying humid coastlands from the vast semi-arid interior plateau. Its width is approximately comparable to the Zona da Mata.

The Agreste has fairly reliable rainfall averaging thirty to forty inches per year. It is a generally hilly area, dotted with large rock outcroppings. The soil is of poor quality, but their structure and depth, in conjunction with a reasonably favorable climate, have permitted the development of a diversified agriculture. The Agreste has become the Northeast's primary internal source of foodstuffs. Beef, dairy products and such staples as beans, manioc, corn, and rice are produced in this area. Beef cattle are generally raised on extensive holdings, while the staples are typically produced under share-cropping arrangements or on the "minifundia" prevalent in the area.

Inland from the Agreste lies an extensive semi-arid region called the Sertão. Normal rainfall in this area is from twenty to thirty inches, but it is highly uncertain and typically concentrated in the first five months of the year. This leaves a dry season extending from June through December. Soils are shallow and have a low water retention capability. Drought is therefore a yearly occurrence, the seriousness of the phenomenon depending upon the volume of precipitation -- which may vary 30 percent from the average -- and the relative concentration or dispersion of the rainfall. Beef cattle, tree cotton, and sisal are the major products of the area.

The fourth sub-region consists of the tropical rain forest areas of Maranhão and southern Bahia. The expansion of slash-and-burn agriculture, especially in Maranhão, may eventually result in the deforestation of these areas.[118]

Economic History of Brazil's Northeast

In the early 1500's the Northeast became the site of the first Portuguese settlement in Brazil. With the ever-present hope that the Brazilian territory would eventually bear untold riches in precious metals, the colonizers sought an economic base that would enable them to support the defense and permanent occupation of the region. The solution emerged in

[118] Charles Slater, Harold M. Riley, *et al.*, *Market Processes*, pp. 2/3-2/7. Also, Robock, *op. cit.*, pp. 70-74.

the form of large-scale production of sugar, a commodity highly enough valued in European trade to offset the costs and uncertainties of long distance sea transportation. In addition to the suitable production conditions in the Zona da Mata, the technical expertise of Portuguese in sugar production and refining, the availability of an expanding European market, and access to African slaves as a cheap source of manpower, all contributed to the development of a sugar colony that flourished for more than a century. As a consequence, extensive sugar plantations emerged on the better coastal lands of Northeast Brazil and instituted a pattern of land use which has tenaciously resisted change to this date.[119]

At the height of its prosperity the sugar economy expanded rapidly. It is estimated that at one point in its growth, retained earnings were sufficient to finance a doubling of production every two years.[120] The profitability of this monoculture, however, resulted in an economic structure that had little impact on a broader economic development and integration of the region. Income was concentrated in a few hands, resulting in little incentive for the development of locally produced goods. Further, both consumption and investment were largely oriented toward the external sector. In fact, the basic organization of the sugar economy enabled it

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[119] Celso Furtado, The Economic Growth of Brazil, (Berkeley and Los Angeles: University of California Press, 1963), pp. 1-12.

[120] *Ibid.*, p. 48.

to withstand the ensuing decline in sugar prices without major structural change. Since in a slave economy where the major components of production are fixed capital it is in the best interest of the entrepreneur to maintain high levels of production, the sugar economy persisted even though by the mid-1600's Caribbean competition had depressed prices to one-half their former levels.[121]

The one economic outgrowth of the sugar economy was the development of cattle raising inland from the Zona da Mata. Both the demand for draft animals during the expansion of the sugar industry and the unprofitability of using sugar lands for cattle raising contributed to the growth of this enterprise. With the decline of the sugar industry, cattle raising inland assumed a new role, that of subsistence production to feed a growing indigenous population as well as emigrants from the depressed sugar growing area. Because cattle raising for subsistence purposes does not depend upon an external market for its maintenance, a second economic pattern emerged in the Northeast which had a great capacity to persist over time.[122]

The discovery of gold in Southern Brazil sparked the first major influx of European immigrants into the colony. This event was short-lived, however, reaching its peak in 1760 and declining to a minimal level of activity within the next two decades. Despite the early atrophy of the mining

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[121] _Ibid._, pp. 48-58.

[122] _Ibid._, pp. 58-77.

economy, there did exist for a time a rudimentary internal market such as had never occurred in the Northeast. Its existence is largely attributed to the broader distribution of the economic rewards from mining and the greater cost of imports in the interior mining areas.[123] In 1762, the movement of the capital of Brazil from Salvador to Rio de Janeiro signaled the shift in the center of economic gravity from the Northeast to the more richly endowed southern regions of Brazil.

With the decline of mining another center of economic growth developed in the Maranhão area of Northeast Brazil. A struggling colony had for some time existed in this area, progressing from capturing of indian slaves as the main enterprise to the collection of cocoa, vanilla, cinnamon, cloves and aromatic resins for export. A serious conflict between the colonists and Jesuit priests over the use of forced indian labor in the gathering of these tropical products culminated in the Portuguese government taking the side of the colonists and shortly thereafter establishing a well financed trading company to develop the region. The directors of the newly formed company seized upon the immediate world market opportunities for cotton and rice, fostering their production and subsequently avoiding the general depression that was common to all other regions of Brazil in the late 1700's.[124]

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[123] Ibid., pp. 77-92.

[124] Ibid., pp. 95-99.

Following a brief revival of sugar and cotton prices -- due to world political events in the early 1800's -- the Brazilian economy fell into a period of general economic decline by the mid-1800's.[125] Since manufacturing had not progressed rapidly, which can be attributed both to a lack of technical expertise on the part of the Portuguese and a weak internal market, Brazil was in desperate need of an export commodity which could assist it in becoming reintegrated with the world economy. The development of coffee production in the Rio de Janeiro area met this need and provided the stimulus for rapid development in the southern region. In its early stages of development coffee production capitalized upon pre-existing and under-utilized resources which had been idle since the demise of the mining economy. Later, without the alternative of importing slave labor, a second influx of European immigrants arrived in the South to work on the coffee farms. Further, the abundance of high-quality land permitted a great expansion of subsistence food production which also served as a stimulus for the most rapid population expansion of any region in Brazil. Finally, the rapid development of an internal market, spurred by coffee development, created economic incentives which were previously nonexistent and propelled the southern region into becoming the dynamic center of growth in the Brazilian economy.[126]

In the final years of the nineteenth century, the economy

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[125] _Ibid._, pp. 107-118.

[126] _Ibid._, p. 144.

of the Northeast suffered another setback which was dealt by the severe drought of 1877. The severity of the drought, in which one-half million people were reported to have perished, was exacerbated by the previous three decades of ample rainfall which had facilitated migration from the sugar producing area to the semi-arid areas inland. The Government of Brazil recognized the Northeast's drought as a problem, but relief efforts were slow and disorganized. The relief took the form of (1) emergency food and clothing, (2) make-shift public works to employ drought emigrants, and (3) relocation of emigrants to the Amazon basin.[127] There were many claims of irregularities in handling the relief funds, at that time entrusted to the state governments, which became a permanent criticism of the works against the droughts in the ensuing years.

Supported by the belief that the application of science and engineering could avert such disasters in the future, the government dispatched an Imperial Commission to make recommendations for government action. The Commission recommended building a series of dams and improvement of the transportation facilities in the Northeast, an approach that was to be followed without question for many years. The Inspectoria of Works Against the Drought was established to implement this approach.[128] The funds available to the Inspectoria and its successor agencies have varied widely

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[127] Albert O. Hirschman, Journeys Toward Progress, (New York: Twentieth Century Fund, 1963), p. 22.

[128] *Ibid.*, pp. 22-24.

over time, the highest levels of financing generally being correlated with major drought years and the presence of Northeasterners in high places in the federal government.[129] The lower levels of financing were often the result of the resumption of ample rainfall and fiscal problems faced by the government. These fluctuations in financial support suggest the theory that expenditures in poor areas generally must take second place to those in the vigorously growing economic areas, except in those times of national emergency.[130]

The highest level of funding was reached during the term of the only President from the Northeast, Epitacio Pessão, when 15% of the national budget was directed toward works against the drought. President Pessão believed that simultaneous development of reservoirs, roads, railroads, and port facilities was imperative because they were all part of a single system and to eliminate any one of them would leave the program incomplete. He pursued this policy with the accompanying detriment to Brazil's fiscal situation throughout his term in office from 1919 to 1923. His successor, in the face of fiscal difficulties, began suspending public works and by 1925 a complete suspension of such efforts had occurred.[131]

The construction of dams and public works received another major stimulus during the Vargas Administration in

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[129] Ibid., p. 18.

[130] Ibid., p. 34.

[131] Ibid., pp. 30-34.

in the 1930's.[132] However, the creation of irrigation facilities to utilize the stored water resources were continually delayed. Arguments for the value of the dams in themselves (as sources of water for humans and livestock), the fact that in normal years irrigation water is not a prerequisite for agricultural production, and the reluctance to disturb the landholding patterns downstream from the dams probably all contributed to this delay.[133] To date only about 18,000 hectares of 250,000 hectares of potentially irrigable land created by the dam projects are under irrigation.[134]

Doubts began to arise in the 1940's as to the efficacy of the "works against the droughts," especially dams, as a solution to the problems of the Northeast. José Augusto Trindade, first Director of Research and Extension in the drought area, noted the need to change attitudes toward water use and recommended expropriation of large landholdings in order to make optimum use of irrigable land. He also put forth the belief, to be reiterated by others later, that the dams did not serve the small farmers who were affected most by the droughts. Still another observation, by Trindade's successor Guinares Duque, even cast a shadow on irrigation as a solution to the Northeast's problems. From his calculations

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[132]<u>Ibid.</u>, pp. 38-39.

[133]<u>Ibid.</u>, pp. 42-43.

[134]Robock, <u>op. cit.</u>, p. 78.

of watershed-irrigation relationships it can be concluded that of a total 8 million hectares in the Northeast's drought area, a maximum of 800,000 hectares (10.0%) could be successfully irrigated from available rainfall.

With the advent of interest in economic planning, an alternative "economic solution" to the problems of the Northeast began to take shape. An early step in this direction was the creation of the Northeast Development Bank (BNB) in the early 1950's, which was charged with utilizing a portion of funds constitutionally set aside for the "fight against the drought" to make long-term loans for the development of the area's agriculture and industry.[135] The 1958 drought, one of the most severe ever in terms of displacement of the Northeast's population, intensified the belief that previous policies had not been adequate and further stimulated the search for an "economic solution." In response to this need, Celso Furtado, Director of BNB, prepared an economic report on the region. He recast the problems of the Northeast in terms of an increasing economic disparity between this region and other parts of the nation. In fact, he suggested that government policies on exports and imports had transferred resources to the industrial South.[136] In Furtado's view the main resource in the Northeast was cheap labor for industrialization, but the high cost of food limited the utilization of this labor for industrial

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[135] Ibid., p. 62.

[136] Robock, op. cit., p. 107.

purposes.[137] His proposals for economic development of the region contained three main thrusts: (1) intensification of investments in industry, (2) reorganization of agriculture, and (3) colonization of the Maranhão. Among his suggestions for restructuring agriculture was greater use of irrigation in the semi-arid regions for food production and a major effort to achieve better utilization of the lands in the sugar producing area.[138] The Superintendency for Development of the Northeast (SUDENE) came into being in 1959 to prepare and implement overall development plans following the Furtado suggestions and coordinate the activities of all those agencies charged with development efforts in the Northeast.[139] With SUDENE's emergence a new era had begun in the quest for solution to economic ills of Brazil's oldest region.

The Data from Northeast Brazil

During 1966-67, a team of Michigan State University researchers cooperated with SUDENE (the Northeast Brazil Economic Development Agency) in conducting a study of the marketing processes in the Recife area of Northeast Brazil.[140] Considerable emphasis was placed upon the marketing of farm products, with the total scope of the project covering farm

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[137] Hirschman, *op. cit.*, p. 75.

[138] *Ibid.*, p. 76.

[139] *Ibid.*, p.

[140] Charles Slater, Harold Riley, *et al.*, *Market Processes*, pp. 1/15-1/18.

production, assembly of farm products, wholesaling, retailing, urban consumers, industrial production, and the distribution of agricultural inputs. As a part of this study, a survey of 781 farms -- representing rice, bean, manioc, cotton and milk producers -- probed the production and marketing activities of farmers in municipios identified as important suppliers for the Recife urban market.

It should be noted that this survey was not a random sampling of farmers in the Northeast, but instead provided a representative sample of the farmers who in 1966 had sold at least NCr $100.00 (United States $45.45) of the commodities under study (rice, beans, cotton, manioc, and milk). Since the main interests in the LAMP study centered about the marketing of certain commodities, the observation of farms which introduced less than NCr $100.00 into the marketing system were believed to contribute relatively little toward understanding the problem at hand. Although exclusion of such farms is perhaps unfortunate for the purposes of the present study -- decision-making with regard to agricultural innovations -- it should be emphasized that annual sales at or near NCr $100.00 still represents a very low level of economic activity. Thus, even though the poorest of farmers may be omitted, the data does provide a considerable range of farm operations as given by size of holdings and annual sales.

The selection of the sample was accomplished in such a way as to allow a greater probability of sampling within those

municipios which were the most important suppliers of given commodities to the Recife urban market.[141] At the same time the sample size associated with the selected municipios was adjusted so that all producers (those selling NCr $100.00 of a specific commodity) had the same probability -- ex poste -- of entering the sample. In addition, each observation was drawn by a method which assured that the sample reflected the same distribution of farm size (over three general categories: 0-20 hectares, 21-120 ha., and 121 plus ha. -- except for cotton and milk producers) as was estimated for the population of producers (with annual sales over NCr $100.00) in each particular municipio. The primary sample was compiled from a list of property owners assembled by the IBRA, the Brazilian Land Reform Institute; while some non-owners were included as substitute interviews when the intended interview could not be completed. Table 1 below presents the location and number of observations from which the MSU/SUDENE farmer data was developed.

A broad range of questions were asked of the farmers in this survey; covering their attitudes and personal characteristics (age, size of family, educational background, etc.), the availability of farm inputs including credit, their marketing activities and the characteristics of their farm operations (including the use of specific practices -- innovations). Several of these questions seemed to be suitable as sources of data for the present study.

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[141] Ibid., pp. A/10-A/12.

Table 1.--MSU/SUDENE Survey of Farmers in Northeast Brazil.

Commodity	Location of Area	No. of Observations
Rice	Alagoas & Sergipe	127
	Maranhão	27
Beans	Alagoas & Pernambuco	130
	Bahia	51
Manioc	Pernambuco	155
Cotton	Paraiba & Pernambuco	165
Milk	Pernambuco	126
	TOTAL	781

Source: MSU/SUDENE Farm Survey (1967).

All of the products and areas encompassed in the MSU/SUDENE survey were not, however, included in the data utilized in the present study. Milk farmers and Maranhão rice farmers are the portions of the survey which were omitted. Since several of the questions asked of the milk farmers were necessarily different from the questions used with the crop farmers, milk farmers were omitted to allow treating the remaining areas and products as a group. The Maranhão rice area was omitted because of the very primitive nature of the agriculture in this area -- slash and burn. The geographical location of the areas which comprise the data in this study is indicated by the map on the following page.

Selected Characteristics of the Sample Farms and Farmers

The MSU/SUDENE survey data provides a considerable amount of information about the farms and farmers sampled.

Legend
Areas Sampled in Farm Surveys
[1]Rice Area
[2]Bean Areas
[3]Manioc Area
[4]Cotton Area

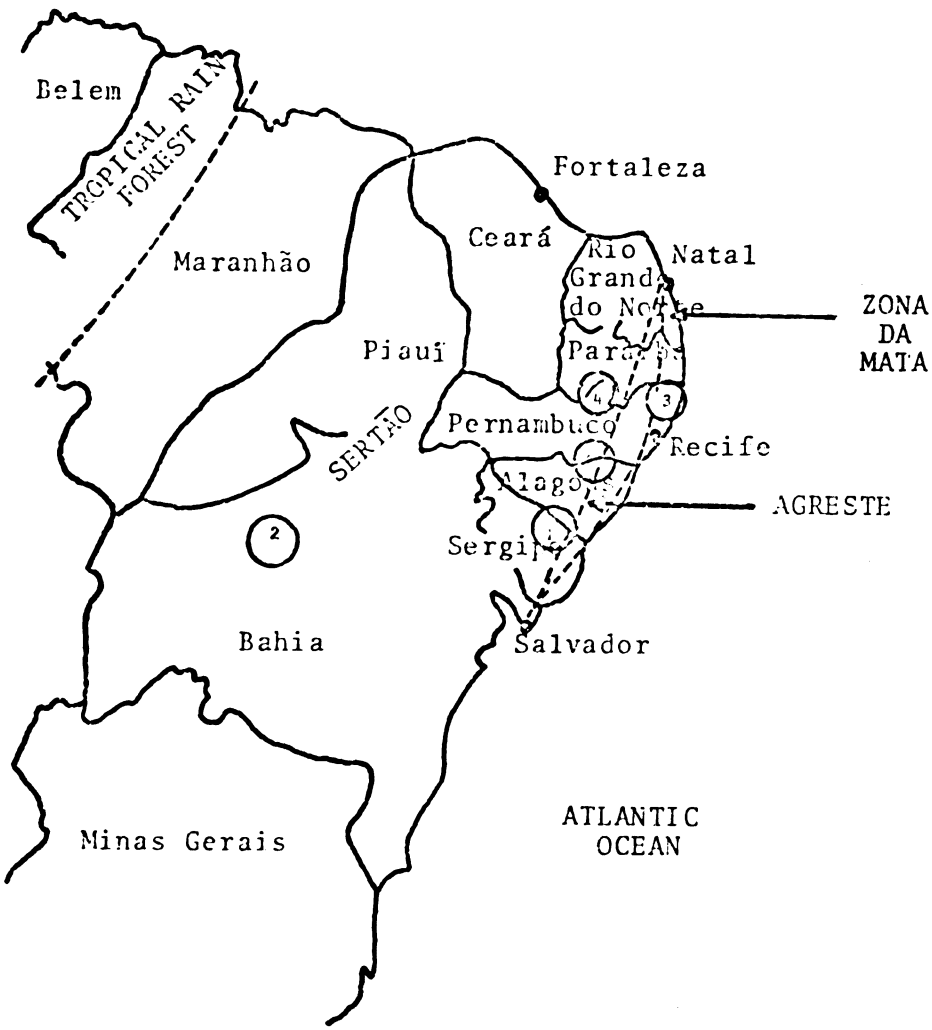

Figure 9.--Map of Northeast Brazil Showing Sample Areas for Commodities Studied.

, before we pursue the affects of certain on adoption of new technologies, is to present of the characteristics of the farmers studied. g is a brief summary of the crop yields, farm sales, farmers' attitudes, educational achieve-ication behavior, and the agricultural practices the farmers included in the sample.

elds were generally very low for the farms the MSU/SUDENE survey, as may be seen by ith the average yields in areas outside the able 2). Although average rice yields in the o area were somewhat higher than the average r areas of Brazil, they were less than 50 percent al yields found in the United States. Bean e survey farms were substantially less than the other areas of Brazil and roughly one-third of United States. Corn yields were even smaller n, with the average yield of the survey farms approximately one-fifth of average yields for tates. Finally, cotton yields for the survey nly about 25 percent as large as those for other zil.

Table 2.--Average Yields, By Commodities, for the MSU/SUDENE Survey Farms, and Other Areas.

Production Area	Rice	Beans	Corn	Cotton
	Pounds Per Acre			Bales Per Acre
Northeast[a]				
São Francisco--Rice (Alagoas and Pernambuco)	1704	--	--	--
Irecê--Bean (Bahia)	--	437	720[b]	--
Algoas-Pernambuco--Bean	--	415	1204[b]	--
Cotton	--	--	--	.26
All Brazil--Outside Northeast[c]	1502	715	--	1.48
United States[d]	4123	1319	5076	--

Sources: [a]Average 1965 yields for major crops in the various production areas sampled by the MSU/SUDENE Farm Survey (1967). Most of these figures can be found in Market Processes in the Recife Area of Northeast Brazil, p. 8/4.

[b]Corn yields are for 1966 rather than 1965.

[c]Annârio Estatistico do Brazil (1965).

[d]1964 United States Census of Agriculture (1964 yields).

Size of Farms and Farm Sales

The size of farms included in the sample vary from as small as two acres to as large as 7,472 acres. The bulk of these farms, however, tend to be at the smaller end of the continuum. Table 3 provides a summary of the distribution of farm sizes.

Table 3.--Distribution of Farm Size Over the Sample Farms.

Production Area	Average Size (acres)					
	Mean	Median	0-49 acres	50-244 acres	245-1234 acres	1234 & above acres
			per cent			
São Francisco-Rice	237	37	54	31	11	5
Irecê--Bean	180	89	39	35	26	0
Al-Pe--Bean	200	74	38	50	10	2
Cotton	256	85	34	42	19	5
Manioc	47	17	84	8	1	1
Total	224	44	51	34	12	3

Source: MSU/SUDENE Farm Survey (1967).

A few large and still fewer very large farms result in an extremely skewed distribution of farm size (as evidenced by the wide dispersion between mean and median acreages -- especially in the São Francisco rice area). At the same time many farms are quite small. Over 50 percent of São Francisco rice farmers and a still higher percentage (84) of manioc farmers (where 15 percent of the sample were on farms of less than ten acres) operate properties of less than fifty acres.

The average gross farm sales computed for the MSU/SUDENE study is $1,185 (crop farms), but averages tend to hide a considerable amount of information. Table 4 presents a more comprehensive view of gross farm sales. Over 40 percent of the farmers sampled had gross farm sales of less than one-half the overall average ($454). While there were a few

Table 4.--Distribution of Gross Farm Sales for Farmers in the Recife Area.

Production Area	Mean (in U.S. dollars)	Percentage Distribution[a]			
		Less than $454	$455- $2272	$2273- $4545	Above $4546
		-------------percent-----------			
São Francisco--Rice	$2,843	40.3	34.8	11.3	13.7
Irecê--Bean	1,274	40.8	40.8	12.3	6.0
Al-Pe--Bean	834	59.4	35.9	1.6	3.2
Cotton	665	64.6	27.4	7.3	0.6
Manioc	684	73.5	21.1	4.1	2.7

Source: MSU/SUDENE Farm Survey (1967).

[a]Converted from NCr$ at the exchange rate of 2.2 NCr$= 1.0 U.S. dollar ($455 ≈ 1000 NCr$, $2273 ≈ 5000 NCr$, $4546 ≈ 10,000 NCr$).

farmers who did have quite large gross sales relative to their Recife area counterparts, still only 1.8 percent of the farms sampled managed to equal or exceed the average gross farm sales for the United States farmers ($11,176 according to the 1964 Census). Thus again we find considerable dispersion among respondents, with many farmers whose annual sales are small and a few with much larger sales, yet still generally less than the average for United States farmers.

Attitudes and Beliefs

A farmer's attitudes and beliefs are often thought to have an affect on the decisions he reaches. The Recife Survey asked a number of attitudinal questions. Those which seemed to be most applicable to the present study are briefly

this section. Later we will consider them in
ail.

nan is a social being, not only his own attitudes
itudes that he believes his neighbors hold may
ect on his behavior. The Recive survey asked
reveal how they believed their neighbors would
an innovative member of the community and how
feel if he were able to progress more rapidly
lves. Table 5 gives the percentage of farmers
that their neighbors would not look favorably
circumstance.

ne Percentage of Farmers Who Believed That Their
ould Look Unfavorably Upon Someone Who Tried
ew or Who Progressed More Rapidly Than Themselves.[a]

a	"Local farmers think it's odd when somebody tries anything new."	"Local farmers wouldn't like to see me progress more than themselves."
	percent	
to--		
	92.0	44.9
	16.7	42.9
	66.7	37.5
	40.4	47.7
	77.6	33.9

J/SUDENE Farm Survey (1967).

percentages are based upon the number of
(usually 60-80 percent of the total sub-sample)
be interpreted cautiously.

The percentage of farmers who believed their neighbors would respond unfavorably toward an innovative member of the community varied widely by production areas, from as high as 92 percent for São Francisco rice farmers to as low as 17 percent for Irecê bean farmers. The farmers' assessment of his neighbors' attitudes toward those who advance more rapidly than themselves was considerably less variable between areas, from 34 percent to 48 percent believing that their neighbors would look unfavorably upon such a person.

Six questions probing the individual's own attitudes and beliefs were selected from the Recife Survey as measures of variables which might be expected to have an effect on the adoption of new technologies. The responses to single questions rather than indexes of responses to several somewhat similar questions are used as variables in this study. The reason for this approach is two-fold. First, the epistemological relationship between attitudinal questions and individual attitudes is problematic enough without blurring it still further by utilizing a set of questions which may each measure a somewhat different attitude (variable). Secondly, there is the difficult question of how each of the supposed measures of an attitudinal variable should be weighted as they are combined into indexes. As a result, we will use a more cautious approach of choosing single questions which seem to represent attitudes which might have an effect on innovativeness.

The following discussion briefly reviews these six questions and Table 6 indicates the response of farmers in

Table 6.--The Percentage of Recife Farmers Agreeing With Selected Attitudinal Statements.

Production Area	Nowadays the farmer alone can't do much to improve his life	To make more money, it is better to know how to do business than to be lucky	If someone has to choose, it's better to receive NCr $90. one year from now than NCr $30, today	We would be in a better situation if the technicians left things as they are	One can trust equally in relatives and other people	When new agricultural practices are suggested it is better to wait and see what happens when they are used by others
São Francisco--Rice	67.0	55.0	44.0	24.4	44.0	80.3
Irecê--Bean	98.0	49.0	22.0	23.4	51.0	76.6
Al-Pe--Bean	74.0	46.0	27.0	12.2	57.0	59.6
Cotton	89.3	41.8	38.0	24.5	45.3	68.9
Manioc	87.3	65.1	44.8	17.6	69.7	69.7

Source: MSU/SUDENE Farm Survey (1967).

each of the production areas.

Farmers in less developed countries are often believed to be fatalistic. This concept is defined by Rogers as "the degree to which an individual perceives a lack of ability to control his future."[142] The Recife farmers' responses to the following statement was used as a measure of his fatalism: "Nowadays the farmer alone can't do much to improve his life."

Table 6 gives the farmers' responses for each of the production areas. Since 75 percent to 98 percent of the respondents -- depending upon the area -- agreed with the above statement, one might suspect that farmers in the Recife area are rather "traditional" in their views. However, such premature generalizations should be avoided. When Michigan farmers were confronted with nearly the same statement, 66 percent gave responses which indicated a similar fatalistic view.[143] It should be recognized that these statements did not specify in what sense the farmer is fatalistic; toward the possibility of improving things on his own farm or in the agricultural sector in general.

Rogers also proposes an alternative view of fatalism. He suggests that fatalism may be simply an ad hoc

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[142] Rogers, Modernization Among Peasants, p. 273.

[143] Dale Hathaway, et al., Michigan Farmers in the Mid-Sixties, (Research Report No. 54, Agricultural Experiment Station, Michigan State University) includes the following question: "Today farmers can't do much to determine the way things turn out." Sixty-six percent of their sample agreed with this statement.

rationalization for failure, a psychological mechanism for reducing cognitive dissonance.[144] This view will be kept in mind during the later analysis of the variable.

With the <u>fatalism</u> variable the main concern was whether the farmer thought much could be accomplished toward improving his life situation. The following statement deals with the farmer's view of which of two alternative components, luck or knowledge, is most important in achieving a better situation: "To make more money, it is better to know how to do business than to be lucky."

From Table 6 we find that from 42 percent to 65 percent of the Recife farmers believed that knowing how to do business was of greater value in obtaining increased incomes than simply being lucky. This may seem rather strange given the high percentage of farmers who reported that they were fatalistic. One rationalization might be that although farmers believe in general that they cannot do much to improve their situation, they also believe that if there are any gains at all to be made, one should not depend upon luck to achieve them. Still another argument is simply that farmers hold inconsistent beliefs. This problem will be considered again somewhat later.

The following question probes the Brazilian farmers' willingness to defer economic gratification: "If someone has to choose, it's better to receive NCr $90. one year from

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[144] Rogers, <u>Modernization Among Peasants</u>, pp. 275-276.

now than NCr $30. today." (This amounts to roughly United States $13.63 today as opposed to United States $40.90 in one year.) Although an imperfect measure, this question may give some crude estimate of the farmer's willingness to defer current income in order to obtain a larger return in the future. Table 6 reveals that most farmers -- roughly 60 percent -- prefer the smaller amount immediately to three times as much a year from now. It should be remembered that Brazil has experienced a considerable amount of inflation in recent years and that the farmer would likely evaluate 90 NCr$ a year from now as somewhat less than three times 30 NCr$ now (for a reason completely apart from time preference).[145]

Much has been made recently about the unwillingness of farmers in less developed countries, especially "peasant" farmers, to trust anyone outside their own family.[146] The following question was used in the MSU/SUDENE survey as a measure of an individual's willingness to trust others: "One can trust equally in relatives and other people." Interestingly enough, a large proportion -- 44 percent to 70 percent -- of Recife farmers agreed with this statement (see Table 6).

The Recife farmers' general attitude toward new technology was of particular interest in this study.

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[145] Inflation rates of 20% or more per year have been common since World War II. A level of 20% per month was reached in early 1964.

[146] Rogers, Modernization Among Peasants, pp. 26-28.

Agreement or disagreement with the following statement was utilized in attempting to assess this attitude: "We would be in a better situation if the technicians left things as they are." This question was intended to elicit the farmer's overall attitude toward the change-generating activities of people in these positions. Negative responses should indicate a hopeful view of technical change. A positive response would suggest that the farmer believes that the activities of scientists and technicians -- introducing new methods -- can offer little to improve his individual well-being. In general, Recife farmers exhibited a rather favorable attitude toward new technology as only 12 percent to 25 percent agreed with the above statement (see Table 6).

Also of considerable interest in this study was the farmers' unwillingness to try new methods without first observing them in use by others. The following statement lends itself to this interpretation: "When new agricultural products are offered it is better to wait and see what happens when they are used by others." As might be expected, a large proportion -- 60 percent to 80 percent -- of the Recife farmers agreed with this statement.

Table 6 summarizes the attitudes discussed in this section. Although a good deal of variation occurs between production areas, a general profile of the attitudes of Recife farmers can be developed. They are generally fatalistic, even though it is fairly likely that they may believe that knowing how to do business is a more dependable way of getting ahead than being lucky. The chances are greatest that they will prefer a smaller amount of money now to a larger amount in even the near future. They are surprisingly favorable toward new technology and about equally split in their willingness to trust people who are unrelated to them. Finally, over two-thirds of these farmers believe that the best strategy is to let someone else try new methods first.

Educational Achievement

The level of formal training received by the Recife area farmers is generally low. In Table 7 the educational accomplishment of Recife farmers is divided into the six groups used throughout this study.

Table 7.--The Educational Achievement of Recife Farmers.

Production Area	Years of Education Completed					
	none	1 year	2-3 years	4-5 years	6-12 years	more than 12 years
São Francisco--Rice	31.7	12.7	23.8	19.0	11.1	1.6
Irecê--Bean	30.6	28.6	24.5	6.1	8.1	2.0
Al-Pe--Bean	55.5	10.2	21.1	7.0	4.0	2.4
Manioc	45.3	19.3	22.0	8.0	5.4	0.0
Cotton	46.6	22.4	20.0	7.2	3.0	0.6

Source: MSU/SUDENE Farm Survey (1967).

From the table, we find that roughly one-third or more had not attended school. Again, except for rice farmers, over 80 percent of the sample had completed less than four grades of schooling. Even so, a few farmers had completed an elementary level education or attended secondary school, and a smaller number still had achieved more than a secondary level of education. If formal educational achievement can be thought of as influencing the individual's ability to process information about new methods -- literacy and conceptual ability -- a wide range of such abilities should be encountered among Recife farmers.

Communication Behavior

The Recife farmers were asked where they had learned about the newest method they were using. Their responses are given in Table 8.

Table 8.--From Where or Whom Recife Farmers Had Learned the Latest Farming Method They Were Using.[a]

Production Area	Information Source						
	Relative	Neighbor	Agronomist	Businessman	People from a different place	Mass Media	Another Source
	percent						
São Francisco--Rice	10.0	53.7	12.7	3.6	7.2	2.8	10.0
Irecê--Bean	26.1	54.3	10.9	4.4	--	2.1	--
Al-Pe--Bean	14.6	54.0	8.9	9.7	12.1	0.8	--
Manioc	20.0	50.9	10.5	4.3	7.9	--	6.2
Cotton	25.0	49.3	11.8	6.3	3.4	2.7	1.4

Source: MSU/SUDENE Farm Survey (1967).

[a]Computed on the basis of respondents who were using one of several "innovations" selected by SUDENE/MSU researchers and who indicated where they had learned about the one most recently applied. Some farmers were either using none of these methods or didn't respond to the question.

The importance of "indirect sources," neighbors and relatives, is immediately obvious. Neighbors usually accounted for about 50 percent of the responses, and with the addition of relatives, two-thirds or more of the responses are accounted for by indirect sources. "Direct sources," such as the agronomist and mass media, account for approximately 10 percent to 15 percent. Other sources, which lie somewhere between these "direct" and "indirect" sources, account for the remaining responses.

The use of radio, farm magazines, and attendance at extension meetings was also examined by the Recife survey. Table 9 presents the percentage of farmers who had ever read a magazine about agriculture, attended an extension meeting, and those who have a functioning radio in their home.

Table 9.--Percentage of Recife Farmers Who Have Read a Farm Magazine, Attended an Extension Meeting, and Have a Functioning Radio in Their Home.

