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A MODEL OF TECHNOLOGICAL ADOPTION FOR THE COFFEE GROWERS IN SOUTHERN MINAS GERAIS STATE, BRAZIL

By

José Norberto Muniz

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ABSTRACT

A MODEL OF TECHNOLOGICAL ADOPTION FOR THE COFFEE GROWERS IN SOUTHERN MINAS GERAIS, BRAZIL

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The goal of this study is to develop a model for farmers' adoption behavior, in which the farmers' entrepreneurial attributes and the adoption act are considered as intervening variables in the process. The rationale for the model derives from Parsons' social-action theory, and an objective course of behavior is elaborated through some concepts considered at a level intermediate between the abstract concepts and the empirical indicators.

The level of analysis in this study is the individual. The unit of analysis is the coffee grower, and the area studied is Southern Minas Gerais, Brazil. The sample consists of 108 farmers. The research findings reveal that several hypothesized relationships were not supported by the data. Some negative effects between variables were also found to be contrary to what was hypothesized. Also, the variance of the key intervening variables in the model was not accounted for by the proposed independent variables.

As a consequence, the hypothesized model was revised. The revision indicates that the expenditure for technologies is better explained for the elements in the structure of the farmers' situation

than by farmers' attributes as economic agents. For the farmers, the implication of this result does not seem very favorable for medium and longer periods of time. Although one economic outcome has been achieved by the farmers studied, this may not be the case for a longer time period. Coffee is a very important commercial crop and source of wealth for Brazil; however, the situation has shown signs of change. If the farmers continue their adoptative behavior as consumers only, they may suffer severe economic consequences. Nevertheless, the research findings must be appraised within the context and limitations under which this research was developed, and they must be viewed as a consequence of an effort to change the way of looking at adoption phenomena.

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CHAPTER I

INTRODUCTION

Background of the Problem

The study of the adoption of innovations in rural areas has received much attention from social scientists. Much of this research is based on the approach developed by Rogers and Shoemaker (1971). However, some authors have suggested slight modifications of the usual paradigm (Campbell, 1966; Valkonen, 1970), and a few researchers have disagreed with the dominant theoretical perspective (Galgart, 1969, 1971; Havens, 1975). (See Appendix A for more references on this subject.)

Basically, the theoretical difference among these researchers is in the identification of the explanatory variables they use to account for the adoption of innovations. For instance, Havens' study of coffee growers in Colombia stressed the need to consider variables that express class structure, whereas Rogers and his followers emphasized individual and social-system variables in the innovation-decision process, the notion of the adoption process, research on attributes of innovations, and analysis of adopter categories.

Nevertheless, there is a common feature in these studies: the emphasis they place on adoption as the main dependent variable of interest. Thus, although they consider different categories of independent variables, the analyses do not go beyond the point at which

relationships between those variables are evaluated. There is little or no concern with studying the consequences of the adoption of innovations. Goss (1979) already pointed out such weaknesses in the traditional adoption research, and Gasson (1973) stressed that farmers' goals and values should also be investigated to gain a better understanding of their economic behavior. In other words, the assumption that adoption leads to positive results needs to be investigated instead of simply being assumed.

However, this is not the only assumption in adoption research. Holden (1972) discussed several such suppositions, but, for the moment, it is important to point out just one more. That is, research on adoption of innovations assumes that little modification of farmers' characteristics or psychological variables is required. This is an interesting point. Rogers and Shoemaker (1971) placed the following variables under that category: cosmopolitanism, fatalism, empathy, dogmatism, achievement motivation, and attitude toward change. The crucial issue is not whether these variables are or are not valid indicators of farmers' characteristics or psychological constructs. Rather, these indicators mainly reveal farmers' values with regard to the broader social system. In one way or another, research using these kinds of indicators assumes that farmers' internalization of the greater society's values is one condition for the occurrence of the adoption of innovations. This seems to be a very loose proposition. As a consequence, an attempt was made in this study to investigate farmers' characteristics in a more restrictive context. That is, some personal variables are considered, but only to reflect farmers' ability

as rural entrepreneurs. Considering that farmers buy production factors at known prices in order to produce goods the price of which is uncertain, and considering that they are subject to climatic factors, have no control over the physical environment, make mistakes, and often live by rule of thumb, it is supposed that variables expressing farmers' entrepreneurial features may lead to a better understanding of their adoption behavior. The number and kinds of variables characterizing an entrepreneur vary widely (Sachs, 1973), but some restrictions will be imposed here in order to specify these variables. For the moment, it is sufficient to be explicit about the nature of the assumptions from which this research problem was derived, leaving the discussion of the variables to be developed later. In other words, the assumption concerning farmers' personal characteristics is among the subjects investigated in this dissertation. However, one point needs to be made clear. Unlike the usual adoption research, the emphasis in this work is on variables that reflect farmers' features as rural entrepreneurs.

The term "rural entrepreneur" has a specific meaning in this study. It is not used in the context in which McClelland or Hoselitz applied it. "Rural entrepreneur" refers to a farmer who owns the land on which the coffee is cultivated, combining means of production. In addition, it is important to note that the focus of this study is on the importance of some characteristics of the rural entrepreneur in determining the combination of the means of production; there is no concern with the problems related to role and status of the entrepreneur in a developmental context. Again, the term "rural

entrepreneur" is useful as it is defined solely for the context of this dissertation.

It is important to add that this study is not without assumptions, and that they will be clarified as the presentation evolves. The main point to be stressed is that the subject matter for this investigation is the two assumptions already discussed. The main concern is not with their isolated analysis but rather with their part of a process, namely as component elements of farmers' economic action directed toward the production process. According to Weber (1964), an economic action is one that is economically oriented. As such, it is hypothesized that discerning the entrepreneurial traits of farmers as decision makers is important in understanding the course of their adoption behavior, when such behavior is undertaken to perform an economic action directed to the production process. From the perspective of this dissertation, adoptive behaviors are not performed in a vacuum. There are constraints, such as those from the economic and socio-cultural context as well as those deriving from the farmers' entrepreneurial ability, that determine the combination of the means of production to achieve some economic results.

Under this perspective, two main questions are proposed for this study: (1) How do some of the farmers' entrepreneurial characteristics affect the adoption act, and how are they affected by the variables in the structure of the situation? and (2) What are some of the economic outcomes achieved by the adoption act? For now, it is important to note that the adoption act is defined as farmers' expenditure in acquiring technical means of production, which is

usually considered as one of the dimensions of the innovation, that is, its cost. Following Weber's point of view, a technological question arises in an economic action because of the doubt concerning the most efficient means of achieving an end. For Weber, given an end, efficiency is a matter of choosing the most economical means. In other words, from the economic point of view, technical questions involve consideration of costs. Thus, the adoption act is here regarded as the farmers' expenditures in acquiring technologies to achieve certain economic outcomes.

In addition, it is also important to mention that the unit of analysis is farmers on whose farms the primary economic activity is coffee cultivation. This study was conducted in the state of Minas Gerais in Brazil, specifically in southern Minas. A characteristic of the situation studied is that the kinds of innovations to be evaluated are not programmed; that is, their appearance is not scheduled in advance. Therefore, the term "innovation" is not used in this research. Instead, "technology" is the appropriate term, and it is used to designate means of production, such as fertilizers and cultural practices, that are applied to a phase of coffee cultivation.

As a consequence of this approach, the production alternatives may or may not be new for the farmers in question, they may or may not be relevant to all farmers, and they may vary in the quantity used. Therefore, the act of adoption only indicates that the farmers have applied the technologies at least to a certain degree.

Definition of the Objectives

Adoption research in general has placed strong emphasis on studying specific elements of the adoption process. Despite Rogers and Shoemaker's (1971) theoretical elaboration of the paradigm of the innovation-decision process, few empirical studies have tried to focus the adoption problem in terms of a process, and even fewer have attempted to stress it as a process pertinent to farmers' economic behavior.

Usually, there is the impression that the adoption of innovation is an isolated process or that the act of adopting innovations takes place in a vacuum. In reality, this condition is not true. The main objective of this dissertation, therefore, is to place the adoption problem in a more inclusive context. The adoption act is here considered as just one of the elements in the farmers' performance of their adoption behaviors. The adoption act is regarded as the application of certain means of production, and adoption behavior reflects a process established through the interdependence of the concrete events pertinent to the farmers' economic and socio-cultural contexts.

Therefore, the goal of this study is to develop a model for the farmers' adoption behavior. Here, the term "model" expresses the existence of a group of concepts nominally defined and corresponding to a type of empirical phenomenon. Considering that models are never exhaustive, the model to be developed here is mainly derived to accomplish the purposes at hand and is restricted to the amount of available data. The main concern is with an attempt to change the

way of looking at the adoption problem--that is, as an intervening variable rather than as only a dependent or a mainly independent factor, without any reference to the farmers' economic behavior.

The main contributions of this adoption-behavior model may be observed as follows: (1) it considers the role of normative elements in addition to conditional and nonnormative elements in explaining the adoption act; (2) the approach does not discard the variability in farmers' entrepreneurial characteristics, which exists in the empirical world; (3) the model allows the inclusion of a large range of theoretically interrelated variables that characterize the farmers' adoption process; (4) the use of an innovation does not imply correlated concepts such as modernization or cosmopolitanism; and (5) the farmer is considered as a dynamic element, combining means of production to achieve certain economic outcomes.

Overview

Six more chapters follow this introductory chapter. Presented in Chapter II is the frame of reference to be used in the dissertation. The focus is on Parsons' theory of social action as a rationale, providing basic principles for constructing an adoption-behavior model. Middle-range concepts are developed and the model is defined. Chapter III is devoted to the operationalization of the proposed model. Variables are defined and measured, hypotheses are established, and path analysis is suggested as a statistical technique to test the hypotheses.

The data-collection and sampling procedures are described in Chapter IV. This chapter also focuses on the definition of the technologies to be studied as well as their importance for the coffee plantation. One important aspect of this section is to show how the application of these technologies depends on the farmers' ability as rural entrepreneurs. Chapter V is basically directed to the test of the hypotheses, and Chapter VI is devoted to the reformulation of the proposed adoption-behavior model on the basis of the explained variance of the set of independent variables in the study. The main research findings and conclusions in reference to the proposed adoption-behavior model are included in Chapter VII.

CHAPTER II

THEORETICAL FRAME OF REFERENCE

In developing research, the investigator has basically two alternatives: (1) to specify a theory as a framework, considering it as the main guideline for the research; and (2) to undertake an investigation without any theoretical orientation. However, the research to be developed here does not fall into either of these two alternatives. The guideline for the analysis is not a theory, but rather it is what might be designated as middle-range concepts in Mertonian terms. Therefore, the expression "theoretical frame of reference" refers to the elaboration of a model reflecting an intermediate conceptual level between theoretical variables and empirical indicators. The term "model" has been defined differently by different authors, but in this dissertation it is used to refer to a conceptualization of the occurrence of a phenomenon, constructed by means of a rationale, with the purpose of establishing some testable relationships between variables. The objective of this chapter is to present this rationale and to indicate what the model looks like.

The rationale for the model derives from Parsons' social-action theory, more specifically, from the actor-situation frame of reference. Parsons started by saying that the smallest unit of an action system is the unit act. This unit is composed of the concrete

elements of action--for instance, concrete ends, concrete conditions, concrete means, and guiding norms that regulate the selection of means to achieve the ends. From a descriptive point of view, these elements are meaningful for the theory of action insofar as the units arrived at can be referred to as constituting such elements of an act or a system of acts. The isolated description of any one of these elements destroys its relevance to the action scheme.

In defining the actor-situation context, Parsons and Shils (1962) pointed out that an actor may be an individual (or a collectivity) who may be studied in regard to his orientation and process of action toward objects. In this context, the actor is considered as a system of action. In regard to the situation, it consists of social and nonsocial objects of orientation. The term "social" pertains to individuals and collectivities, whereas the term "nonsocial" refers to physical and cultural elements.

A fundamental point is that the situation reflects the notion of an external world in which the actor acts and to which he is oriented. The orientation to the situation may be divided into two aspects: motivational orientation, which involves the gratification or deprivation of an actor's need-dispositions, and value-orientation, which reflects only those aspects that commit the actor to observing certain criteria such as choice and norms.

In Parsons' theory of social action, stressing the organization of the actor's orientation to a situation is a crucial issue. Such orientation is reflected by the meaning the actor attaches to the action in its relationships to his goals, means, and interests.

Besides, as the situation provides objects (classified in terms of physical objects, accumulated cultural resources, and individuals and collectivities as actors), the orientation of actions toward these objects entails selection and choice. For instance, a selection is made possible by cognitive discriminations (location and characterization of objects), by cathexis (attachment to objects that are gratifying), and by evaluation (assessment and comparison of objects in accord with their consequences).

Until now, only one attempt has been made to present the basic principle as well as the nominal concepts underlying Parsons' notion of the unit act. More explicitly, Turner (1978: 43) represented the unit act as follows:

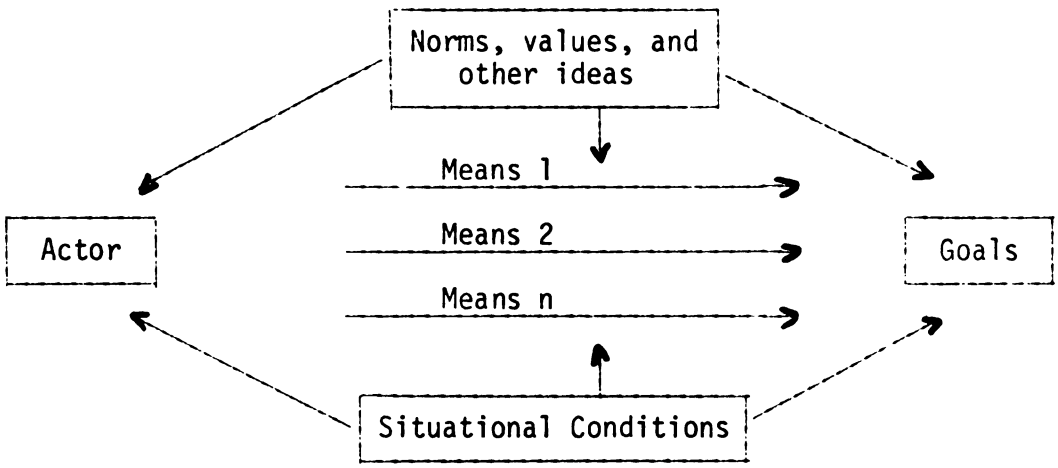

Figure 1: The units of voluntaristic action.

This figure seems to be very important in facilitating an understanding of the component elements of the unit act. However, in terms of the relationships between theoretical concepts, the

figure misses much of the Parsonian theoretical content. This is not a criticism of the figure as depicted by Turner. Rather, it is an attempt to show that although Parsons' scheme is prodigious in terms of concepts, it lacks clarity in expressing their interrelations when a representational scheme is drawn. In other words, "conceptual schemes centering around the ideas of institutions, roles, social action, meaning, symbolic interaction, statuses, the interrelations of class, status, power, norms, values, sanctions, attitudes, and mores are all characterized by an iconic rationale of representation of phenomena. But none of these schemes has a mechanism" (Willer, 1967: 39). That is, a relational statement may be drawn from Parsons' scheme; however, it is not unambiguously derived when it is not possible to sketch it.

For instance, Parsons stressed that the theory of social action concerns the organization of the actor's orientation to a situation. However, looking at Figure 1, it becomes difficult to visualize Parsons' statement. The main point is that Parsons' language and its diagrammatical representation are not isomorphic. Therefore, an evaluation of Parsons' conceptual-scheme rationale is possible if the concepts and their relational statements are considered in a more logical way. For example, action theory might be translated into causal language.

The objective of this chapter is to show how this translation is made, its limitation, and the restrictive scope in which the model here developed is applied. For now, it is important to say that the term "cause" is introduced as a device to aid thought, and it is

restricted to the case studied. According to Willer (1967), "causes and effects and all seemingly necessary connections in our data are impressed as a consequence of our points of view, either unsystematically by tradition or systematically by the use of models" (p. 64).

In Parsons' analysis of the unit act, no reference is made to how the actors acquire orientations. Only when Parsons discussed the personality as a system did he analyze this problem. For him, "when the processes of learning and performance are classified on the basis of the way they serve to meet the requirements of the system, they are termed mechanisms" (Parsons & Shils, 1962: 125).

Moreover, mechanisms are elements in the actor-situation to which the actors do not orient themselves. The term "mechanism" is broadly defined, but it reflects elements acting on the personality system, with the function of solving problems inherent in that system. Again, Parsons did not provide a list of the mechanisms of the personality system, but he classified them according to their functional problems. For instance, he considered mechanisms of learning, mechanisms of defense, mechanisms of adjustment, and so on.

Despite this classification, the emphasis in this dissertation is on the mechanisms of learning. Parsons and Shils (1962) pointed out that these mechanisms "deal with acquisition or extinction or any other changes in habits of cognition, cathection, and evaluation (including changes in internalized value standards)" (p. 125). Mechanisms exert influence on the personality system. At this stage, Parsonian statement is clear and easily formulated for

empirical investigation. However, when the focus is on the actor as a personality system, a complication arises once again.

As already discussed, the actor has been considered as an element that becomes oriented to his situation. The actor is a system of orientation and motivation, attaching meaning to the objects of the situation, which may be seen as means or goals to be achieved. The crucial point is that in cross-sectional survey research the apprehension of such meanings for empirical analysis is not easy, specifically if one attempts to represent the action process in causal terms.

Initially, it is difficult to apprehend actors' orientation by means of questionnaires, that is, by asking questions about actions that the actors performed one or two years before. Second, the notion of means and goals in Parsons' theory involves the concept of subjective elements, and the kinds of data collected by questionnaires only allow the analysis of objective means and goals. Kochen and Levy (1956) already made this distinction, and some of the statements made here are based on those authors' arguments. Third, from the moment it is admitted that the distinction between subjective and objective means/goals is possible, a change from theoretical to empirical language may also be suggested. That is, empirical language (or causal analysis, for example) states the connection between objective concepts closer to an empirical phenomenon, whereas theoretical language remains at a more abstract level (subject concepts) as a result of its vague reference to the behavior of an empirical phenomenon.

Because of these specifications, the concept of action should be changed. For Parsons, social action is mainly characterized by the actor's subjective reference, and, in this study, the notion of an action follows that determined by Kochen and Levy (1956): "An action shall be called of a purely logical type if: (a) the future state of affairs to which the end-variables refer, whether it occurs or not, is objective (i.e., no future internal state variables of the actor enter into its description), and (b) the associated means are objective" (p. 281). In this sense, the actor as a personality system will not be considered in terms of a system of orientation. Like the notion of means and ends, the actor is also seen by means of objective characteristics, which are defined and determined by the type of action to be analyzed.

In reality, determining the type of action to be studied is crucial in identifying the rest of the component elements of the objective action. As the subject of the present investigation is the adoption of technologies by farmers who grow coffee, the farmer as an actor is seen not as a system of orientation but as having some entrepreneurial characteristics, combining means of production to achieve certain economic outcomes. Therefore, from the theoretical Parsonian course of action depicted in Figure 1, it is possible to elaborate a middle-range course of action that is less abstract, objective, and composed of concepts and relational statements of empirical reference. Figure 2 shows this proposed course of action.

Figure 2: Research farmers' adoption-behavior model.

If Figures 1 and 2 are compared, it will be noticed that three things have been changed: (1) their forms, (2) their conceptual terms, and (3) the relational statements between conceptual terms. In Figure 2 the term "entrepreneurial characteristics" is applied in place of "actor"; the "structure of situation," considered by means of mechanisms, is substituted for "situational conditions" and "value, norms, etc."; "adoption act" is employed instead of "means"; and the term "economic outcomes" replaces "ends."

An attempt has been made to show that the elaboration of less abstract concepts is necessary in order to develop empirical research. It has also been shown how the linkage between abstract and middle-range concepts was made for the case in question. From this point onward, the discussion will center around operationalization of the middle-range concepts, identification of their empirical indicators, definition of the hypotheses that will guide the development of the middle-range analysis, and identification of the statistical instrument used to test the hypotheses of the study. These topics are the subject of the next chapter.

CHAPTER III

OPERATIONALIZATION OF THE ADOPTION MODEL

The adoption model is elaborated to study one sphere of farmers' economic behavior, namely the production process. If this restriction imposes certain limitations on identifying the factors affecting this process, it does not avoid further complications. That is, the concepts underlying the variables are multidimensional, and the indicators included to represent them are defined mainly in terms of the available data related to the research problem. In this sense, the term "operationalization" as used in the title of this chapter refers to the identification of indicators that generate an instance of a concept. According to Cohen (1980), this strategy is designated as the strategy of indicators, which allows conceptual definitions close to denotative definitions. "A denotative definition provides a partial definition by pointing to examples to which we would attach the term in the definiendum" (Cohen, 1980: 143). Hence, another researcher could obtain different results if he used other indicators under the same theoretical concepts. In addition, an effort is made to establish the linkage between empirical and theoretical indicators by means of statements and assumptions exclusively. At this point, it is clear that such an effort may reveal one weakness of the present study.

This is a study of the causal relationship between indicators that may express dimensions of certain middle-range concepts. Following are definitions of the key terms and the specification of the measurement procedure applied to the empirical variables. The presentation follows the scheme of Figure 2 in Chapter II.

The Structure of the Situation

The term "structure" does not have any functional or Marxist connotation. Structure only specifies the existence of a configuration of elements, observable entities in a situation. The term "situation" concerns the rural setting, in which a configuration of elements may be identified. Hence, the concept "structure of the situation" is used to refer to a cluster of factors or elements at a given moment that afford alternative possibilities and impose limitations on the farmers' adoption behavior.

The structure of the situation is considered through the use of four categories: attributes of the coffee plantation, mass media of communication, contact with extension agents, and attributes related to the farmers as individuals. It is important to note that there is not an explicit criterion to justify the aggregation of the elements of the situation in these four categories. At this level, the focus is on the objective situation of the farmers, which is assumed to be expressed in terms of the categories mentioned above. To acquire an understanding of the categories, each one is treated separately.

Attributes of the Coffee Plantation

This category refers only to factors related to the coffee plantation itself. Three aspects are considered: income from the coffee plantation, productivity, and age of the coffee plantation. These factors have an independent role in the context of the model that will be delineated, and they are expected to function as the stimulus for the farmers' coffee-growing activity.

Income from the coffee plantation. This variable represents the money income that the farmer receives from the coffee plantation. Income is measured in cruzeiros, and, to avoid the influence of the size of the cultivated area, income is divided by size of the area (in hectares). Furthermore, since two agricultural years are analyzed, the income from the coffee plantation is considered to be the average of the 1972-73 and 1973-74 agricultural years.

Productivity. This variable is viewed as a result of assembling and using resources in past periods by the farmer's economic action. Unlike the other variables, productivity is a summary variable that reflects the performance of the farm as a productive unit. As such, it is assumed that for each agricultural year, the farmer evaluates his farm performance to orient himself to establishing priorities and changes in his economic behavior. The productivity variable is calculated in terms of 60-kilo sacks of coffee beans, divided by the cultivated area and averaged for the two agricultural years considered.