Production Area	Read a Farm Magazine	Attended an Extension Meeting	Have a Functioning Radio in the Home
São Francisco--Rice	18.5	19.5	76.4
Irecê--Bean	32.7	26.5	65.3
Al-Pe--Bean	7.0	16.4	50.8
Manioc	12.6	10.7	56.7
Cotton	14.5	9.7	52.7

Source: MSU/SUDENE Farm Survey (1967).

While more than one-half of the Recife farmers had a functioning radio in their home, a much smaller percentage had read a magazine about agriculture. Attendance at meetings where agronomists talked about production methods was reported by an average of 14.3 percent of the sample farmers with Irecê bean farmers indicating the highest level of attendance. In all, the data suggests (despite the rather frequent presence of radios in the home) that the bulk of information about new farming practices comes from an "indirect" source, flowing from farmer to farmer.

Use of Selected Agricultural Practices

Certain farm practices were selected by the MSU/SUDENE research team as "innovations." The researchers believed these practices to be useful improvements over present methods and to represent a suitable base for measuring the innovativeness of Recife area farmers. A complete assessment of the economic contribution of each of these practices is not available. Thus we have to trust the judgement of the researchers who conducted the field work. The percentage of Recife farmers using these selected practices is given in Table 10.

The use of these practices vary considerably from area to area. Fertilization of crop land was not a common practice among the Recife farmers sampled. The application of barnyard manure was reported by 24 percent of the São Francisco rice farmers, 35 percent of the manioc farmers, and less than 10 percent of the farmers in the other areas.

Table 10.--Percentage of Farmers Using Selected Innovations By Commodity, 1967.

Production Area	Non-Chemical Fertilizer	Chemical Fertilizer	Improved Seed	Insecticides	Fumigants	Ox and Plow	Hand Planter	Tractor	Pesticide Dusting Machine
São Francisco--Rice	24.4	11.8	58.3	70.1	26.8	23.6	10.2	51.2	18.9
Irecê--Beans	0.0	0.0	65.3	44.9	89.8	14.3	49.0	65.3	24.5
Al-Pe--Beans	9.4	0.0	56.3	14.1	73.4	94.5	80.5	1.6	7.8
Manioc	35.3	0.7	50.0	18.7	0.0	8.7	0.0	2.0	20.0
Cotton	7.9	0.6	52.1	64.8	0.6	34.5	0.6	4.2	31.5

Source: MSU/SUDENE Farm Survey (1967).

The use of chemical fertilizer was even less frequent, with the São Francisco rice farmers being the only group to have a significant number of its members (12 percent) employing this practice.

The use of improved seeds was reported by over half the respondents in each area, but this response is probably not very meaningful as the data seems to reflect the selection of the biggest and best looking seeds from the individual's own production rather than the use of improved strains, varieties, or hybrids. Insecticides were quite commonly used by farmers in the São Francisco rice area (70 percent), the cotton producing area (65 percent), and Irecê bean area (45 percent); while less than 20 percent of the Alagoas-

Pernambuco and manioc areas used this practice. The application of fumigants to stored crops was mostly found among the Irecê (90 percent) and Alagoas-Pernambuco (73 percent) bean farmers, although a few (24 percent) of the São Francisco rice farmers were using this practice. The ox and plow and the hand planter were practices most frequently used by Alagoas-Pernambuco bean farmers (95 percent and 81 percent respectively). The use of tractors, on the other hand, seemed to be concentrated in the São Francisco rice (51 percent) and Irecê bean (65 percent) areas. Finally, the highest percentage of farmers using a pesticide dusting machine was found in the cotton area (32 percent).

CHAPTER V

ANALYSIS OF SELECTED VARIABLES AND THEIR RELATIONSHIP TO THE ADOPTION OF AGRICULTURAL INNOVATIONS BY FARMERS IN NORTHEAST BRAZIL

Introduction

The conceptual framework proposed in Chapter III describes the adoption of new technology as an individual decision-making process involving the interaction of a number of variables. Using the data from the MSU/SUDENE survey of farmers in Northeast Brazil, this chapter provides an empirical examination of a portion of this conceptualization. For the present, the emphasis will be upon those variables which might be expected to affect the individual's evaluation of a new agricultural practice, while the next chapter examines some possible constraints upon the implementation stage of the adoption process. Attention is given to the inter-relationships between the variables as well as their relationship to the use of new agricultural methods.

Community Attitudes

As suggested in the conceptual statement, the attitudes a farmer perceives that his neighbors hold might be expected to influence his decisions toward new agricultural practices. This proposed relationship was examined in the context of the Recife farmers' perception of how local farmers would react to someone who tries something new or someone who progresses more rapidly than his neighbors.

Combining the responses of sample farmers, it was discovered that a direct relationship between perceived community attitudes and the farmer's use of certain modern practices could not be supported statistically. Farmers who believed their neighbors would respond negatively toward those members of the community who tried something new or who advanced more rapidly than their counterparts were no less inclined to use barnyard manure, chemical fertilizer, field insecticides or tractors than those individuals of the opposite persuasions. Given the possibilities for interactions of numerous variables in the decision-making process, the attitudes of the Recife farmers' neighbors may still be of some influence in the adoption process even though they are not by themselves useful as predictors of innovativeness.

Setting aside this matter momentarily, it would be of interest to know if those farmers who believed that their neighbors would resent the more rapid advancement of a community member also thought that their neighbors would laugh at innovators. Although the two opinions are not necessarily interconnected, there is a tendency for them to be associated. Of those who believed local farmers would disapprove of their more rapid progress, 54.3% reported that their neighbors would think it was funny if someone tried something new. Among farmers who held the opposite opinion, 41.3% believed that their neighbors would laugh at innovators. (This association was significant at less than the .005 level using chi-square analysis.) Thus, there seems to be some evidence of an interconnection between these views in the rural Recife communities, at least as the farmers perceive them. Yet even farmers viewing their communities as both opposing individual advancement and regarding innovators as foolish were not found to be significantly less inclined to adopt certain modern practices (chemical fertilizers, insecticides, and tractors) than those holding other expectations about their neighbors.

We return to the question of what relationship, if any, is there between perceived community views and individual behavior toward new agricultural practices. One might suggest that negative neighborhood attitudes toward innovators or individual advancement would influence a farmer's evaluation of new technologies. He might be expected to discount the value of new technologies which promise economic advance if he presumes that his community will look upon such progress unfavorably. Or, he may be influenced by his neighbor's assessment of innovators as foolish in developing his own general evaluation of new ideas. There seems to be some justification for these propositions, even though farmers in Northeast Brazil seem to generally view the activities of technicians in a hopeful light. (Recall that less than 25% of the Recife farmers believed things would be better if technicians left things alone.) By far the largest percentage of those holding a negative view of new technology were farmers who believed their neighbors would not like to see them get ahead -- 62.0%. The reverse is true of a positive attitude toward new technology where only 47.9% of the group were fearful that their neighbors would not like to see them advance more rapidly than the rest of the community. (A chi-square analysis of these relationships was significant at the .01 level.) The results are much the same for the farmer's expectation of his neighbor's attitude toward innovators and its relationship to attitudes toward the activities of technicians. Here 63.0% of those holding a negative attitude toward new technology believed their neighbors would regard innovators as foolish, while 47.9% of those with a positive attitude believed this to be the case. (A chi-square analysis was significant at less than .005 for these relationships.) This would seem to imply that negative neighborhood attitudes, as perceived by the individual farmer, contribute to the low esteem in which the activities of technicians are held by certain producers.

A similar argument can be made for the significant relationship between the farmer's view of neighbors' attitude toward personal advancement and his knowledge of how to improve crop yields. Recife farmers were presented with the following question: "How would you try to increase output without cultivating more land?"

While 62% of the Recife farmers were able to articulate some method of increasing present yields -- using fertilizers, insecticides, irrigation, closer spacing of crops, etc. --

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NOTE: Unless otherwise stated statistical significance is reported at the .05 level.

the remaining farmers seemed to have no idea how they could increase present output without bringing more land under cultivation. Of those who believed their neighbors would not like to see them get ahead, 58% knew of some method to improve yields. By comparison, 67% of those Recife farmers holding the opposite view were able to suggest a method for increasing yields. These relationships were significant at the .05 level. (A similar difference was found between the farmers who held opposing views about their neighbors' attitudes toward innovators, but it was not of a statistically significant magnitude.) An explanation for this finding might be that individuals who believe their neighbors would look unfavorably upon them getting ahead are less motivated to learn ways to improve their situation.

There is some additional evidence which suggests that farmers who believe their neighbors would respond unfavorably to their individual advancement were less aggressive in gathering information about new agricultural practices. While most of the Recife farmers reported that they had learned the latest practice from neighbors or relatives -- 72% --, the importance of this "indirect" source of information varied significantly with the individual's perception of his neighbor's attitudes. By comparison, 66% of those who believed their neighbors wouldn't object to their individual advancement depended upon neighbors and relatives as a source of information as opposed to 78% of the farmers who perceived their neighbors to hold the opposite view.

This suggests a tendency on the part of those who would expect community disapproval to be less likely to use the more direct sources of information -- local businessmen, agronomist, and mass media -- in obtaining their ideas about new agricultural practices. (See Table 11.)

Table 11.--Information Sources Used by Recife Farmers Holding Opposing Expectations of Community Attitudes.

"Local farmers would not like to see me progress more rapidly than themselves."	Percent Using These Information Services[a]			
	Neighbors and Relatives	People From a Different Place	Local Businessman	Agronomist and Mass Media
Agree	78	7	3	12
Disagree	66	8	10	16

[a]Represents 72.3% of the sample. The unspecified category termed "another source" is omitted and a large number of farmers did not give a response.

At this point we have some evidence that community attitudes may have a certain amount of influence on the decision-making process through their effect upon the individual's general attitude toward new technology and upon his motivation for learning about ways of improving his situation. There is another interesting dimension to Recife farmers' perception of community attitudes. Somewhat surprisingly, 58% of those farmers who believed business knowledge to be superior to luck in earning more money also thought their neighbors would resent seeing them get ahead. At the same time, of those who were inclined to think of higher earnings as a matter of luck, 46% believed that local farmers would disapprove of their advancement. A chi-square test of these relationships indicated that the knowledge-oriented farmers were significantly (at the .01 level) more likely to expect neighborhood resentment of their progress.

Farmers favoring business knowledge over luck were also more likely to be among the ranks of those who believed local farmers would regard innovators as foolish -- 57.3%, while less than half -- 46.7% -- of those counting on luck believed that an innovator would be laughed at in their community. A chi-square test found this association to be significant at the .05 level.

It would certainly be difficult to postulate an acceptable causality between negative community attitudes toward individual advancement and innovativeness and a choice of business knowledge over luck as a means of earning more money. The more useful approach seems to be to reason in the opposite direction. Perhaps the roughly 50% of the Recife farmers who chose business knowledge over being lucky represent a somewhat more progressive, business-oriented, segment of the sample. This possibility seems to be supported by the fact that a choice of business knowledge is associated with farmers with relatively higher incomes and larger acreages. These farmers may have done things that were "different" in the past and may have progressed more rapidly than their neighbors, and thereby personally experienced the resentment of local farmers. Since _expectations_ of community behavior (which is the basis of the community variables under discussion) are the product of past experiences, this group of farmers may be more sensitized to community attitudes than their less progressive counterparts. In a somewhat similar vein, Rogers found that innovative farmers often remarked that they could not win popularity contests by their method of operation.[147]

In summary, the MSU/SUDENE Survey has provided us with some useful data on the effects of perceived community attitudes upon the decision-making of Recife farmers. Non-progressive attitudes toward innovators and individual advancement seems to be associated with low esteem for the activities of technicians, less aggressive information seeking, and less knowledge of how to improve yields. On the other hand, slightly more progressive, "business-oriented" members of a community may be somewhat more likely to assess their neighborhood's response as negative toward innovators and individual achievement.

Individual Attitudes

The logic behind the expected impact of the six attitudes selected from the Recife survey will be discussed in this section and an attempt will be made to determine if the MSU/SUDENE data lends support to the arguments.

Fatalism

Our assumption in this study is that fatalism is an attitude which might be expected to inhibit innovativeness. (Note that it is not termed a "barrier" to innovativeness.)

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[147]Rogers, Diffusion, p. 200.

The fatalistic farmer, it would seem, will be less willing -- than his non-fatalistic colleagues -- to entertain the notion that adoption of new methods will improve his situation. His fatalistic view of life may be presumed to negatively bias his expectations toward innovations. This does not prevent his eventual adoption of new methods since additional information, collected over time, can ultimately cause a revision of his expectations. It would, however, retard his progress toward acceptance of innovations.

The majority of Recife farmers agreed with a fatalistic view of their situation, which is apparently not uncommon (as indicated by Michigan data) to farmers elsewhere. Rogers (see page 14) states that fatalism is a characteristic of the peasant subculture.[148] The Recife data, however, indicates that fatalism is not limited to small and poor farmers. In fact, the poorest farmers in the sample were not significantly more fatalistic than their wealthier counterparts. (See Table 12 below.)

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[148] Rogers, Modernization Among Peasants, p. 35.

Table 12.--Percentage of Recife Farmers Who Expressed A Fatalistic View By Income Levels.

Per Capita Family Income (U.S. Dollars)	"Nowadays the farmer alone cannot do much to improve his life."	
	Agree	Disagree
	---------------percent---------------	
Less than $50	82.8	17.2
$50 - $99	81.3	18.7
$100 - $199	82.4	17.6
$200 - $499	81.9	18.1
$500 and above	78.0	22.0

Nor did fatalistic farmers operate smaller acreages. Only the farmers on the very largest acreages were less fatalistic (although not significantly so by a chi-square test) than the smallest farmers.

Table 13.--Percentage of Recife Farmers Who Expressed A Fatalistic View By Farm Size.

Farm Size (in acres)	"Nowadays a farmer alone cannot do much to improve his life."		Number of Observations
	Agree	Disagree	
0 - 49	84.6	15.3	322
50 - 244	82.2	17.8	214
245 - 1234	86.1	13.9	73
1235 and above	66.7	33.3	18

Education and age also did not seem to be associated with fatalism. Fatalistic farmers were, however, significantly less likely to defer income than their non-fatalistic neighbors.

Of the fatalistic farmers, 37.8% stated that they would prefer 90 NCr$ one year from now to 30 NCr$ immediately. At the same time, 49.5% of the non-fatalistic farmers would be willing to wait a year to receive the larger sum.

Of perhaps greater interest is the effect of fatalism/non-fatalism upon the adoption process. Fatalistic farmers were not found to be significantly less likely to adopt tractors, chemical fertilizer, or insecticides than non-fatalistic farmers. But this relationship is beyond what was postulated earlier. Recall that we thought it reasonable to expect fatalistic farmers to be "less willing to entertain the notion that adoption of new methods will improve his situation." There is some evidence that a fatalistic view did "retard progress toward acceptance of innovations." However, it did not seem to manifest itself in a negative attitude toward the activities of technicians (perhaps because technicians offer a hope for improvements that individual farmers feel incapable of accomplishing themselves). Yet the fatalistically inclined farmers exhibited considerably less knowledge of new methods which might improve the productivity of their farms and subsequently their well-being. Table 14 indicates that the fatalistic farmers were less inclined to know about fertilizer specifically and about ways to improve yields in general.

Table 14.--The Percentage of Fatalistic and Non-Fatalistic Recife Farmers Who Knew About Fertilizer and Knew How to Improve Yields.[a]

Attitude	Know What Fertilizer Is	Know How to Improve Yields
	--------------percent--------------	
Fatalistic	54.8	59.4
Non-Fatalistic	73.5	74.5

[a]These relationships were significant at the .005 level using chi-square analysis.

This finding seems to indicate that non-fatalistic farmers were more highly motivated to learn about new methods. In addition, non-fatalistic farmers tended to use more direct sources of information (in learning about the newest method they were using) than the fatalistic producers. Table 15 describes this situation.

Table 15.--Information Sources Used By Fatalistic and Non-Fatalistic Farmers in the Recife Area.[a]

Attitude	Percent of Farmers Using These Information Sources			
	Relatives and Neighbors	People From a Different Place	Business-man	Agronomist and Mass Media
Fatalistic	74.2	7.8	5.7	12.2
Non-Fatalistic	68.6	2.4	9.6	19.9

[a]Represents 82.5% of the Recife sample of crop farmers. An unspecified category termed "another source" was omitted and several farmers did not respond to the question.

The percentage of fatalistic farmers who had attended meetings where an agronomist had talked about new farming methods was, however, not significantly different than for non-fatalistic farmers. Nor were non-fatalistic farmers more likely to have read a farm magazine. Radio listenership, on the other hand, exhibits a unique pattern of differences between fatalistic and non-fatalistic farmers. The non-fatalistic farmers listen somewhat more frequently, but listen fewer hours than their fatalistic colleagues.

In summary, "fatalism" seemed to be largely independent of age, income level, farm size and the education level of the respondent. The evidence suggests the notion that non-fatalistic farmers are more aggressive in acquiring knowledge about how to improve farm production. They tend to look beyond relatives and neighbors more frequently in seeking this information, although they don't seem to have read farm magazines or attended sessions with an agronomist more often than fatalistic farmers. In general, the MSU/SUDENE data indicates that fatalistic attitudes may have an inhibiting effect upon the rate at which farmers form favorable expectations toward new technologies. That fatalism does not influence the decision-making process, but instead is an ex poste explanation for failure as suggested by Rogers, tends to be negated by the previous analysis.

Luck versus Knowledge

The Recife farmer's choice between luck or knowledge as the most important component of achieving higher earnings seems to be related to past business success (due either to good management or good fortune). Those who believed in business knowledge tended to earn higher incomes and operate larger farms than farmers who favored being lucky. Tables 16 and 17 illustrate these relationships.

Table 16.--The Importance of Business Knowledge in Earning Higher Incomes as Judged By Recife Farmers at Various Income Levels.[a]

Family Per Capita Income Level[b]	"To make more money it is better to know how to do business than to be lucky." Agree	Disagree
	--------------percent--------------------	
Less than $50	42.3	57.7
$50 - $99	45.2	54.8
$100 - $199	50.5	49.5
$200 - $499	62.9	37.1
$500 and up	67.3	32.6

[a]Chi-square test for these relationships was significant at .005.

[b]Family income from all sources divided by number of persons in the household, a measure of level of living. (U.S. dollars)

Table 17.--The Importance of Business Knowledge in Earning Higher Incomes as Judged By Recife Farmers on Various Sized Farms.[a]

Farm Size in Acres	"To make more money it is better to know how to do business than to be lucky." Agree	Disagree
	---------------percent--------------------	
0 - 49	45.1	54.9
50 - 244	47.8	52.2
245 - 1234	60.6	39.4
1235 and above	66.7	33.2

[a]Chi-square tests gave a significance level of .05.

Apparently, relative business success reinforces the belief that knowing how to do business is the best means of improving one's situation, while less fortunate farmers tend to attribute success or failure to luck. Educational achievement, which is also related to income and farm size, seems to be associated with the farmer's choice between luck and knowledge. Table 18 describes the greater likelihood of Recife farmers believing in the advantages of knowing how to do business as their level of education increases.

Table 18.--The Importance of Business Knowledge in Earning Higher Incomes As Judged By Recife Farmers With Various Levels of Education.[a]

Last Year of School Completed	"To make more money it is better to know how to do business than to be lucky." Agree	Disagree
	percent	
None	38.2	61.8
1 year	46.3	53.7
2 - 3 years	53.6	46.4
4 or more years	70.3	29.7

[a]Chi-square table was significant at the .005 level.

It is well to know that farm size, income levels, and educational achievement are the antecedents of this attitude, but of more importance is some knowledge of its consequents. Among poorly educated farmers, (roughly 60% of Recife farmers were functionally illiterate) a belief that luck is the more important component in business success may have a significant effect on their decision-making process. It may be reasonable to expect that farmers who would depend on luck are not as motivated to seek out information as their knowledge-oriented colleagues. Since the formation of realistic expectations usually involves a certain amount of information gathering and assimilation, the farmer's attitude toward luck versus knowledge may be thought to affect the pace of innovation adoption.

Like fatalism, there was no significant relationship to be found between luck/knowledge and the adoption of non-chemical fertilizer, chemical fertilizer and insecticides. But, unlike fatalism, farmers who favored business knowledge used tractors significantly more often than their associates who regarded luck as the source of higher earnings. Tractor usage was reported by 21.4% of those favoring knowledge, while 13.7% of the remaining farmers used tractors. It might seem reasonable to explain this in terms of the relationship between luck/knowledge and income and farm size, since tractor usage is significantly related to both of these variables. The logic of a relationship between an expensive tractor -- selling for about $6,000 in the Recife area[149] -- and larger farm size and higher incomes seems to present an imposing argument for such reasoning. The difficulty is that almost 30% of the Recife farmers reported the availability of rental tractors in their area. In addition, the use of chemical fertilizer is also significantly

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[149] Slater, Riley, et al., Market Processes ...., reports the prices of two tractors sold in the Recife area: Massey-Ferguson 50X -- $6,395.45 and Valmet -- $6,090.90.

related to both farm size and farm income, but not significantly related to luck/knowledge. One can only speculate, then, that the relationship between luck/knowledge and tractor use may reflect some of the impact of farm size and income.

The information sources used by farmers expressing these opposing views seems to support the contention that farmers who depend upon luck are not as motivated to seek out information as those who are inclined toward business knowledge as the most important factor in financial success.

Table 19.--Information Sources Used by Recife Farmers Differing In Their View of the Source of Higher Earnings.[a]

"To make more money it is better to know how to do business than to be lucky."	Percent of Farmers Using These Information Sources			
	Relatives and Neighbors	People From a Different Place	Businessmen	Agronomist and Mass Media
Agree	67.6	7.7	8.1	10.6
Disagree	78.2	6.5	4.6	10.3

[a]Chi-square table was significant at the .05 level.

In general, those farmers associating themselves with business knowledge tended to learn about innovations from relatives and neighbors less frequently and use more "direct" sources with greater frequency than those farmers who believed that luck controlled their fortunes. They were significantly more likely to have attended meetings where agronomists talked about new farming methods (18% attended as opposed to 11.9%) and were more likely to have read a farm magazine (37.2% versus 26.2%). With respect to listening to the radio, however, the behavior of farmers who put their faith in business knowledge was not significantly different than those who believed in luck. Again a significantly (.005 level) greater percentage of the business knowledge-oriented farmers knew about fertilizer (65.6%) than their luck-oriented counterparts (50.2%). Yet, they were not particularly more likely to know how to improve yields. The evidence also suggests that there is not a relationship between luck/knowledge and the Recife farmers' attitude toward new technology. This seems to indicate that a business-orientation does not necessarily imply a favorable attitude toward new methods. Such a finding might come as a surprise had we not discovered earlier that fatalism and luck/knowledge were apparently unrelated. While each of these attitudinal variables should be recognized as representing a different aspect of the farmer's view of the world ("image"), it would be intellectually more satisfying if all of his views were completely consistent. This is undoubtedly too much to expect of man. Certainly "rationality," as defined in this study, is not negated by the apparent inconsistencies in the belief patterns of (largely poorly educated) Recife farmers.[150]

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[150] If consistency would require that the farmers' beliefs be non-fatalistic + business knowledge + positive attitude toward technicians or the reverse, only 15.2% of the Recife sample would hold consistent beliefs.

In general, the data from the Recife area indicates that the business knowledge-orientation of the farmer, which was strongly related to past success, appears to influence the decision-maker's motivation to seek information. A business knowledge-orientation does not, however, imply a favorable attitude toward new technologies in general (although the greater information-seeking efforts of these farmers probably implies a more rapid formulation of a favorable image toward specific new methods).

Deferred Income

The survey question involving a choice between NCr $30. immediately and NCr $90. a year from now was used here to measure the relationship between the Recife farmers' time preference for income and his adoption of new methods. It was reasoned that the farmer whose time preference is weighted heavily to the present would be relatively unwilling to sacrifice present consumption in order to finance the use of new methods which promised higher future earnings.

Many of the innovations available to traditional farmers involve additional cash expenditures. In the absence of abundant credit, the farmer must forego part of his present income in order to earn the higher future returns available with new methods. His willingness (or unwillingness) to sacrifice current consumption on the expectation of a higher level of consumption at a later point in time might have an effect on how favorably he views innovations. Not unexpectedly, the Recife farmers' time preference, as measured by this question, was not significantly related to his use of tractors, insecticides, and fertilizer. Since there is no reason to believe that his attitude toward deferring income would influence the sources of information used or his knowledge situation, the influence of this variable, within the decision-making process, cannot be tested further until Chapter VI (where the interaction of several variables will be examined using an Automatic Interaction Detection program).

In the meantime there are certain other relationships which are of interest. One in particular is the association between deferred income and fatalism. Fatalistic farmers were found to be significantly less inclined to wait a year for larger returns than non-fatalistic farmers. By comparison, 37.8% of the fatalistic farmers chose the NCr $90. future alternative, while 49.5% of the non-fatalistic farmers were willing to wait for the larger sum. Thus, it appears that farmers who believe they can do little to influence the future have a tendency to live for today, while farmers with a more hopeful view of the future are more willing to wait for future rewards. With respect to the luck/knowledge dichotomy, we find that farmers who believed that higher earnings are largely a matter of luck were significantly (.01) less likely to choose the future return than their business knowledge-oriented counterparts (35.4% as opposed to 45.2%). Again an underlying confidence or lack of confidence in the future seems to be at work in the association of these variables. A somewhat surprising development was the lack of association between willingness to defer income and income levels. One would expect that the immediate needs of the poorer farmers in the sample would severely limit their willingness to defer income. Perhaps the wording of the question reduces the possibility of such an outcome. The specific wording gives the impression of a hypothetical gift for which the respondent can choose the timing. If the farmer were asked whether or not he would pay NCr $30. now for a certain income of NCr $90. one year from now (more directly a time preference investment question), one would certainly expect the immediate needs of the poorer farmers would be reflected in their choices.

There is little that may be concluded (at this point) regarding the effect of a willingness to defer income upon the adoption process. The effect of the variable was not sufficiently strong to be independently related to the use of certain innovations. Nor was there reason to expect it to influence other variables within the decision-making system.

Attitude Toward New Technology

The majority of the Recife farmers -- according to the MSU/SUDENE data, were inclined to favorably view the activities of technicians, which has been interpreted to mean a rather positive attitude toward new technologies in general. The farmers who didn't share this view, as was noted earlier, were somewhat more likely to believe that their neighbors would disapprove of their individual advancement or regard innovators as foolish. Beyond this association, however, the data provides little by way of relationships with other variables which could be utilized in characterizing the farmers holding opposing views toward new technology. The likelihood of a positive (or negative) attitude toward new technology was not found to be a function of educational achievement, income level or farm size. Nor was it at all related to fatalism or luck/knowledge.

Of greater interest, however, is the influence of attitudes toward new technology on the adoption of agricultural innovations. The general perspective in which farmers view new technology may be expected to bias their decision-making with respect to innovations. The farmer who perceives new methods as a route to improvement of his situation will tend to expect favorable results from innovations. This does not imply that he immediately accepts every innovation disregarding the uncertainties surrounding it. It does mean that he engages in the process of information gathering and expectations formation under the assumption that the innovation might be found useful. The farmer whose general attitude toward new methods is negative may be expected to seek out little in the way of additional information about innovations. He would be expected to believe that any additional information would simply support his present negative conclusions.

Since the majority of farmers seemed to be generally favorable to new technologies, we will address our analysis to examining the ways in which the minority -- those who view new technologies negatively -- behave differently from the rest. The Recife farmers' use of tractors and fertilizer was not related to their overall attitude toward new technologies, but insecticide usage did seem to be associated with their view toward new methods. Forty-three percent of all Recife farmers reported that they used insecticides. A slightly higher percentage (45.7%) of farmers with positive attitudes toward new technology applied insecticides, while a significantly smaller proportion (35.8%) of the farmers with negative attitudes used this practice. In addition we find that farmers possessing negative attitudes toward new methods are significantly less likely to know how to improve yields than other Recife farmers -- 45.9%, as opposed to 68.1%. This evidence begins to support the contention that farmers with a negative view toward new technologies in general seem to utilize this opinion in developing their expectations toward specific innovations, and are consequently less likely to seek out additional information about new practices.

Still more support for this hypothesis is provided by an analysis of the information sources used by Recife farmers divided along their views toward new methods. Local (indirect) sources were reported significantly (.005) more often by farmers with the negative attitudes as being the origin of their knowledge about the newest practices they were using.

On the other hand, the proportion of farmers utilizing the agronomist or mass media as a source of information was three times greater for producers with positive attitudes toward new technology than for their counterparts with

Table 20.--Information Sources Used By Recife Farmers Divided According to Their Attitude Toward New Technology.

Attitude Toward New Technologies	Percent of Recife Farmers Using These Information Sources			
	Relatives and Neighbors	People From Another Place	Local Businessmen	Agronomist and Mass Media
Positive	68.3	8.1	6.7	16.8
Negative	84.1	5.3	5.3	5.3

negative views.

Based upon the available data, the Recife farmers with negative attitudes toward new technologies were also significantly less likely to have read a farm magazine than their positive-oriented colleagues -- 16.4% versus 36.8%. They listened to the radio significantly less often -- 38.3% as opposed to 29.6% seldom listen, while 20.3% as against 33.2% listen more than one hour per day. Yet, surprisingly enough, farmers with negative attitudes toward new methods were not any less likely to have attended a meeting where an agronomist had talked about new production methods.

In all, the weight of the evidence seems to suggest that Recife farmers who hold a generally unfavorable view of new technologies were less inclined to seek out additional information, upon which to base their expectations about new methods, than those farmers who are predisposed in favor of new technologies.

Interpersonal Trust

It was expected that a distrust of outsiders would be associated with a reduction in the sources of information about new technologies that the individual is willing to accept. If one can trust only relatives, it would seem unlikely that the advice of government extension agencies would be assigned much credibility. The individual might, through his distrust of others, be excluding himself from information that would help him to formulate favorable expectations about new methods. The hypothesis that non-trusting farmers would tend to concentrate upon their relatives as a source of information about agricultural innovations was not, however, supported by the data. Nor was there any evidence of an association between trust and other attitudinal variables, or trust and farm size, income level, or educational achievement. In general, it was concluded that a Recife farmer's willingness to trust others had very little to contribute, at least as it was measured in this study, to an understanding of the adoption process.

Attitude Toward Trying New Methods

Farmers who are willing to try new methods, without first waiting to see what success others have had, would be expected to use more modern techniques than their more conservative counterparts. There are three possible reaons for their willingness to experiment with locally untried practices: (1) they may be very confident of their ability to formulate accurate expectations; (2) more willing to accept risks; or (3) better able to withstand the cost of being wrong. The source of this venturesomeness will be examined in the course of analyzing the variable.

A small percentage -- 26.4% -- of the Recife farmers indicated that they would be willing to try a new method without first observing it in use by others. One would expect this small group, on the average, to be more innovative than the remaining farmers. The evidence seems to be evenly divided regarding this proposition. Over the four innovations examined, those farmers who were willing to try things first used barnyard manure and tractors significantly more frequently, but did not seem to use chemical fertilizers and insecticides much more often than their more conservative counterparts. Table 21 presents this data in detail.

Table 21.--Use of Selected Innovations By Recife Farmers Differing in Their Attitudes Toward Trying New Practices.

"When new agricultural products are offered it is better to wait and see what happens when they are used by others."	Percent of Farmers Using Selected Innovations			
	Barnyard Manure[a]	Chemical Fertilizer	Insecticides	Tractors[a]
Agree	15.9	2.6	42.0	15.6
Disagree	23.3	3.1	45.4	23.9

[a]Chi-square analysis was significant at the .05 level.

In general, these results seem to suggest that farmers who are willing to try a new method without the guidance of others' experiences may have been somewhat more innovative than the remaining Recife farmers.

The second part of the analysis is to attempt to determine what factors influence the farmer's willingness/unwillingness to use locally untried practices. The best explanation provided by the Recife data is that venturesomeness is related to the farmer's ability to withstand losses. The percentage of farmers who preferred to wait and observe the experiences of others is greatest among the smaller and poorer farmers. Table 22 describes the relationship between farm size and the Recife farmer's strategy for trying new methods.

Table 22.--The Recife Farmer's Attitude Toward Trying New Practices by Size of Farm.[a]

Size of Farm (acres)	"When new agricultural products are offered it is better to wait and see what happens when they are used by others."	
	Agree	Disagree
	percent	
0 - 49	76.5	23.5
50 - 244	74.8	25.2
245 - 1234	63.0	37.0
1235 and above	50.0	50.0

[a]Chi-square analysis is significant at the .05 level.

The largest farmers were twice as likely as the smallest farmers to assert their willingness to use (locally) untried practices. They apparently recognize their better position for risk-taking and are willing to act upon it. The small farmers also seem to be cognizant of their situation and typically prefer to observe some local experience with new practices before they try them (to reduce their level of uncertainty).

The association between the farmer's expressed willingness to use untried practices and his level of income is much the same as for farm size. Table 23 presents these relationships.

Table 23.--The Recife Farmer's Attitude Toward Trying New Practices By Level of Income.[a]

Per Capita Family Income (U.S. Dollars)	"When new agricultural products are offered it is better to wait and see what happens when they are used by others."	
	Agree	Disagree
	percent	
Less than $50	78.6	21.4
$50 - $99	70.0	30.0
$100 - $199	77.1	22.9
$200 - $499	63.3	36.6
$500 and above	64.0	36.0

[a]Chi-square analysis significant at the .05 level.

Here it was found that as the farmer's level of living decreases he has a greater tendency to be cautious in using new practices. One might think of this finding in terms of the theoretical framework where as the farmer's income level approaches some "subsistence level of living" it becomes more difficult to persuade him to accept the risks inherent in untried practices.