Coffee plantation age. Unlike the two previous variables, this variable does not have an economic content, but it does represent

an important element to which the farmer must adjust his action. This variable indicates how old the plantation is, and this age reflects the potentiality of the coffee trees. Plantation age is measured in terms of the number of years since the coffee trees were planted.

Mass Media of Communication

Basically, the media are considered as mechanisms for diffusing the institutionalized cultural-value patterns of the society being studied. These patterns indicate relevant moral values for performing the specific kind of behavior being studied. It is assumed that the individuals in contact with such means of communication commit themselves in one way or another to these patterns of behavior.

There is no emphasis on the specific content of the communication. On the contrary, only those sources of information are considered that are assumed to diffuse specific and general information about the performance of economic activity on the part of farmers. It is necessary to point out that specific information deals with technical elements of the cultural tradition related to the coffee plantation and that general information refers to orientations other than technical.

The term "technical" refers to the basic capabilities required for the development and management of the coffee plantation. That is, "technical" implies skills that the farmers acquire by having certain experiences or by receiving such orientation through certain

sources of information. The following are ways in which the farmer can gain information.

Reading of technical bulletins. This variable provides information on the farmer's access to at least one of the following sources of information: Suplemento Agricola, Correio Agropecuario, A Gleba, A Granja, Gado Holandes, Dirigente Rural, O Ruralista, Boletins do Campo, and Agricultura de las Americas. The subject matter treated in these bulletins is directed to those who depend on the farm as a productive unit. These bulletins provide basic information about how to farm, fertilizers, cultural practices, product prices, and market news. In one sense, it is supposed that by the act of reading these sources of information, the farmers are learning and incorporating a set of standard values closely related to their economic activities. This variable is considered as a dummy variable, for which the farmers who read these sources receive a value of one and those who did not receive a value of zero.

Listening to rural instructive programs on the radio. This is another variable that reflects the farmer's access to technical knowledge through at least one of the following radio programs: "Hora do Fazendeiro," "Hora do Agricultor," "Bolsa de Cereais," "ACAR," and "Sindicato." The meaning attributed to this variable is the same as that for the previous one. These sources of information also reveal ways of discriminating, acting, and viewing patterns of farming behavior. This variable differs from the previous one in that the radio represents another vehicle for the transmission of these values. This variable is considered a dummy variable, for

which the farmers who listened to these programs receive a score of one and those who did not receive a score of zero.

Listening to general news programs on the radio. This variable measures only programs that have general news content, such as "Hora do Brasil," "Reporter," "Jornal Falado," and "Voz do Paraiso," and an educational program called "Projeto Minerva." Listening to general news indicates whether or not the farmers are subject to broader standards and values that may orient their actions differently. In terms of content, this variable includes nonfarming aspects, such as international and national economics and politics. This variable is considered a dummy variable, for which the farmers receive a score of one if they listened to these programs and a score of zero if they did not.

Reading of a newspaper. This variable indicates if the farmer read a local, statewide, or regional newspaper. Among the newspapers included were Folha Machadense, A Cidade Cruzeiro do Sul, Jornal de Batatais, O Estado de Minas, Diario de Minas, Jornal do Brasil, O Estado de São Paulo, Folha da Manha, Folha de São Paulo, and O Globo. These sources of information involve more diverse subjects than those listed for the previous variable. These subjects include national and international political and economic news, sports, religion, advertising, and so on. This variable, as well as the previous one, indicates the possibility of the farmer's being influenced by a set of informative values that come from a broader subsystem through different channels of communication. In addition, these two variables differ from the variables "reading of technical bulletins"

and "listening to rural instructive radio programs" in terms of content of the standard values transmitted. As for these variables, reading of newspapers is considered a dummy variable, with a score of one for those who read a newspaper and a score of zero for those who did not.

Contact With Extension Agents

The feature that distinguishes this kind of mechanism from the previous one is that this category implies the notion of social interaction with the extension agents. As with mass media of communications, this interaction process transmits patterns of behavior that are supposed to be internalized by the farmers.

It is supposed that if the farmers interact with the rural technical-assistance agents they may acquire a specific kind of technical information. As with the mass media of communication, the extension agents are considered as actors acting in behalf of a broader system (the urban) and providing specific and selective kinds of skills and information. These actors represent the Brazilian Institute of Coffee and the Credit Association and Rural Extension (ACAR).

Because of the restricted focus of this category, the variables reflect the farmer's acquisition of knowledge on specified subjects related to coffee cultivation. Since two technical-assistance agencies are being studied, the same subjects are examined in relation to each. It is necessary to point out that the activities of the Brazilian Institute of Coffee are only directed to the

assistance of those who grow coffee, and that ACAR attends to the farmer's needs in general--it does not matter if a farmer grows coffee or not.

The specific subjects discussed between the farmers and the technical-assistance agents are commercialization, cultural practices, and credit. These variables are considered as dummy variables. Farmers who had access to this kind of information receive a score of one, and those who did not receive a score of zero.

Individual Attributes

Individual attributes are included, in an attempt to consider the individual as a component element of the structure of the situation. This structure then reveals elements outside the individual as well as elements possessed by the individual through his characteristics. The point of view expressed in this dissertation is that the farmer as an individual may be studied through his objective characteristics, which are analyzed in different ways, depending upon the approach undertaken by the investigator.

Two individual attributes are considered as pertinent to the farmer's structure of the situation. They are farming experience and formal education. The common feature in these two variables is that they reflect the farmers' acquisition of knowledge throughout the years, which may affect other characteristics of the farmers as rural entrepreneurs. Basically, experience and formal education are mechanisms of learning, contributing differentially to the formation of the farmers' background in farming.

Farming experience. This variable involves technical knowledge. Unlike the others, it is considered as a consequence of the farmer's own interaction with his social, economic, and physical environment. The main assumption is that through this constant interaction, farmers learn from their own mistakes and from other farmers' as well, correcting mistakes by attempting different and new ways of behavior. This variable reflects the farmer's behavior as influenced by his experience with his coffee plantation. The variable is measured in terms of years that a farmer has produced coffee as one of the economic activities on the farm.

Formal education. This variable refers to formal schooling. It is measured by the following values for different levels of training: illiterate (1); primary grades (2); secondary grades (3); and college (4). Farmers' formal education is important to this study for various reasons, mainly because it may reflect the access to more general behavior patterns and values, besides presenting the possibility of learning faster and of having more frequent access to the means of communication and extension agents.

Entrepreneurial Characteristics

Many traits are used to identify an entrepreneur; each author focuses on different attributes. Nevertheless, considering that the emphasis in this dissertation is on the farmers' behavior as economic agents in a productive process, only three aspects of the entrepreneurial role are analyzed. In addition, it is important to note that such aspects are assumed to be relevant to the study in

question; the three features described below are not necessarily part of the farmers' connotation of entrepreneur.

It is important to remember that the purpose of this investigation is to understand the farmers' adoption behavior through their objective attributes, not only in terms of the structure of the situation but also by means of certain features of the farmers as economic agents. There is no concern here with the farmers' subjective decision process. Rather, the component elements placed under the designation of entrepreneurial characteristics are hypothesized to be crucial for the farmers' adoption act. As this act involves the expenditure of money, it is supposed that the following three characteristics are important to the rural entrepreneur: technical knowledge, farmer's incentives for cultivating coffee, and farmer's economic orientation. Whereas the first variable allows the identification of the farmer's skill in farming, the other two express the farmer's attitudinal values in relation to coffee cultivation as an economic activity and to the economic acquisition of the technological means of production. These variables are defined in the following paragraphs.

Technical Knowledge

This variable indicates the farmer's ability to manage the technologies considered as factors or means of production in this study. This variable evaluates the farmer's technical knowledge through questions on criteria that must be considered in selecting

an area in which to plant coffee, planting, spacing, liming, fertilizing, and pest control. (See Appendix B, p. 127.)

Technical knowledge is measured by eight items with four response alternatives, one being correct. The coefficient of reliability for this scale is .49.[1] A total score is computed by summing the weighted scores from the individual items. The possible range of the total scores on this scale is 0 to 23.

Farmer's Attitude Toward Cultivating Coffee

This variable shows how a farmer sees certain aspects of his reality as elements that may impel or inhibit his performance as an economic agent. The aspects to be included here are the farmer's attitude toward governmental policies for coffee pricing and for loans at a certain interest rate, and his attitude toward the organization of the coffee-growing activity in terms of bookkeeping, management, mechanical cultivation, and better salaries and educational training for his employees. (See Appendix B, p. 131.)

This variable is measured by a Likert scale with eight items. A total score is computed by summing the scores for each item. The coefficient of reliability for this scale is .80, and the possible range of the final scores on this scale is 8 to 40.

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[1] Coefficient of reliability = $\frac{k\,\bar{r}}{1 + (k-1)\,\bar{r}}$

where: k = number of items
$\bar{r}$ = average intercorrelations of item responses.

Economic Orientation

This variable refers to the farmer's attitude toward the farm as a productive unit. Unlike the previous variable, the economic orientation variable identifies how the farmer economically sees his decisions as related to selected aspects of the coffee-growing activity. It is not a question of whether or not the farmers cultivate coffee on a commercial basis. By definition, coffee is a commercial crop. In this variable, there is an attempt to identify the development of the activity under some economic principles. The economic orientation variable is measured by a Likert scale with 14 items that cover the farmer's criteria for buying fertilizers (price, quality, and salesman's suggestion); other factors that influence the farmer's decision-making process in regard to economic activity (profit, productivity); the farm as an economic activity compared with nonfarm economic activity; and the farmer's expectations about the future of his economic activity. (See Appendix B, p. 129.)

A final score is calculated by summing the individual scores assigned to each item. For this scale, the coefficient of reliability is .40. The possible range of the final scores on the scale is 14 to 70. It should be noted that Souza (1974) developed and used this scale.

It may be observed that two of these measures are not highly reliable. The unreliability indicates that some random measurement errors are present in these scales. Despite this fact, these scales will still be applied in further analyses. That is, considering that this investigation is based on data already collected and that these

three variables are the only ones that may express farmers' attributes as economic agents, the reliability aspect is not considered to be a problem. It may be a necessary but not sufficient condition for valid measurement. Most important, one of the assumptions of the statistical technique used for the data analysis is violated. Therefore, to apply this technique, it is necessary to "correct for attenuation (unreliability) by dividing r_{xy} by the square root of the product of the reliabilities (the maximum possible correlation between the imperfect measures)" (Cohen & Cohen, 1975: 63).

The Adoption Act

The term "adoption" usually implies that a certain number of technologies have been applied to at least some extent. Depending on the objective of the study, this variable may be conceptualized and measured in different ways. As a consequence of the usual orientation in adoption research, which considers adoption as the dependent variable, the adoption is almost exclusively considered in terms of the use of technology. Moreover, adoption quotients have been elaborated and adoption scales constructed in different ways, with other aspects of the technologies or innovations considered as their dimensions only. Thus, there are such dimensions as complexity, costs, communicability, risk associated with innovations, and compatibility (Lin & Zaltman, 1973).

The important point is that from the moment a change is proposed in relation to the focus of a phenomenon, some of the usual concepts applied to comprehend it may lose importance in the new context. What is suggested here is that under the conception of

adoption as a means or as an intervening variable, the notion of costs may be a better alternative in understanding the course of the farmers' adoption behavior.

Despite the fact that cost is often considered as a dimension of the technologies or innovations, it is referred to here as the adoption act. The adoption act is the farmer's willingness to spend a certain amount of money to buy technologies to be used as means of production applied to the care and maintenance of the coffee plantation. The main point is that in producing a commercial crop under the conditions of scarcity and uncertainty that characterize all agricultural activity, the adoption act is seen as an act of buying technologies, measured as the amount of cruzeiros spent per hectare. These technologies are defined in the next chapter.

Economic Results

The economic results of the farm as a productive unit may be evaluated from different perspectives and by means of different indicators. Nevertheless, the term "economic results" is used here to refer to the outcomes achieved by the productive unit in terms of the society's institutional pattern. That is, because coffee is an important source of wealth, it is assumed that those who are engaged in this kind of economic activity are achieving the economic results expected by the society's economic pattern.

In this context, the economic results are considered in terms of two indicators: On one hand, the farmers may be looking for

technological efficiency of the means of production, of which productivity seems to be one indicator. On the other hand, the farmers may consider the achievement of profit from the coffee plantation, for which net income is used as the indicator.

Productivity is measured as the total coffee production divided by the cultivated area for the 1975 agricultural year. Net income is considered as the income from coffee production in 1975 divided by the cultivated area minus the expenditure that the farmers made with the adoption of their technological means applied to coffee growing. Specifically, this variable identifies the influence of the cost of technological adoption on the profit achieved through the coffee plantation. It is important to note that the meaning attributed to the notion of net income is very limited, restricted only to coffee growing and to some of its costs.

Definition of the Hypotheses

This study deals with two different kinds of variables. In Chapter II, the conceptual framework for the analysis was discussed. The variables were treated on a theoretical level and consequently are viewed as theoretical variables. The function of that set of variables is to provide a more comprehensive understanding of the objective course of a behavior in a specific case. Another category of variables is the empirical variables or indicators. These variables are closer to the data and are considered as measures that represent middle-range, conceptual variables.

The ensuing discussion of the hypotheses follows the proposed theoretical model shown in Figure 2. The model is very important for

this study because it provides a theoretical course of action for the problem being addressed. To test the model, the hypotheses are elaborated at two levels: general and specific. In the former, there is a treatment of what is supposed to be found at the theoretical level; in the latter, there is its representation through the empirical variables.

> General Hypothesis 1: The component elements of the structure of the situation positively affect the entrepreneurial characteristics of the farmers.

This hypothesis reflects the need to look for antecedents of the adoption act. It is not a search for an invariant connection but is only one attempt to identify the connections between the mechanisms of stimulus and learning of the situation (seen by Tolman, 1962, as environmental entities presented to the individual actor at the given moment) and its influence on the course of the adoption act. This hypothesis is an attempt to evaluate what the factors are and how they act on the farmer's overall background formation as a rural entrepreneur.

> Specific Hypothesis 1.1: The dependent variable, technical knowledge, is positively affected when the following independent variables are considered simultaneously: reading of technical bulletins, listening to general news programs on the radio, listening to rural instructive programs on the radio, reading newspapers, contact with the technicians from the Brazilian Institute of Coffee and from ACAR about cultural practices, farming experience, and education.

This hypothesis predicts that the mass media of communications, contacts with extension agents, and individual attributes contribute positively to the farmer's acquisition of technical knowledge. That is, the component elements of the structure of the situation cited

above are expected to be mechanisms of learning through which the farmers can acquire more technical knowledge.

> Specific Hypothesis 1.2: The dependent variable, farmer's attitude toward growing coffee, is positively affected when the following independent variables are considered simultaneously: income from coffee, productivity, coffee-plantation age, reading of technical bulletins, listening to general news programs on the radio, listening to rural instructive programs on the radio, reading newspapers, contact with technicians from the Brazilian Institute of Coffee and ACAR about commercialization and credit, farming experience, and education.

This hypothesis indicates the expectation that coffee plantation attributes, mass media of communications, contact with extension agents, and individual attributes of the farmers have a positive influence on the farmer's attitude toward developing coffee as an economic activity.

> Specific Hypothesis 1.3: The dependent variable, farmer's economic orientation toward farming, is positively affected when the following independent variables are considered simultaneously: reading of technical bulletins, listening to general news programs on the radio, listening to rural instructive programs on the radio, reading newspapers, contact with technicians from the Brazilian Institute of Coffee and ACAR about cultural practices and credit, farming experience, and education.

This hypothesis assumes that there is a difference among farmers in their economic orientation that may be attributed to the antecedents of the adoption act. Such specific factors, closely related to exposure to sources of influence on the rural setting as well as individual attributes, are supposed to be responsible for the difference among the farmers in their economic orientation toward farming.

> General Hypothesis 2: The farmer's entrepreneurial characteristics positively affect the adoption act.

This hypothesis is very important to the theoretical model proposed in this study. Its confirmation would show that the farmer's preparation to cultivate coffee is crucial in applying technological means of production. Since the adoption act is seen as the money spent to acquire technologies, it is supposed that a farmer's preparation in terms of skills, incentives, and economic knowledge is decisive in regulating the amount of money spent during the care and maintenance phase of coffee cultivation.

> Specific Hypothesis 2.1: The dependent variable, adoption act, is positively affected when the following independent variables are considered simultaneously: technical knowledge, farmer's attitude toward growing coffee, and farmer's economic orientation toward farming.

This hypothesis stresses the adoption act in the context of the three entrepreneurial characteristics of the farmers in the study. They are postulated as important intervening causal variables in the acquisition of the means of production. Therefore, to what degree and in what direction they determine the dependent variable are crucial to an understanding of the course of adoption behavior hypothesized.

> General Hypothesis 3: The adoption act positively affects the economic outcomes of the farm as a productive unit.

This hypothesis evaluates the consequences of the adoption act. As it was theoretically stated, the adoption act only makes sense if it leads the productive unit to the achievement of positive outcomes. In many studies on the adoption of technologies, such an effort is rarely undertaken, and when it is proposed, it is not considered in the context defined here, that is, as elements conditioned

by other intervening variables that make up a theoretical course for the adoption behavior. Hence, the isolated analysis of this hypothesis is not meaningful. It must be considered as a part of the farmer's adoption behavior, linked indirectly to the farmer's background formation as a rural entrepreneur and other antecedents of the structure of the situation in which the adoption behavior has occurred.

> Specific Hypothesis 3.1: The dependent variable, productivity, is positively affected by the independent variable, expenditure on technologies.

This hypothesis allows the evaluation of the adoption act in terms of a specific economic outcome: productivity. Because productivity is usually postulated as an indicator of farm efficiency, which is highly stressed by the society's institutional pattern, this hypothesis will reveal whether the farmers are or are not achieving an outcome that is strongly emphasized by those who act in connection with the rural subsystem.

> Specific Hypothesis 3.2: The dependent variable, net income from coffee, is positively affected by the independent variable, expenditure on technologies.

This hypothesis explores another goal to be achieved, which is supposed to be determined by the application of the means of production already described. Unlike the last hypothesis, this one allows the evaluation of the means in terms of the benefits acquired through coffee cultivation, which may also in some sense be determined by factors outside the farmer's control.

So far, the hypotheses have been defined in terms of the different steps of the analytical model. It is important to keep in mind that the focus of this study is on the set of steps. The

ordering of the hypotheses is due only to the importance of those parts to the whole. The goal is to identify a model in which the course of adoption behavior may be recognized, and in which the farmers are seen through specific characteristics as economic agents, applying means of production that lead to the achievement of positive economic outcomes. In addition, the farmers are also considered to be influenced by factors that mold their abilities and perspectives as entrepreneurs. The important aspect is that the course of the farmer's adoption behavior is seen as a set of integrated and dependent concrete elements, having specific meaning for the farmers in question. The hypothetical model is represented graphically in Figure 3.

To better understand Figure 3, the names of the variables are defined as follows:

INC = Income from coffee plantation

PROD = Productivity

COFAGE = Age of the coffee plantation

TBUL = Reading of technical bulletins

RIP = Listening to rural instructive programs on the radio

RGN = Listening to general news programs on the radio

FEXP = Farming experience

NEWSP = Reading of newspapers

ED = Formal education

COBIC = Participation in meeting about commercialization with technicians from the Brazilian Institute of Coffee

CPBIC = Participation in meeting about cultural practices with technicians from the Brazilian Institute of Coffee

CBIC = Participation in meeting about credit with technicians from the Brazilian Institute of Coffee

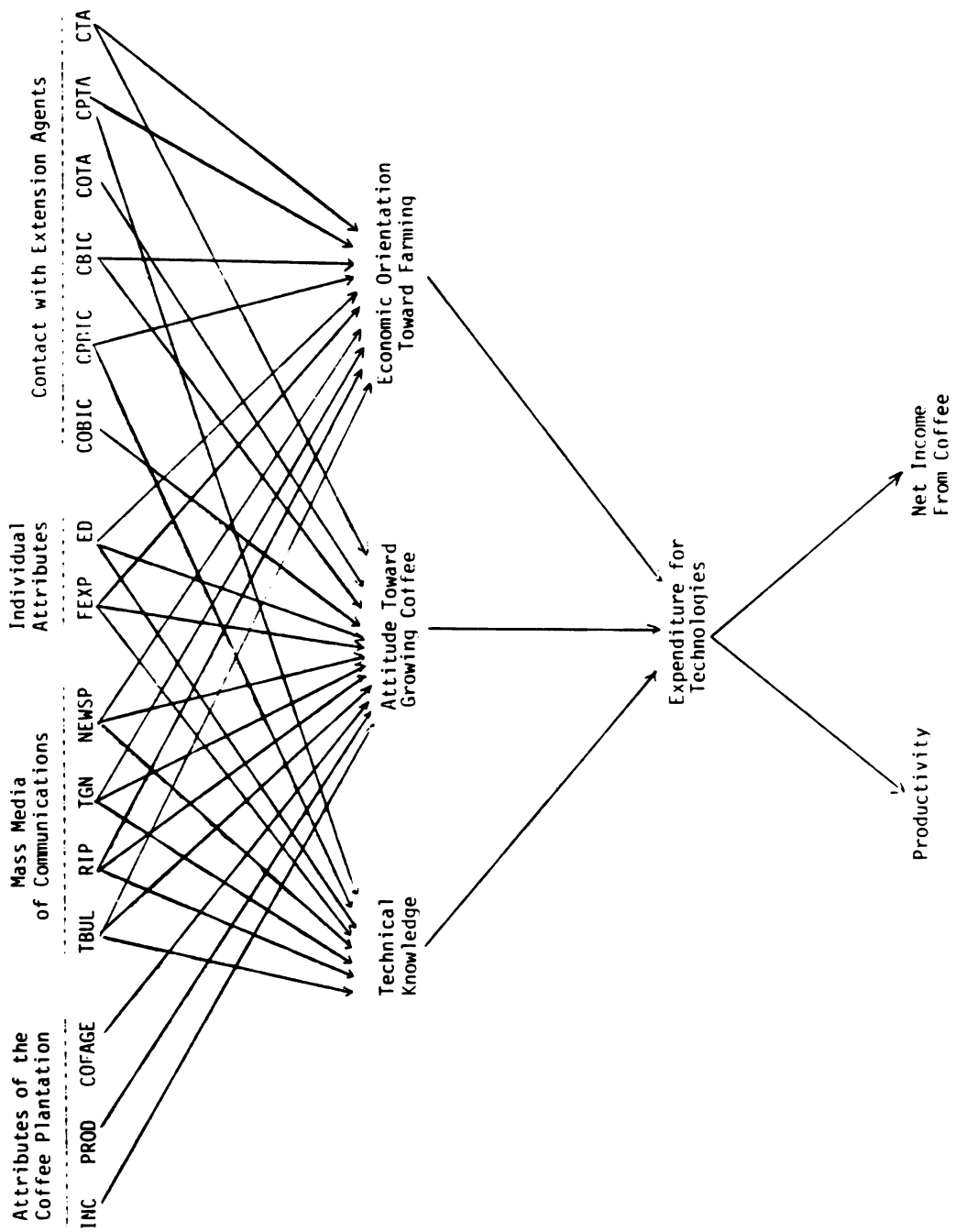


Figure 3: Hypothesized relationships in the model of the adoption behavior.