Although capacity to absorb risks seems to be a fairly adequate explanation of the Recife farmer's choice of strategies in trying new practices, conclusive evidence does not exist which would exclude such other possibilities as: (1) being willing to accept risks (a gambler preference concept as opposed to capacity to absorb risks); or (2) degree of confidence in one's ability to formulate accurate expectations. The evidence that is available, however, seems to cast doubt upon these alternative explanations. Higher educational levels and a business-orientation might be thought of as related in some way to an individual's degree of confidence in his ability to formulate accurate expectations, without locally generated empirical information. Yet neither of these variables was significantly related to the Recife farmer's strategy for trying new practices. A variable exploring the individual's willingness to accept risks in order to obtain certain gains in income (to be examined somewhat later in this chapter) was also found to be unrelated to the farmer's approach to trying new methods.

In summary, the individual's willingness/unwillingness to try new practices without first observing the outcomes experienced by others seems to be largely based upon his capability to absorb the cost of making mistakes. Those who indicated a willingness to use locally untried practices may also be somewhat more innovative than the remaining farmers.

Summary

Reviewing the attitudinal variables examined in this section, we find evidence in support of the conceptualization of the decision-making process as suggested in Chapter III. Even though it was the unusual case where the attitudinal dichotomies involving fatalism/non-fatalism, luck/knowledge, and positive/negative attitude toward new technology were found to be significantly related to the use of certain innovations; each of these variables seems to influence -- in a predictable manner -- the sources of information used by the decision-maker, his use of certain communication channels, and his knowledge of fertilizer or other ways to improve yields. In addition it was found that the farmer's attitude toward trying new practices seemed to be related to his adoption of some new practices. These four variables seem to enter into the decision-making process and to influence this process in a fairly predictable manner. On the other hand, it was impossible to determine if the Recife farmer's time preference for income level had any influence upon his decisions. And finally, interpersonal trust did not exhibit the hypothesized influence upon his choice of information sources.

Educational Achievement

Educational level is usually assumed to be related to individual innovativeness. Yet, from the standpoint of this study, formal education is only a proxy measure of certain skills which are useful in the formulation of expectations about new technologies. Education involves a certain mastery over symbols -- literacy and mathematical skills -- and a development of conceptual structures useful in evaluating particular situations. As an example of the impact of this second factor upon the adoption of new technologies, consider the case of fertilizer. The farmer who understands the relationship between soil type and nutrient holding capacity is probably in better position to form expectations about the effect of fertilizer on his particular fields than the farmer who lacks this conceptual framework. Presumably he will be better able to interpret the recommendations of the agricultural specialist.

It is necessary, however, to be considerably less specific in our analysis of the decision-making system involving Recife farmers. Here we find that higher educational levels seem to be associated with knowledge about chemical fertilizer, the difficulty perceived in using fertilizers, and a knowledge of how to improve yields in general. Table 24 describes these relationships.

Table 24.--The Percentage of Recife Farmers Knowing About Fertilizer, Believing That It Was Difficult to Use, and Knowing How to Improve Yields -- By Education Level.[a]

Number of Years of School Attended	Know What Fertilizer Is	Believe That Fertilizer Is Difficult To Use[b]	Know How To Improve Yields
	percent		
None	50.4	45.3	54.0
1 year	46.0	38.8	58.4
2 - 3 years	63.8	28.4	65.9
4 - 5 years	76.7	28.3	80.0
6 - 12 years	83.3	23.3	66.7
More than 12 years	100.0	14.3	100.0

[a]Chi-square tables involving these variables were significant at .05 or less.

[b]Involves only those farmers who knew about fertilizer.

Despite certain interruptions in the trends, the data suggests that the better educated farmers are more knowledgeable about chemical fertilizer and other methods of improving yields.

It would be an illusion, however, to attribute the better educated farmer's greater likelihood of knowing about fertilizer and other methods of imporiving yields entirely to his superior conceptual abilities, if for no other reason than the association between education and the use of more direct sources of information. In Table 25 we find that the better educated farmers were more inclined to have read a farm magazine or attended an agronomist's meeting than their less educated counterparts.

Table 25.--Percentage of Recife Farmers Who Had Read a Farm Magazine or Attended a Meeting Where an Agronomist Talked About New Production Methods -- By Educational Levels.[a]

Number of Years of School Attended	Read a Farm Magazine[b]	Attended an Agronomist's Meeting
	percent	
None	24.9	8.8
1 year	26.6	8.0
2 - 3 years	39.5	17.4
4 - 5 years	49.2	30.0
6 - 12 years	82.9	34.0
More than 12 years	83.3	71.4

[a]Chi-square analysis was significant at .005 level.

[b]The survey question allows for someone to have read "a" magazine to the farmer.

It should be noted that while Recife farmers with less than a fourth grade education represent 83.7% of the sample, they account for only 62.0% of those who had attended meetings where an agronomist talked about new production methods. In general, the better educated farmers were either better prepared or more highly motivated to use these sources of agricultural information.

This same characteristic, involving better educated farmers using more direct information sources, is exhibited in the responses given by Recife farmers regarding the origin of their knowledge about the latest practice that they had employed. Table 26 summarizes these relationships.

Table 26.--The Source of Information Used by Recife Farmers to Learn About Their Latest Practice According to Educational Levels.[a]

Number of Years of School Attended	Percent of Recife Farmers Using These Information Sources: Relatives and Neighbors	People From Another Place	Local Businessmen	Agronomist and Mass Media
None	76.0	9.8	6.7	7.5
1 year	74.2	9.3	6.2	10.3
2 - 3 years	72.3	6.3	6.3	15.2
4 - 5 years	68.6	0.0	7.4	24.1
6 years or more[b]	62.8	0.0	2.9	34.3

[a]Chi-square analysis was significant at .05 level.

[b]More than 12 years category was omitted because it included only 4 observations. Total table was compiled on the basis of 83.3% of the sample either because of lack of responses to the question of information sources or failure to have adopted any new practices.

The table indicates that as the level of education increases the degree of dependency upon indirect sources -- relatives, neighbors, and people from another place -- tends to decrease; and farmers begin to look more frequently to such direct sources as the agronomist and the mass media. Again we might speculate that the intellectual skills of better educated farmers enable them to make greater use of direct information sources, than less educated farmers, in formulating their expectations about new technologies.

The relationship between education level and radio listenership is so unique as to deserve special attention. As the educational level of farmers increased they were more likely to listen to the radio, but tended to devote less time to this practice. Table 27 illustrates the relationship between educational achievement and radio listening habits.

Table 27.--The Relationship Between Frequency of Listening to Radio and the Educational Level of Recife Farmers.[a]

Number of Years of School Attended	Listen to Radio			
	Never	Seldom	1 hr./day	More than 1 hr./day
	percent			
None	12.7	36.3	28.8	22.1
1 year	8.1	30.6	26.1	35.1
2 - 3 years	7.4	33.1	23.5	36.0
4 - 5 years	0.0	16.9	40.7	42.4
6 years or more	0.0	30.0	42.5	27.5

[a]Chi-square analysis significant at .005 level.

Note that all Recife farmers with more than a fourth grade education listen to radio, but while the proportion who listen more than one hour per day increases through the fifth grade it declines considerably for higher levels of education.

Education levels, in turn, are associated with size of farm and level of income. Since the flow of causality between these variables is probably in both directions, the relationships will simply be reported. Table 28 indicates the relationship between educational level and farm size. Note that as the size of farm increases the percentage of farmers having higher levels of education also increases.

Table 28.--Educational Level of Recife Farmers By Size of Farm.[a]

Size of Farm (acres)	Number of Years of School Attended					
	None	1 year	2-3 years	4-5 years	6-12 years	More than 12 years
	percent					
0 - 49	51.9	19.6	20.2	5.0	3.4	---
50 - 244	41.6	16.8	22.9	13.1	5.1	0.5
245 - 1234	23.3	16.4	24.6	15.1	13.7	6.8
1235	5.6	11.1	27.8	27.8	22.2	5.6

[a]Chi-square analysis is significant at the .005 level.

The situation is much the same with respect to levels of incomes (Table 29).

Table 29.--Educational Level of Recife Farmers By Level of Income.

Per Capita Family Income (U.S. dollars)	Number of Years of School Attended					
	None	1 year	2-3 years	4-5 years	6-12 years	More than 12 years
Less than $50	57.9	17.9	19.7	3.6	0.9	---
$50 - $99	37.9	18.6	31.0	6.2	4.7	1.6
$100 - $199	34.0	23.7	19.6	12.4	10.3	---
$200 - $499	30.5	18.1	22.2	20.8	6.9	1.4
$500 and above	16.0	6.0	16.0	30.0	24.0	8.0

[a]Chi-square relationship was significant at .005 level.

Here again we find the level of education, as would be expected, generally increasing with increasing levels of family income. Neither of these relationships are particularly surprising, but they do contribute somewhat to our understanding of the data being studied.

In conclusion, there appears significant relationships between the Recife farmer's educational achievement and his knowledge of fertilizer and other methods of improving yields. In addition, a higher level of education seems to be associated with somewhat less dependency upon indirect sources of information (particularly relatives and neighbors) about agricultural innovations.

Communicated Information

In past sections we have examined the association of certain variables with the information sources used by Recife farmers. This has involved the assumption that "direct" sources -- sources closest to the origin of the innovation -- were related to a more rapid adoption of new agricultural practices. The intention of this section is to examine that assumption.

It will be recalled that one of the variables used to identify the farmer's choice of information sources is based upon a question probing where he had learned about the newest method he was employing. If we are prepared to argue that those sources used with respect to the most recent method typify the information sources generally used by Recife farmers, we can proceed with an analysis of the association between information sources and certain innovations. Given this assumption, we find the relationships described in Table 30.

Table 30.--Percent of Recife Farmers Using Selected Innovations By Source of Information.[a]

Source of information about latest method used	Percent Using Selected Innovations			
	Insecticide	Tractor	Chemical Fertilizer	Non-chemical Fertilizer
Relative	44.0	18.0	1.0	17.0
Neighbor	42.3	17.5	2.8	18.2
People from another place	31.6	15.8	0.0	18.4
Local business-men	66.7	3.0	0.0	21.2
Agronomist	76.3	35.6	11.9	20.3
Mass Media	70.0	30.0	0.0	20.0

[a]Chi-square analysis was significant at .001 level for insecticides, tractors, chemical fertilizer and not significant at .05 level for non-chemical fertilizer. Table is based upon 83.6% of the sample who responded to the question.

The association between the Recife farmer's source of information (about his last practice) and selected innovations seems to support the notion that the farmers who make use of "direct" information sources are more innovative than others. Recife farmers who reported the agronomist as a source of information were more likely to use insecticides, tractors, and chemical fertilizer than farmers reporting other sources. (While the agronomist was reported by only 11.8% of the respondents given in Table 30, these farmers accounted for 43.8% of the users of chemical fertilizer, 18.0% of insecticide usage, and 21.2% of those who used tractors.) Those who used the mass media were more likely than farmers using other sources (except the agronomist) to have adopted tractors and insecticides, but not chemical fertilizer. Again, those farmers who learned of their latest practice from a local businessman tended to use insecticides more often than those who gathered their information from relatives, neighbors, or people from another place. The fact that insecticides are sold by a large number of firms in the rural Recife area, whereas tractors and fertilizer are not, may help to account for this relationship.[151] Finally, the use of non-chemical fertilizer (manure), however, was not found to be significantly associated with the farmer's source of information.

A similar case may be made from the relationship between the farmer's use of certain forms of communication and his

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[151] Slater, Riley, et al., Market Processes, p. 8/27.

adoption of selected innovations. Table 31 describes these associations.

Table 31.--Percent of Recife Farmers Using Selected Innovations by Use/Non-Use of Certain Information Sources.[a]

Use of Selected Sources of Information	Percent Using Selected Innovations			
	Insecticide	Tractor	Chemical Fertilizer	Non-Chemical Fertilizer
Had read a farm magazine	68.6	37.3	7.8	31.4
Had not read a farm magazine	37.4	13.7	1.7	15.0
Own a functioning radio	49.5	25.1	4.1	22.9
Do not own a functioning radio	32.6	6.6	0.8	10.9
Attended an agronomist's meeting	63.0	35.8	6.5	28.3
Not attended an agronomist's meeting	38.9	14.4	2.1	15.9

[a]A chi-square analysis of each of these relationships was significant at the .005 level.

The Recife farmers who had read farm magazines were more likely to have used fertilizers, insecticides, and tractors than those who had not. Those who had attended meetings where an agronomist had talked about new farming methods seemed to be more innovative than their counterparts who had never attended such meetings. A difference in innovativeness also seems to occur between farmers who had a functioning radio in their home and those who did not. In addition, it should be observed that a significant (.05) association exists between exposure to these channels and the Recife farmer's latest farming practice. The percentage of respondents who indicated that they had learned their latest practice from an agronomist or from the mass media is greater among those farmers who had read farm magazines, attended an agronomist's meeting, or who had a radio in their home.

In all, the evidence seems to support the assumption that the farmers who make use of "direct" sources of information tend to be more innovative than those who depend upon local "indirect" sources of information. The use of "direct/indirect" as opposed to "cosmopolite/localite" as a division of information sources seems to be a conceptual improvement since "people from a different place" are "cosmopolite" by definition (see page 40), but such sources of information (according to Table 30) do not appear to be any improvement over one's neighbors and relatives.

Before concluding this section, it should be mentioned that income and farm size, as well as certain attitudes and the farmer's education level, are related to sources of information. The use of the agronomist and the mass media as a source of information about new methods increases with larger farm sizes and higher levels of income.

Utility Function

Until now, the emphasis has been upon the effect of certain variables as they contribute to the farmer's knowledge of innovations, which in turn shape his expectations of these innovations. The theoretical framework of Chapter III postulates an overall relationship between the farmer's expectations, his utility function for income, and his ultimate decision regarding particular innovations. Just as we were unable to directly examine the farmer's expectations in past sections, we are unable to duplicate his utility function in this section. Nonetheless, as in past sections, there is certain data from the Recife survey which may provide some insight into the interactive process of farmer decision-making. Thus we turn our attention to a discussion of certain propositions related to the effect of the utility function upon the adoption of new technologies.

As a beginning, consider the relationship between income levels and the adoption of new practices. In past sections we have found income levels to be associated with certain attitudes -- luck/knowledge and attitude toward trying new technologies --, educational levels, and the sources of information used by farmers. All of these might interact in the decision process causing innovativeness to be associated with level of income. Adding to this the fact that new methods often involve additional capital outlays, the financial capabilities of higher income levels provides still another reason for income to be related with innovativeness. Finally, there is the hypothesized relationship between nearness to a "subsistence level of income" and the farmer's willingness to accept the risks inherent in new technologies. Since each of these factors may be involved in a relationship between income levels and innovativeness, as given in

Table 32, it is necessary to look for additional evidence of the latter relationship. One possible source of such evidence lies within the responses of Recife farmers to the following question:

> "Let's pretend you have tried a new method or technique on your crop and the results were bad causing you to lose half of your production. What would happen to the crop and to the family?"

Table 32.--The Percentage of Recife Farmers Using Selected Innovations By Income Level.[a]

Level of Per Capita Family Income (U.S. dollars)	Percent Using Selected Innovations			
	Insecticides	Tractors	Chemical Fertilizer	Non-Chemical Fertilizer
Less than $50	29.4	7.3	0.0	13.2
$50 - $99	42.2	15.5	3.0	15.5
$100 - $199	57.8	20.6	2.1	19.6
$200 - $499	50.0	33.3	5.9	23.6
$500 and above	76.0	60.0	14.0	34.0

[a]Chi-square analysis was significant at the .005 level for each of these relationships.

Table 33 indicates the farmers' responses to this question separated on basis of family income levels.

Table 33.--Recife Farmers' Indication of the Consequences of the Failure of an Innovation, According to Levels of Income.[a]

Level of Per Capita Family Income - 1966 (U.S. dollars)	Consequences of the Failure of an Innovation: Would have to borrow money	Would have to sell assets	Family would suffer	Would get a part-time job or become a rural worker	Would try again	Would never try again
	percent					
Less than $50	3.7	4.1	74.7	3.3	10.8	3.3
$50 - $99	4.7	3.9	71.3	1.0	14.7	4.7
$100 - $199	2.0	4.2	64.5	2.1	21.9	5.2
$200 - $499	4.2	12.5	51.4	1.4	25.0	5.6
$500 and above	4.2	4.0	46.0	6.0	32.0	8.0

[a]Chi-square table was significant at .005 level

Approximately three-quarters of the farmers in the lowest income bracket -- less than $50 per family member -- believed their families would suffer from the failure of an innovation. By comparison, less than half of those farmers with $500 or more per capita family income believed their families would bear the cost of such a catastrophe. Again, the proportion of farmers in the highest income group who would react to such a situation by "trying again" was three times greater than for the poorest farmers. Although these empirical relationships do not provide a conclusive argument for the hypothesized relationship between nearness to a "subsistence level of income" and reluctance to accept the risks of new technologies, they do seem to support his proposal in a general way. If we add to this evidence the association, as discovered earlier, between the willingness/ unwillingness to try locally untested practices and the farmer's income level, the case favoring this particular hypothesis is once again strengthened.

In turning to consideration of the Recife farmers' utility for increased income, the MSU/SUDENE survey provides very limited possibilities for analysis. From the standpoint of the logic involved, the best of these possibilities is embodied in the following question.

> Now let's play a little game. Look at this house. (Respondent is shown a drawing of a house with three rooms.) As you can see, there are three rooms and in each room there are four boxes. In the first room, three of these boxes have NCr \$5.00 each; in the second room two boxes have NCr \$20.00 and in the third room only one box has NCr \$50.00. You don't know which boxes have the money and to play the game you have to pay NCr \$.50. Then you may get into one room and open only one box and keep the money you find. Do you understand the game? (If not, the instructions were repeated.) Would you pay NCr \$.50 to join the game? Which room would you prefer?

There is no pretense made that the data from this question is, in fact, a measure of differences in utility for increased income between the Recife farmers. There was considerable concern among the MSU researchers (MSU/SUDENE Study) that this question was too difficult for most of the farmers to understand. It was included in this study upon the chance that it might provide some crude grouping of farmers on the basis of their desire for additional income.

If one analyzes the possible responses to this question (as diagrammed in Figure 10), the following groupings could be developed:

a. Very low utility--would not take any risk at more-than-fair odds (would not play).
b. Low utility--would require higher returns to accept risks equivalent to rooms II and III.
c. Medium utility--would require higher returns to accept risks equivalent to room III. (Room II)
d. High utility--finds high returns sufficiently attractive to accept the risk. (Room III)

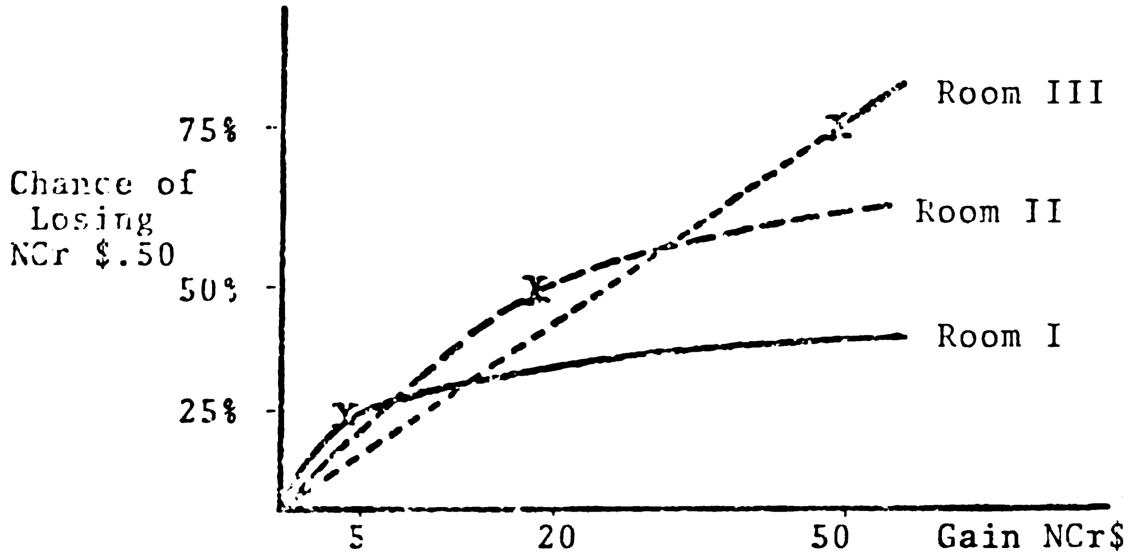

Figure 10 --Iso-Utility Curves for Choices in the Risk Game.

The Recife farmers' risk choices were as follows: 42.7% preferred not to play the game (very low utility); 15.5% chose room I (low utility); 8.0% chose room II (medium utility); and 33.7% chose room III. These choices seemed to be independent of farm size, education level, and with one exception, income. Farmers in the highest income grouping ($500 per capita family income) were significantly more willing than their colleagues to accept a small risk for chance of a small return (36.0% of this group chose room I as opposed to 15.5% for the sample as a whole), but their acceptance of the other alternatives was approximately in the same proportion as the total sample. Contrary to expectations, the Recife farmer's risk choice was not found to be significantly related to his use of insecticides, fertilizers, and tractors. This causes us to question the variable (MSU researchers were doubtful that the risk game was understood by many of the Recife farmers) and withhold judgement on the importance of the farmer's utility for increased income as an interacting force in his decision-making process.

Summary

Chapter III (p. 97) presents a schematic representation of the adoption process as conceptualized in this study. This presentation of the adoption of new agricultural practices will be enlarged upon in summarizing the findings of this chapter. Figure 11 should be of assistance in our attempts to visualize the decision-making system in terms of the data that has been examined. Note that the implementation phase of the schema has been omitted since this is the subject of the following chapter.

Although community attitudes -- as perceived by the individual farmer -- would have been a poor prediction of the use of new agricultural practices, they did seem to

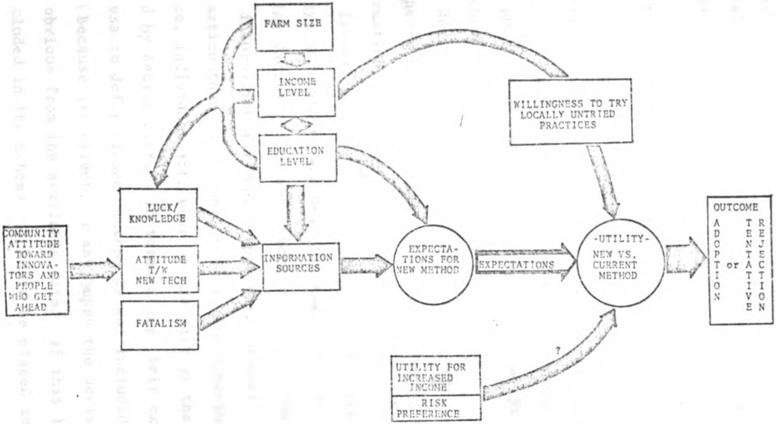

Figure 11-- Schematic View of the Decision-Making System of Farmers in the Recife Area.

have an influence on the formation of the farmer's own attitude toward new technology. Specifically, it was found that Recife farmers' attitudes toward new technology were statistically associated with the attitudes they perceived their community to hold toward innovators and individuals who progressed economically at a more rapid pace than their neighbors. These same community attitudes apparently have some influence upon the individual's desire to learn about new technologies, but this influence was rather weak relative to the farmers' own attitudes and level of education. Note that the position of community attitudes (to the far left) in the schema reflects these relationships.

The Recife farmer's own beliefs and attitudes seem, as the theory had suggested, to become involved in his expectations formation about new agricultural methods. Fatalistic farmers, farmers with negative attitudes toward new technology, and farmers who believed that luck was the controlling factor in business success are less inclined to seek out information and depend upon less "direct" sources of information than the farmers holding the opposing views. In essence, individual attitudes become part of the information used by Recife farmers in formulating their expectations. Willingness to defer present income is not included in Figure 11 because its effect, if any, upon the decision process was not obvious from the available data. If this item were to be included in the schema, it would be placed adjacent to the other attitudes with an arrow connecting it with the circle involving utility of the innovation, where the influence of time preferences would be expected to affect the decision outcome. Attitude toward trying locally untested practices seems to be intertwined with the relationship between low income levels and the reluctance to accept the risks inherent in innovations. For this reason, it is located between income and the evaluation of relative utilities in the schema. Finally, it will be recalled that the farmer's business-orientation (luck/knowledge variable) was associated with past successes and is indicated as such in the schema.

In addition to the influence of farmer attitudes, education achievement seemed to be associated with his choice of information sources. Educational achievement, in turn, was significantly related to farm size and income level, which were also associated with the sources of information used by the farmer. Higher levels of education, larger farm size, and higher incomes tended to be associated with the more direct sources of information.

In turn, information sources were significantly associated with the use of certain innovations, which leads us to conclude that farmers who have the capacity and willingness to utilize the more direct sources of information have greater knowledge of innovations (less uncertainty about them) and formulate favorable expectations more quickly than those who obtain information from "indirect" sources such as relatives and neighbors.

The Recife data provided some evidence that better educated farmers were more knowledgeable about new agricultural practices. This may be in support of the theoretical contention that the conceptual structures possessed by the farmer influence his ability to interpret information about new technologies and, consequently, formulate expectations.

Among other reasons for the significant association found between income and innovativeness, evidence was uncovered which seems to support the hypothesized relationship between low incomes (nearness to a "subsistence income level") and the farmer's unwillingness to accept the risks of new methods. On the other hand, the Recife data did not provide supporting evidence for a relationship between the farmer's utility for increased income and his adoption of innovations. Here we must leave a question mark in Figure 11.

Admittedly, not all reasonable variables have been examined, nor has the evidence been sufficient to conclusively prove the theoretically derived relationships. Yet, the overall logic of an interactive decision-making process -- such as conceptualized in Chapter III -- does appear to provide a framework which is useful in understanding the Recife farmers' adoption of innovations.

CHAPTER VI

ANALYSIS OF SELECTED VARIABLES WHICH MIGHT SERVE AS CONSTRAINTS UPON INNOVATIVE BEHAVIOR

Even though farmers might hold favorable expectations about certain new methods, they may find themselves unable to adopt these practices because other factors constrain their behavior. Three factors which might be thought of as having an impact upon the farmer's ability to implement decisions -- credit availability, input availability, and tenure arrangements -- are considered in this chapter. The extent of discussion regarding these variables varies with the availability of data provided in the MSU/SUDENE survey of farmers in the Recife area.

Credit

The availability of credit is usually considered as essential to the "transformation of agriculture." Improved methods often involve the purchase of modern inputs, which may be difficult for the farmer to finance from his present earnings. In turn, limitations may be placed upon the farmer's acquisition of external financing due to inadequacies in the credit system or to self-imposed barriers on the amount he is willing to borrow. Several questions about credit asked during the Recive survey afford an opportunity to give rather detailed consideration to credit usage in the Northeast of Brazil.

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Amount of Credit Used by Recife Area Farmers

An overview of the credit used by the farmers examined in the Recife survey is provided in Table 34.

Table 34.--Percent of Farmers Using Credit and Amount of Credit Used.

Commodity Area	Percent of Farmers with Loans	Mean Amount Borrowed	Median Amount Borrowed	Length of Loans in Months
		(U.S. dollars)	(U.S. dollars)	
Rice				
São Francisco	63.8	944.13	237.50	3 - 5
Bean				
Irecê	53.1	752.27	511.36	3 - 10
Al-Pe	47.7	386.57	227.20	3 - 5
Manioc	36.7	349.77	114.55	1 - 4
Cotton	68.5	424.70	181.82	4 - 6

Several characteristics of farm credit in the Recife area are rather clearly portrayed by this table. First, there is a great deal of variation in borrowing from area to area. The percentage of farmers having loans varied from 36.7% in the manioc area to 68.5% in the cotton area. The mean size of loans was equally as varied with an average loan to São Francisco rice farmers of nearly three times the mean amount borrowed by manioc farmers. Similar variations exist between the median amount of borrowings. The duration of loans was very short, in all cases less than one year (although there is the untested possibility that some farmers may have been able to refinance their indebtedness).

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Differences between the median and mean loans clearly indicate the very skewed distribution of loan sizes among those borrowing. Table 35 gives a more complete description of the distribution of loan sizes.

Table 35.--The Percentage of Recife Farmers Who Borrowed Amounts of Less than a Given Amount and the Range of Amounts Borrowed by Commodity Area.

Commodity	Range of Loans (dollars)	Percent of Loans Under $100	Percent of Loans Under $500	Percent of Loans Under $2500
São Francisco Rice	$ 7 - 18,182	24.4	65.4	93.6
Al-Pe Bean	23 - 2,273	24.2	75.8	100.0
Irecê Bean	18 - 4,545	18.5	48.1	96.3
Manioc	4 - 2,273	50.0	82.8	100.0
Cotton	22 - 7,727	33.0	78.6	99.1

Except for Irecê bean producers, approximately one quarter or more of those farmers who borrowed used less than $100 of credit, from one-half to four-fifths borrowed less than $500, and very few farmers had utilized more than $2500 in credit. Together, Tables 34 and 35 indicate that manioc farmers tended to receive the least amount of credit, followed by cotton farmers (although they borrowed most frequently), and then by Algoas-Pernubuco bean and São Francisco rice farmers. The Irecê bean farmers seemed to be able to acquire relatively larger amounts of credit.

It is especially interesting to note that the amounts borrowed per acre of crops planted presents a very different view of

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In Table 36 we find the manioc area -- the area with the smallest average amount (mean or median) borrowed per farm -- using the largest amount of credit on a per acre basis.

Table 36.--The Amount of Credit Used Per Acre Planted by Commodity Area.

Commodity	Loan Size Per Acre Planted	
	Mean	Median
	----------U.S. dollars----------	
São Francisco Rice	21.60	13.80
Al-Pe Bean	9.04	8.28
Irecê Bean	14.33	9.63
Manioc	26.55	13.47
Cotton	11.20	7.36

Again the Irecê bean area, which had the largest median loan, used considerably less credit per acre than either the manioc area or the São Francisco rice area -- both of which had much smaller median loans per farm. One possible explanation of these findings is that the variation in credit per acre simply reflects the difference in credit needs for the production of various crops. Additional analysis indicates that this is not an adequate explanation. First, the duration and timing of loans suggests that credit used by the Recife farmers may be misunderstood if it is viewed entirely as production credit. According to the MSU/SUDENE research it takes roughly 120 days from seeding to the harvesting of rice and 18 to 24 months for manioc to mature, yet th

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yet the length of loans was typically 3 to 5 months in the São Francisco rice area and 1 to 4 months in the manioc area. The length of loans in the manioc area is inadequate to cover a production cycle and loans in the rice area are barely adequate. In addition, rice in the São Francisco area is planted in seedbeds in either January or February and transplanted to fields approximately 20 days later, yet 26.9% of the loans were taken in March (as compared to 19.2% in January and 12.7% in February), 20.5% in April, and 9.0% in May. This suggests the possibility that loans were often obtained to meet the family's living expenditures until the next harvest.

It was also noted that the areas with the largest median per acre loans were generally those with the smallest median farm size. Table 37 contrasts median farm size with the median loan sizes (on a per acre basis).

Table 37.--Median Farm Size and Median Amounts Borrowed Per Acre by Commodity Areas.[a]

Commodity Area	Median Farm Size (Acres)	Median Loan Size (U.S. dollars per Acre)
Manioc	17	13.47
São Francisco Rice	37	13.80
Al Pe Bean	74	8.28
Cotton	85	13.47
Irecê Bean	89	9.63

[a]Includes median farm size for all farms and median size of loan for only those who borrowed.

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One would suspect from Table 37 that amounts borrowed per acre were inversely associated with farm size. Table 38 verifies this hypothesis. Here we find that farms of less than 50 acres borrowed an average of twice as much money per acre as farms from 50 to 244 acres. Together, farms under 245 acres accounted for more than three-quarters of the loans reported in the sample. It is not surprising, given this data, that areas with the smallest median farm sizes had the largest median per acre loans.

Table 38.--Percentage of Loans Received and Mean Amount Borrowed Per Acre by Size of Farm.

Size of Farm	Percent of Loans Represented By Each Farm Size[a]	Mean Loan (U.S. dollars per Acre)
0-49	38.3	12.20
50 - 244	38.3	5.05
245 - 1234	18.8	3.23
1235 and above	4.6	1.49
All Farms	100.0	7.28

[a]Based upon farms that received one or more loans.

Further, this information adds weight to the contention that a sizeable proportion of the Recife farmers borrowed in order to survive until the next harvest.

Before concluding this section, it should be noted that the likelihood of credit usage varies by size of farm. The smallest and largest farmers were somewhat less likely to have loans than the intermediate groups. Table 39 describes this situati

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Table 39.--Percentage of Recife Farmers Using Credit by Size of Farm.

Size of Farm (Acres)	Percentage of Farmers Using Credit
0 - 49	43.8
50 - 244	63.3
245 - 1234	60.0
1235 and above	52.8

In summary, it has been discovered that credit usage varies considerably between and within commodity areas, with each area represented by a skewed distribution of loan sizes. A reasonably large percentage of the sample (generally 25% or more) borrowed sums of less than $100.00. Smaller farmers borrow less frequently and tend to borrow larger amounts on a per acre basis than their larger counterparts. The evidence strongly suggests that small farmers (and perhaps some larger farmers) often are borrowing to maintain their households until the next harvest.

Sources of Credit

Not only does the percentage of farmers using credit differ by farm size, but so do the sources from which they obtain their loans. Table 40 describes the relative importance of credit sources for farms of varying sizes. Small farmers were much more dependent upon relatives and neighbors; credit cooperatives; and landlords, local

Table 40

Size of Farm (Acres)
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Table 40.--Percentage of Farmers Borrowing From Given Sources By Size of Farm.

Size of Farm (Acres)	Relatives and Neighbors	Credit Coop-eratives	Govern-ment Bank	Private Bank	Landlord, Local Busi-nessmen, Buyer
		First Loan			
0 - 49	15.0	23.3	34.0	1.3	24.5
50 - 244	8.3	19.0	62.0	1.3	8.8
245-1234	6.4	11.5	74.4	3.8	2.6
1235 and above	0.0	5.3	84.2	5.3	0.0
		Second Loan			
0 - 49	30.9	--	14.3	2.4	45.2
50 - 244	20.0	--	37.8	8.9	28.9
245-1234	19.1	--	42.9	19.0	19.1
1235 and above	0.0	--	80.0	0.0	20.0
		Third Loan			
0 - 49	33.4	--	0.0	0.0	61.1
50 - 244	21.4	--	21.4	7.1	50.0
245-1234	33.3	--	11.1	33.3	33.3
1235 and above	0.0	--	66.7	0.0	33.3

businessmen, and buyers than larger farmers. The larger farmers, especially the largest farmers, seemed to use the government bank more frequently (which suggests that larger farmers had better access to this form of credit). Again, small farmers depended very little upon private banks relative to thei

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to their larger colleagues.

Even though small farmers (51.4% of the sample) were relatively less likely to use government banks as a source of credit, they still accounted for 22.4% of the loans obtained from that source. Medium-sized farms (50-244 acres, which represented 34.1% of the sample) accounted for 44.0% of the government bank loans, followed by large farms (245 to 1234 acres and 11.6% of the sample) which obtained 24.5% of these loans. Finally, the relatively few very large farms (2.8% of the sample) received 8.2% of the loans supplied by the government banks.

Sources of credit also seem to be associated with the tenure status of the farm operator. Although the Recife survey concentrated upon landowners (owner-operators and landlords), a sufficient number of tenants were included to provide a comparison in terms of the sources of credit used. Table 41 describes the differences in credit sources

Table 41.--Percentage of Farmers Borrowing From Given Sources By Tenure.

Tenure	Relatives and Neighbors	Credit Coop-erative	Govern-ment Bank	Private Bank	Land-owner	Local Business-man and Buyer
Land-lord	10.9	18.6	59.0	4.2	--	6.7
Owner-Operator	12.3	20.0	50.1	1.5	5.0	10.2
Tenant	8.0	--	24.0	--	48.0	20.0

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utilized by tenants, owner-operators, and landlords (owners with tenants). There are notable differences between tenants and landowners. Nearly half of the loans obtained by tenants came from their landowners. Local businessmen were also a much more important source of credit to tenants than landowners. At the same time, the proportion of tenants securing loans from the government banks was less than one-half the percentage of owners who were able to obtain credit from this same source. Finally, none of the tenants in the survey had obtained credit from cooperatives or private banks. In general, one can conclude that tenants found it more difficult than the property owners to obtain credit from the commercial sources (government banks, private banks, and credit cooperatives) and were consequently more dependent upon landowners for their loans.

Since we have determined that the use of particular sources of credit varies with the size of farm and farm tenure, it would be useful to understand somewhat more about the sources themselves. The following table indicates the percentage of total loans attributed to each source and their mean and median size of loans.

The largest share of the loans received by Recife farmers was supplied by the government banks. Credit from this source should be considered as subsidized since the average rate of inflation (roughly 3.0% per month) exceeded the interest rate on these loans. Perhaps one of the reasons for the small percentage of credit supplied by the private banks (3.3%) is due to competition of the subsidized government credit program.

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Table 42.--The Percentage of Total Loans Accounted for by Various Sources of Credit and Their Mean and Median Size of Loans.

Source of Credit	Percent of Total Loans from this Source	Mean Loan Size	Median Loan Size
Government Bank	51.7	$829	$414
Credit Cooperatives	16.8	266	182
Neighbors	7.2	138	45
Local Businessmen	5.7	329	73
Landowners	5.2	83	34
Buyers	4.1	335	273
Private Banks	3.3	1763	273
Relatives	2.9	199	91

Credit cooperatives were the second most important supplier of credit. Although the size of loans from the credit cooperative were smaller than from the banks, they tended to provide somewhat larger loans than were usually obtained from other non-bank sources. Neighbors and relatives combined provided 11.1% of the loans, generally smaller in size than the credit cooperatives. Local businessmen and buyers accounted for 10.0% of the loans, with the amount obtained from buyers tending to be somewhat higher than those supplied from local businessmen. The smallest loans, upon which tenants are largely dependent, came from the landowners. It is worth noting that the São Francisco rice farmers seemed to be able to obtain somewhat larger average loans from private banks (mean loan equal to $3377), businessmen ($1035), and local buyers (

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The evidence developed in this section suggests that smaller farmers tend to depend heavily upon non-bank sources of credit which loan relatively small amounts of money, except for the credit cooperatives which appear to serve small farmers by providing somewhat larger loans. Buyers and businessmen provided some relatively large loans, although they were apparently concentrated in the São Francisco rice area. Landowners, whom tenants are particularly dependent upon, provided the very smallest of loans. The larger loans were typically obtained from government and private banks. These sources were used proportionately more often by the larger farmers, although 22.4% of the government bank loans were granted to small farmers (0 - 49 acres).

<u>Reasons for Not Borrowing</u>

The Recife survey asked farmers who had not borrowed why they hadn't; and asked the farmers who did borrow why they didn't borrow more. Their responses were quite interesting, especially as viewed in terms of farm size and level of income. Table 43 describes the responses given by Recife farmers as reasons for not borrowing.

The percentage of farmers who did not believe that they needed credit increased with the level of family income. Yet, in terms of the total sample of Recife farmers, 43.0% of those who "didn't need credit" were to be found among farmers who earned less than $50 per capita family income. The meaning of the response "didn't need credit" may well

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Table 43.--Reasons Given by Non-Borrowing Recife Farmers For Not Using Credit by Levels of Family Income.[a]

Family Per Capita Income (U.S. Dollars)	Didn't Need Credit	Couldn't Get a Loan	Afraid to Borrow	Other
Less than $50	25.6	38.2	34.0	2.1
$50 - $99	28.3	26.4	41.5	3.7
$100 - $199	51.4	14.2	28.5	5.7
$200 and above	73.3	30.3	15.1	6.1
All Incomes	32.5	31.7	32.5	3.4

[a]This table represents crop farmers only and the differences were significant at the .01 level by the chi-square analysis.

have been different for farmers at different income levels. To the relatively poorer farmers it may have meant that they were able to survive from harvest to harvest without needing a loan to meet family living expenses. For larger and relatively higher income farmers the phrase may have reflected an ability to finance the costs of production -- hired labor, purchased inputs, and perhaps loans to tenants -- from their own resources.

A large percentage -- 38.2% -- of non-borrowers in the lowest income grouping (less than $50 per capita) indicated that they "couldn't get a loan." This reason was relatively less important among the intervening groups, but then increased to 30.3% for farmers with family incomes of more than $200 per capita. Such a result could be rather perplexing without giving consideration to some additional information. It

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should be kept clearly in mind that these percentages represent the relative importance of the reasons given for each income category. While only 28.5% of the largest income grouping failed to use credit, 53.9% of the lowest income group did not obtain a loan. Consequently, those not able to acquire credit represent 20.6% and 8.6% for the low and high income groupings respectively. Again, low income farmers who were unable to obtain a loan represent 9.1% of the entire sample, as compared to 1.6% for high income farmers who found themselves in the same situation. Taken as a whole, it seems that low income farmers had greater difficulties in securing a loan than their somewhat wealthier counterparts.

Fear of borrowing appears to be associated with lower family incomes (as was the fear of accepting the risks of innovations). Farmers with under $200 per capita family income were much more likely to indicate that being "afraid to borrow" was the main reason that had kept them from obtaining a loan. Other reasons for not borrowing represented a small percentage within each income grouping.

Much the same situation is discovered when the Recife farmer's reasons for not borrowing are compared on the basis of farm size. (In fact, the data for farms of less than fifty acres is nearly identical to the responses given by farmers with less than $50 per capita family income.) The relative proportion of farmers who believed they "didn't need" credit increases with the size of farm. At the same

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Table 44.--Reasons Given by Recife Farmers For Not Using Credit By Size of Farm.[a]

Size of Farm (in acres)	Didn't Need Credit	Couldn't Get a Loan	Afraid to Borrow	Other
0 - 49	24.1	38.2	35.2	2.4
50 - 244	42.5	23.3	31.5	2.7
245 and above	55.6	14.8	18.5	11.1

[a]Chi-square analysis significant at the .005 level.

time, the larger farmers seemed to have relatively less difficulty obtaining loans than their smaller counterparts, and were generally less fearful of borrowing.

Turning to the Recife farmer's reasons for not using more credit, we again find important differences on the basis of income and farm size. Table 45 describes the responses of borrowers divided by levels of income.

The percentage of farmers who indicated that they "didn't need more credit" tends to increase with higher levels of income. In total, 13.2% of the borrowers (7.1% of the total sample) believed that they had obtained sufficient credit to meet their needs.

Risk was an important consideration to those who borrowed, as well as those who didn't. A large percentage -- 30.6% -- of Recife farmers who had obtained loans were unwilling to borrow more because of the risks involved. The proportion was, of course, larger among the lower income farmers -- 39.3% for those with earnings under $50 per capita

Table 45.--Reasons Given by Recife Farmers For Not Using More Credit by Income Levels.[a]

Per Capita Family Income (U.S. dollars)	Bank Does Not Give Larger Loans[b]	Lack Assets[c]	Risk[d]	Don't Need More Credit[e]	Other
Less than $50	19.6	28.7	39.3	9.0	3.3
$50 - $99	27.1	15.7	34.3	15.7	7.1
$100 - $199	27.8	21.3	31.1	13.1	6.6
$200 and above	46.2	13.7	13.7	17.5	6.2
All Incomes	29.7	21.0	30.6	13.2	5.4

[a]Chi-square analysis was significant at the .005 level.

[b]Responses coded under: "Banks don't make larger loans available to farmers."

[c]Responses coded under: "I have no assets to guarantee a larger loan."

[d]Responses coded under: "I would run the risk of being unable to pay back or even lose my property."

[e]Responses coded under: "I don't have anything on which to use a larger amount of money."

as compared to 13.9% for farmers with per capita family incomes in excess of $200.

A lack of sufficient assets to secure a larger loan also seems to be associated with lower income levels. Proportionally twice as many of the lowest income farmers gave this reason as compared to their counterparts within the highest income grouping. In total, 21.0% of those farmers utilizing credit found their assets inadequate to obtain larger loans.

Finally, we find that higher income farmers complained most frequently that "banks did not give larger loans." This reason for not using additional credit is also importantly related to the size of farm, as seen in Table 46.

Table 46.--Reasons Given By Recife Farmers For Not Using More Credit By Size of Farm.[a]

Size of Farm (in acres)	Banks Don't Give Larger Loans	Lack Assets	Risk	Don't Need More Credit	Other
0 - 49	20.1	31.3	30.6	11.8	6.3
50 - 244	36.1	13.6	35.3	11.3	3.9
245 and above	41.4	12.1	20.7	19.0	6.9

[a]Chi-square analysis was significant at the .05 level.

The percentage of borrowers on farms of 245 acres or more who indicated the unwillingness of banks to give farmers larger loans as primary constraint on the amount they borrowed was roughly double the proportion of small farmers (0-49 acres) giving this same response. This fact, in conjunction with the observation that large farmers use government banks relatively more frequently than smaller farms, suggests the following as a possible interpretation of their situation. (See Figure 12 on page 203.)

Note that the supply curve for credit is drawn completely elastic to the extent of the government bank's resources. Beyond this point the supply curve is upward sloping at a positive real rate of interest. Large farmers would like to obtain more credit at the subsidized government bank rates (or even at a low real rate of interest), but credit from this source must be rationed since the supply does not equal the demand by larger farmers. Further, they may not consider the positive rate lenders as important sources. Thus, large

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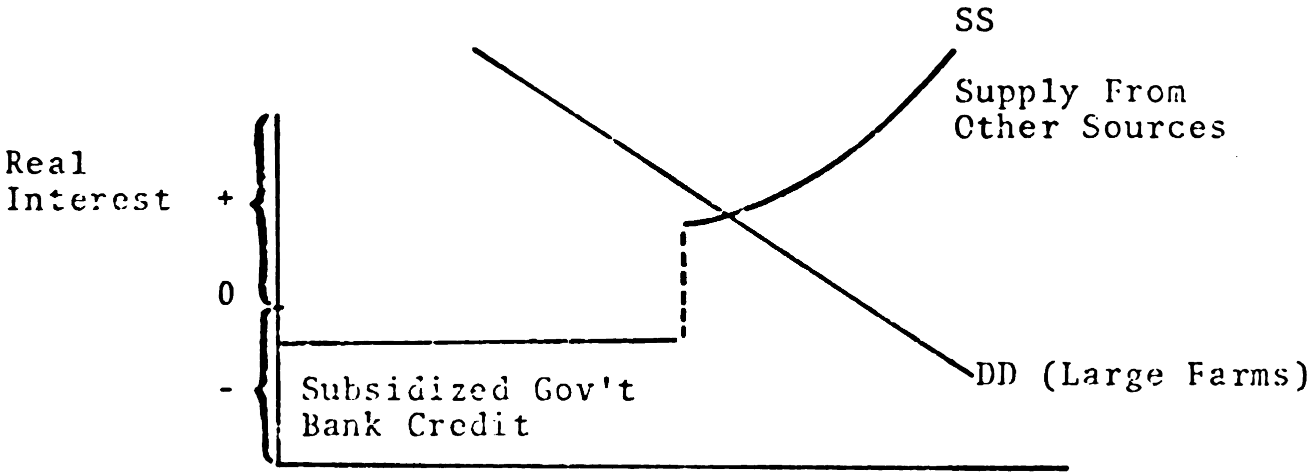

Figure 12.--Supply and Demand For Credit By Large Recife Farmers.

farmers often explained that they did not borrow more because "banks do not give farmers larger loans." The smaller farmer, on the other hand, may find that the upward sloping section of the curve is relevant, since he seems to be relatively less able to obtain government sponsored credit (at least he tends to use other sources more frequently than his larger counterpart). As a consequence, "risk" and asset limitations would be more important among the reasons he gives for not acquiring additional credit.

Returning to the examination of Table 46, we find the small farmers (0-49 acres) were considerably more encumbered by lack of assets than their larger counterparts. It should be noted that the average loan to farmers of this size (0-49 acres) was approximately $132. Consequently, a tempting conclusion is that the small farmers in the Recife area must meet with extremely stringent collateral requirements when they at

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Finally, farmers with less than 245 acres were considerably more likely to cite the "risk" of borrowing as a reason for not obtaining larger loans. At the same time they were, of course, less likely to indicate that they had obtained sufficient credit to meet their (perceived) needs.

In summary, larger and relatively wealthier farmers tend to give different reasons than smaller and poorer farmers for either not borrowing or not borrowing more if they are currently using credit. Risk as a deterrent to credit usage seems to be associated with smaller farm sizes and smaller farm incomes. Lack of a need for credit or lack of a need for additional credit (representing 7.1% of the sample) is a response found relatively more frequently among larger farmers and farmers with higher incomes. At the same time, difficulty in obtaining credit or additional amounts of credit seems to be related to small farm size and lower farm incomes. Finally, the complaint that "banks do not give larger loans," as an explanation for not using more credit, was more often voiced by larger farmers and the farmers with higher incomes.

Amounts of Credit Used by Farmers -- Regression Analysis

An initial regression model of the amounts of credit used by Recife farmers indicated that property values and the amount of crops planted, both related to size of farm, were the only significant explanatory variables when the population involved all farms in the sample. Further, these variables were capable of explaining less than 5.0% of the varian

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variance. This suggested that a more fruitful approach would be to divide the sample according to farm size and analyze the more homogeneous subsamples. A number of variables were proposed[152] and a least squares add regression technique was applied to the problem. This approach utilizes the computer in selecting variables in order of their importance in explaining the variance within the sample.

Small Farms (0-49 acres)

Among the proposed variables the computer selected reasons for not borrowing as the first two variables to be included in the equation computed for small farms. Fear of borrowing resulted in an R^2 of .0646 (explained 6.5% of the variance) and "no need to borrow" increased the R^2 .1318. Since the sample included both borrowers and non-borrowers this finding is simply a correlation between not having a

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[152] List of variables:

y--Amount borrowed (dependent variable)
x_1--Assets (property value)
x_2--Income level (per capita family)
x_3--Percent of acreage farmed
x_4--Income per hectare planted
x_5--Days of illness, 1966
x_6--Crop failure in 1966 (dummy variable)
x_7--Number of crop failures (1960-1966)
x_8--Risk choice I-low risk and low return (dummy variable)
x_9--Risk choice II-moderate risk and moderate return (dummy variable)
x_{10}--Risk choice III-high risk and high return (dummy variable)
x_{11}--Irrigation on farm (dummy variable)
x_{12}--Used tractor (dummy variable)
x_{13}--Used chemical fertilizer (dummy variable)
x_{14}--Hired labor (dummy variable)
x_{15}--Number of tenants
x_{16}--Afraid to borrow
x_{17}--No need to borrow

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loan and one of the reasons for not borrowing. The value of the farmer's assets (property value) was the next variable to be selected by the computer, and together with reasons for not borrowing explained 20.8% of the variance (R^2=.2077). The last signficant variable was the farmer's level of income (larger amounts of credit associated with larger per capita family incomes), which increased the level of the R^2 statistic to .2336. Each of these variables were significant at less than the .05 level.

Medium-Sized Farms (50-244 acres)

The number of tenants on farms was the initial variable chosen by the computer to explain the variance in amounts borrowed by farmers operating 50 to 244 acres. Perhaps the landlords in this group commonly borrowed in order to relend to their tenants. The amount per tenant, as indicated by the equation, was $60.80 (133.78 NCr$). An R^2 statistic of .1914 was accomplished by this variable alone. The second variable chosen was the farmer's income level, increasing the R^2 measure to .2950 (roughly 30% of the variance explained). "No need for credit," as a variable explaining why some farmers in this group had not borrowed, was the third variable selected by the computer, which resulted in an R^2 of .3569. A fourth variable chosen, income per hectare of crops planted, seems to indicate that the farmers earning higher returns per hectare utilized more credit than farmers obtaining lower levels of productivity from their land (R^2=.4191). Finally, the percentage of the farmer's acreage used in crops seems t

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seems to be positively related to the amounts of credit used (R^2=.4346).

Large Farms (245-1234 acres)

The most important variable, according to the computer program, in explaining the amount of credit used by large farmers was the value of their assets. Alone, this variable explained 75% of the variation in amounts borrowed (R^2=.7538). Three additional variables -- risk choice III (high risk-high return), risk choice II (medium risk-medium return), and number of tenants -- increased the R^2 statistic to .8077, but their interpretation is uncertain. Farmers who were willing to accept higher risks for higher returns seemed to be willing to borrow substantially larger amounts than other farmers, but risk choice II and the number of tenants per farm were negatively associated with the sums borrowed. Finally, the variable indicating those farmers who perceived "no need to borrow" was included in the equation (R^2=.8178).

Very Large Farms (1235 or more acres)

Only one variable, percent of the farm devoted to crops, was significantly related to the amount borrowed by very large farms -- R^2=.2586. On the average, these farmers planted only 12.5% of their total acreage (including land planted by tenants). By comparison, small farmers utilized an average of 61.1% of their acreages for crop production, medium-sized farmers planted 33.1% of their farms, and large farmers raised crops on 20.0% of their land. The maximum percentage of land devoted to crops by any of the very large farmer

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farmers was 66.7%.

In all, the regression equations seem to reinforce the notion that an explanation of the amount of credit used by Recife farmers involves different variables for farms of different sizes. With respect to small farms, those variables indicating the reasons farmers did not borrow and variables reflecting their ability to obtain loans -- assets and income level -- were variables of primary importance. In all probability, much of the borrowing done by farmers of this size represented loans for the purpose of covering family expenditures until the coming harvest. The variables selected by the computer in explaining the amounts borrowed by medium-sized farms (averaging $332) seem to reflect a more "commercial" orientation in credit usage. Such items as the number of tenants per farm, income per hectare (a proxy variable for productivity per hectare) and percent of the farm devoted to crops indicate a relationship between the production process and the use of credit. Nonetheless, there were still farmers in this group who were afraid to borrow, even though this

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Credit Regression Equations

Small Farms (0-49 acres): $R^2=.2336$
$$\hat{Y} = 114.066 - 195.592X_{16} - 213.511X_{17} + 0.016X_1 + 0.191X_2$$

Medium-Sized Farms (50-244 acres): $R^2=.4346$
$$\hat{Y} = 368.982 + 133.780X_{15} + 0.208X_2 - 857.366X_{17} - 686.689X_{16} + 0.787X_4 + 579.241X_5$$

Large Farms (245-1234 acres); $R^2=.8178$
$$\hat{Y} = 57.830 + 0.043X_1 + 1564.464X_8 - 1849.671X_9 - 104.963X_{10} - 1443.992X_{15}$$

Very Large Farms (1235 acres or more); $R^2=.2586$
$$\hat{Y} = 673 + 12450.704X_3$$

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variable seemed to be less important than for small farms. The lack of interpretable relationships between large farms (245-1234 acres) and variables which reflect the use of credit for production activities may indicate that many of these farmers were either not interested or unable to make maximum use of their farms for agricultural production. This notion is reinforced by the small percentage of their total acreage that was devoted to crop production. On the other hand, the relationship between amounts borrowed and asset position may be of such importance that it simply outweighs other variables. Finally, the association between the percent of very large farms (over 1235 acres) devoted to crop production and amounts of credit used suggests that some of the very large farmers were not intensively utilizing their properties for agricultural production.

Summary

Somewhat less than half (45.6%) of the Recife farmers had not borrowed money in 1966. The largest share of these farmers could be found on small farms and among those with relatively low incomes. Approximately one-third of the farmers who didn't use credit indicated that they were afraid to borrow. Another third were unable to obtain loans. Most of those remaining indicated that they "did not need credit." "No need for credit" was the reason given most frequently by the larger and relatively wealthier non-borrowers. Yet, in an absolute sense, the poorer and smaller farmers were more important among all the farmers

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giving this response. It is reasonable to assume that the small farmers believed that they "didn't need credit" if they had managed to meet their family's consumption needs from one harvest to the next without a loan. The possibility that they were able to finance new agricultural inputs from their own meager resources seems quite remote.

When the smaller and poorer farmers did borrow, they were relatively more likely than their larger and wealthier counterparts to have obtained loans from neighbors, relatives and other non-commercial sources. These sources typically loaned fairly small amounts. Credit cooperatives, however, seemed to provide somewhat larger loans to the small and medium-sized farmers.

The largest loans, however, were usually obtained from the government banks. Larger and relatively wealthier farmers seemed to have less difficulty obtaining credit in general, and they were the ones relatively more likely to receive their loans from the government bank (and private banks). Nonetheless, a large proportion of the government bank loans (probably the smaller ones) went to the relatively smaller and poorer farmers simply because they constituted such a great proportion of the sample.

In all, 7.1% of the Recife farmers indicated that they had obtained sufficient credit to meet their needs. A large number of these responses were from the larger and relatively wealthier farmers. Although some small and medium-sized farmers also gave this reason for not obtaining larger loans.

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Tenure

Although the Recife survey involved largely landowners, a few renters were interviewed and a number of the owners reported tenants on their land. With respect to the relationship between tenure and innovativeness, one would generally expect owner-operators to be the most innovative and both landlords and renters to be less innovative, but for quite different reasons.

The tenant is usually considered to be less progressive than the owner-operator. One of the common reasons suggested is that he is unwilling to make the long-range decisions and investments necessary to improve his farm operation. His unwillingness results from uncertainty about whether he will remain on the land long enough to reap any of the benefits. It may be found that renters are at the mercy of unsympathetic landlords. This appears to be the case with Recife sharecroppers.

> The most common sharecropper arrangement is equal shares. In other words, the sharecropper gives half his production to the landowner and keeps the remaining half for himself. The usual agreement also requires that the sharecropper sell to the landowner any part of his share which is not consumed. The sharecropper must sell this part at harvest time when prices are lowest. If the sharecropper does not sell to the landlord, he will be removed from the land the following year.[153]

It is hardly reasonable to expect the renter to be particularly innovative under the circumstances cited above.

A second reason that might be given is that the tenant (sharecropper) receives only a share of the increased product

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[153] Charles Slater, Harold M. Riley, *et al.*, *Market Processes*, pp. 7-11.

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from a new method. If he must bear all of its cost, the new input may be unprofitable to him even though it is quite profitable in the aggregate sense. A third reason for expecting the tenant to be less innovative is that he may find it difficult to finance new methods of production, especially where credit sources demand land as collateral for loans. Finally, we might expect tenants to be very backward in their beliefs and attitudes, and to lack the educational background of other members of the community.

The Latin American landlord has at times received considerable attention because of his lack of progressiveness. Arguments over the reasons for his laggardliness have apparently not ceased.[154] Typical of the reasons suggested are that his income is adequate without giving his holdings the attention they would require for maximum profits, that he is more politically oriented than economically motivated, and that he holds land for purposes other than agricultural profit. For the moment, we will assume that the Recife-area landlord is enough similar to the general concept of Latin

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[154]Ernest Feder, "The Latifundia Puzzle of Professor Schultz: Comment," Journal of Farm Economics, (May 1967), pp. 507-510; Theodore W. Schultz, "The Latifundia Puzzle of Professor Schultz: Reply," Journal of Farm Economics, (May 1967), pp. 511-513.

Dale W. Adams, "Resource Allocation in Traditional Agriculture; Comment," Journal of Farm Economics, (November 1967), pp. 930-932; Theodore W. Schultz, "Resource Allocation in Traditional Agriculture: Reply," Journal of Farm Economics, (November 1967), pp. 933-935.

James E. Grunig, Information, Entrepreneurship, and Economic Development: A Study of the Decision Making Processes of Colombian Latifundistas, (unpublished Ph.D. dissertation, University of Wisconsin, 1968), pp. 9-12.

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American landlords that we would expect him to be less innovative than the owner-operators.

Many of our preconceptions about the differences between farmers with different tenure statuses are not, however, supported by the data from the Recife survey. First, we find that tenants, except for fatalism, held attitudes and beliefs which were not significantly different from landlords and owner-operators. Again, tenants seemed to be nearly as likely to know how to improve yields as landlords and owner-operators (53.5% as compared to 64.1% and 60.6% respectively). Also, the educational achievement of tenants was not significantly different from owner-operators, while landlords tended to have completed somewhat more schooling than the others.

Table 47.--The Percentage of Tenants, Landlords and Owner-Operators Who Had Achieved Given Levels of Formal Education.

Tenure	Years of School Completed				
	None	1 yr.	2-3 yrs.	4-5 yrs.	6 or more yrs.
	percent				
Tenant	48.8	14.0	20.9	16.3	--
Owner-Operator	47.7	20.3	20.3	6.8	4.9
Landlord	34.8	14.6	25.8	13.1	11.6

Although none of the tenants had completed six or more years of schooling, they were somewhat more likely than owner-operators to have completed from two to five years of formal education. Landlords were considerably less likely to not have attended school at all, and were much more likely to have completed more than six years of education. In fact, 2.5% of the landlords had attended school beyond the twelfth year (as compared to 0.5% of the owner-operators and none of the tenants).

At least one of our contentions about tenants seems to be correct. As may be recalled from the previous section, they seem to find it more difficult to obtain credit than their landowner counterparts. The greatest percentage of tenants depended upon loans from landowners, which were generally for very small amounts. At the same time, this source of credit was relatively unimportant to the Recife farmers who owned their farms.

Of greatest interest, of course, is the relationship between tenure and the farmer's use of particular inputs. From examination of the use of four selected innovations, some general impressions about the relative innovativeness of tenants, owner-operators, and landlords can be obtained.

Table 48.--The Percentage of Tenants, Owner-Operators, and Landlords Using Selected Innovations.[a]

Tenure	Non-chemical Fertilizer	Chemical Fertilizer	Insecticides	Tractors
Tenant	6.9	2.3	58.3	25.6
Owner-Operator	16.6	1.8	32.6	14.3
Landlord	21.7	4.0	58.1	21.8

[a]A chi-square analysis of insecticides and tractors was significant at the .05 level.

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Landlords seem to be more likely to use insecticides and tractors than owner-operators, although the differences were not significant for barnyard manure and chemical fertilizers. This result is probably a byproduct of the landlords generally higher level of education and more favorable financial position. At the same time, the percentage of tenants using tractors and insecticides seems to more closely resemble his landlord rather than his owner-operator counterparts. The likely conclusion is that landlords either require their tenants to use these innovations or provide them with tractors and insecticides. In general, evidence does not support the contention that Recife area owner-operators are more innovative than tenants and landlords. On the contrary, the evidence seems to suggest that landlords are the most innovative and that tenants may use insecticides and tractors at the landlord's insistance.

In summary, we have found that many of our initial suggestions about differences between tenants, owner-operators, and landlords are not supported by the Recife data. Except for fatalism, the attitudes and beliefs of farmers with different tenure statuses were not found to be statistically significant. In addition, the tenants seemed to be as well educated as the owner-operators, while landlords tended to have somewhat more schooling than either of the other two groups. However, tenants were found to be at a disadvantage in obtaining credit. Finally, the hypothesis that owner-operators are more innovative than landlords and tenants seems to be unsupported. If any generalizations may be made, it appea

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appears that landlords and tenants are more innovative than owner-operators. The most reasonable explanation of the tenant's behavior is that decisions regarding farm inputs are made by the tenant's landlord.

Input Availability

A farmer can hardly be expected to be innovative if modern agricultural inputs are difficult to obtain. Consequently, it seems reasonable to consider the availability of certain inputs in an examination of the Recife farmer's innovativeness. Fortunately, the Recife survey addressed certain questions to this matter. In a separate survey, the MSU/SUDENE researchers interviewed a sample of thirty rural suppliers located in the same areas from which farmers' survey was conducted. Table 49 gives the percentage of respondents who stocked selected inputs. In addition, the table indicates the percentage of farmers from the Recife sample who were using these inputs.

A general impression gained from Table 49 is that a relationship seems to exist between the local level availability of agricultural inputs and their use by Recife farmers. The availability and corresponding use of "selected seeds," alone, fails to fit this overall pattern. An explanation of this particular outcome is probably best given by the following passage from the Recife research report:

> The high response on improved seeds, however, is probably due to the wording of the question, which led most farmers to reply affirmatively even if they were doing nothing more than selecting the biggest and best looking seeds from their own production for

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Table 49.--Percent of Rural Distributors Supplying Selected Inputs and the Percentage of Recife Farmers Using These Inputs.[a]

Inputs	Percent of Rural Suppliers Carrying Selected Inputs	Percent of Recife Farmers Using Selected Inputs
Chemical Fertilizer	--	3
Tractor -- Rental	15	17
Selected Seed	18	53
Insecticides	78	43
Fungicides	48	27
Hand Planters	52	22

[a]Inputs correspond with practices considered innovations in the Recife Farmer Survey.

> planting. Had the question specified use of special improved varieties, strains, or hybrids, the response would have been much lower, since the supply of such improved seeds that have been developed for the Northeast is very limited.[155]

With exclusion of "selected seeds," we find that our general impression is supported statistically. The correlation co-efficient between input availability (as given by the Input Survey) and the use of selected practices is r=.9481 (which is significant at the .05 level).

In more specific terms, insecticides seemed to be the most readily available input, and (aside from "selected seeds") the most commonly used innovation. At the other extreme, the survey of rural suppliers failed to find a firm which

[155]Charles Slater, Harold M, Riley, *et al.*, *Market Processes*, p. 8/21.

handled chemical fertilizer, an innovation which only a very few Recife farmers were found to be using. The availability of tractors for rent is found to be very closely related to the percentage of farmers using them. In addition, 7.0% of the rural suppliers had tractors to sell.

The Recife Farmer Survey also asked about the availability of certain inputs. Farmers were asked if they believed that they could find chemical fertilizers, insecticides, and rental tractors in the stores in their own municipio (county). Table 50 indicates the responses of the farmers interviewed.

Table 50.--The Percentage of Recife Farmers Who Believed Chemical Fertilizer, Insecticides and Rental Tractors Were Available in Their Municipio, By Commodity Area.

	Percent Who Believed These Inputs Were Available In Their Municipio		
	Chemical Fertilizer	Insecticides	Rental Tractors
São Francisco--Rice	7.9	50.4	43.3
Al-Pe--Bean	11.7	69.5	28.9
Irecê--Bean	8.2	93.9	98.0
Manioc	4.6	42.4	14.7
Cotton	25.4	87.9	15.3

It is interesting to note that nearly all of the Irecê bean farmers thought that they could rent a tractor locally. It was also found that 65.3% of the Irecê farmers used tractors. In fact, the relationship between the availability of rental tractors -- as perceived by the farmers -- and their use in the

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the different areas was highly correlated (r=.8873).

The use of insecticides and chemical fertilizers, however, does not seem to vary directly with their local availability. The bean farmers sampled did not use chemical fertilizer at all, even though a few farmers in each area believed they could buy this input from local storekeepers. At the same time, the percentage of São Francisco rice farmers who used fertilizer was greater than the proportion who believed it was available locally (11.8% as opposed to 7.9%). Apparently, some of these farmers were capable of reaching beyond their own community to obtain inputs for use on their farms. The percentage of manioc and cotton farmers using fertilizer was minimal (0.7% and 0.6% respectively), despite the fact that 25.4% of the cotton farmers thought that they could buy it locally.