COTA = Participation in meeting about commercialization with technicians from ACAR

CPTA = Participation in meeting about commercialization with technicians from ACAR

CTA = Participation in meeting about credit with technicians from ACAR

It is important to note that, in the proposed adoption behavior model, some linkages between the empirical variables have been omitted. Since path analysis will be the technique used to test the model, it is expected that the coefficients will be equal or close to zero in the cases noted earlier. Following Heise's (1968) suggestion, since zero and nonsignificant path coefficients are observed, it is advisable to delete the referent causal linkage, thus permitting a trimming of the hypothesized theoretical model. According to this point of view, "path analysis is basically concerned with estimating the magnitude of linkages between variables and using these estimates to provide information about the underlying causal process" (Asher, 1976: 29). Therefore, as is also allowed in path analysis, the evaluation of the causal process implied in the hypothesized model will be assessed through the decomposition of the correlation coefficients between variables into a sum of simple and compound paths. Probably this strategy will allow the reorganization of the theoretical variables in a way different from that proposed for this research.

Path Analysis

Path analysis is employed here to test a theory rather than to generate it. In this perspective, it is conceived as "a technique

used in the causal analysis of phenomena by means of linear relations" (Nurmi, 1974: 159-60).

A linear causal model may be mathematically expressed as:

$$X_2 = a_2 + b_{23}X_3 + b_{24}X_4 + R_u$$

$$X_1 = a_1 + b_{12}X_2 + b_{13}X_3 + R_u$$

where the coefficients of the b's give the relative contribution of each variable to the determination of the dependent variables, and the R's are the error terms. One important aspect in this kind of equation is that it reflects a deterministic causal model (Lindsey, 1973). This model states that if the events X_3 and X_4 occur, for example, then the event X_2 necessarily follows.

The independent variables are considered as necessary conditions for the occurrence of the dependent variables. In this kind of deterministic model, the sufficient conditional assumption is not assumed. That is, it is not assumed that the independent variables in the model are sufficient to cause the dependent one. Therefore, the model as here applied deals with the identification of variables that increase the likelihood of occurrence of a given phenomenon without assuring with certainty that the phenomenon will be found.

The main point is that the term "cause" is restricted to the effect of a specific independent variable given the inherent assumptions of the causal model. Path analysis is not a method for discovering or deducing causes. Path coefficients only stand for the numerical contribution of one variable in determining the other one, which has

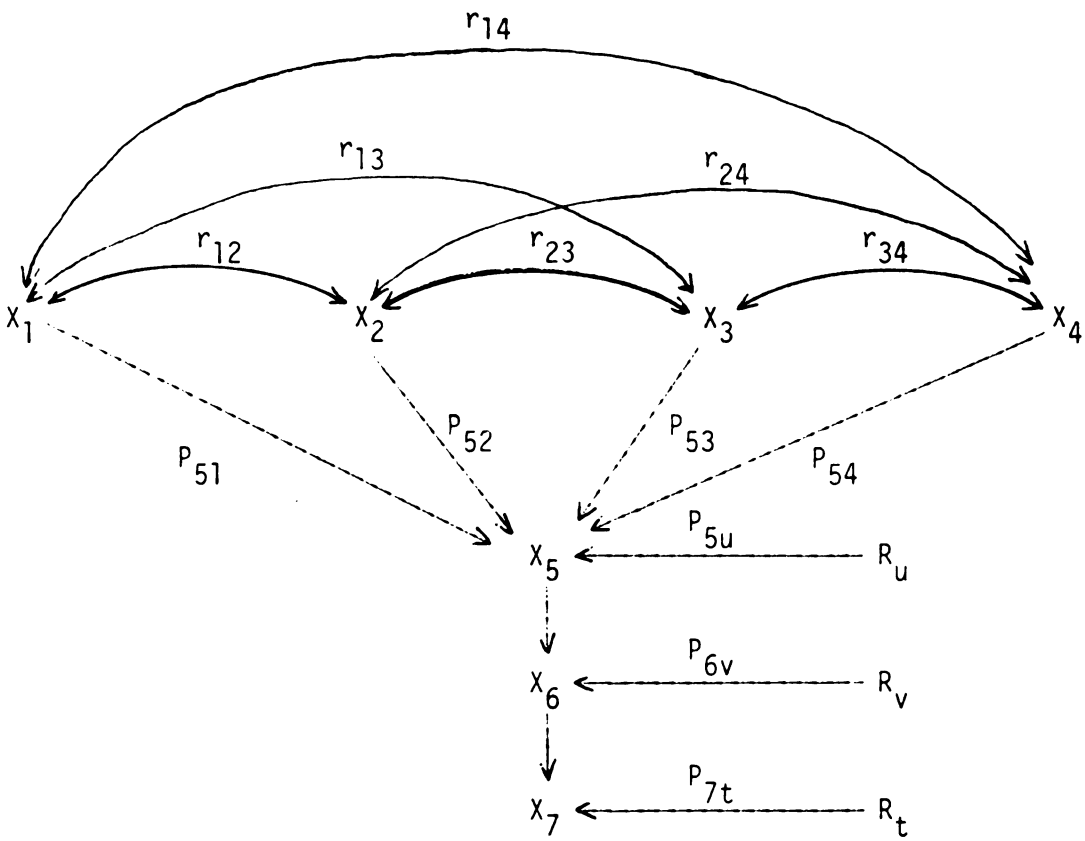
theoretical meaning restricted to the path diagram that represents the proposed theoretical scheme.

Although there is a clear correspondence between the postulated causal and noncausal relationships of a path model and its path diagram, there is an argument that the causal approach is too simple to describe reality and that it cannot be empirically verified. Despite the fact that path analysis leads to a polemic discussion about the concept of cause or causation in social science, the meaning of this term is restricted to the definition given earlier--that is, it implies a necessary direct effect of the independent variables--without going into specifics in the philosophical entanglement. It is known that there is a risk of error when causal argument is used in sociological study. However, this does not mean that such a strategy should not be used in this context. If in dealing with this kind of model it is necessary to make some untestable simplifying assumptions that may cause doubt regarding the correctness of the empirical predications, it is recognized that these assumptions will, even so, be more realistic than others (Blalock, 1964).

Moreover, it is under these conditions that path analysis is going to be applied. A causal process is assumed to operate among the variables identified in the theoretical model, and a path diagram may be drawn for the assumed causal scheme as shown in Figure 4.

Three kinds of variables can be identified in this diagram. X_1, X_2, X_3, and X_4 are identified as exogenous variables since they are not determined by other variables in the model. X_5, X_6, and X_7 are considered endogenous variables because they are influenced by

other variables in the model. The R's are residual or unmeasured variables that are not included in the actual model. In addition, the P's represent the path coefficients, which are considered as weights that reveal the impact of one variable upon another, and the r's represent the correlation between two variables from which the causal path is not of theoretical interest.



where: X_1 = attributes of the coffee plantation
X_2 = mass media of communication
X_3 = contact with extension agents
X_4 = individual attributes
X_5 = entrepreneurial characteristics
X_6 = adoption act
X_7 = economic outcomes

Figure 4: Theoretical adoption model with residual variables and path coefficients included.

From these postulated causal relationships, it is possible to identify the structural equations to which each refers. These recursive equations are:

$$X_5 = P_{51}X_1 + P_{52}X_2 + P_{53}X_3 + P_{54}X_4 + P_{5u}R_u$$

$$X_6 = P_{65}X_5 + P_{6v}R_v$$

$$X_7 = P_{76}X_6 + P_{7t}R_t$$

The main point is that this set of structural equations reflects a theoretical sociological model in which not only the relationship between the independent variables and the ultimate dependent variable is specified, but in which the relationships among the previous linkages are also explicit. To develop this kind of analysis, the required basic assumptions are that the relationships among the variables are unidirectional, linear, additive, and in a causal form. As can be observed through the description of the adoption behavior model, the basis for these requirements is provided. Furthermore, assuming that the assumptions about uncorrelated disturbances and measurement reliability are also verified, it is possible to design the plan of analysis to be developed later through the following steps:

1. Computation of the path coefficients for the hypothesized linkages that will be made through ordinary least square, due to the properties of the recursive model in question (Wonnacott & Wonnacott, 1970: 194).

2. Model testing and deletion of paths.

3. Decomposition of the correlation coefficient between independent and dependent variables to obtain more details about the ways through which previous variables affect subsequent variables.

These elements reflect how path analysis may be useful in structuring social reality. It makes the assumptions clear and provides discussions about the consistency of the hypotheses in terms of direct and indirect effects, allowing the elimination of some paths and the creation of new linkages suggested by the data.

CHAPTER IV

THE RESEARCH SITUATION[1]

In this chapter, two different subjects are treated. The first is the identification of the area studied and a description of the sampling procedures used. The second subject is a discussion of coffee growing itself.

Study Area

Minas Gerais, one of the Brazilian states, extends from the Atlantic coastal mountain range on the east to the Federal District, where Brazil's capital is located. The agriculture in Minas Gerais is varied. Farmers in the south concentrate on the production of market crops such as coffee, sugar cane, and tobacco, whereas the farmers in the north have a subsistence agriculture based on such field crops as corn, beans, and rice. In addition, there are cattle

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[1]It is necessary to point out that the location in which the research was conducted, the sampling procedure, the development of questionnaires, and data collection were developed and coordinated in 1975 by a group of researchers, of which I was a member, from the Economic Department of the Universidade Federal de Vicosa, Minas Gerais, Brazil. At that time, there was a research agreement between the Economic Department and the Empresa Brasileira de Pesquisa Agropecuaria (EMBRAPA) with the objective of developing research on coffee growers. Moreover, because the amount of information embraces several aspects of the coffee planters, from the economic and social points of view, the data available proved very useful for the kind of analysis that is here developed.

operations of two types: beef on open ranges in the western regions and dairy herds in the central and southern regions.

Minas Gerais in area is about the size of Spain. In population, this state is second among Brazilian states, the density being 19.83 inhabitants/km^2. According to the 1970 statistical census, Minas Gerais had 454,919 farmers with 42,269,249 ha of land. In 1973/74, the state ranked third among the states in the number of coffee trees, with 592 million. Paraná and São Paulo were first and second (Instituto Brasileiro do Café, 1974a).

The region that produces coffee in this state is called South Minas. There are 144 municipalities in this region, which has boundaries with the states of São Paulo and Rio de Janeiro. This region is near the three important cities of Belo Horizonte, São Paulo, and Rio de Janeiro. Its climate, soil, and topography are very favorable to the development of coffee growing. The Instituto Brasileiro do Café--Grupo Executivo da Racionalizacão da Cafeicultura (IBC-GERCA) instituted a plan for renewing coffee growing in the country. South Minas planted 150 million coffee trees, which represented 60 percent of the state total and 20 percent of the total of the entire country (Instituto Brasileiro do Café, 1974b). Figure 4 is useful in showing the main divisions within Minas Gerais, as well as for identifying the area of production and the region to be considered in the study.