The percentage of farmers who believed insecticides were available locally and the percentage who utilized this input seems to be somewhat more related than was found with fertilizers. Still, they were not significantly correlated. With respect to insecticides, again we find the percentage of São Francisco rice farmers using this input exceeding the percentage who believed that it was available locally. The same was true of manioc farmers. Yet only about one-fifth of Al-Pe bean farmers who believed that they could obtain insecticides locally were utilizing this input.

The most reasonable conclusion from the Recife data is that a general relationship between input availability and input

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input use seems to exist, yet other factors involved in the decision system can inhibit many farmers from adopting an innovation and a few farmers may use new inputs even when they do not find them available locally.

Summary

In Chapter V a schematic representation was developed relating several variables to the decision-making process involved in the adoption of new technologies. Figure 13 adds to this schema three variables which can affect the ability of the farmer to implement his decision to utilize a new technology.

The indicated relationship between credit and either farm size or income is supported by a number of findings which were forthcoming in this chapter. First, there is an association between farm size and the percentage of farmers receiving loans, with the small farmers being less likely to have obtained a loan than their larger counterparts. Next, farm size was found to be related to the source of credit utilized; small farmers tending to make greater use of credit cooperatives and non-commercial sources while larger farmers depend more heavily upon government banks. The percentage of farmers who were afraid to borrow or indicated that they were unable to get a loan decreased as farm size and farm income increased. Among borrowers, lack of sufficient assets and the additional risk involved were more often cited by small farmers than by larger farmers as reasons for not using more credit.

Tenure also affects the source of credit and size of loans.

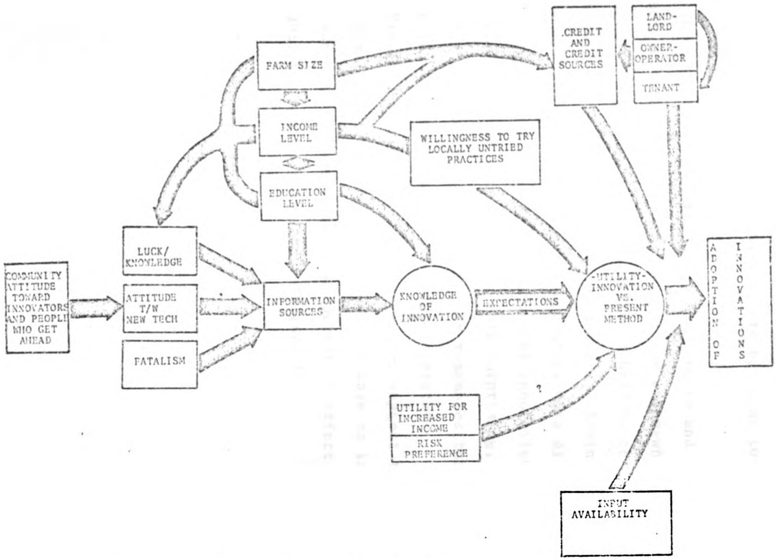

Figure 13 -- Schematic View of the Decision-Making System of Farmers in the Recife Area-II.

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Tenants seem to be heavily dependent upon landowners for their credit and resulting loans are generally small by comparison to those from other sources. This preceding relationship is depicted by the arrow connecting tenure patterns to credit in the schema.

The expected relationships between tenure and attitudes was not supported by the data. Except for a somewhat greater tendency to be fatalistic, the attitudes held by tenants were not significantly different than landowners. Again, contrary to the proposed hypotheses, owner-operators were discovered to be less likely to have used particular innovations than either landlords or tenants. Even more surprising, the use of innovations by tenants more closely resembles the pattern of the landlord than that of the owner-operator.

Finally, the analyses in this chapter suggest that the local availability of inputs is likely to have an impact upon their adoption and use. Thus, the potential effect of input availability is also indicated in Figure 11.

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CHAPTER VII

THE INTERACTION OF SELECTED VARIABLES IN THE ADOPTION PROCESS: AN AUTOMATIC INTERACTION DETECTION APPROACH TO THE ANALYSIS OF INNOVATIVENESS

Central to this discussion of innovativeness has been a concept of the adoption of new methods as involving the interaction of several variables within the decision-making processes of individual Recife area farmers. Within the context of the theoretical framework developed earlier, Chapters V and VI have attempted to outline the systematic interaction of certain variables as they appear to be related to the adoption process. The task of this chapter is to examine this interactive process, once again, in an effort to develop a greater understanding of innovativeness among Recife farmers and to provide some estimate of the relative importance (predictive value) of those variables which seemed to be involved in the adoption process. A computer program termed Automatic Interaction Detection (A.I.D.) will be used in this analysis. This approach permits the simultaneous analysis of certain variables which have been constructed with the benefit of those analyses undertaken in the two previous chapters.

The Automatic Interaction Detection Program

Automatic Interaction Detection is a computer program developed by Sonquist and Morgan at the University of

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Michigan.[156] They explain the purpose of its development in the following excerpt:

> It [A.I.D.] is focused on a particular kind of data-analysis problem, characteristic of many social science research situations, in which the purpose of the analysis involves more than the reporting of descriptive statistics, but may not necessarily involve the exact testing of specific hypotheses. In this type of situation the problem is often one of determining which of the variables, for which data have been collected, are related to the phenomenon in question, under what conditions, and through what intervening processes, with appropriate controls for spuriousness.[157]

In essence, this program is specifically designed for the analysis of data where the interaction of the independent variables is expected to have an effect on the value of the dependent variable. Sonquist and Morgan, in their description of A.I.D., elaborate on this particular point:

> The objective is to explain the variance of the dependent variable Y. Where the number of predictors is small, the problems of isolating the relationships between X_i and Y are manageable, but when the number of predictors is large, which is typical of many survey data analysis problems, then an analysis of the joint effects of X_i or Y presents serious problems.[158]

From this brief description, the purpose of the A.I.D. computer program seems to closely coincide with the analytical objectives of this study. From the beginning, an interactive system of decision-making has been proposed; and secondly, the objective of developing and testing of an overall

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[156] John A. Sonquist and James V. Morgan, The Detection of Interaction Effects, (Ann Arbor, Institute for Social Research, Report No. 35, University of Michigan).

[157] *Ibid.*, p. 2.

[158] *Ibid.*, p. 2.

conceptual framework of the adoption process has been at the forefront of this research. Thus, the A.I.D. program promises to be a useful tool in examining the interaction of certain independent variables as they affect the innovativeness of Recife area farmers.

Advantages and Disadvantages of A.I.D.

In practice, the A.I.D. program seems to have certain advantages over multiple correlation for the type of analysis involved in this study. First, one need not specify in advance the interaction terms ($X_i X_k$) that will be needed in the analysis. It is obvious that preparing and interpreting a regression model with a large number of interaction possibilities would soon become rather burdensome. At the same time, the A.I.D. program allows considerable flexibility for the interaction of variables and, in effect, specifies these interactions in the course of the computations. Secondly, the A.I.D. program can be used to analyze a dichotomous (0-1) dependent variable. Finally, the A.I.D. technique lends itself to a very comprehensible visual display of the program results (in the form of a branching tree with specific variables related to each branch).

A.I.D. does have certain limitations. From the experiences of this study, it appears that small sample sizes (less than N=400 or 500) pose a problem to the analysist. Operationally, the program divides and subdivides the sample on the basis of the variables which explain the greatest amount of the total sums of squares (maximizes the between sums

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sums of squares at each split). Small sample sizes mean that the number of useful "splits" is limited. One reason is that as the program divides the sample into subgroups, the sample size of the subgroups rapidly diminishes to sizes from which additional partitions are of questionable value. (Sonquist and Morgan set N=25 as the minimum group size from which further partitions should be considered legitimate.) Secondly, the number of observations for each classification within a variable (predictor) also can quickly become too small to trust the significance of their mean values (which are important to the operation of the A.I.D. program). For example, in the A.I.D. I model which follows, the "tenant" classification within the predictor variable "tenure" initially included 16 observations from a total sample of N=119. Five steps later this classification included only six observations in this particular subgroup. If there had initially been five times as many observations (N=80) for this classification, we could be much more comfortable with the mean value (percentage who had adopted fertilizer) calculated from a probable "tenant" subgroup size of N=30 after five computational steps. In short, small sample sizes limit our ability to take advantage of the possible predictive value of certain variables. The difficulties of dealing with small sample sizes is, of course, not unique to the A.I.D. program, but it nonetheless should be recognized as a problem in its usage.

Another difficulty is that the A.I.D. program does not supply us with the coefficients we are accustomed to dealing with in multiple correlation analyses. The output does not provide a beta coefficient (and accompanying statistics) relating numerical values of the independent variables to the value of the dependent variable. For some analytical purposes this may be objectionable. The program does, however, provide an estimate of the value of the dependent variable (and accompanying standard deviation) for groups which include certain classifications from within the various independent variables (say a mean innovation index of 58.1% for farmers with more than one year of education, per capita family incomes of over $200, and access to sufficient credit). For the purposes of this study, an identification of the interactive relationships between the dependent and independent variables, and their relative importance (amount of variance explained) is probably sufficient.

The Dependent Variables

> Innovativeness is defined as the degree to which an individual adopts new ideas relatively earlier than others in his social system. (Rogers: 1969)[159]

General Approaches to Indices of Innovation

Typically, there have been two approaches to measuring an individual's innovativeness: (1) those which use an adoption/non-adoption dichotomy and (2) those which use the

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[159] Rogers, Peasants, p. 294.

time of adoption.[160] The first approach involves computing the percentage of a list of "applicable practices" adopted by an individual and considering this to be a measure of his innovativeness relative to other members of his community. The second approach involves determining the date of the individual's first use of an innovation and measuring his innovativeness in terms of the earliness or lateness of his adoption relative to his colleagues. An implicit assumption included in this second approach is that an individual's response to some particular innovation is sufficient to measure his general level of innovativeness. The first approach also involves an implicit assumption, that all innovations are equivalent units. It may be recalled, from Chapter II, that Rogers and others have suggested that innovations differ with respect to various characteristics (see pp. 34-35). Yet, it is usual practice to construct innovation indexes ignoring these differences. Intuitively it would seem that an individual who has adopted chemical fertilizer should be considered more innovative than the farmer who has adopted non-chemical fertilizer (application of barnyard manure), but the impact of either of these practices (differing in relative advantage, complexity, and compatability with previous experiences) upon the typical index of innovation (where both were considered as "innovations") is implicitly

[160] Tom W. Carroll, "Diffusion Research: Application to National Surveys in Developing Countries," (Working Paper #20, Department of Communications, February 1968), p. 9.

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assumed to be equivalent. It should be recognized, then, that an innovation scale of this type is in fact a weighted index, with all "innovations" given exactly the same weight.

An Improved Innovation Index

It would seem reasonable to argue that adoption of an innovation which is both technically complex and a considerable departure from past practices would be a greater test of an individual's innovativeness than adoption of an innovation which is simple and not greatly different from present practices. Perhaps the same argument could be made for differences in other characteristics such as divisibility (technical characteristic which permits small scale trials) and communicability (observability of the results of an innovation), although the reasoning is not as clear for these characteristics. Suppose, for example, that both tractors and the ox and plow are included within a list of practices to be used as an index of innovativeness for farmers in a less developed country. It would be the unusual peasant who would have considerable experience with mechanical apparatus and internal combustion engines but little knowledge of farm animals. The tractor, barring such extreme cases, would clearly be a more complex and less compatible innovation than the ox and plow. It should then carry a greater weight within the innovation index. Assigning weights on this basis presents some problems, however, since we as yet have no objective method of scaling the degree of differences found in these characteristics. Nonetheless, it seems that innovations could be placed into groups that are somewhat alike in terms of their complexity and compatibility on the basis of the judgement of a competent observer. Since neglect in doing so is to assume them equal in these characteristics, a carefully considered subjective ranking -- recognizing these differences in the innovations -- would probably provide an improvement in the index.

Consideration of the relative advantage of innovations is the point of great disagreement between economists and diffusion researchers (emphasized by the first and de-emphasized by the latter). Both argue that the farmer does what is to his advantage, but diffusion researchers seem to believe it is the perceived advantage (involving both economic and non-economic factors) that contributes to adoption of an innovation while economists prefer to regard the actual profitability of the technology as the motivating factor.[161] The way in which one regards the relative advantage of an innovation has considerable impact on the method the researcher uses to weight this factor in an index of innovation. The approach followed in this chapter is to regard the innovative individual as the one who is first to formulate realistic expectations about the profitability of various innovations and adopt those which would be profitable

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[161] Diffusion, p. 126 for the "perceived relative advantage" view.

See Schultz, Transforming, p. 164 for the "objective" profitability view.

See Wharton, Subsistence, p. 459 for an interesting discussion of peasant "rationality" as viewed by economists and non-economists.

(with some discounting for uncertainty) in his particular situation. This view places the emphasis on the profitability of the innovation, with innovations which have less impact on agricultural output and efficiency being considered as less important than more productive innovations. Such a view is consistent with adoption as a decision-making process proposed in this study (expectations about innovations being formulated and acted upon by the individual) and consistent with the developmental goal of increasing agricultural production through the diffusion of output-increasing technologies. Establishing a relationship between innovativeness and the profitability of the applicable innovations adds an extra dimension to the traditional definition of innovativeness. The innovative individual is thus not only relatively early in his adoption of new ideas, but also more inclined to adopt those ideas which are most profitable (and generally have the most impact on increasing productivity).

An improved innovation index, then, would include relative weightings for various innovations on the basis of their characteristics. While determining the weightings for such characteristics as complexity and compatibility must probably still rely on the judgement of the researchers, the relative profitability of innovations could be derived empirically. One method would be to use experiment station comparisons of old and new practices and rank the various innovations on the basis of their contribution to increased farm incomes. Non-comparability of experiment station and farm level results from innovations, however, is a recognized problem. It would also be possible to measure differences in output at the farm level and from a budgeting study determine the relative profitability of various innovations. Still another method would be to use Cobb-Douglas or other production functions to determine the marginal productivity of certain innovations at common levels of usage and rank the innovations on this basis. Utilizing some of these approaches, which might involve only a marginal increase in information gathered in a diffusion study, would certainly serve to improve the adequacy of innovation indexes and bring economists and non-economists to a greater level of agreement on procedures for studying the diffusion of innovations.

The Index of Innovativeness Used in This Study

Unfortunately, the data derived from the LAMP/SUDENE Farm Survey does not provide the information needed to calculate the relative profitability of the technologies considered as innovations. Since the LAMP study was primarily concerned with market processes, the researchers involved did not gather this type of information. The choice thus becomes one of following traditional practices and assuming all innovations as equivalent units, or attempting, although perhaps quite subjectively, to provide some relative weighting of the innovations considered. Since there seems to be no theoretical loss in weighting the innovations differently (as all innovation indexes in

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involve a weighting) and there may be some gains in even a somewhat subjective weighting, a simple weighted index will be used in this study.

There were nine "modern farm inputs" studied by the LAMP research team in Northeast Brazil: (1) non-chemical fertilizer (barnyard manure), (2) chemical fertilizer, (3) improved seeds, (4) insecticides, (5) fumigants used in grain storage, (6) ox and plow, (7) hand planter, (8) tractor, and (9) pesticide dusting equipment. The use of these inputs is given in Table 21.

These innovations will be divided into two groups on the basis of their expected potential for increasing productivity, compatibility with past practices, and complexity. This is, of course, some distance from an ideal index, but it does seem to be a movement in the correct direction. Of the nine innovations, insecticides, fumigants, chemical fertilizer, and tractors are judged to be the most complex, have the least compatibility with past experiences, and offer the most potential for increasing productivity. Improved seeds would normally fit within this category, but in this case the data seems to reflect the selection of biggest and best looking seeds from the individual's own production rather than the use of improved strains, varieties, or hybrids.[162] It might also seem that tractors would not be a suitable innovation to include

[162] Charles Slater, Harold Riley, et al., Market Processes, p. 8-21.

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as a more profitable input because of the large number of small farms included in the sample. The practice of renting tractors is reasonably widespread in the bean and rice areas, however, and although large farmers were more likely to use tractors, one-third of the respondents who had used tractors in 1966 farmed fifty acres or less. These four practices (insecticides, fumigants, chemical fertilizer, and tractors) are therefore weighted more heavily than the remainder of the inputs. For lack of a better system of establishing relative weights, which will hopefully be included in future studies, the use of each of these four innovations is weighted twice as heavily as the use of any of the other innovations in calculating individual innovativeness scores. The inadequacy of this method of weighting innovations is clearly recognized, but it is believed to be at least somewhat more adequate than the typical system of preparing indexes of innovativeness.

The Dichotomous Dependent Variables Used in This Study

In addition to the innovation index proposed above, the adoption/non-adoption of three innovations will be considered individually (dichotomous dependent variables). As a counterpart to the usual index of innovations it would also seem useful to attempt to identify (from the available data) the variables with the greatest impact upon the farmer's decision-making process with respect to the use of particular innovations. Fortunately, the A.I.D. program provides a statistical technique for examining the

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relationship between independent variables and the adoption/non-adoption of selected new practices. Three such practices were chosen for individual attention: chemical fertilizer, tractors, and insecticides. The program subdivides the sample on the basis of explaining the percentage of farmers adopting a particular practice.

Selected Independent Variables

The A.I.D. analysis reported in this chapter involves variables which have been selected with the benefit of the analyses in previous chapters and the results of an initial computer run. A number of possible variables, both those which were utilized and those which were not, are discussed in this section. (See pages 245-247 for a summary of the independent variables.)

Farm Size

Size of farm was found to be associated with income levels, credit usage, educational achievement and information sources used by the Recife farmer. Although it was not reported earlier, the size of farms was significantly associated with the use of certain innovations -- chemical fertilizer, tractors, and insecticides. One of the reasons for not emphasizing size of farm in earlier chapters and not including it in the A.I.D. program is its close identification with other variables which seem to have a more direct relationship to farmer decision-making with respect to innovations. Again, since it is difficult to hypothesize a "uni-dimensional" (direct) relationship between size of far

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farm and innovativeness, it would seem to be a better practice to deal with variables (such as education level, income, credit usage) which have a clearer theoretical justification.

Tenure

The evidence of Chapter V indicates that, contrary to our original hypotheses, tenants are more akin to landlords than owner-operators in their likelihood of using new technologies. And that the proportion of tenants and landlords using insecticides is higher than with owner-operators. The rationale proposed for this finding is that landlords are more innovative because of their larger farm size and greater financial capability, while the innovativeness of tenants reflects their relationships with the landlord. Specifically, landlords may either furnish certain inputs to tenants or insist that they use them. Some verification of these arguments is possible by including tenure as a variable in the A.I.D. programs.

Income Level

Income level as a variable must be recognized as having a "multi-dimensional" character. They reflect both the financial ability to purchase new inputs and the capacity to withstand the risk inherent in new technology. Income is also interrelated with a number of other variables: educational level, credit usage, and information sources used by the Recife farmers. Consequently, a program division ("split") based upon income should be carefully exa

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examined in an attempt to identify which of the dimensions of this variable are affecting the decision-making process. As before, this variable is included in the A.I.D. program as per capita family income, a family "well-being" form of the income variable. It is hoped that in this form it will tend to reflect the willingness of individuals to accept the "risks" involved in new methods.

Credit

There are several ways in which credit could be included in the A.I.D. analysis. One could use the amount borrowed or the amount borrowed per acre as the variable. In either case the variable would strongly reflect the size of farm (as large farmers borrow more in total, but small farmers tend to borrow more per acre). A second approach is to simply divide farmers on the basis of those who borrowed and those who didn't. This would provide a very minimum of information about the relationship between credit and use of new agricultural methods. Another alternative is to construct the variable on the basis of the sources of credit used by the farmers, remembering that the amounts advanced and the typical clientele differed by sources. It will be recalled that banks (government and private) tended to loan the larger amounts and the larger farmers were more likely to borrow from this source. Nonetheless, approximately one-quarter of the bank loans were obtained by farmers with less than fifty acres. Credit cooperatives were frequently used sources of credit among small farmers and tended to prov

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provide their clientele with larger loans than non-commercial sources -- neighbors and relatives, local businessmen, and landowners. Non-commercial sources, with the notable exception of buyers (who loaned relatively large amounts to a few São Francisco rice farmers and whose total credit activities accounted for only 3.4% of the loans received by Recife farmers), tended to loan very small amounts (especially landowners) and were an important source to smaller farmers. It might be argued, then, that the ability of farmers to finance new agricultural methods is related to the sources from which they were able to obtain credit. We would expect farmers who had obtained credit from banks to use new methods more frequently than those who had borrowed from credit cooperatives, and farmers who had borrowed from either of these sources to be more innovative than producers who had obtained their loans from non-commercial sources.

Still another approach would be to divide farmers into three groups depending upon whether or not they had borrowed, and if those borrowing believed they had obtained sufficient credit to meet their needs (recalling that 7.1% of the Recife farmers didn't borrow more because they had "no need" for additional credit). The resultant groups would consist of (1) farmers who had not borrowed for various reasons, (2) borrowers who did not obtain larger loans because of internal ("risk") or external (couldn't get larger loans) credit rationing, and (3) those who bel

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believed they had obtained sufficient credit to meet their needs. Intuitively, it would seem that the latter group would be in the best position to adopt new methods (sufficient credit), and that the second group (borrowers who might have wished to borrow larger amounts) would be in a somewhat less satisfactory position to purchase (or rent) new inputs, but still better able to adopt new practices than those who did not borrow at all. This generalization is, of course, affected by the individual's ability to finance new practices from his own resources.

The credit variable used in the A.I.D. analysis combines some of these possibilities in order to glean the greatest amount of information from the program. Five classifications are involved in this variable. The first includes those farmers who didn't use credit, allowing the program to "split" the sample on the basis of use/non-use of credit. Classifications two through four relate to the sources of credit used by farmers -- (2) non-commercial sources, (3) credit cooperatives, and (4) banks. This permits the program to seek out those sources of credit which are used most by the more innovative farmers. The final classification involves those few farmers who "didn't need" additional credit, allowing the program to "split" off this group if sufficient credit (as perceived by the farmer) is found to be related to innovativeness. In essence, an attempt has been made to construct one credit variable capable of providing information equivalent to two or three variables.

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Attitude Toward Trying New Practices

Slightly over one-quarter (26.4%) of the Recife farmers indicated that they would be willing to try a new method without first observing it in use by others. One would expect these individuals, on the average, to be more innovative than the remaining farmers. As such, a dichotomous variable involving the farmer's attitude toward trying new methods may be one method of measuring the importance of the "risk factor," as separated from the financial capacity to purchase new inputs, to decision-making with regard to the adoption process. It should be remembered that the willingness of Recife farmers to use untried methods was found to be associated with their capacity to absorb losses (in terms of income levels and farm size).

Risk Preference

The "risk-choice" question (p. 179) was designed to determine the farmer's willingness to accept risks in order to obtain additional income. It was hoped that this variable would provide some ranking of the Recife farmers on the basis of their utility for increased income. The evidence given in Chapter IV indicated, however, that the farmer's "risk-choice" was not significantly associated with the use of insecticides, chemical fertilizers, and tractors. The A.I.D. program provides an additional opportunity to examine the usefulness of this variable.

Price Responsiveness

The farmer's response to increases in prices is often

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used as a measure of his economic motivation. For this reason price responsiveness (expected increase in acreage devoted to crop A ÷ the total acreage currently devoted to crops, given a hypothetical price increase) was expected to be associated with the farmer's responsiveness to the profit opportunities represented by new practices. The decision was made to eliminate this variable from the A.I.D. program following the initial computer runs. In several cases it was selected by the computer as a statistically important variable, but these results were all incomprehensible. Nearly without fail, the program would select the less price responsive individuals as the most likely to use innovations. Since a suitable interpretation of this outcome could not be developed, the variable was simply omitted in the final programs.

Input Availability

The local availability of modern inputs is thought to be a prerequisite for progress in backward rural communities. The Recife survey asked farmers to indicate whether or not they believed rental tractors, insecticides, and chemical fertilizer were available in their municipio (county). The responses to these questions were used as a measure of input availability in the A.I.D. program. For the analyses of single innovations (dichotomous dependent variables) the farmer's response regarding the availability of that particular input was used as a variable. An index of input availability was prepared for use with the programs involving an index of innovativeness as the dependent variable. This index was simply a summation of the affirmative responses given by farmers to questions about the local availability of each of the following inputs: chemical fertilizers, insecticides, and rental tractors.

Educational Level

Educational achievement is usually assumed to be related to individual innovativeness. A rationale for this relationship, as hypothesized in this study, is that the skills concomittant with increasing levels of formal education enable the better educated individuals to formulate realistic expectations about new methods more rapidly than uneducated and poorly educated farmers. Evidence presented in Chapter IV seems to support this hypothesis. It was found that the better educated farmers were more likely to know about fertilizer and how to improve crop yields, and were more inclined to use "direct" sources of information than their less educated colleagues. In order to provide continuity with the earlier analysis, the same classifications of educational achievement are utilized in the A.I.D. program.

Information Sources-I

Information sources-I is a variable based upon the farmer's response to the survey question asking him to indicate the source from which he had learned about the latest method he was employing (relative, neighbor, agronomist, mass media, etc.). Since the question ignores the possibility that information might have been received by t

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by the farmer from several sources, it must be assumed that the respondent's choice represents the source that had the most important impact upon his decision-making process. In addition, it must be assumed that the source indicated is usually of considerable importance to the respondent. Given these assumptions, information sources-I was included among the variables used in the A.I.D. program.

Information Sources-II

Information sources-II involves the individual farmer's exposure to extension meetings (meetings where agronomists had talked about new methods), farm magazines, and radio. Exposure to each of these sources of information were found to be associated with the use of new agricultural practices in Chapter IV. For the purposes of the A.I.D. program, a variable was constructed which identifies the use of each of these sources and combinations of their usage. The variable was composed of the following classifications:

1. Extension meeting, farm magazine, radio
2. Extension meeting, farm magazine
3. Extension meeting, radio
4. Extension meeting
5. Farm magazine, radio
6. Farm magazine
7. Radio
8. None

As initially conceived, this variable would permit the program to "split" on the basis of the most important of these three sources. Alternatively, it could "split" on the basis of the combinations of information sources which are most associated with new practices. In the final computer run, however, this variable was constrained in such a manner as to consider only the second alternative. Small sample numbers related to some classifications and little indication of any one source being independently superior to others resulted in the decision to constrain the variable in the final computations.

Attitude Variables

The farmers' responses to certain attitudinal questions (fatalism/non-fatalism, luck/business, attitude toward technicians, and willingness to defer income) were included in the A.I.D. analysis. The variables were not expected to become involved in the early "splits" performed by the program, but it was believed that they could be involved after other variables had been taken into consideration. The farmer's interpretation of his neighbor's views were included as variables in the initial computer run, but omitted in the final computations. The reason for omitting these variables was to provide for their substitution by more informative variables in the computer output. (After two intermediate "splits," São Francisco farmers who believed their neighbors wouldn't like to see them get ahead were found to use tractors more often than those who believed their neighbors would not be disturbed by their individual progress.)

Summary of the Variables Included in the A.I.D. Program

The following listing summarizes the variables and the classifications within variables which were utilized in the

A.I.D.

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A.I.D. program:

Tenure: (Free)
1. Landlord
2. Owner-operator
3. Tenant

Income (annually): (Monotonic)
1. < $50 (per capita family)
2. $ 50 - $ 99
3. $100 - $199
4. $200 - $499
5. $500 and above

Credit (Free)
1. Didn't use credit
2. Obtained credit from non-commercial sources
3. Obtained credit from credit cooperative
4. Obtained credit from banks
5. Didn't need additional credit (borrowed from one of the above)

Attitude Toward Trying New Practices ("Try Second"): (Free)
"When new agricultural products are offered it is better to wait and see what happens when they are used by others." (Question from MSU/SUDENE Farm Survey.)
1. Agree
2. Disagree

Risk Preference (see p. 179): (Monotonic)
1. Very low utility
2. Low utility
3. Medium utility
4. High utility

Education
1. None
2. One year
3. 2 - 3 years
4. 4 - 5 years
5. 6 - 12 years
6. More than 12 years

Input Availability: (Monotonic)
- A.I.D.-I (Fertilizer--São Francisco Rice Area)
  1. Fertilizer available locally
  2. Fertilizer not available locally
- A.I.D.-II (Insecticides--São Francisco Rice Area)
  1. Insecticides available locally
  2. Insecticides not available locally

A.I.D.-III (Tractors--São Francisco Rice Area)
1. Rental tractors available locally
2. Rental tractors not available locally

A.I.D.-IV & A.I.D.-V (Innovation Index--São Francisco Rice Area and Combined Bean Areas)
1. Fertilizer, insecticides, rental tractors <u>not</u> available locally
2. One of the above available locally
3. Two of the above available locally
4. All of the above available locally

Information Source-I (Free)
1. Relative
2. Neighbor
3. Agronomist
4. Businessman
5. People from a different place
6. Mass media
7. Another source

Information Source-II (Monotonic)
1. Extension meeting, farm magazine, radio
2. Extension meeting, farm magazine
3. Extension meeting, radio
4. Extension meeting
5. Farm magazine, radio
6. Farm magazine
7. Radio
8. None

Fatalism: (Monotonic)
"Nowadays the farmer alone cannot do much to improve his life." (Question from MSU/SUDENE Farm Survey.)
1. Agree
2. Don't know
3. Disagree

Luck/Knowledge: (Monotonic)
"To make more money it is better to know how to do business than be lucky." (Question from MSU/SUDENE Farm Survey.)
1. Agree
2. Don't know
3. Disagree

Attitude Toward New Technology: (Monotonic)
"We would be in a better situation if the technicians left things as they are." (Question from MSU/SUDENE Farm Survey.)
1. Agree
2. Don't know
3. Disagree

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Deferred Income: (Monotonic)
"If someone has to choose, it's better to receive NCr $90.00 one year from now than NCr $30.00 today." (Question from MSU/SUDENE Farm Survey.)
1. Agree
2. Don't know
3. Disagree

Note that either the word "free" or "monotonic" is indicated in parentheses across from the variable. A "free" variable means that the computer can rearrange the classifications in descending order on the basis of the value of their means. "Monotonic" instructs the computer to perform the A.I.D. operations with the classifications ordered as given by the researcher.

A.I.D.-I: Fertilizer Use by São Francisco Rice Farmers

Nearly all of the farms using chemical fertilizer were from within the São Francisco Rice Area. Still, even within this area the percentage of farmers who adopted this practice was very small -- 11.8%. The use of fertilizer by these farmers was examined with the aid of the Automatic Interaction Detection program and the results are presented by Figure 14.

According to the program, the most important predictor of fertilizer usage was the farmer's identification of the agronomist as a source of information. Of the 14 São Francisco farmers who had learned their latest method from the agronomist, 42.9% were using chemical fertilizer. This figure is contrasted with the 7.6% of those farmers indicating other sources of information. In all, 12.4% of the variance in the sample was explained by this initial "split." The second choice predictor, which would have explained 10.0% of the total variance, was education. Income and credit

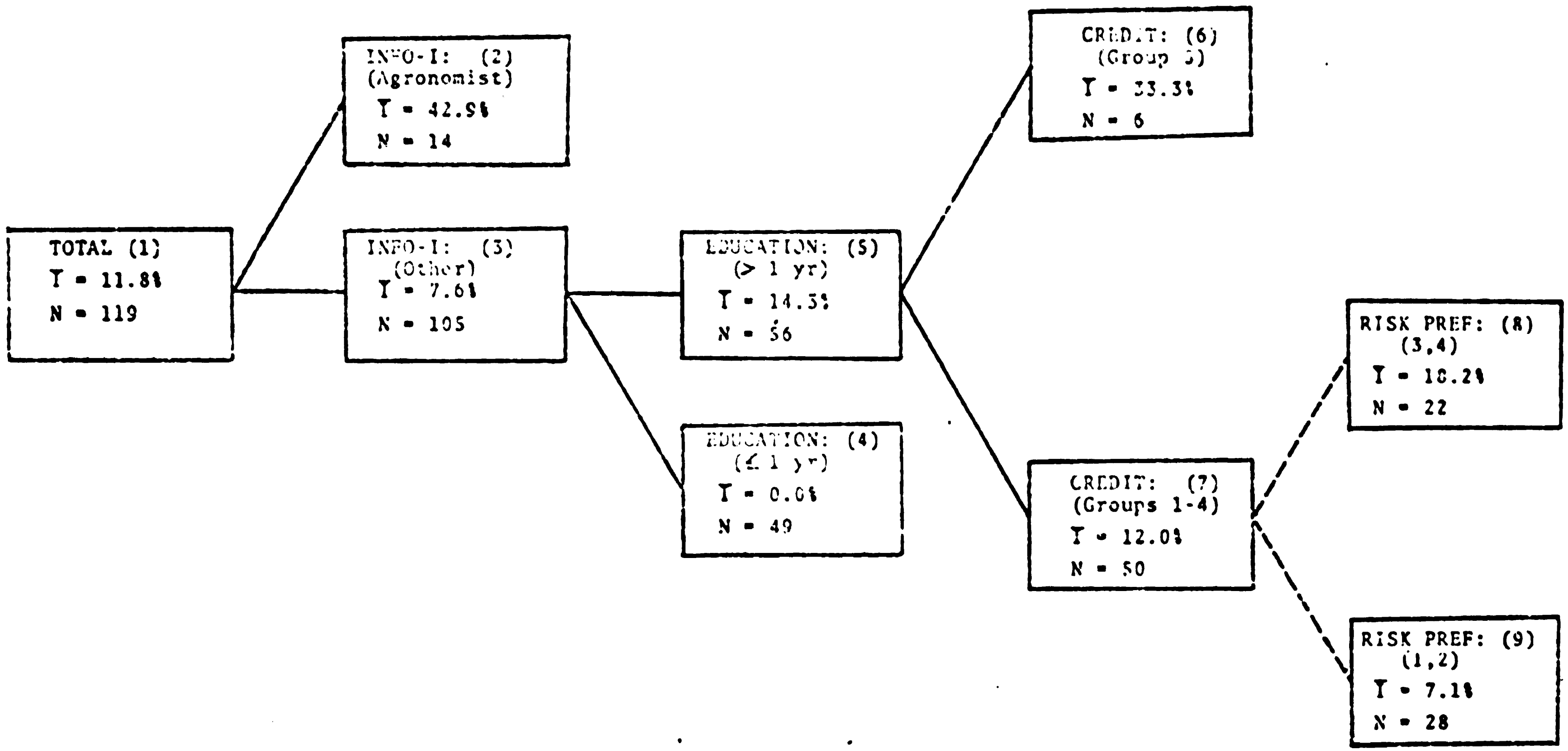

Figure 14 -- A.I.D.-I: Fertilizer Use by São Francisco Rice Farmers.

$\bar{T}$ = Percentage using fertilizers
N = Number of observations

variables were considerably less helpful at this early stage, in explaining the adoption of fertilizer (see Appendix A).

Educational achievement was assigned primary importance in the second "branching" of the "tree" (dividing Group #3 into Groups #4 and #5). The "split" occurs between farmers who had less than two years formal education (n=49) and farmers with at least two years of schooling (n=56); and adds an additional 4.3% to the explained variance (R^2=.1672). All too clearly, the most poorly educated segment of the Recife farmers were not among the innovators with respect to fertilizer usage. One might expect that low levels of income would be a close substitute for educational disadvantage at this juncture, yet its influence appears to be somewhat limited. While 7.2% of the variance within Group #3 is explained by education, only 3.1% would have been explained by a division of farmers into groups with less than $50 per capita family income and those with more. Instead, the individual's exposure to extension meetings, farm magazines, and radio ("information sources-II") seems to be nearly as important as his educational achievement in explaining the adoption of fertilizer (explaining 6.4% of the parent group variance as compared with 7.2% for education). Eleven farmers who were exposed to the combinations of extension meetings, farm magazines, and radio or extension meetings and farm magazines would be separated from the remaining 94 farmers.

Among the better informed farmers, 27.3% were using fertilizer as compared to 5.3% of the larger group.

Among the Recife farmers who had completed more than one year of education (except for those who had indicated the agronomist as an information source), those few (n=6) who had obtained "sufficient credit to meet their needs" were more likely to use chemical fertilizers than the remaining farmers -- 33.3% as opposed to 12.0%. These six farmers represented two-thirds of the farmers who believed that they "didn't need" additional credit, the remaining third was included among those who indicated the agronomist as an important information source.

Turning attention to those farmers who were apparently less fortunate in obtaining credit, we find the ordering of the credit classifications as would be expected, but with mean values that are not greatly different. Among the non-borrowers, 9.5% were found to be using fertilizer as compared to 10.0% for those borrowing from non-commercial sources (neighbors, relatives, businessmen, buyers and landowners). A somewhat greater percentage -- 15.8% -- of those borrowing from banks were employing this innovation. Despite the fact that these findings are rather satisfying in terms of the proposed theory, they should be interpreted cautiously. It should be kept in mind that the parent group (Group #5) consisted of only 56 farmers and that Group #6 -- those with "sufficient" credit contains only six observations. In general, we need to be more cautious about our findings as we move outward through the "tree."

Differences in the willingness to try new methods ("Try second") and variations in exposure to extension meetings, farm magazines and radio ("information sources-II") were nearly as useful as credit in explaining the variance within Group #5. Of those 11 farmers willing to try new methods without benefit of observing other peoples' experiences, 27.3% were using fertilizers. This is compared to 11.1% of the farmers (n=45) who preferred the alternative -- "wait and see" -- strategy. Once again, we find those farmers exposed to both extension meetings and farm magazines (n=11) more inclined to use fertilizer than the remaining farmers -- 27.3% as contrasted with 11.1%. Finally, income level was almost as important a variable and would have separated out the 9 farmers who had per capita family incomes of less than $50 and did not use fertilizer at all.

In all, the first three "splits" are capable of "explaining" 18.7% of the variance (R^2=.1869) in fertilizer use among São Francisco rice farmers. Two additional "splits" were made by the A.I.D. program, but they were of doubtful value and were "pruned" from the tree. An alternative "split" of Group #7 is indicated by dashed lines, dividing these farmers into groups with "high" or "moderate" utility for increased income (as measured by the "risk preference" variable) and "low" or "very low" utility for additional income. Such a "split" would have provided an additional explained variance of 1.2% (R^2=.1991), but

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given the fact the irrational "splits" were already "pruned" at this point it should be given a very cautious interpretation.

In interpreting the A.I.D.-I output, it appears that factors related to the development of expectations about fertilizer are critically important to its adoption. Even though 88.2% of the São Francisco farmers indicated that they knew what fertilizer was, those who use the agronomist as an important source of information were the farmers most likely to adopt the technology. The most poorly educated among the Recife farmers (one year or less of schooling) failed to have any of its members using fertilizer. Finally, the farmer's exposure to extension meetings and farm magazines repeatedly emerged as a "second best" explanation of fertilizer usage.

Secondly, the availability of "sufficient" credit resources seemed to improve the farmer's chances of using fertilizer. In addition, there is some reason to believe that the willingness to take risks and higher utilities for increased income may be related to innovativeness with respect to fertilizer. These conclusions, however, should not be strongly supported on the basis of the present information.

A.I.D.-II: Insecticide Use Among São Francisco Rice Farmers

Unlike fertilizer, the use of insecticides is reasonably widespread among São Francisco rice farmers. And, as exhibited in Figure 15, a configuration of variables different from those associated with fertilizer usage seems to be related to the use of this innovation. The availability of adequate credit resources appears to be particularly important to insecticide usage. Of those farmers who reported bank loans or indicated they had obtained "sufficient" amounts of credit, 88.8% were using fertilizer. Only 55.4% of their counterparts who either had not borrowed or had obtained loans from non-commercial sources were utilizing this practice.

The division of the São Francisco farmers on the basis of credit usage resulted in the explanation of 13.4% of the variance in insecticide use. A partition of these farmers on the basis of tenure would have been nearly as useful. Landlords and tenants would have composed one group (with 84.4% using insecticides) and the second would have consisted of owner-operators (of whom 52.7% were using insecticides). This relationship, between tenure and insecticide use, was encountered earlier in Chapter V. At that time it was suggested that landlords were generally better educated and had greater financial resources than owner-operators, and that tenants were probably either furnished this input by their landlords or required to use insecticides.

Even among those farmers who had not obtained bank loans or didn't use credit at all, the better educated individuals were most likely to use insecticides. While 86.4% of those farmers who had completed at least four

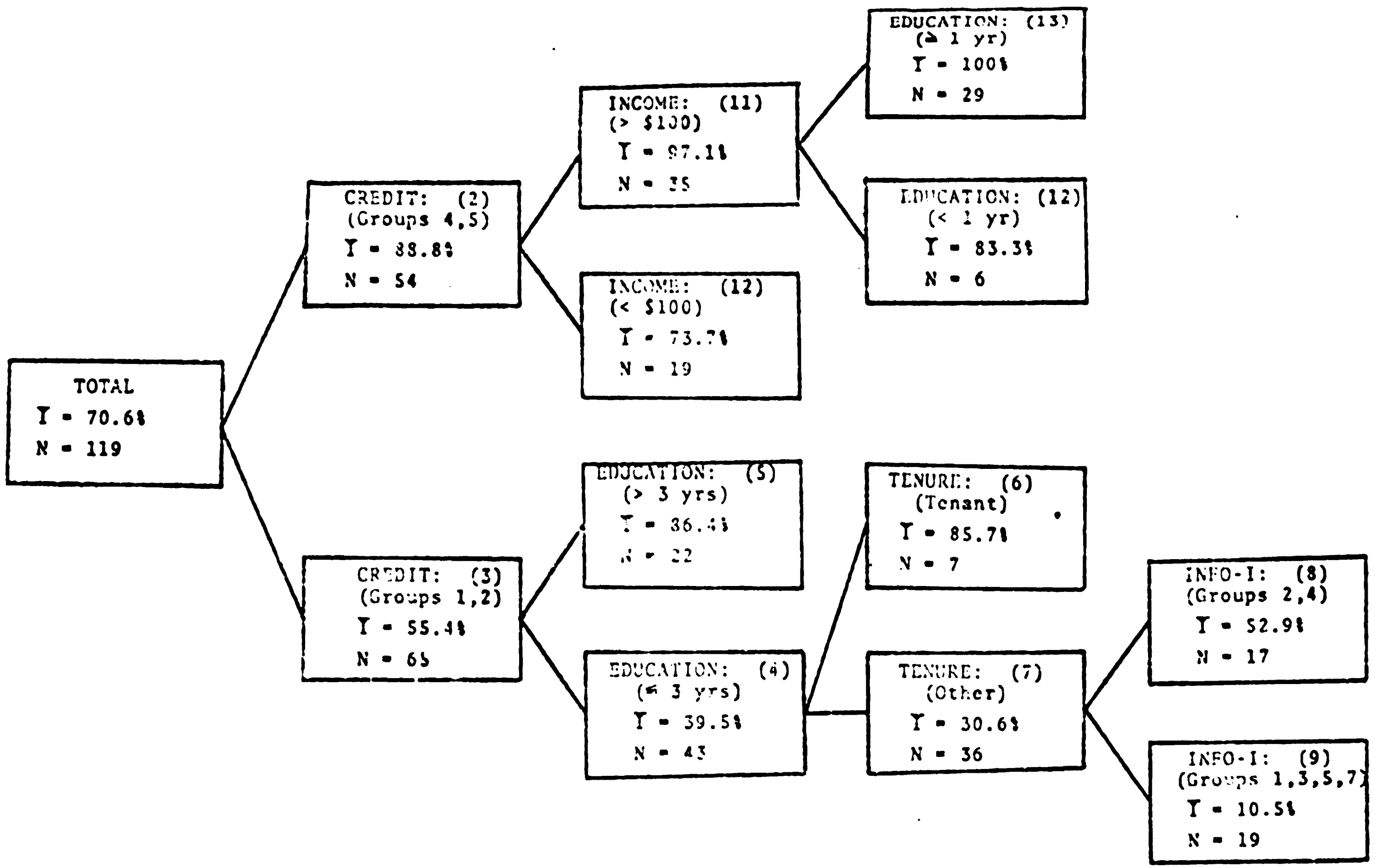

Figure 15 -- A.I.D.-II: Insecticide Use by São Francisco Rice Farmers.

Υ = Percentage using insecticides
N = Number of observations

years of education were using insecticides, the figure is only 39.5% for farmers with three years or less of schooling. In an identical comparison among the São Francisco rice farmers who had either bank loans or credit "sufficient" for their needs, it was found that 100.0% of those with more than three years of education were using insecticides as contrasted to 83.3% for farmers with less than three years of schooling. This seems to suggest that improved credit arrangements might have considerably increased the number of farmers in Groups #4 and #5 who were using fertilizer.

Focusing again upon education, the partition of Group #3 between farmers with three or less years of schooling and those with more explained 12.9% of the total variance in insecticide use. The next best predictor would have been the sources of information given by the respondents, explaining 9.5% of sample variance. Interestingly enough, the farmers of Group #3 (non-borrowers and loans from non-commercial sources) would have been subdivided into a group containing those who had learned about their latest method from neighbors and businessmen (n=34) and those who had utilized other sources (n=31). Only 4 members of the second group had indicated the agronomist as a source of information and two had given the mass media as a response. Over two-thirds of the latter group had indicated either relatives or another (undefined) source of information. In all probability, such a split would have indicated that neighbors were a better source of information than relatives and another source. In fact, neighbors may have been a reasonably good source of information about insecticides given the relatively widespread use of this practice. This might be contrasted with the considerable importance placed upon the agronomist -- a "direct" source of information -- by A.I.D.-I as the program attempted to explain the use of fertilizer -- a practice which was not widely used. One might generalize that as the number of farmers using a particular practice increases, the importance of "direct sources" of information in the adoption process decreases.

The third partition created by A.I.D.-II indicates that the poorly educated tenant is more likely to adopt insecticides than the landowners who are in the same circumstance with respect to education and credit. Again, this is probably because the decision of whether or not to use insectidies was "handed down" from their landlords. Note that 85.7% of those few tenants remaining in the parent group (Group #4) were using insecticides, while only 30.6% of their landowner counterparts had adopted this practice. We should remember, however, that we are reaching the point in terms of sample numbers that partitions should be interpreted more cautiously.

This particular "split" explained approximately 7.2% of the variance in the use of insecticides. A division on the basis of information sources, similar to the one discussed above, would have been nearly as useful. A third alternative, based upon the farmer's choice between luck or knowledge as the best means of attaining larger incomes, would have explained a considerable amount of the variance in Group #4 (< 3 years of education). According to the program, 54.5% of those who favored knowledge were using insecticides as opposed to 25.0% of the farmers favoring luck.

The final "split" on the lower branch was based upon information sources, dividing farmers into a group who indicated neighbors or businessmen as important sources and one composed of the remaining sources. This is not a very informative partition since it largely reflects the difference between neighbors and another (unidentified) source of information. "Pruning" this partition from the "tree" would reduce the explained variance by 6.5%. An alternative would be to "split" this same parent group on the basis of the farmer's reaction to luck as opposed to knowledge as a means of earning higher incomes. The percentage of adopters among those favoring knowledge was 44.4% as compared to 16.6% for farmers favoring luck. Such a partition would have explained 5.8% of the variance in insecticide use. It is interesting to observe that after adjustments have been made for the interaction of other variables, an attitudinal variable emerges as potentially useful in explaining the adoption of insecticides.

Turning our attention to those among the São Francisco rice farmers who had either received loans from banks or obtained "sufficient" credit to meet their needs, we find that the lower income individuals were considerably less likely to use insecticides. While 73.7% of the farmers with less than $100 per capita income used this practice, nearly all -- 97.1% -- of those with higher incomes had adopted insecticides. There is some indication, given the reasonably favorable credit situation of these farmers, that the "willingness to accept the risks of new methods" is involved in this partition. The fact that these farmers had either obtained bank loans (generally larger amounts than from other sources and with government-subsidized interest rates associated with most of them) or indicated that they "didn't have any use" for additional credit suggests that the ability to finance inputs from their own resources is of diminished importance in interpreting this particular "split." In addition, those variables which were found to be associated with income levels -- educational achievement and information sources -- were not nearly as useful in explaining the variance within the parent group (see BSS_i/TSS_i for Group #2 in Appendix B). In all, the evidence seems to suggest that the "dimension" of the income variable involving the lower income farmer's reluctance to "accept the risk" of new methods may have been prominent in this partition.

This particular "split," based upon income levels, explained 2.7% of the variance in the use of insecticides. A partition on the basis of tenure would have separated the 6 tenants and 27 landlords from 21 owner-operators, and explained 2.2% of the variance. Tenure, in this case, appears to be a reasonably good substitute for the income variable (as landlords tend to own larger farms and have higher incomes than owner-operators).

Continuing with the larger income farmers (above $100 per capita), we find that only among those without any formal education (n=6) were there farmers who were not using insecticides. Unfortunately, the size of this group and the amount of variance explained by this partition -- 0.5% of the total variance -- make one hesitate to draw strong conclusions. Nonetheless, it is interesting that, among farmers who were apparently able to withstand the "risk" of innovations and probably able to finance these inputs with credit, the few who had not adopted insecticides had also never attended school.

In summarizing A.I.D.-II, it was found that four interacting variables -- credit, education, income, and tenure -- were capable of explaining 36.8% of the variance in insecticide usage. (The total "tree," as presented in Figure 15, resulted in a R^2 of .4336.) Credit seemed to be the most important predictor of insecticide use, accounting for one-third of the explained variance. The likelihood of a São Francisco rice farmer using insecticides was enhanced by access to either bank loans or "sufficient" amounts of credit (from whatever source) and inhibited by failure to use credit or a dependency upon non-commercial sources for loans. Which suggests that an improvement in the availability and use of credit would have increased the use of insecticides in this area. Better educated farmers were inclined to use insecticides more frequently than their poorer educated colleagues. All of those farmers possessing a combination of "sufficient" credit or bank loans, income levels sufficient to "accept the risk" of new methods and some formal education were found to be using insecticides. Farmers with more than three years of education, even though they had either not borrowed or had obtained their loans from non-commercial sources, were twice as likely to use insecticides (86.4%) as those in the same circumstance but with less education (39.5%). Among those poorly educated farmers who had either not obtained credit or had received loans from non-commercial sources, the tenants were much more likely to use insecticides than their landowning counterparts. This, once again, suggests that the landlord had influenced the tenant's decision.

A.I.D.-III: The Use of Tractors by São Francisco Rice Farmers

Slightly over half (51.3%) of the São Francisco rice farmers were using tractors. The availability of rental tractors makes a considerable contribution to the large proportion of farmers using this practice. A.I.D.-III (given Figure 16) identifies the local availability of tractors for rent (as perceived by farmers) as the most important variable explaining their use. This variable alone accounts for 12.3% of the variation in tractor usage.

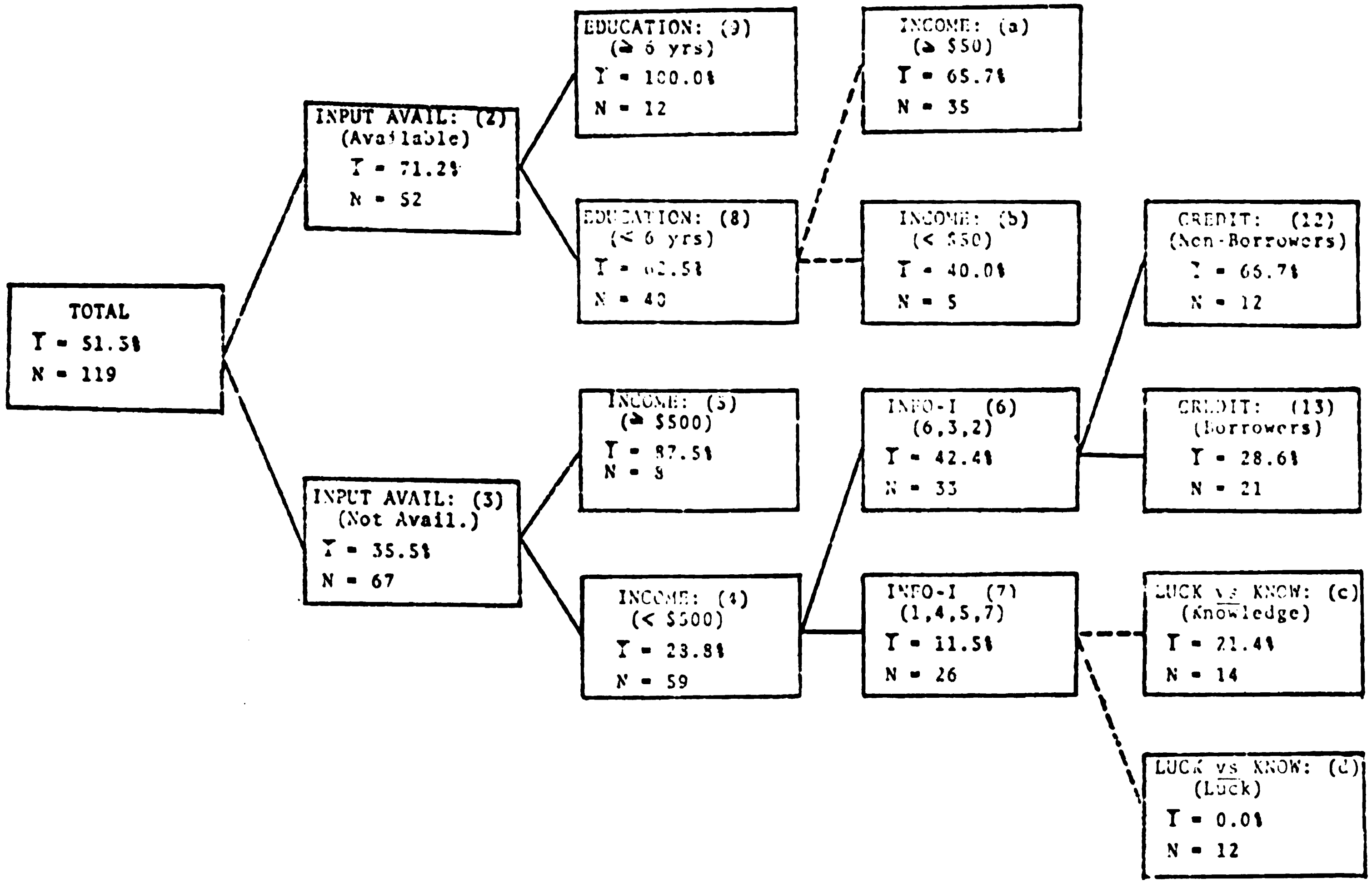

Figure 16 -- A.I.D.-III: The Use of Tractors by São Francisco Rice Farmers.

T = Percentage using tractors
N = Number of observations

Among those who found rental tractors available locally, 71.2% were utilizing this method of tillage. This proportion is contrasted with 35.5% who did not believe they could rent a tractor in their municipio. The importance of the availability of rental tractors is underscored by the fact that 31.0% of the poorest farmers in the São Francisco sample were using tractors.

Nearly as large an explanation of the variance in tractor usage (in the initial partition) could have been achieved using income levels or educational accomplishment. Individuals earning per capita family incomes of $500 or more (83.3% using tractors) would have been separated from the remainder of the farmers (43.2% using tractors), explaining 10.4% of the variance. In terms of education, those with no formal education (27.8% using tractors) would have been set apart from the rest (61.4% using tractors).

It is interesting to note that a division of income, in the form suggested above, is the basis of the next most important "split." Even when they didn't find rental tractors available locally, the wealthiest farmers ($500 or more per capita family income) were still very inclined to be using tractors (87.5%). Either they owned tractors themselves or rented them from sources outside the immediate municipio. (It should be noted that the question upon which this variable is based asks if tractors can be rented "from suppliers in the municipio where you live?" It might have been possible to rent tractors from more distant sources.) Farmers with incomes below this amount, and without locally available tractors to rent, were largely inclined to use other means for tilling their land -- as only 28.8% were using tractors. Thus, once we have adjusted for the availability of rental tractors, the financial capability of the farmer is very much related to whether or not he used this means of power. An interesting sidelight is that income levels and the belief that rental tractors were available locally were found to be significantly associated at the .005 level (by chi-square analysis). The reason for this relationship is open to speculation. Perhaps the relatively wealthier farmers were less isolated and more aware of the availability of such inputs throughout the municipio. Or perhaps the wealthier and poorer farmers were clustered with rental tractors being more readily available in the vicinity of the wealthier farmers.

This partition, dividing between the highest level of income and all lower levels, explained an additional 8.2% of the variance in tractor use. (Approximately 20.5% of the total variance is explained by input availability and income levels alone.) The second most important variable at this point was the farmer's exposure to extension meetings, farm magazines, and radio. These farmers who were exposed to at least two of these channels of communication adopted tractors more often (68.8%) than the other members of the group (25.5%). Educational achievement was also a reasonably good predictor at this juncture, with a division suggested between

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those with more than three years of education (42.9% using tractors) and farmers with three or less years of schooling (32.7% using tractors). This alternative bears mentioning since exactly this "split" was found in A.I.D.-II in the same position in the tree, although it followed credit usage rather than input availability.

According to the A.I.D. program, sources of information best explain the variance in tractor usage among the lower income farmers. Although the group whose members were more likely to be using tractors includes farmers who looked to the mass media (n=1) and agronomists (n=4) as sources of information, the partition is largely a division between neighbors as an information source and "another source" (which is left unidentified in the survey data). As such, it adds little to the information available about the farmer's decision-making regarding tractors. An alternative variable would be the farmer's exposure to extension meetings, farm magazines, and radio. Again, we find that the individuals exposed to two or more of these channels of communication were more likely to be using tractors (54.5% with n=11) than their colleagues with less exposure (22.9% with n=48). While the partition selected by the computer accounted for 4.6% of the variation, the alternative suggested above would have explained 3.1% of the total variance in tractor usage. Although less important statistically, the alternative partition would seem to be more informative. It suggests that the farmers with a greater exposure to modern (or perhaps more "direct") channels of information were more innovative than others.

Returning to the farmers who indicated that they could rent tractors locally, we find that all of those individuals with six or more years of education were using tractors. Among the corresponding group, with less than six years of schooling, only 62.5% of the farmers had employed tractors in tilling their land. This represents a partition of the educational variable at a somewhat higher level than had been observed in A.I.D.-I and A.I.D.-II. It may be that even the most poorly educated farmers are aware of the obvious technical advantages of tractors, while the economic advantage is best understood by the better educated individuals. Whatever the reasons are, 4.4% of the total variance is explained by this "split" and there were no substitutes suggested by the program.

An additional 0.8% of the variation in tractor usage is accomplished by dividing the farmers with less than six years of education on the basis of income levels. This partition would group together those farmers with $50 or more per capita income (n=35) and those with smaller earnings. Only 40.0% of the members of the latter group were found to be using tractors, while 65.7% of those farmers with at least a $50 per capita family income had adopted this innovation. Since there is probably very little "risk" associated with trying tractors, a difference on the basis of income levels would undoubtedly reflect the ca

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capacity of the farmer to pay the rental fee. Yet, whether or not a real difference is given by this partition is open to question. Other "splits" at this location in the "tree" have already been "pruned" because they were unsatisfactory statistically, and this partition itself involves a very small number of observations in the lower income groups. (Even though it represents five-sixths of the farmers at the less than $50 level who also believed tractors were available locally.)

The remaining partitions (yet to be discussed) in Figure 16 are perhaps even more tenuous. Although a division of Group #6 into sub-groups of non-borrowers and borrowers has some claim to statistical validity, it makes little sense theoretically. It is difficult to conceive of a reason why those farmers who hadn't used credit would be more likely to either own or rent tractors than those who had obtained loans, especially when the wealthiest of the farmers had been separated by an earlier "split." Statistically, this partition explained 3.7% of the total variance. The best alternative -- based upon exposure to extension meetings, farm magazines, and radio -- would have accounted for 2.5% of the variance. Farmers who were exposed to two or more of these channels of information would have been placed in one group (n=7, with 71.4% using tractors), with a second group being composed of those with less exposure (n=26, with 34.6% using tractors). Unfortunately, this alternative is extremely questionable since the three classifications composing the group with greatest exposure to modern channels of information contain a total of only seven observations.

A partition of Group #7, which would have been satisfactory from the theoretical standpoint, was "pruned" from the "tree" for statistical reasons. This particular "split," also based upon credit, would have separated one individual with "sufficient" credit, and who also had used a tractor, from the others. A more acceptable alternative, based upon the farmer's evaluation of luck as opposed to business knowledge as the best means of "getting ahead," has been substituted into Figure 16. None of the farmers who favored luck were using tractors, while 21.4% of those favoring business knowledge had adopted this practice. The original "split" would have accounted for 2.7% of the variance, as contrasted with the 1.0% increase in explained variance contributed by the substitute partition.

Considering only the first three branches of the "tree" (Groups #1,2,3,4,5,8,9), A.I.D.-III accounts for 24.8% of the variance in the São Francisco farmers' use of tractors. This portion of the "tree" largely reflects the farmer's ability to secure the services of a tractor. Where rental tractors were not available locally, it was quite unlikely that farmers would be using this source of power unless they were among the few with fairly substantial income (over $500 per capita). Only 28.8% of those farmers with less than $500 per capita family income, and who believed rental tractors were not available locally, were using this innovation. Yet, 66.6% of this same income grouping who indicated that they could rent tractors locally were found to be employing this practice. This seems to indicate that an increase in the availability of rental tractors would have expanded their use.

Even though access to the services of a tractor seems to be the most critical factor in tractor usage, certain variables related to expectation formation were included in the "tree." Even among farmers who found tractors available locally, those with higher levels of education (6 or more years) used them more frequently (Groups #8 and #9). And when we substitute exposure to extension meetings, farm magazines, and radio for the uninformative "split" of "information sources-I," we find that the individuals with greater exposure to these channels of communication (utilizing two or more of them) were more likely to be using tractors. Including this alternative partition, A.I.D.-III accounted for 27.9% of the variance in tractor usage.

Finally, if we accept the possibility -- as suggested in Figure 16 -- that farmers with per capita family incomes of less than $50 are relatively less able to acquire the services of tractors for hire, A.I.D.-III would account for 28.8% of the variance in tractor usage among the São Francisco rice farmers.

A.I.D.-IV: An Analysis of Innovativeness Among São Francisco Rice Farmers

A.I.D.-IV outlines the relationship of certain variables to the general innovativeness of São Francisco rice farmers. The range of the innovation index, used as a measure of the farmer's innovativeness, varied from 0 to 100. The average index number was 35.1%. For farmers with more than one year of schooling the average index value increased to 42.6%, and dropped to 25.0% for those with less education. This particular partition, which accounted for 17.5% of the variance in innovativeness, suggests that the better educated farmers were at a considerable advantage in formulating their expectations toward new technologies.

Other variables would also have been capable of explaining sizeable amounts of the variation in innovativeness. A "split" on the basis of credit, separating those who had "sufficient" credit or had received bank loans from farmers who either didn't borrow or obtained loans from non-commercial sources, would have explained approximately 14.2% of the variance. Exposure to extension meetings, farm magazines, and radio would have accounted for 13.2% of the variance; separating those who were exposed to extension meetings and one or more of the other sources from the remaining farmers. A division of the sample into groups of farmers with $50 or more per capita income and farmers with lower levels of income would have explained 12.8% of the total variance.

The second partition divided the better educated group

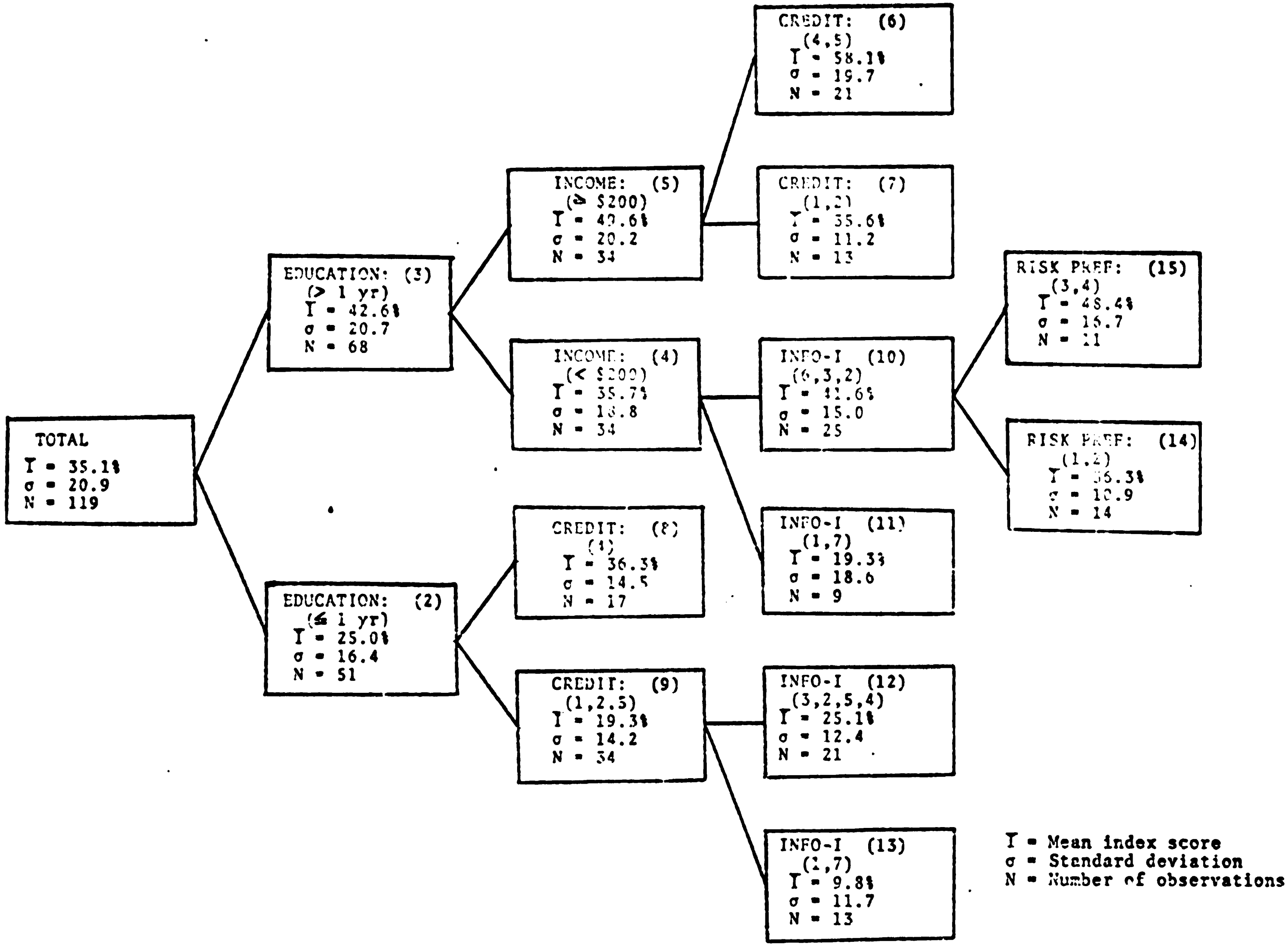

Figure 17 -- A.I.D.-IV: Innovativeness Among São Francisco Rice Farmers.

on the basis of income, resulting in a mean index number of 49.6% for those with over $200 per capita family income and 35.7% for farmers with incomes below this level. An additional 6.2% of the total variance was explained by this "split." It would appear, given the importance of credit to the innovative behavior of the higher income group (as indicated in the next partition), that the reluctance of lower income farmers to accept the "risks" inherent in new methods was an important factor in this partition. If the ability to independently finance new inputs had been the critical advantage of higher incomes, it would seem unlikely that credit usage would have had such a significant impact upon the farmer's innovativeness.