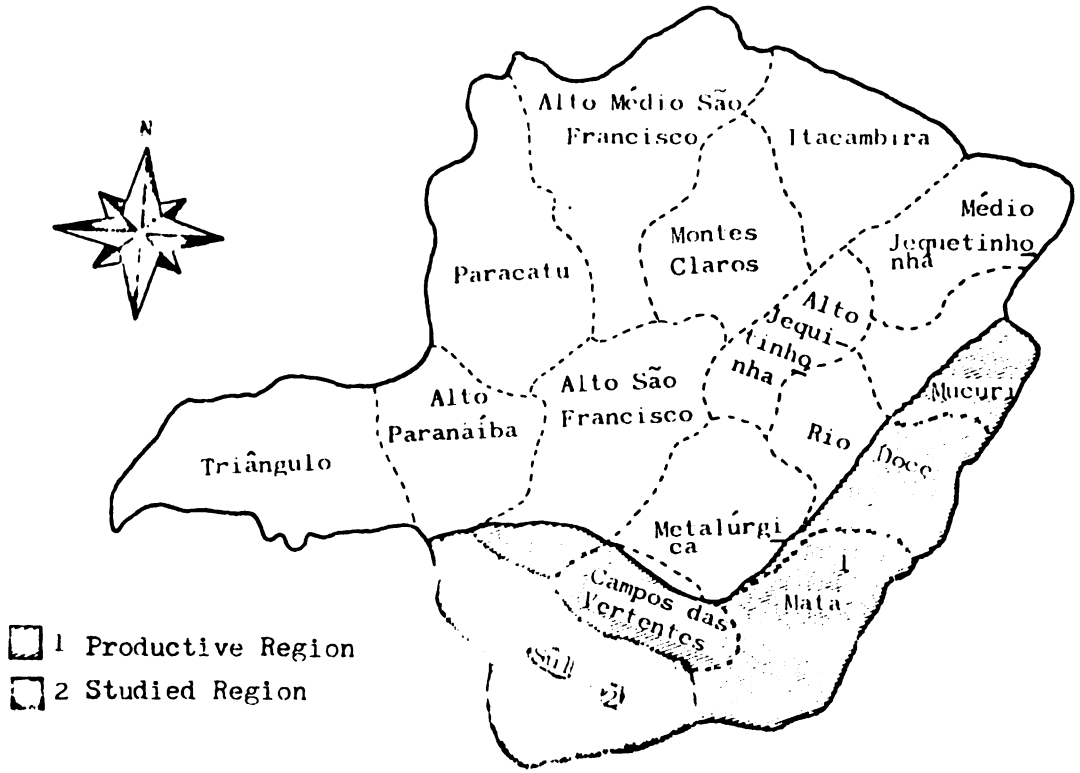


Figure 5: The state of Minas Gerais with its main regions.

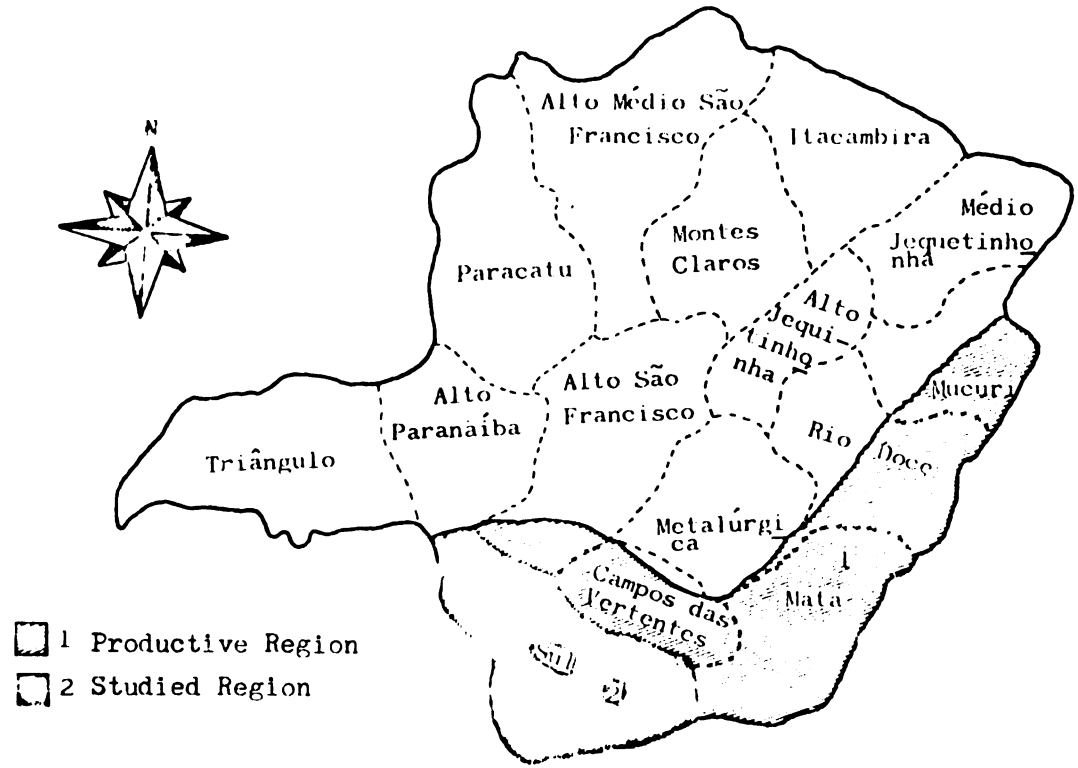


Figure 5: The state of Minas Gerais with its main regions.

Sampling Procedure

From the region to be studied, three municipalities were chosen. Such selection was intentional, for these municipalities planted more coffee trees within the renewal plan established by the IBC-BERCA, and they were the municipalities that more adequately represented the studied region in terms of topography, soil, and infra-structure. São Sebastião do Paraiso, Machado, and Três Pontas were selected for this study.

To fit the sampling frame, the farmer population was restricted to those coffee growers who took part in the renewal planting of coffee trees defined by the IBC-GERCA. In Brazil, it is very hard to get a complete list of all coffee planters. Since about 90 percent of the coffee growers in the studied region were listed in the IBC-GERCA's office, it was decided to consider these farmers as the population to be studied.

In addition, since there was information about the planted area for each farmer, it was possible to derive a stratified sample. For this case, the sample size selected from each stratum was made proportionate to the population size of the stratum. It is important to note that the problem of optimal allocation is not considered. Therefore, according to Castanheira (1976: 10), the calculated stratified sample size may be presented as shown in Table 1.

After defining the sample size, a table of random numbers was used to select the sampling elements in the different strata. It is necessary to say that after identifying the sampling elements, 10 percent of the total of the elements in each municipality was also

selected in order to have a reserve list. Thus, if any of the elements initially selected should be missing, the first element in the reserve list would be interviewed.

Table 1: Size of sample by strata and by municipalities.

Strata	São Sebastião do Paraiso (no.)	Machado (no.)	Três Pontas (no.)	Total (no.)
From 1 to 10 ha	29	11	21	61
From 10.1 to 50 ha	16	10	18	44
From 50.1 to 100 ha	5	4	3	12
Total	50	25	42	117

The interviews were conducted by technicians provided by the Associacão de Crédito e Assistência Tecnica (ACAR) in July and August, 1975. (See Questionnaire in Appendix B.) After collecting the data, during the editing and coding phases of the research, seven questionnaires from São Sebastião do Paraiso (three from the first stratum and four from the second) and two from Machado (both belonging to the first stratum) had to be discarded. Such action was taken because these questionnaires lacked information related to the production costs of the farms. Moreover, the total sample size was reduced to 108 elements, 43 from São Sebastião do Paraiso, 23 from Machado, and 42 from Três Pontas.

Coffee Culture

Coffee culture was introduced into Brazil in the eighteenth century. By the end of the nineteenth century, Brazil was one of the main coffee suppliers for the world. However, since the present century, coffee culture has presented some signs of change in relation to the Brazilian economic situation. Table 2 illustrates this aspect very well.

Table 2: The role of coffee in Brazilian exports, 1963-1973.

Year	Total Brazilian Exports (US $1,000)	Coffee as a Percentage of Total Exports
1963	$1,406,480	53.10
1964	1,429,790	53.14
1965	1,595,479	44.33
1966	1,741,442	44.41
1967	1,654,037	44.31
1968	1,881,344	42.37
1969	2,311,169	36.59
1970	2,738,920	35.84
1971	2,903,585	28.31
1972	3,991,211	26.40
1973	6,199,200	21.68

Source: Instituto Brasileiro do Café, 1974a: 11.

As this table shows, the role of coffee in Brazilian exports has decreased, and, at the same time, the total value of these exports has increased. Despite this fact, the coffee plantation still represents one of the main sources of Brazilian income in terms

of exterior commerce. It is necessary to say that one element responsible for the decline of the coffee culture in the national context was the industrial revolution that affected Brazil after World War II. After that time, the coffee grower lost his importance as the main political agent, the large farms started to be divided, and the coffee plantation entered a decline. Only after Brazilian plans for renewing the coffee plantation started in the early 1970s did the planting of coffee begin to increase.

Unlike the earlier period of the coffee plantation, the farms now exhibit a different structure. The large-sized coffee farm of the past is no longer commonly seen, the coffee grower has lost much of his political participation, and the relationship between employers and employees has changed from the relations of previous times. Despite this, the coffee grower operates a type of farm that is different from that of other types of agricultural activity. The coffee grower has usually received more formal education, has more access to institutional facilities (such as credit and technical assistance), and usually receives much more assistance from the government because coffee plantations still have an important role in the Brazilian economy.

In relation to the cultivation of coffee, it varies from place to place. The main reason for this divergence is physical conditions such as climate and soil quality. In addition, specific factors such as shade, fertilization, pruning, and disease-resistant

coffee varieties are determinants of the crop yield (De Geus, 1973). Moreover, the factors that influence coffee production can be placed in two categories: (1) the elements on which the rural entrepreneur does not have any kind of control and (2) those aspects that depend on rural entrepreneurs' ability to manage.

Under this second type, the coffee grower's influence may be observed in three different areas. The first includes several aspects: selection of land for planting coffee, cleaning up the ground and preparing the soil for cultivation, such as terrace construction, liming, digging the soil, erosion prevention, holing, spacing, and choice of coffee variety. The other two areas are related to the care and maintenance of the coffee trees themselves. The second is restricted to the care and maintenance during the early years, and the third is the care and maintenance after the fifth year of coffee cultivation.

As a consequence, coffee culture varies from place to place in terms of productivity, period of maximum production, and the life span of a coffee tree. Thus, how long a coffee tree will live and prosper depends on different circumstances. Haarer (1962) said that trees of robusta coffee in Uganda bear good crops in spite of the fact that they are more than one hundred years old. However, a plantation of Arabian coffee in a hot country of low rainfall ceases to give economic returns in six years, dying of disease and die-back.

In South Minas, the coffee plantation usually bears economically in the third year. Nevertheless, the period of maximum production is between five and ten years, with cyclical periods of bad and good crops. Coffee trees decline in their production after they attain an age of 15 to 20 years. But this is not the rule for all of the coffee plantations in the study area. It is possible to find coffee trees 20 years old and bearing economically. Therefore, to specify the population to be studied, it was decided to include only coffee planters who had coffee plantations that were more than five years old. It is important to note that one of the objectives of the plan for renewing the coffee plantations established by the Instituto Brasileiro do Café was to eliminate the old and unproductive coffee trees for new ones.