It should be indicated, however, that a partition of the better educated farmers on the basis of income was somewhat equivalent to dividing the group into those who had used the agronomist as a source of information and those who had not. Ten of the fourteen São Francisco rice farmers who had indicated that the agronomist was important to them as a source of information about new methods are to be found within the thirty-four members of Group #5. Thus, the advantages possessed by this group are not only related to their level of income, but probably also to their access to "direct" sources of information. In fact, a partition on the basis of use/non-use of the agronomist as a source of information was one of the better alternatives of income levels (exceeded only by a division on the basis of credit equ

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equivalent to that given in Groups #6 and #7).

Among the better educated, higher income farmers; those with either "sufficient" credit or bank loans were more innovative than others. The average index of innovativeness for these farmers was 58.1%, as compared to 35.6% for farmers who either didn't borrow or secured their credit from non-commercial sources. This particular "split" contributed 7.8% to the variance explained by the total "tree."

An additional 6.3% was explained by the credit variable in its application to the poorly educated farmers (for a total of 14.1% of the explained variance attributed to this variable). The São Francisco farmers who had completed less than two years of schooling were divided into those who had received bank loans (n=17) -- with mean index of 36.3% -- and those who either didn't borrow (n=22), borrowed from non-commercial sources (n=9), or believed they had obtained "sufficient" credit (n=3) -- with an average index of 19.3%. (The latter classification contains too few observations to be of much practical importance.) One might well conclude from this evidence, that even among the poorly educated farmers a more adequate source of credit allows individuals to be more innovative.

The best alternative to credit, among the poorly educated farmers, would be a partition on the basis of the availability of inputs -- specifically insecticides, chemical fertilizers and rental tractors. Such a "split" would have placed in one group the farmers who believed that one or two of the important inputs were available locally and in another those farmers who did not believe any of these inputs could be acquired locally. It should be noted that none of the farmers with less than one year of education thought that all three inputs -- tractors for rent, insecticides and chemical fertilizer -- could be obtained locally (while 8.8% of the better educated farmers believed this to be the case).

Two of the remaining partitions, based upon information sources, largely reflect the difference between neighbors as a source of information and the unidentified classification called "another source." Although these partitions are statistically valid, they are not at all informative. Before we examine some acceptable alternatives to these partitions, it is interesting to examine the remaining partition based upon risk preference. This partition may have some claim to validity, despite the fact that it is preceded by an uninformative partition. Among those farmers with more than a year of schooling and less than $200 per capita family income, one might postulate that a few individuals would be more willing than others to accept certain risks in order to secure a larger income. Setting aside those with the poorest sources of information, this appears to be the case. Eleven farmers with somewhat more utility for increased incomes, as measured by the risk preference variable, had -- on the average -- adopted a greater percentage of the new methods (mean innovation index of 48.1%) than their less venturesome counterparts (mean index of 36.3%). The problem with accepting this as strong evidence of the importance of variations in the motivation for economic gain, is that we have reached the very minimum acceptable size of a subsample to allow another partition (n=25). The most that may be said is that there is some evidence that differences in the utility for increased income has an effect on the individual's innovativeness.

Returning to the partitions based upon the "information sources-I" variable, we find that among the poorly educated farmers the availability of inputs is a reasonably good alternative. While the "split" selected by the computer would have explained 3.6% of the variance in innovatives, the availability of inputs could account for 3.1% of this variation. A partition of this type would have grouped together those farmers who believed one or two of the important inputs -- rental tractors, insecticides, fertilizer -- were available locally and those individuals who did not think they could acquire any of these inputs in their immediate areas. The associated innovation indexes would have been 23.0% and 11.5% respectively.

An equally good alternative does not exist for the subsample including the better educated farmers with less than $200 per capita family income. The best that is available is a partition between those farmers who were willing to try a new practice before others in their community had used it and those who believed the best strategy was to "wait and see" what happens to those farmers who are first to use an innovation. Unfortunately, only three observations were included in the first group. Thus, even though such a "split" would have explained 4.2% of the variance, as compared to 6.3% for the variable selected by the computer, this partition is of questionable usefulness because of the very small size of one of the resultant groups. A second alternative, explaining only 1.5% of the variance in innovativeness, would have separated those farmers who believed that being lucky was the best way to "get ahead" (n=15) from those who would have placed their faith in knowing how to do business (n=19). The mean index values for such a "split" would have been 30.3% and 40.0% respectively.

The A.I.D.-IV program, as given in Figure 17, provides an explanation of 49.5% of the variance in innovativeness among São Francisco rice farmers. If we consider only the effects of education, income, and credit, an explanation of 37.9% of the variance would be provided. Adding the alternative partitions suggested as replacements for the "information sources-I" partitions (input availability and luck/knowledge), we can account for as much as 42.5% of the variation in innovativeness.

Setting aside these gross statistics, it is interesting to note the important role -- in the decision-making process --

which seems to have been assigned to the intellectual skills acquired with at least some amount of formal education (more than one year). A careful analysis of data indicates that a relationship between educational achievement and the use of "direct" sources of information is clearly indicated, since the farmers with more than one year of school nearly monopolized the use of agronomists and the mass media. Again, we find that the better educated group had a much greater exposure to extension meetings and farm magazines than their relatively poorly educated colleagues. In fact, exposure to these sources was an important alternative to education as a partition. Yet there seems to be somewhat more to the impact of education than its association with a greater use of the "direct" sources of information (which, of course, is important in itself). Recalling the "tree" related to A.I.D.-I, we found that even when we had eliminated the critical importance of the agronomist as a source of information, educational achievement (greater than one year of schooling) was still an important predictor of the use of fertilizer. Thus, we probably cannot ignore the importance of the conceptual structures, obtained with even a fairly short exposure to formal education, in their impact upon the adoption process.

A.I.D.-IV suggests that the lower income farmers are inhibited in their innovativeness by the "risk" involved in new agricultural practices. This is supported by the findings of A.I.D.-II, which suggested that lower income farmers (less than $100 per capita in this case) were more reluctant to adopt insecticides, despite the fact that they might well have had sufficient credit to finance these inputs.

The use of credit was important to the innovativeness of both the better educated and the poorer educated São Francisco rice farmer. Since education and income are strongly associated (20 of the 29 lowest income farmers had less than two years of schooling), it can probably be said that credit is important to the innovativeness of both poorer and wealthier farmers. Individuals who were able to obtain "sufficient" credit to meet their needs and farmers who had received bank loans were found to be generally more innovative than non-borrowers or those who obtained loans from non-commercial sources (relatives, neighbors, local businessmen, landowners, and buyers).

The local availability of inputs seems to be most critical to the innovativeness of farmers who were disadvantaged in terms of educational achievement, credit, and probably income. The innovativeness of poorly educated and poorly financed farmers were greatly enhanced by the local availability of inputs, a variable which did not emerge as important among the remaining farmers.

Again, there was some evidence that the farmer's utility for increased income affects his innovativeness. Finally, it should be noted that attitudinal variables, as measured in this study, seemed to be of much less importance than other factors in their effect on innovativeness. Perhaps with increased sample sizes it would have been possible to identify an interactive effect of attitudinal items (as suggested by the use of luck/knowledge as an alternative partition of Group #4).

A.I.D.-V: Innovativeness Among Recife Bean Farmers

Among the Recife bean farmers, merging the Alagoas-Pernambuco and Irecê samples, a range of 0 to 76 is found in the index measure of innovativeness. To explain this variation the A.I.D. program generated a "tree" which bears a striking resemblance to the one proposed for the São Francisco rice farmers (A.I.D.-IV).

The first partition is quite unlike A.I.D.-IV separating 12 farmers who were exposed to extension meetings, farm magazines, and radio from those farmers who were exposed to less than all three channels of information. Since this partition is somewhat surprising, it is useful to examine the other characteristics of this very innovative group. Upon closer inspection we find that all of Group #2 had completed more than one year of schooling, as opposed to 31.8% of Group #4. Approximately 83.2% of these farmers had either received loans from the credit cooperative and banks or indicated that they had obtained "sufficient" credit to meet their needs. This is compared to a figure of 44.2% among the remaining members of the sample. Three quarters of these more innovative individuals had income levels of $100 or more, as contrasted to 31.0% of the other farmers

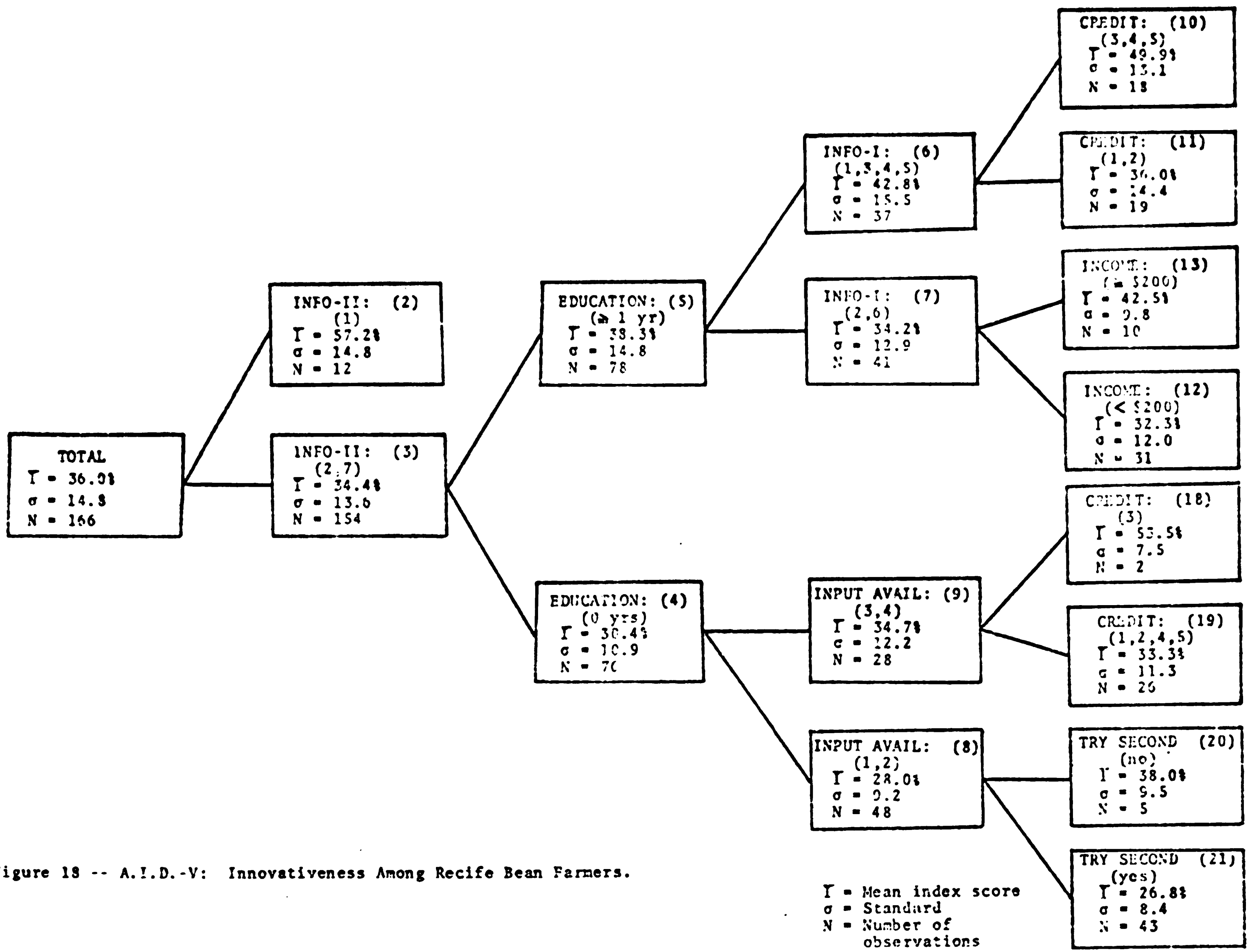

Figure 18 -- A.I.D.-V: Innovativeness Among Recife Bean Farmers.

under study. In addition, it appears that they are more likely to try new methods without the benefit of first observing the experiences of others and somewhat more inclined to believe that knowing how to do business (as opposed to being lucky) is the best means of earning higher incomes. In effect, the 12 innovative farmers selected by this partition are a rather elite group -- better informed, better educated, better financed and holding generally more modern attitudes than was typical of the remaining individuals in the sample.

This initial "split" accounted for 15.8% of the variance in innovativeness among the Recife bean farmers. As should be expected from the preceding discussion, education, credit and income were important alternatives to the suggested partition. Education, separating the bean farmers into one group with less than one year of formal education and another with at least that many years of schooling, would have explained 12.1% of the variation. A partition between those who received loans from banks and credit cooperatives or believed they had obtained "adequate" amounts of credit and those who either did not borrow or received their loans from non-commercial sources could have contributed 11.6% to the explained variance. And finally, a division on the basis of farmers with $100 per capita income or more and those with smaller incomes, would have accounted for 7.7% of the total variance.

With the second partition, on the basis of education, the "tree" begins to resemble the explanation of innovativeness suggested for the São Francisco rice farmers. Bean farmers with at least one year of schooling had an average index number of 38.3%, while those without any formal education avaraged 30.4% on the innovativeness scale. (The equivalent partition in A.I.D.-IV involved average scores of 42.6% for farmers with more than one year of formal education and 25.0% for those with a year or less of formal education.) This particular "split" contributed an additional 6.4% to the explained variance. The best alternative to education would have been a partition between those farmers who were not exposed to extension meetings, farm magazines, or radio and those who were exposed to at least one of these channels of information. (An important alternative to education in A.I.D.-IV was a partition between those who were exposed to extension meetings and those who were not.) A division of the sample into groups composed of farmers with bank loans, credit cooperative loans and "sufficient" credit or non-borrowers and farmers with loans from non-commercial sources would also have been an important alternative. (Such a partition -- omitting credit cooperative loans which did not exist in the rice area -- was indicated as the "best" alternative to education in A.I.D.-IV.)

Among the better educated farmers, those who had learned their latest method from relatives (n=17), agronomists (n=6), people from a different place (n=6), and businessmen (n=8) seemed to be more innovative than those who indicated that neighbors (n=17) and the mass media (n=1) were as important to them as a source of information. This particular partition is somewhat difficult to interpret, especially given the small number of observations in some of the classifications (an unfortunate consequence of small sample sizes). What can probably be said, with some assurance of validity, is that farmers who used agronomists as a source of information tend to be more innovative than those who depended upon their neighbors for information about agricultural innovations. This statement gains support from the fact that the mean innovativeness score, across all farmers, in both the bean and rice areas was highest for those learning new ideas from the agronomist. It may also be the case that relatives were a better source of information than neighbors, although there is no particularly useful rationalization for such a contrast. (A.I.D.-IV does not provide support for the opposite view because of the small number of observations included within the "relatives" classification whenever this variable was involved in a partition.) Statistically, this "split" accounts for 3.9% of the variance in innovativeness among bean farmers. An alternative partition would have involved credit divided in the same manner as discussed earlier.

The availability of locally supplied inputs seems to be particularly important to the innovativeness of those farmers who did not have any formal education. Individuals who believed that at least two of the three important inputs -- rental tractors, fertilizer and insecticides -- were available locally tended to be more innovative ($\bar{I}$=34.7%) than farmers who thought that local suppliers handled, at most, only one of these items ($\bar{I}$=28.0%). (It may be remembered that this same partition would have been the best alternative to credit -- Groups #8 and #9 -- among the poorly educated rice farmers.)

An explanation of 2.2% of the total variance was provided by this "split." The best alternative partition would have been to separate those farmers who had not been exposed to extension meetings, farm magazines, and radio ($\bar{I}$=27.4%) from those who were exposed to one or more of these channels of communication ($\bar{I}$=33.3%). Because of the small number of observations in some of the classifications, such a partition would largely reflect differences between those who were exposed to radio and those who were not.

Income levels and credit usage, which were found to be important predictors of innovativeness among rice farmers, were equally useful in explaining the innovativeness among those bean farmers who had completed at least one year of schooling. As with their counterparts among the rice farmers, the bean farmers who had obtained loans from the better credit sources tended to be more innovative than other farmers with similar backgrounds. Figure 18 illustrates the partition of Group #6 between those farmers who had obtained bank loans, credit cooperative loans, or w

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"sufficient" amounts of credit and those who had either not borrowered or received their loans from non-commercial sources. The innovativeness scores associated with this partition were 49.9% and 36.0% respectively. (Index numbers in the equivalent A.I.D.-IV partition equaled 58.1% and 35.6% in the same order.) Partitioning the sample on this basis contributed an additional 4.9% to the variance explained by the "tree."

Farmers with per capita family incomes of $200 or more were found to be more innovative than individuals with incomes of less than that amount (based upon the partition of Group #7). The relatively wealthier farmers had an average innovativeness score of 42.5% as opposed to 32.3% for their poorer colleagues. Since there is no evidence to indicate differently, we must assume that the effect of income is a mixture of differences in the ability to finance new methods and willingness to accept the "risks" involved in applying them. For whatever reasons, this partition contributed 2.5% to the explained variance.

Credit was also used to subdivide these bean farmers who lacked formal education, yet found inputs readily available. The A.I.D. program separated the farmers who had obtained loans from the credit cooperatives (n=2) from those who either did not borrow or used other sources of credit (n=26). Although this partition is very questionable statistically, there may be some validity in setting the credit cooperatives apart from other sources. In earlier chapters, it was found that credit cooperatives were a very important source of loans to small and medium sized farmers. Loans given by this source also tended to be larger than other non-bank sources, which also supplied a very large proportion of the small farmer's credit. It was clear that credit cooperatives were superior to other non-bank sources, and it is possible that they may even do a better job of serving smaller farmers than the banks. The mean innovation index number, across all bean farmers, was somewhat higher for those using credit cooperatives ($\bar{I}$=44.3%) than for those using banks ($\bar{I}$=41.2%). Thus, since size of farm was found to be closely associated with educational achievement, a partition setting credit cooperatives apart may have had some real meaning.

If instead we assumed that this "split" was simply spurious, it would be possible to provide an alternative partition based upon the farmer's willingness to forego present income for a larger amount in the future (deferred income). The group who would be willing to defer income were more innovative ($\bar{I}$=44.3%) than those whose preference was for present income ($\bar{I}$=32.1%). While the original "split" (based upon credit) would have explained 2.1% of the variance, the alternative partition could account for 1.9% of the variation in farmer innovativeness.

Among those farmers who found inputs less available (Group #8), those few individuals (n=5) who were willing to try new methods without observing other people's experiences were discovered to be more innovative ($\bar{I}$=38.0%) than those who would prefer a "wait and see" approach to innovations ($\bar{I}$=23.5%). Interestingly enough, the more innovative individuals tended to be from the lower income classifications of the parent group. To the extent that this partition involves a "real" difference, the five more innovative people were apparently simply more willing (as opposed to being better able) to accept "risks." Finally, this partition contributed 1.5% to the variance explained by the "tree."

In total, the "tree" illustrated by Figure 18 explained 29.5% of the variation in innovativeness among bean farmers. (It should be noted that additional partitions were suggested by the A.I.D. program, but have been "pruned" from the "tree" because of their questionable statistical value.) The upper portion of A.I.D.-V was found to contain the same variables as A.I.D.-IV, although their configuration was different. Again we have found farmers with at least some education to be more innovative than others; the farmers with $200 or more per capita income to be more innovative than those with less, and farmers with bank loans, credit cooperative loans, and "sufficient" credit to be more innovative than their counterparts.

There is evidence, especially in terms of the initial partition involving 12 of the better informed farmers, that access to "direct" sources of information hastens the adoption process. Once again, the positioning of a partition utilizing differences in the local availability of certain inputs suggests that the innovativeness of the most poorly educated farmers is apparently enhanced by supplies of modern inputs at convenient locations. Finally, as in the case of rice farmers, there is some evidence which suggests that farmers who are more willing, or better able, to accept the "risks" involved in new methods tend to be more innovative.

Summary

Considering all of the A.I.D. programs presented, certain generalizations seem to emerge. At the forefront is support for the basic contention that the adoption of innovations involves a decision-making process which can be described in terms of the interaction of certain variables hypothesized to (1) have an effect upon the formulation of expectations, (2) indicate the farmer's willingness to accept "risks," and (3) suggest an individual's ability to implement his decisions. In a sense the A.I.D. could do little else than support the notion of an interactive system, yet it need not have paralleled the theoretical and analytical developments of earlier chapters. We might have found, for instance, that only those variables which relate to the individual's ability to put new methods into practice -- input availability, credit, and income levels -- were important. Such a finding would have indicated an argument for "economic determinism" of innovativeness. On the other hand, the A.I.D. programs might have indicated that individual and community attitudes largely governed innovativeness, suggesting a "socio-cultural determinism" of the adoption process (although such an outcome would have been extremely surprising given the analysis of Chapter IV).

Yet, neither of these outcomes were suggested by the evidence. The variables describing the adoption of various new practices, and innovativeness in general, are a combination of those expected to affect the decision-making process and those affecting likelihood of implementing the resultant decisions.

The Effect of Attitudes Upon Innovativeness

A prediction of the Recife farmer's innovativeness on the basis of his attitudes, given the evidence of this chapter, would undoubtedly be very inaccurate. To the extent that farmer attitudes may affect innovativeness, their influence was clearly overshadowed by other variables. This is not to say that attitudes have no effect upon innovativeness, as Chapter IV suggests that attitudes may influence the information-gathering process, but at least as measured in this study they were not among the more important predictors of the farmer's innovative behavior. There was, however, some indication that with larger sample sizes it might have been possible to identify an interactive effect of farmer attitudes, especially since attitudinal variables were occasionally important alternative partitions late in the development of the "trees." Looking ahead to possible policy conclusions, this finding would suggest that programs designed to hasten the adoption of more productive technologies, at least in Northeast Brazil, need not be directly oriented toward changing the attitudes of farmers (such as those examined in this study).

Education, Information Sources, and Innovativeness

Educational achievement, which is not easily altered in the short run, was continually found to be among the more important predictors of adoption, especially in the case of describing variations in the general innovativeness of both rice and bean farmers. Although the general educational level of Recife farmers is very low, 68.3% of the rice farmers and 86.0% of the bean farmers had not completed more than three years of school; even a very few years of schooling was often found to enhance the individual's innovativeness (see A.I.D.-I, IV, V). There was, of course, a relationship between the farmer's educational achievement and the sources of information that he tended to use, but there seems to be more to the impact of education than this "dimension" alone. The best assessment of the "other dimension" of education seems to be the development, concommitant with educational achievement, of mental processes which enhance the farmer's ability to process information and develop expectations regarding new agricultural practices.

The advantage of utilizing "direct" sources of information (those emanating from nearest to the origin of the innovation -- agronomist and certain mass media channels) is fairly evident, even though it is not always readily apparent from the A.I.D. presentations. The clearest example is with fertilizer usage in the São Francisco rice area where 42.9% of the farmers who indicated the agronomist as an important source of information were using this innovation as compared to only 7.6% of the remaining farmers. The initial partition of A.I.D.-V also suggests the importance of "direct" sources of information. Here, it may be recalled, a rather elite group of farmers who had been exposed to extension meetings, farm magazines, and radio (and at the same time constituted a large proportion of those indicating the agronomist as source from which they had learned their latest innovation) were found to be considerably more innovative than their counterparts with less exposure to these channels of information. In addition, the more innovative among the rice farmers (although separated on the basis of other variables) included nearly all of those individuals who had used the agronomist as an information source (as Group #5 contains 10 of the 14 farmers who had used this source). Finally, exposure to extension meetings, farm magazines, and radio provided an important alternative to many of the partitions selected by the program. One might therefore conclude that providing greater access to more "direct" sources of information, and encouraging their use, might substantially improve the overall innovativeness of the Recife farmers.

Innovativeness and the Willingness to Accept "Risks"

One of the important general hypotheses of this study was that the adoption of new agricultural practices involves "risks" and that those farmers who were more willing or able to accept these "risks" would be the more innovative members of the sample. While approaching this matter of "risk" directly would be quite difficult, it is possible to examine certain indicators of the farmer's willingness to accept the uncertainty of new methods. One approach was to examine the effect of a farmer's willingness to try something new before others in his community had tried it, as opposed to a more widely acknowledged strategy of "wait and see." A positive relationship between innovativeness and the farmer's willingness to try locally untried practices received some support among bean farmers (Groups #20 and #21 of A.I.D.-V). Again, the identification of this characteristic was the most important alternative to an existing partition (of Group #4 in A.I.D.-IV) among rice farmers. Although the number of farmers who exhibited this trait was quite small in each case, it does provide at least tentative evidence that farmers who are more willing to accept the uncertainty inherent in new methods adopt them more rapidly.

An alternative approach is to assume that one of the main reasons why lower income farmers are less innovative is that they are reluctant to jeopardize the "well-being" of their family by risking the failure of an unfamiliar practice. The difficulty with this approach is that lower incomes not only mean less buffer against unfortunate outcomes but represent a decreased capacity to finance the inputs usually associated with new methods. In each of the A.I.D. programs, except A.I.D.-I, income was an important predictor of innovativeness. (Recall that income was represented in terms of family per capita figures in an attempt to make the variable reflect family "well-being.") The relative importance of the two effects of income, as suggested above, is fairly clear with respect to the adoption of tractors (A.I.D.-III). Here we found that when rental tractors were not available locally, the relatively wealthy farmers (income ≥ \$500 per capita) were still very likely (87.5%) to use them. Undoubtedly, they had been able to purchase their own tractors. The outcome is not nearly as clear for A.I.D.-II (use of insecticides) and A.I.D.-IV (general innovativeness among rice farmers) but the surrounding evidence seems to support the contention that the poorer farmers' desire to avoid risks was important in these partitions. In these particular cases the relationship of credit to income levels suggests that self-financing of inputs was probably not the critical advantage of higher incomes. Finally, in the case of A.I.D.-V there is no basis for speculation about the reasons for the importance of incomes, so it must simply be assumed that the partition given represents a combination of the factors suggested above.

While we have argued that the disutility of losses causes poorer farmers to be reluctant to try new practices, it can also be argued that differences in the utility for increased incomes can affect the farmer's willingness to accept the "risks" of new methods. Although we must remain skeptical about our measure of utility for increased income -- responses to a risk game proposed in the Recife survey --, it did appear in A.I.D.-IV and A.I.D.-I following the manner that was hypothesized. Those with "moderate" and "high" utility for increased incomes tended to be more innovative than those with "low" or "very low" utility for gains in income. Adding to the uncertain nature of this outcome is the position of the partitioning related to this variable. In each case the partition occurs at the end of the "tree," where it must be interpreted with considerable care, and in A.I.D.-I it represents an alternative to an unacceptable "split." The most that may be said on behalf of the relationship between innovativeness and utility for income is that there is tentative evidence suggesting that farmers with greater utility for increased income are more innovative than others.

In total, there seems to be sufficient evidence to argue that a farmer's willingness to accept "risks," which is in turn related to his utility for gains in income and especially his disutility for losses, is related to his innovativeness. Thus, the contention that those who are willing or able to bear the uncertainties of new technologies tend to adopt them more rapidly seems to be supported empirically.

Innovativeness and the Ability to Implement Decisions

Two variables were presented in Chapter V -- credit usage and input availability -- which were expected to have an effect on the farmer's ability to implement his decisions. According to the A.I.D. programs, both of these variables were important predictors of innovativeness. Farmers who either had not borrowed at all or had borrowed from non-commercial sources (neighbors, relatives, landowners, businessmen and buyers) were found to be less likely to adopt new methods than those who had either obtained loans from credit cooperatives (not available in the rice area) and banks (government and private), or indicated that they had received "sufficient" credit to meet their needs. Credit, divided in this manner, was the most important variable in explaining the use of insecticides among the São Francisco rice farmers (explaining 13.4% of the variance). There were exceptions, however, to this usual division of the credit variable. Only those farmers who had obtained "sufficient" amounts of credit were found to be greatly different from others in their use of fertilizer. Also, there was evidence, among bean farmers, that the credit cooperatives may have done a better job than the banks of serving the needs of the smaller farmers. Finally, in A.I.D.-III we find a partition of credit which is exactly the reverse of what one would postulate, non-borrowers being more innovative than others. Given its position within the "tree," one would be rather reluctant to assert that this particular "split" negated other findings with respect to credit. On balance, it seems that those farmers who were able to obtain "sufficient" credit or had received bank and credit cooperative loans were more innovative than individuals who either had not borrowed or had received their loans from non-commercial sources of credit. This outcome suggests that improving the credit system in the Northeast of Brazil might well contribute to the overall innovativeness of the area's farmers.

The local availability of inputs also seems to be important to the adoption process. In the case of tractor usage among the São Francisco rice farmers, the local availability of rental tractors was the most important variable in explaining the adoption of this innovation (accounting for 12.3% of the variance among farmers). An index of input availability (including tractors, insecticides, and fertilizers) emerged as a useful predictor of innovativeness of rice farmers. The location of this variable within the "tree" suggests that local availability is most important to the innovativeness of the smaller poorly educated farmers. Perhaps their situation imposes special limitations on their ability to acquire inputs from other than the nearest trading center. In general, it appears that an increase in the local availability of certain inputs would widen their use among the farmers in the Recife area.

Tenure and Innovativeness

In Chapter V it was found that most of our preconceptions about the relationship between tenure and the use of certain inputs were incorrect. Landlords and tenants seemed to be about equally likely to use insecticides and tractors, while owner-operators were discovered to be less likely to have adopted these practices. The rationale suggested then was that landlords were generally better educated and better financed than owner-operators, and that the landlords either furnished modern inputs to the tenant or required that he use them. This contention seems to be supported by A.I.D.-II, where poorly educated and poorly financed tenants were found to be considerably more likely to use insecticides than their landowner counterparts in the same situation.

CHAPTER VIII

SUMMARY AND CONCLUSIONS

Review of the Research Project

There seems to be considerable agreement that one of the pressing problems of agricultural development is to secure a more rapid adoption of improved practices among the farmers in developing countries. There is less agreement, however, about the appropriate strategies for accomplishing this task. Some believe that emphasis should be placed upon the social interactions involved in the adoption process, while others prefer to focus their attention upon the economic considerations related to technological change. These differing points of view stem from contrasting opinions about the behavior of farmers in less developed countries. One view is that they behave quite differently from their counterparts in a modern agriculture. The reason given for these differences is that the traditional farmer is primarily a "social being" and that he lives by attitudes, beliefs, values and cultural norms which widely diverge from those of the modern farmer. An alternative view is that farmers in a traditional agriculture are no less "economic men" than those in developed countries.

The frame of reference used in this study was to view the adoption of new practices as an individual decision-making process under conditions of uncertainty and involving the interaction of social, economic and personality variables. Although many researchers have recognized the adoption process as a matter of individual decision-making and have acknowledged the element of "risk" in adopting unfamiliar practices, few have approached the problem with this particular frame of reference. Such an approach provides sufficient flexibility for examining a wide variety of variables which might be hypothesized to have an effect upon the farmer's decisions toward innovations. The objectives of this study were to:

1) Develop a conceptual framework of decision-making under uncertain conditions which can be applied to examining the adoption of new agricultural practices in less developed countries.

2) Within the context of this conceptual framework, to postulate relationships between certain variables and the adoption of innovations, and test these relationships using data provided by a survey of farmers in Northeast Brazil.

3) Examine the relative importance of the postulated relationships as explanations of the variance in the adoption of innovations among the Recife area farmers.

4) Suggest, on the basis of this research, some elements of a strategy to hasten the adoption of more productive agricultural practices by the farmers in Northeast Brazil.

5) Provide an assessment of decision-making under uncertainty as a framework for studying adoption of innovations, and suggest further research which might be conducted utilizing this approach.

In pursuing these objectives the study began with a review of the literature on the behavior of farmers in less developed countries, the diffusion of innovations, and decision-making under uncertain conditions (Chapter II). In turn, some of the useful theoretical notions and insights contained in this review were incorporated into a conceptual framework of the farmer decision-making process under conditions of uncertainty (Chapter III).

Under the guidance of the conceptual framework, relationships were hypothesized between innovativeness and certain variables which were amenable to analysis using the MSU/SUDENE farmer survey data from Northeast Brazil. As the study progressed, these relationships and the interrelationships between the variables themselves were subjected to statistical analysis (Chapters V and VI). Each of the relationships examined can be placed within one of seven hypotheses.

1) Farmers' attitudes have an influence on their innovativeness.

2) Farmer innovativeness is positively related to his educational achievement.

3) Innovativeness is related to the sources used by farmers to learn about new agricultural practices.

4) Farmer innovativeness is positively related to the financial capacity to accept "risks." (Poorer farmers are less innovative because they are reluctant to subject their families' well-being to a crisis involving the failure of an innovation. Stated differently, they are unable to accept the "risk" perceived in new methods.)

5) Farmer innovativeness is positively related to his anticipated utility from increased income.

6) Farmer innovativeness is positively related to the availability of inputs and credit.

7) Farmer innovativeness is related to tenure arrangements.

A more general hypothesis -- to which these seven are subservient -- is that: an <u>interactive system</u> of social, economic and personality variables as developed in the conceptual framework can be verified empirically, and that the relative importance of these variables to the adoption of an innovation can be established. Identification of such a system would be useful to planners as they develop strategies for increasing the pace of technological change within the agricultural sectors of developing nations. Thus, the analysis of the seven hypotheses was conducted in such a manner as to provide an assessment of the more general hypothesis as well.