In regard to those factors that depend upon the entrepreneur's ability, Haarer (1962) pointed out three elements that can interfere with coffee yield: (1) the case in which the seed has not been sown from selected trees, (2) the case in which coffee has been carelessly treated, and (3) the case in which the soil is very poor. The focus of this research is on the second case. Assuming that the soil and seed are properly selected, the problem is with the coffee grower's behavior as a rural entrepreneur related to a specific source. Up to this point in the study, the analysis was considered in terms of economic activity involving coffee only. From now on, there is a specificity of that level within this activity. Since it is impossible to cover all three factors, the focus is on the care and maintenance of the coffee plantation right after the fifth year of coffee

cultivation, which embraces the period of maximum coffee production in the region studied.

The point that needs to be stressed is that after the fifth year, coffee production depends on annual manuring, combating disease, pest control, and annual ground cleaning, including cleaning up under the trees before harvesting coffee and spreading under the trees after harvesting coffee. In other words, the analysis will cover a phase during which the coffee is in production. Thus, the innovations to be considered for the purpose of this analysis are those techniques applied by the coffee growers with the objective of caring for and maintaining their cultivation area.

More specifically, two different aspects are being considered: (1) the use of nutrients as fertilizer and the use of insecticides and fungicides and (2) cultural practices. Under the first category, the following elements will be distinguished: the combination of nitrogen, phosphorus, and potassium; calcium; sulphate of ammonia; calcium nitrate; urea; single superphosphate; triple superphosphate; chloride of potassium; sulphate of zinc; boron acid; oxichloride of copper; insecticides; adhesive spreader; and organic manure. Under cultural practices the following aspects will be stressed: mechanical cleaning/weeding, chemical cleaning/weeding, cleaning under the trees, sweeping, spreading after harvesting, calcium distribution, foliar manuring, pulverization, and soil conservation.

The term "innovation" in this study, therefore, refers to a set of techniques applied to a phase of coffee cultivation. Those techniques may or may not be applied by all the farmers, and they may

vary in the quantity applied as well. Since the definition of the term "innovation" is somewhat different from that in more traditional studies, probably the term "techniques" would be more adequate for the purpose. That is, the term "innovation" usually reflects the notion of newness for an individual. Since the term reflects the application of or failure to apply a productive strategy (new or not), the word "technique" seems to be more appropriate since it does not underline the notion of newness. So, the focus will be on techniques that characterize a part of the production system applied by coffee planters.

To illustrate, Table 3 shows the importance of some nutrients for a coffee tree when it attains the age of ten years.

Table 3: Quantity in grams of nitrogen, phosphorus, potassium, calcium, magnesium, and sulphur, required by a coffee tree at ten years of age.

Parts of Coffee Tree	N	P	K	Ca	Mg	S
Trunk	61.2	2.0	33.0	39.1	6.8	4.4
Branch	59.5	5.2	46.1	38.2	4.8	5.6
Leaf	98.6	8.3	100.8	58.4	17.8	13.6
Coffee berry	21.0	2.1	26.7	2.7	1.7	1.4
Total	240.3	17.6	206.6	138.4	31.1	25.0

Source: Instituto Brasileiro do Café, 1974a: 96.

It is important to stress again that from a technical point of view, the amount of nutrients to be applied depends on the natural conditions of the soil. For example, De Geus (1973) said that the use of nitrogen and potassium should be stressed for coffee in production. This same author noted that "it seems reasonable to assume that a hectare of fast growing high yielding coffee will take up at least 135 kg N, 34 kg P_2O_5, and 145 kg K_2O" (p. 445).

Nonetheless, coffee growers do not always follow such technical requirements. Their actual behavior is framed by past experience, by socialization, and by their own interpretation and adaptation of external sources of information. This aspect is also observed in relation to the care that a coffee plantation requires. Haarer (1970) stressed that the coffee planter must watch the coffee grow. A grower needs to walk up and down between his rows of coffee at regular intervals to identify the presence of diseases and pests. In both cases, special care is needed, and this is achieved in combating pests by the application of sufficient quantities of insecticides and at the correct period of time. For example, routine spraying for leaf disease may not be necessary or economically viable under certain climate conditions.

It is necessary to stress that this research does not allow any evaluation of how the things are being done, for instance, whether or not the application of fertilizer, insecticides, and mulching procedures are being correctly carried out. Rather, the evaluation will be in terms of the consequences of such activities as they were performed, considering the coffee grower's objective in his economic

activity. It is supposed that the coffee grower as a rural entrepreneur tries to use means of production in the care and maintenance phase adequate to his goals and adapted to the situational determinants. For now, it is only necessary to call attention to this issue, leaving it to be discussed in the following chapters.

CHAPTER V

THE BASIC MODEL OF THE ADOPTION BEHAVIOR

In this chapter, the model hypothesized earlier is discussed. Most of the analysis centers on the evaluation of the direction of the effects, the size of the path coefficients, and their deletion or retention based on statistical criteria. For purposes of clarity, the hypothesized model is analyzed in steps.

The theoretical model used as the frame of reference in this study places special emphasis on the characteristics of the farmers as entrepreneurs as an important factor in explaining the course of adoption. Before going into a more thorough analysis of the adoption behavior, it seems reasonable to start with a description of the categories of the selected sample, identifying certain features of the farmers that may be useful in understanding the subsequent analysis.

Table 4 displays frequency distributions of scores on the test of technical knowledge for the study sample of farmers. The range of the frequency distribution is 8 to 23. Fifteen farmers (about 14 percent) obtained the maximum score of 23, and the same percentage also achieved scores of 18 and 20 on the test. One interesting aspect is that those who got 20 points on the test made a mistake either answering the question on manuring with boron and zinc or answering the question on control of coffee borer. However,

those who made 18 points on the test made a mistake on one of these two questions in addition to the question on the criteria for planting coffee trees. The average score is 17, the standard deviation is 4, and the mode is 15. Forty-nine percent of the farmers are above the average, 44 percent are below, and 7 percent are on the average. Thus, in addition to the low average, the percentage of the farmers who have high scores indicates a low level of technical knowledge. This means that most of the farmers studied are using means of production in coffee cultivation without adequate technical knowledge for this activity.

Table 4: Frequency distribution of technical knowledge.

Test Score	Frequency	Test Score	Frequency
8	4	16	2
9	2	17	8
10	4	18	15
11	2	19	0
12	8	20	15
13	4	21	7
14	3	22	0
15	18	23	15

In regard to the attitude toward growing coffee, a different perspective on the sample of farmers emerged. Table 5 shows the results.

Table 5: Frequency distribution for attitude toward growing coffee.

Test Score	Frequency	Test Score	Frequency
16	1	33	5
26	2	34	2
27	1	35	3
28	6	36	16
29	1	37	7
30	2	38	6
31	3	39	9
32	9	40	34

The range of the frequency distribution for this variable is from 16 to 40. The maximum score achieved on this test is 40, and 34 of the farmers (around 32 percent) attained that score. The average is 36, the standard deviation is 5, and the mode is 40. Fifty-two percent of the farmers are above average, 33 percent are below average, and 15 percent are on the average. In regard to attitude toward coffee growing, considering that the average is not far from the maximum score, in addition to the fact that the mode is the maximum value, these results reveal that the farmers present a highly favorable attitude toward growing coffee.

Table 6 presents the frequency distribution for the variable "economic orientation toward farming" on the part of the sample of farmers.

The range of the economic orientation variable is from 40 to 67. Not one farmer achieved the total possible score of 70 for the test. The average is 55, the standard deviation is 6, and the mode

is 58. About 50 percent of the farmers are above the average, 42 percent are below, and 8 percent are on the average.

Table 6: Frequency distribution for farmers' economic orientation toward farming.

Test Score	Freq.	Test Score	Freq.	Test Score	Freq.	Test Score	Freq.
40	1	47	2	54	3	61	6
41	0	48	3	55	9	62	7
42	1	49	2	56	7	63	2
43	2	50	8	57	8	64	1
44	3	51	6	58	11	65	2
45	2	52	6	59	3	66	1
46	2	53	4	60	4	67	1

The average value for the economic orientation variable may be considered as low. Only half of the sample is above the average, and the mode is only a little above the average as well. It is possible to infer that the farmers in the sample are not sufficiently economically oriented in the performance of their economic activities. They do not often buy fertilizers, for instance, with full consideration of price or possible profit, but rather accept the salesmen's opinions.

In comparing Tables 4, 5, and 6, it appears that the farmers seem to have a low level of technical knowledge, a low level of economic orientation toward the activity itself, and a high level of favorable attitudes toward performing the role of coffee grower. Theoretically speaking, these three variables were expected to

exhibit a better correlation. But the results do not support the expectation as shown in Table 7.

Table 7: Correlation coefficients[a] between variables expressing the farmers' entrepreneurial characteristics.

	Technical Knowledge	Attitude	Economic Orientation
Technical Knowledge	1.00	.14*	-.16**
Attitude		1.00	.23***
Economic Orientation			1.00

*Significant at .20, two-tailed t-test.

**Significant at .10, two-tailed t-test.

***Significant at .02, two-tailed t-test.

[a]These coefficients were corrected for attenuation. Following Hunter's (n.d.) argument, two-sided correction for attenuation was applied.

$$r_{tu} = \frac{r_{yx}}{\sqrt{r_{xx}}\ \sqrt{r_{yy}}}$$

where

r_{tu} = corrected correlation coefficient

r_{yx} = observed correlation coefficient

$\sqrt{r_{xx}}$ = square root of the reliability of X

$\sqrt{r_{yy}}$ = square root of the reliability of Y

According to this table, the correlation coefficients are not only low and in one case negative, but they are also statistically significant at different levels. The largest correlation of .23 represents the relationship between attitude toward planting coffee

and economic orientation toward farming. An interesting finding is the negative relationship between technical knowledge and farmers' economic orientation. This indicates that a low score on economic orientation tends to go with high scores on technical knowledge, and that a low score on technical knowledge is more common for farmers who have a high score in their economic orientation. The correlation between technical knowledge and attitude toward growing coffee is positive but very low, .14.

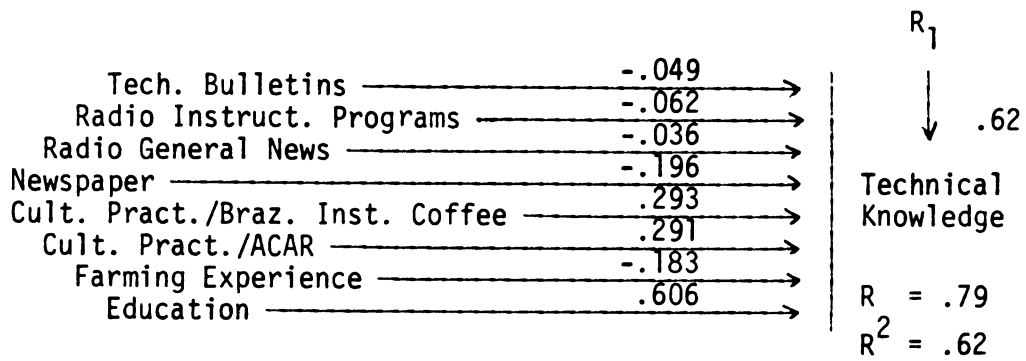
In general, the coefficients shown in Table 7 do not indicate a strong linear relationship between the variables in the study. On one hand, this suggests that the farmers' entrepreneurial characteristics considered in this study do not make an integrated and coherent system of entrepreneurial values. This suggests that the farmers in the study have particular attributes as economic agents that reflect the complex situation in which they are involved. For instance, they must buy means of production at known prices in order to produce goods to be sold at an uncertain price, and in addition, they are subject to totally uncontrollable climatic factors. On the other hand, if the correlations between the variables shown in Table 6 were very substantial, it would be difficult to interpret the results. In that case, they might be expressing the same aspects of the farmers' entrepreneurial characteristics and would not be interesting for further analysis.