The final phase of the project involved an examination of the relative impact and interaction of variables which, on the basis of earlier analyses, appear to have an effect upon farmer innovativeness. Automatic Interaction Detection -- a relatively new technique -- was utilized in this analysis (Chapter VII), providing a further assessment of the theoretical and statistical developments in earlier chapters.

Analysis of Decision-Making Under Uncertainty As An Approach to Studying the Adoption of Innovations

From the author's point of view, there appear to be some important advantages of studying the adoption of innovations within the framework of individual decision-making under uncertainty. First, such an approach explicitly recognizes what many researchers have already acknowledged, that the adoption of innovations is a decision-making process and that decision-makers have less than perfect knowledge upon which to base their expectations about new and unfamiliar methods. Explicit recognition of the "risks" inherent in new technology, by itself, suggests an added dimension in our attempts to understand differences in innovativeness among farmers.

This approach has caused the author to view the adoption process as an "interactive system" of variables affecting the farmer's decisions with respect to innovations. It would seem to be useful to encourage this view among other researchers interested in the process of technological change. One reason is that it stimulates additional consideration of "why" certain variables are found to be related to innovativeness and under what conditions (interactions with other variables) these variables have an impact upon the adoption of new practices. Another argument in support of this view is that it transcends the disciplinary disagreement over the emphasis which should be given to the economic versus non-economic factors believed to be influencing the farmer's decisions toward innovations, and might serve to expedite interdisciplinary cooperation in this area of research.

Finally, it is the author's opinion that the findings of this study support the usefulness of viewing the adoption of agricultural innovations in developing countries as an individual decision-making process involving the interaction of social, economic and personality variables, and that approaching the problem with this frame of reference will provide an improved conceptual basis for developing strategies to increase the rate of technological change in the rural sectors of the developing countries.

Conclusions

Perhaps the most concise and meaningful way to summarize this study is to examine the research findings within the context of the seven generalized hypotheses presented earlier. This provides an opportunity to review both the specific and more generalized relationships concurrently.

1) Farmers with "modern" attitudes are more innovative than farmers with "traditional" attitudes.

Both the individual farmer's own attitudes and the attitudes he perceived that his neighbors held were examined in this study to the extent permitted by the available data. Among the Recife farmers surveyed, 46.7% indicated that their neighbors would regard early adopters of new agricultural practices as foolish and 41.2% believed that local farmers would not like to see individuals progress more rapidly than the community as a whole. One might expect that these community attitudes could be interpreted as social pressures inhibiting individual innovativeness. There is, in fact, some evidence that this is true, since the farmers indicating the presence of such views were more likely to hold negative attitudes toward new technology in general and also seemed to be less aggressive in gathering knowledge about new agricultural practices. However, the impact of community attitudes was not found to be statistically significant in terms of explaining variations in individual innovativeness itself.

A large proportion -- 82.0% -- of the Recife farmers expressed a fatalistic view of the possibility of improving their situation through their own efforts. This expression of fatalism was found to be unrelated to the farmer's educational achievement, income level, and the size of his farm. Although their less fatalistic counterparts were more likely to know about fertilizer and other methods of improving yields, they did not seem to be significantly more innovative.

Even though most of the farmers appeared to be fatalistic, nearly half -- 46.7% -- of them believed that "to make more money it is better to know how to do business than to be lucky." Relative business success seems to reinforce this belief, since the larger and wealthier farmers were more inclined to be of this persuasion. Affirmation of this belief was also more commonly found among the better educated members of the sample. The "knowledge-oriented" farmers were expected to be somewhat more motivated to seek out information than their "luck-oriented" colleagues. There seems to be evidence in support of this proposition, as "knowledge-oriented" farmers were found to use the agronomist, mass media, and businessmen more frequently as sources of information about new methods. In addition, they were more likely to have attended extension meetings, read farm magazines, and were more often aware of chemical fertilizer than those who believed that luck was in control of their earnings. Finally, this variable was found to be of some value in explaining the adoption of insecticides and tractors (see A.I.D.-II and A.I.D.-III), although its contribution was relatively small.

The majority of the Recife farmers -- 69.4% -- seemed to hold favorable attitudes toward new technology in general. It is interesting to note that while most of these farmers believed there was little they could do individually to improve their situation, they were nonetheless hopeful that technological advance would bring them a better life. The central argument related to this variable was that attitudes help to shape the farmer's expectations of new methods, and that farmers with a generally negative attitude toward technological change would be less responsive to specific new practices. Evidence was found to support the contention that such farmers were less aggressive in gathering information about new methods. Farmers with negative attitudes toward new technology were also found to be less likely to be using insecticides, but they were not any less likely to use tractors or fertilizer. Finally, the Automatic Interaction Detection programs bypassed the farmer's attitude toward technology as an explanation of farmer innovativeness. Thus, again, we must conclude that other factors were more critical to the farmer's decision-making process than his general attitude toward new technology.

Among the Recife farmers, only 37.3% would have preferred NCr $90 one year from now to NCr $30 today. It was reasoned that an unwillingness to defer income might represent a reluctance, on the part of the farmer, to sacrifice present consumption in order to finance new methods which promised a higher return in the future. The farmer's time preference for income, however, did not seem to be significantly related to his innovativeness. Still, there was a logical relationship found between other attitudes and the willingness to defer income. Fatalistic farmers were less willing to defer income than non-fatalistic farmers, and "knowledge-oriented" farmers were more willing to defer income than their "luck-oriented" counterparts.

Interpersonal trust was also examined in this study. Over half -- 57.0% -- of the Recife sample indicated a willingness to trust outsiders (non-relatives). The hypothesis that non-trusting farmers would concentrate upon their relatives as a source of information about agricultural innovations was not supported by the data. Since there was no alternative evidence suggesting that differences in interpersonal trust affected the innovativeness of Recife farmers, the variable was assumed to be unimportant to the adoption process.

From the information available in this study, it would appear that certain attitudinal variables -- fatalism, luck/knowledge, and attitude toward technology -- may have an effect upon Recife farmer's decision-making process (especially with respect to the information gathering), but the magnitude of this effect was very small by comparison to other variables. At least for the Recife area of Northeast Brazil, this would suggest that altering other variables would provide a greater stimulus for increasing the adoption of new practices than efforts to directly change the farmer's basic attitudes.

2) Farmer innovativeness is positively related to his educational achievement.

Farmers in the Recife area were generally not well educated. A large proportion of the sample (44.0%) had not attended school, and only a few (7.0%) had completed more than six years of formal education. Educational achievement, among these farmers, was significantly associated with farm size and income levels. The larger and relatively wealthier farmers tended to be better educated than their smaller and poorer counterparts.

Greater educational accomplishment was assumed to improve the farmer's capacity to utilize "direct" sources of information (the agronomist, farm magazines, radio messages, etc.) and to enhance his ability to evaluate particular situations (conceptual ability). The better educated farmers in the Recife sample were, in fact, found to be making greater use of the agronomist and mass media as sources of information about agricultural innovations. They also seemed to be more knowledgeable about chemical fertilizers and other methods of improving yields. More importantly, the farmer's level of educational achievement seems to provide an important explanation of his innovativeness. Educational achievement, as a variable in the A.I.D. programs, was the most important predictor of innovativeness among the São Francisco rice farmers (A.I.D.-IV) and the second most useful explanation of variations in innovativeness among the Recife bean farmers (A.I.D.-V). In addition, it appears that even a very few years of formal education (1 to 3 years) had a substantial impact upon the farmer's level of innovativeness. This suggests that the pace of technological change would have been considerably hastened if even an elementary level of education had been widespread among the Recife area farmers.

3) Innovativeness is related to the sources of information used by farmers to learn about new agricultural practices.

Very few of the Recife farmers reported that they had learned about a new method from an agronomist or the mass media (12.9%). Still fewer indicated that they had learned about new practices from a local businessman (5.7%) or people from another place (6.6%). Instead, most of them seemed to have depended upon either neighbors or relatives as a source of information about new agricultural technologies (71.0%)[163] Slightly over half (58.7%) of the farmers owned a radio, while less than one-fifth had read a farm magazine (16.5%) or attended an extension meeting (14.2%). In general, the communication of ideas about agricultural innovations flowed from farmer to farmer by word of mouth.

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[163] An undefined category termed "another source" accounts for the remaining 3.6% of the information sources used by Recife farmers.

One would expect that such a great dependency upon farmer to farmer communication would serve to slow the pace of technological advance, and this seems to have been the case among the Recife farmers. Considering the sample as a whole, those farmers who reported the agronomist as a source of information were more likely to be using insecticides, tractors, and chemical fertilizers than farmers reporting other sources. Those who used the mass media were more likely than farmers using other sources (except the agronomist) to have adopted tractors and insecticides. Again, farmers who indicated local businessmen as a source of information about new methods were more likely to use insecticides than those who had gathered their information from friends, relatives and people from another place. A similar association was found between the farmer's exposure to radio, farm magazines, and extension meetings. The Recife farmers who had read farm magazines were more likely to have used fertilizers, insecticides, and tractors than those who had not. Those who had attended extension meetings used these practices more frequently than their counterparts who had never attended such meetings. And even the presence of a radio in the home seemed to be associated with a greater degree of innovativeness.

The Automatic Interaction Detection programs computed for rice and bean farmers also support a positive relationship between innovativeness and the use of the agronomist and mass media as sources of information about new agricultural practices. The clearest example involved fertilizer usage in the São Francisco rice area, where 42.9% of the farmers who indicated the agronomist as a source of information were using this innovation as compared to only 7.6% of the remaining farmers (A.I.D.-I). Among the Recife bean farmers, exposure to extension meetings, farm magazines, and radio seemed to be strongly related to farmer innovativeness (A.I.D.-V). Finally, the more innovative of the rice farmers (although separated on the basis of other variables) included nearly all the individuals who had used the agronomist as a source of information. Consequently, it appears that techniques which could be employed to encourage and extend the use of the agronomist, the mass media, and perhaps even the businessman as sources of information about new agricultural practices would serve to spur the pace of technological advance in the Recife area of Northeast Brazil.

4) Poorer farmers are less innovative because they are reluctant to subject their family's well-being to a crisis involving the failure of an innovation.

Although there was a wide variation in income levels among the farmers in the Recife sample, most of them were very poor considering the fact that nearly two-thirds of the sample had annual incomes of less than $100 per family member. The niggardliness of the present incomes may well contribute to their continued poverty. In addition to the obvious problem of financing new inputs from their own meager resources, the results of this study suggest that poorer farmers are more reluctant to accept the "risks" inherent in trying unfamiliar practices. The use of chemical fertilizer, insecticides, tractors, and non-chemical fertilizer was found to be significantly related to increasing levels of income. As was the farmer's evaluation of the personal consequences of the failure of an innovation, where the relatively wealthier farmers were less inclined to indicate that their "family would suffer" and significantly more willing, than their poorer colleagues, to "try again." It was also discovered that the willingness/unwillingness to use locally untried methods was significantly associated with the farmer's income level, with poorer farmers being more reluctant to try new practices without first observing the experiences of other members of their community. Finally, it was observed that lower income farmers were less innovative than their wealthier counterparts (A.I.D.-II, A.I.D.-IV, and A.I.D.-V), with sufficient reason to believe that the reluctance to accept "risks" was importantly involved in this relationship.

5) Farmer innovativeness is positively related to his utility for increased income.

Utility theory would suggest that the farmers who are most highly motivated to increase their incomes would tend to be the most innovative. The findings of this study are far less than conclusive on this point (due to probable inadequacies of the method used to measure utility for income) although they suggest, in the author's view, that such a hypothesis deserves further attention. The variable used to indicate utility for increased incomes was found to be of some value in explaining fertilizer usage and general innovativeness among the São Francisco rice farmers. In each case farmers designated as having "moderate" and "high" utility for increased income were more innovative than those designated as having "low" and "very low" utility for additional earnings.

6) Farmer innovativeness is positively related to the availability of inputs and credit.

Favorable expectations toward new practices are of little practical importance if farmers lack the necessary resources for implementing their decisions. Two such resources are credit and the availability of modern inputs.

The availability of modern inputs was found to be an important constraint on their use by Recife farmers. The relative availability of certain inputs -- chemical fertilizer, rental tractors, insecticides, and hand planters -- as indicated by the percentage of rural suppliers handling these products, was highly correlated with the percentage of the sample farmers using these innovations. Somewhat more specifically, the local availability of rental units was discovered to be the most important explanation of tractor use/non-use among the São Francisco rice farmers. An index of locally available inputs was found to contribute to an explanation of innovativeness among Recife bean farmers (A.I.D.-V). In addition, it would have provided a useful alternative to credit and sources of information in explaining the variation in innovativeness among the São Francisco rice farmers (A.I.D.-IV). Finally, there was evidence to suggest that the local availability of inputs was most critically important to the innovativeness of the poorly educated and poorly financed segment of the farmers in the Recife sample. Apparently these farmers were unable to travel beyond their local communities to acquire the inputs used on their farms.

Farmers who had been able to obtain "sufficient" credit (by their own assessment) or had secured loans from banks and credit cooperatives tended to be more innovative than farmers who either had not borrowed or had obtained loans from such sources as relatives, neighbors, landowners, buyers and local businessmen. Smaller and poorer farmers were more likely than larger and relatively wealthier farmers to have either not borrowed or have received loans from non-commercial sources (relatives, neighbors, landowners, etc.). Loans from these sources were typically of smaller amounts than offered by banks and credit cooperatives, while loans in general tended to be small (median of all Recife farmers was $247.73) and of short maturities (less than one year).

About one-third of Recife farmers who hadn't used credit indicated that they were afraid to borrow. Approximately the same proportion of those who had borrowed indicated that they were unwilling to accept the "risk" involved in a larger loan. In either case, the smaller and poorer farmers more frequently gave these reasons than their larger and relatively wealthier counterparts. Thus, not only are poorer farmers more reluctant to accept the "risks" inherent in new technologies, they tend to be less willing to accept the "risks" involved in loans which would enable them to finance improved practices.

In addition, about one-third of the non-borrowers indicated they didn't need credit, while a slightly smaller proportion indicated that they couldn't get a loan. The larger and relatively wealthier farmers were more likely to give the first response, while smaller and poorer farmers were more likely to give the second. There is also evidence to suggest that when smaller farmers indicated that they "didn't need credit" what they really meant was that they were able to survive from harvest to harvest without requiring a loan to meet their family's living expenses. Finally, credit cooperatives appear to be providing small and medium-sized farmers, who had difficulty obtaining bank loans, with larger amounts of credit than they could have obtained from such sources as neighbors, relatives, landowners, buyers, and local businessmen.

7) Farmer innovativeness is related to tenure arrangements.

Initially, the owner-operator was expected to be more innovative than either Recife landlords or tenants. The insecurity of tenancy and the anticipated disinterest of large landlords were assumed to give owner-operators the edge in terms of innovative behavior. These preconceptions, however, proved to be incorrect. In general, landlords and tenants seemed to be more innovative than their owner-operator counterparts. The most reasonable explanation of this finding was that the landlords in the sample tended to be better educated and have greater financial resources than owner-operators, while tenants utilized modern practices either because landlords furnished the necessary inputs or required their use.

A Strategy For Increasing the Adoption of New Agricultural Practices

It is generally recognized that the adoption of new agricultural practices is essential for expanded food and fiber production. At the same time there is a growing awareness that change in the rural sector must serve other developmental goals as well. Such goals as improving the relative well-being of small farmers and reducing the disparity between urban and rural incomes are becoming an important part of the development policies of a growing number of less developed nations. Dissatisfaction among the lower income groups is viewed as a present and potential source of social and political unrest. Failure to respond to this segment of the population may be expected to lead to social and political upheaval. As a consequence of these concerns the strategy suggestions given in this section, while not intending to neglect the larger farming units, give particular attention to the problems of securing the adoption of new technologies among the smaller and poorer farmers within the rural population.

Although the strategy suggestions given in this section are based upon research findings from Northeast Brazil, they may well have wider applicability among developing countries (especially within Latin America). The following are some of the elements which would appear to be important components of a strategy to increase the use of new agricultural methods, at least among farmers in the Recife area of Northeast Brazil.

Informational Input

In order for farmers to accept innovations they must first learn a sufficient amount about these new practices to formulate the expectation that they will benefit from altering their present farming methods. For the most part the communication of such information in the Recife area was from farmer to farmer by word of mouth. However, those few farmers who did utilize the agronomist and the mass media as sources of information were found to be significantly more innovative. This suggests the need to devise schemes to extend contact with the agronomist and the mass media to a greater number of farmers in order to increase the pace of technological change. Since small, poorly educated farmers are least likely to use these sources of information, it is necessary to place special emphasis on designing approaches which will reach this group. On the other hand, due to their generally higher level of education and greater capacity to accept "risks" the larger farmers may assume an important role in these approaches. These farmers could assist less educated farmers to understand mass media messages about new practices in terms of local farming conditions. In addition, they might provide the early field experience with new practices necessary for their wider acceptance within the community.

A version of the radio farm forum technique would seem to be a very useful approach for the following reasons:

(1) Radios are readily available in rural communities (over 50% of the Recife area farmers had functioning radios).

(2) This form of mass communication does not depend upon a literate audience (roughly one third of the Recife sample had not attended school at all).

(3) More importantly, this technique could help expand the number of farmers reached by an extension program and multiply the effectiveness of the agronomist.

Properly structured the radio farm forum groups could become permanent units which the agronomist would meet with at regular intervals. This could serve to extend the number of farmers contacted by the agronomist, especially if sufficient effort is made to obtain the participation of small farmers who would otherwise be unlikely to receive attention from the extension service.

The radio programming would serve to increase the awareness and interest of the group in new farming practices. A relatively better educated member of the community (probably a somewhat larger farmer) could act as monitor of the group and lead discussions following the program. These discussions could not only reinforce the message presented, but would provide an opportunity for farmers to raise questions and doubts which seemed important to them. In some cases these doubts and questions could be answered during the group discussion. In other cases the monitor could record the groups' concerns and supply them to the broadcaster or the agronomist who could attempt to deal with them on the next program or at the next scheduled meeting. Finally, when the agronomist would meet with the groups they would already be aware and at least partially informed about the topics of discussion.

Local demonstration plots, which could be the outgrowth of the radio farm forum groups, would be an additional means of assisting the farmers to develop realistic expectations about new practices and thus reduce the risk they perceive in trying new methods. The agronomist should encourage those farmers whose opinions and judgement are respected in the community ("opinion leaders") to plant the demonstration plots. To multiply the usefulness of the demonstration plots, the extension service could link several of them together in the form of a tour. A truck or bus could be rented to provide transportation for farmers who would otherwise be unable to tour the plots. At each stop the farmers who planted the plot should be encouraged to discuss the new practice with his visitors. This approach would have the advantage of closely paralleling the usual pattern of communication of new practices between farmers. (It will be revealed that over 50% of the farmers in the Recife survey indicated that their neighbors were the most important source of information about new practices.)

The gathering of farmers at the trading center on market day could be another focal point of extension activity enabling the agronomists to reach a larger number of farmers. Simple displays illustrating the advantages of new practices over present practices could be placed near the center of market activity. Slide-film presentations, movies, demonstrations (such as proper use of pesticides and fertilizers) and discussions about new practices could be presented by the extension service. In the evening the extension service might provide a program, arranging for the use of a local theater or even outdoors, which would mix entertainment with an introduction to improved farming methods. A mobile team, bringing their displays and equipment with them, could assist agronomists serving several different locations to implement these programs.

There is also evidence that local input suppliers may provide a useful source of information about new practices and could support the extension service's program. Since suppliers of farm inputs could provide considerable transfer of information in the course of merchandising their wares, the agronomist should assist them in becoming well informed about the proper use of their products. Profitable use of new farm inputs is in the best interest of both the agronomist and the businessman. Further, the agronomist could encourage the input supplier to develop displays in his store and on-going demonstrations (such as feeding trials) contrasting the use of his inputs with existing practices.

In summary, the extension service should attempt to increase its impact on the rural sector through programs of greater use of mass communication methods and greater emphasis on group or mass meetings as contrasted with individual contact with farmers. Special emphasis should be given to making contact between the agronomist and smaller farmers more frequent, at locations and under conditions which are convenient for this segment of the rural population. Finally, the agronomist may find the farm input supplier as a helpful ally in extending information about new practices to farmers.

Reducing the "Risk" of New Methods

Poorer farmers seem to be reluctant to accept the "risks" involved in trying new methods. As a consequence, institutional arrangements which would reduce the "risk" perceived in new practices, and encourage their use among the poorer segment of the rural population, should be given consideration in rural development strategies. Programs to lessen the instability of producer prices would certainly contribute to reducing some of the "risk" associated with new methods. Improving the farmer's knowledge of new methods through greater contact with the agronomist and the mass media as sources of information would also be of value in alleviating his fears, but the

major ingredient of such arrangements undoubtedly involves some method of insuring the farmer against undue losses from trying a new practice. Insurance schemes which would guarantee a certain minimum yield in association with approved new practices would eliminate the possibility of disaster and make these practices more attractive to farmers who can ill afford a crop failure. Where new practices are divisible, the guarantee might cover only a limited acreage encouraging the farmer to employ the innovation on a "trial" basis. Such schemes might be financed through government funding, slight additions to the cost of farm inputs, or possibly through insurance premiums paid by the farmers themselves. The extension service (and researchers) would need to be particularly sensitive to the profitability of the practices they recommended. If the approved practices were indeed more profitable, it would seem that an insurance arrangement of this type would greatly increase the security of farmers desiring to use new practices at a very low cost to those financing the scheme. The biggest difficulty with an insurance scheme in Northeast Brazil would seem to be the provision of the administrative capabilities for its initiation and operation, and financial provision for the effects of periodic droughts.

Alternatively, an insurance scheme could be integrated with a supervised credit program. Such an approach would reduce the farmer's fear of borrowing to finance new practices by assuring his ability to repay his loan. This might encourage the use of credit to purchase the non-farm inputs involved in new agricultural practices.

Credit

Since only a small proportion of the Recife farmers believed they had obtained sufficient credit to meet their needs at the present level of technology being applied in the area, increased use of modern inputs will require a considerable expansion of credit resources. Expansion of loanable funds, by itself, would probably be an inadequate response to the credit problem. Changes in the credit system appear to be necessary if the productivity of small (less than 50 acres) and moderate-sized (50-244 acres) farms is to advance concurrently with larger farms. A large proportion of the small and moderate-sized farmers, which in turn represent the majority of the Recife farmers, were fearful of using credit under the present system. The use of land as collateral and the unpredictability of rains over much of the area surrounding Recife are probably important factors contributing to their fearfulness. Alternative approaches to securing loans and provisions for refinancing (on reasonable terms) or insuring loans which are defaulted due to unfavorable crop years would undoubtedly serve to alleviate much of the "risk" perceived by potential borrowers. In general, expansion of loanable funds and changes in the credit system seem to be necessary for increasing the productivity of agriculture in the Recife area.

Input Availability

There is strong evidence to suggest that increasing the local availability of inputs would stimulate the use of new agricultural practices, especially among the poorly educated and poorly financed segment of the Recife farmers. Some of the Recife farmers seemed to be able to reach beyond local markets to secure certain inputs, but most of the farmers are undoubtedly dependent upon local markets to provide needed supplies. Consequently, schemes to improve the local availability of modern inputs should be given considerable attention by the agencies responsible for the development of the area.

The type of schemes used would depend upon the existing marketing system for farm inputs. Where private outlets for farm inputs are present in most rural communities, the most practical approach might be to encourage the input manufacturing companies to train the local suppliers in modern management practices and in the proper use of various inputs so they could more efficiently serve their clientele. Either private or public credit could be made available to local input suppliers enabling them to stock adequate quantities of the inputs needed in their communities. Where this is not a viable alternative, cooperatives or even government agencies might be formed to supply inputs to farmers. In any case, it appears to be necessary to provide training and financial support to the suppliers of farm inputs who are usually overlooked in agricultural development plans.

Education

While the previous suggestions represent possibilities for increasing the pace of technological change in the short run, improving the education level of farmers seems to offer an opportunity for increasing agricultural productivity in the longer run. Since even a few years of education seems to contribute considerably to innovativeness, efforts to provide at least some training to greater numbers of the rural population might be expected to have a sizeable impact upon the modernization of the rural sector. This would suggest that scarce resources for education should be largely directed toward mass education of rural children through a limited number of years (perhaps three to four years) and some form of an adult education campaign. This would be in contrast to devoting efforts to what is probably an unobtainable goal of a complete elementary and secondary education, and providing such an education to only the fortunate few. It is undoubtedly possible, through careful planning of curriculums, to provide both rural children and adults with the basic skills and concepts necessary for their economic viability in a more technical society within the constraints of a limited term of schooling. Emphasis would be placed upon developing needed basic skills and making the training relevant to the rural environment. As an example, reading could be taught from bulletins on how to raise corn and mathematical concepts could be approached in terms of farm budgeting and accounting.

Suggestions For Further Research

From the author's point of view, the most productive type of continuing research on the adoption of new farming practices would be a thorough evaluation of actual efforts to introduce new farming practices at the community level in less developed countries. Further refinement on development of concepts is likely to make a small contribution by comparison. The point has been reached where available concepts are probably adequate, but the question of how to best utilize what is known is still unanswered. The next logical step is to examine ongoing programs intended to stimulate the use of new methods, especially among small farmers, in order to determine the organizational, institutional and managerial requirements for increasing the pace of technological change in the rural sector. The goal of systematic studies of such programs would be to determine the best approaches to providing information about new practices, extending credit, marketing farm inputs, and reducing the risk of trying new practices in order to secure a rapid rate of adoption of more productive farm practices with the limited economic, technical, and managerial resources that less developed countries can devote to this purpose.

Perhaps further investigation of farmers' expectations of returns from alternative practices would also be of value. A practical research design would be to periodically examine the expectations held by farmers from their first awareness of an innovation until they either adopted or definitely rejected the practice. The researcher would then be in a position to trace the changes in the farmer's expectations and the impact of various information sources in altering their perceptions of the innovation. A better understanding of the process of expectations formation, by concentrating on this element of the decision-making process, might provide some useful insight on how the informational input of development programs could most efficiently be presented.

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APPENDIX

APPENDIX A

AID I--Use of Fertilizer Among São Francisco Rice Farmers

Variables	Group #1	Group #3	Group #5	Group #7
Tenure	.0157	.0001	.00549	.00420
Income	.04296	.0315	.03191	.02597
Credit	.03651	.02840	∇ .03556	.00833
Try 2nd	.0090	.0182	{.03367}	.01515
Risk Pref.	.0191	.0094	.02147	.02843
Education	{.1000}	∇ .0721	.02151	{.03406}
Chem. Fert.	.02939	.0050	.01634	.01515
Info I	∇ .12417	.0215	.02848	.02634
Info II	.0309	{.0642}	{.03367}	.01515
Fatalism	.0009	.0011	.00104	.00617
Luck vs. Know.	.01111	.0119	.00835	.01473
Att. t/w N.T.	.00677	.0174	.01734	.00869
Def. Income	.00858	.0117	.01362	∇ .05364

Proportion of variation in each group explainable for each predictor $(BSS/TSS)_i$

∇Split made on this variable.

{ }Next-best BSS.

APPENDIX B

AID II---Use of Insecticides Among
São Francisco Rice Farmers

Variables	Group #1	Group #3	Group #4	Group #7	Group #2	Group #11
Tenure	{.13205}	.13054	∇ .17346	.01617	{.10390}	.08497
Income	.07755	.05858	.05186	.06494	∇ .12707	.02477
Credit	∇ .13402	.00383	.03713	.00649	.00000	.00380
Try 2nd	.00050	.00213	.02101	.05500	.00223	.07353
Risk Pref.	.00873	.00521	.01393	.07659	.04058	.07353
Educ.	.11709	∇ .19871	.01773	.00649	.06250	∇ .14216
Insec-ticides	.00057	.00029	.00240	.00509	.00017	.03992
Info I	.06619	{.14613}	{.15235}	∇ .21130	.07353	.05637
Info II	.05529	.07608	.000426	.03030	.06250	.02477
Fatalism	.00741	.00669	.04267	.06481	.00444	.02477
Luck vs. Know.	.03472	.06166	.09874	{.09091}	.02500	.01535
Att. t/w N.T.	.03641	.05855	.01536	.00260	.00586	.01018
Def. Income	.00648	.01457	.00440	.04538	.00069	.02778

Proportion of variation in each group explainable for each predictor $(BSS/TSS)_i$

∇Split made on this variable.

{ }Next-best BSS.

APPENDIX C

AID III---Use of Tractors Among São Francisco Rice Farmers

Variables	Group #1	Group #3	Group #4	Group #2	Group #8	Group #6	Group #7
Tenure	.07633	.06279	.01592	.02681	.00659	.04241	.06070
Income	{.10402}	∇ .15752	.02056	.02844	.03086	.03472	.03228
Credit	.01256	.02307	.02477	.02402	.01024	∇ .13749	.30667
Try 2nd	.02599	.06422	.05267	.00060	.00317	.05992	.06070
Risk Pref.	.00597	.00660	.02097	.02207	{.05934}	.02211	.04384
Education	.09573	.10399	.04486	∇ .12162	.0111	.02211	.06070
Tractors	∇ .12294	---	---	---	---	---	---
Info I	.05276	.10112	∇ .11463	{.06905}	∇ .10418	.04241	.03228
Info II	.07976	{.14797}	{.07398}	.00988	.03086	{.09272}	.03228
Fatalism	.00794	.00660	.01942	.00984	.01538	.02748	.00145
Luck vs. Know.	.00530	.01195	.00640	.00002	.00153	.01731	.11180
Att. t/w N.T.	.02609	.04480	.02129	.00447	.00722	.01933	.09565
Def. Income	.00547	.02875	.04933	.01059	.00606	.03165	.09565

Proportion of variation in each group explainable for each predictor $(BSS/TSS)_i$

∇Split made on this variable.

{ }Next-best BSS.

---Variable is constant in this group.

APPENDIX D

AID IV---Innovation Index: São Francisco Rice Farmers

Variables	Group #1	Group #3	Group #5	Group #2	Group #4	Group #9	Group #10
Income	.12328	∇ .11141	.00275	.08937	.05183	.03685	.00535
Credit	{.14238}	{.10395}	∇ .29454	.23824	.04606	.02903	.04812
Try 2nd	.01343	.00690	.02597	.05419	{.08150}	.00748	.07830
Risk Pref.	.01671	.04128	.02262	.00208	.02296	.05902	∇ .15882
Educ.	∇ .17475	.01735	.00018	.06277	.00087	.01683	{.08870}
Input Index	.04632	.02446	.05375	.19102	.00304	.14156	.05703
Info I	.09449	.08839	{.09572}	.13240	∇ .27172	∇ .27241	.00356
Info II	.13168	.05728	.05242	.05494	.01346	.03570	.02407
Fatalism	.00145	.00493	.00612	.02336	.00261	.04165	.01697
Luck vs. Know.	.03124	.03552	.00612	.00185	.06577	.01243	.02651
Att.	.03829	.00320	.05727	.07019	.00527	.04264	.00218
Defy.	.00288	.00049	.02861	.00030	.04350	.00637	.06472

Proportion of variation in each group explainable for each predictor $(BSS/TSS)_i$

∇Split made on this variable.

{ }Next-best BSS.

APPENDIX E

AID V---Innovation Index: Bean Farmers

Variables	Group #1	Group #3	Group #5	Group #4	Group #6	Group #7
Tenure	.01004	.00320	.02441	.00865	.05250	.02835
Income	.07746	.03483	.05813	.00553	.06011	∇ .13419
Credit	.11611	.06037	{.06410}	.05954	∇ .20336	.03818
Try 2nd	.03627	.01275	.00000	.04305	.00121	.00521
Risk Pref.	.00904	.01211	.02004	.01074	.08799	.00115
Education	{.12051}	∇ .08229	.01520	---	.06825	.00294
Input Index	.05042	.05670	.01523	∇ .08912	.05254	.00536
Info I	.05954	.03827	∇ .02428	.05678	.02401	{.11066}
Info II	∇ .15810	{.06495}	.04680	.07235	{.15363}	.07551
Fatalism	.01204	.01664	.00412	.01822	.00012	.04047
Luck vs. Know.	.00034	.00190	.01041	.01905	.01087	.08897
Att. t/w N.T.	.02039	.01712	.02649	.00389	.00131	.03930
Def. Income	.000151	.00223	.03330	.04506	.00335	.09978

Proportion of variation in each group explainable for each predictor $(BSS/TSS)_i$

∇Split made on this variable.

{ }Next-best BSS.

---Variable is constant in this group.

APPENDIX E--Continued

AID V---Innovation Index: Bean Farmers

Variables	Group #12	Group #14	Group #9	Group #8	Group #19	Group #21
Tenure	.00216	.00016	.02716	.02524	.01545	.01854
Income	.00216	.00670	.08361	.03790	.04333	.00607
			V			
Credit	.07797	.07147	.18220	.03520	.04199	.03609
				V		
Try 2nd	.02040	.06869	.00349	.13794	.00066	---
Risk Pref.	.00442	.00345	.02538	.00583	.00821	.01933
Education	.04005	.02586	---	---	---	---
Input Index	.00882	.01915	.00237	.00422	.00007	.00546
	V					
Info I	.12510	---	.09661	.02409	.03009	.04236
					V	
Info II	.07279	.01747	.13043	.01612	.27017	.00745
Fatalism	.04524	.06482	.05529	.04933	.00035	.08657
Luck vs. Know.	.09861	.07865	.00248	{.08532}	.00312	.11827
Att. t/w N.T.	.03720	.06962	.01169	.01442	.02276	.05824
		V				
Def. Income	.12477	.09210	{.16937}	.00881	.11214	.00232