The essential point of this analysis, however, is not the isolated meaning of this category. Rather, the focus is on the relationships that exist between the empirical component elements that

make up adoption behavior. So far, the discussion has focused on only one vital component that has importance for the theoretical framework in explaining the course of adoption. Therefore, from now on the analysis will be centered on the test of the hypothesized relationships between the components of the farmers' adoption behavior as the first step for the evaluation of the theoretical framework explaining that behavior.

The act of drawing path diagrams for complex hypothesized models usually leads to the depiction of figures that look more like a piece of art than anything else. For instance, drawing a path diagram for the whole set of hypothesized relationships as shown in Figure 3 may make this analysis unclear and confusing. Hence, considering the kind of hypothesized model to be analyzed, several path diagrams will be drawn representing the hypothesized relationships between the variables in the study at different stages. After testing the hypotheses and deleting some paths, the whole model will be presented in path-diagram form at the end of this chapter.

The first general hypothesis predicts that the structure of the situation has a positive influence on the background formation of the farmers as rural entrepreneurs. The discussion of this hypothesis is carried out through three specific hypotheses. Each one will be diagrammed and analyzed separately. The first specific hypothesis is represented by Figure 6.



Note: These coefficients were corrected for attenuation. Hunter (n.d.) pointed out that one-sided correction for attenuation may be applied in the following way:

$$r_{tx} = \frac{r_{yx}}{\sqrt{r_{yy}}} \qquad \text{where}$$

r_{tx} = corrected correlation coefficient

r_{yx} = observed correlation coefficient

$\sqrt{r_{yy}}$ = square root of the reliability of Y (dependent variable)

Figure 6: First partial hypothesized model with estimated path coefficients.

In this set of independent variables[1] that affect the acquisition of technical knowledge, two groups have different kinds of influences. One group contributes negatively to the dependent variable, whereas the other group contributes positively. The first specific hypothesis predicts only positive influence of the variables on the acquisition of technology. Moreover, five out of eight hypothesized relationships are in the opposite direction. The variables that have a negative effect on the dependent variable in question are reading technical bulletins (-.049), listening to rural

[1]The variables in this and subsequent figures were defined in Chapter III.

instructive programs on the radio (-.062), listening to general news programs on the radio (-.036), reading newspapers (-.196), and farming experience (-.183).

Among these variables, only reading newspapers and farming experience are statistically significant--both at the .01 level, one-tailed t-test. Despite the statistical insignificance of the other variables, the direction of the effect is very important in evaluating the role of those means of communication molding farmers' skills. Specifically, these are reading of technical bulletins and listening to rural instructive programs on the radio, sources providing information on issues related to the farming activity.

In relation to farming experience, the research result reveals that farmers with more experience in terms of coffee cultivation are not acquiring more technical technology. Probably technologies have been applied as production means, but the way of farming has not been changed from what the farmers learned from their own experience, from parents, or from other sources. Considering the farmers' low technological level (shown in Table 5), and that expenditure in acquiring technologies has been observed through the years, it may be inferred that growing coffee has not been consistent with the technical orientation usually promoted by the rural extension agencies, considering that extension agencies, as will be seen below, have a positive direct effect on the dependent variable in question.

The positive direct effect on the level of farmers' technical knowledge is a result of participation in meetings with technicians from the Brazilian Institute of Coffee and from ACAR about cultural

practices and education. The influence of both technical-assistance agencies has constituted an important source for increasing the level of the farmers' technical knowledge. The technicians from the Brazilian Institute of Coffee contribute .293, whereas those from ACAR contribute .291. There is a very small difference between these agencies, but both seem to be achieving their objectives based on the kinds of meetings that they have held. Both variables are significant at the .01 level.

Formal education constitutes another important factor of influence on the dependent variable. Its direct effect is .606, the largest positive contribution. The main reason for this large contribution of the variable "formal education" is that there is a well-known agricultural school at the secondary level in the region studied. Considering that few farmers go to the college of agriculture and that the contribution from the mass media, as discussed above, is very small, it is assumed that this agricultural school may be an important factor in determining the acquisition of technical knowledge. However, because formal education is measured by years of school and not by the kind of school, it is not possible to explain the reason for this fact more definitely. This variable is significant at the .01 level.

From the eight hypothesized relationships between independent and dependent variables, five are supported by the data, with two contributions occurring in the negative direction. The coefficient of determination is R = .79. Sixty-two percent (R^2 = .62) of the total variance in technical knowledge is explained when the eight

variables are in the equation, implying that a residual path coefficient equals .62. This reflects the square root of the unexplained variation for the dependent variable in question. Considering the statistical significance of the independent variables as one criterion for deleting paths (Duncan, 1971), a regression was run again. Figure 7 shows the diagram after the deletion of some hypothesized paths. This last set of variables presents R = .79 and R^2 = .62. Moreover, there is no loss of information with the reduced number of explained variables.

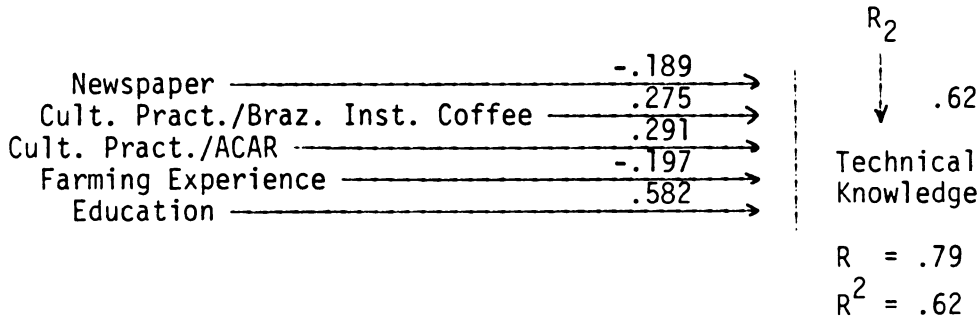
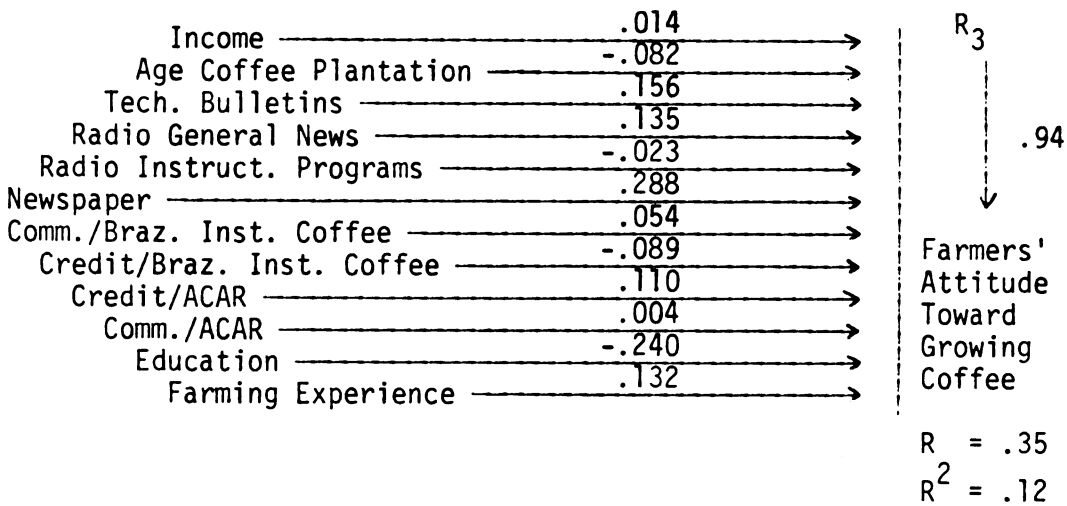


Figure 7: First diagram for the adoption-behavior model with estimated path coefficients.

The second specific hypothesis is concerned with the influences on the farmers' attitude toward growing coffee. The hypothetical system is represented in path-diagram form as shown in Figure 8.

Figure 8 shows that four of the relationships between independent and dependent variables are negative, which means that certain factors act as constraints on the determination of the farmers' attitude toward growing coffee. Among this set of independent

variables, the first expresses an attribute of coffee cultivation, one reflects mass media of communication, another is related to contact with extension agents, and the last reveals individual attributes.



Note: These coefficients were corrected for attenuation. See note to Figure 6 above.

Figure 8: Second partial hypothesized model with estimated path coefficients.

The variables mentioned were hypothesized to affect positively farmers' attitude toward growing coffee. Again, the data revealed that the relationship occurs in an opposite direction. The age of the coffee plantation is one of the variables in this category. Although this variable has a small effect (-.082) and is not statistically significant, the data show that over a period of years, the farmers' attitude toward growing coffee is reduced as the coffee plantation grows older.

In regard to listening to rural instructive radio programs, this variable has a small and negative contribution to the farmers' attitude toward growing coffee (-.023). This influence, like the previous variable, is not statistically significant. In spite of this fact, due to the negative sign, it may be said that this means of communication does not constitute a mechanism of stimulus for the farmers to develop their activities. Probably, unenthusiastic messages are being transmitted through the programs.

Another non-statistically significant and small negative influence (-.089) on farmers' attitude toward growing coffee comes from participation in meetings about credit with technical-assistance agents from the Brazilian Institute of Coffee. This negative effect on the dependent variable may indicate that this agency of rural extension is not doing well in regard to one crucial issue related to the farmers' activity, that is, credit to encourage coffee cultivation.

The last negative influence on farmers' attitude toward growing coffee comes from formal education (-.240). This outcome is the only one that is statistically significant (.05 level) among all the negative influences. In addition, this result is the only one in which formal education has a negative influence on one of the farmers' characteristics as rural entrepreneurs.

The rest of the variables in Figure 8 are in accord with the hypothesized direction of the effects. However, most of the variables make a small and insignificant contribution to the determination of the farmers' attitude toward growing coffee. Income from the

coffee plantation has a small positive effect (.014) on that dependent variable; it is not statistically significant. Hence, the money received from the coffee-growing activity does not constitute a mechanism of stimulus for farmers to grow coffee.

With regard to the reading of technical bulletins, there is a positive effect on the dependent variable (.156). This result shows that this source of information stimulates farmers to develop their activity. The relationship is statistically significant at the .10 level. In addition, another means of communication that has a positive influence on farmers' motivation is listening to general news programs on the radio (.135), which is statistically significant at the .05 level. Another means of communication that influences the farmers' attitude toward growing coffee is reading the newspaper (.288). This result is statistically significant at the .01 level.

It is interesting to note that these sources of information may have different features. The first source is closer to agricultural affairs in terms of the subject matter it contains. The other sources treat issues that are not directly concerned with rural problems. However, in spite of the message content they transmit, both are important mechanisms in stimulating farmers as economic agents, specifically when the programs are seen as influences that come from outside the rural subsystem. That is, they are produced by people who do not have direct contact with or live within the social and economic environments of the farmers.

Participation in meetings promoted by the Brazilian Institute of Coffee concerning commercialization has a positive but small effect

on farmers' attitude (.054). The same trend is also observed in relation to participation in meetings on commercialization organized by ACAR (.004). Neither of the variables is statistically significant. In regard to participation in meetings about credit promoted by ACAR, the direct effect is positive and larger than the effects of participation in other meetings. Its contribution is .110, but it is not statistically significant. Comparing this result with participation in meetings concerning credit with technicians from the Brazilian Institute of Coffee, two differences can be observed: (a) the direction of the influence is different (positive in one and negative in another), and (b) the size of the path coefficient is different. However, neither variable is statistically significant.

One variable that is restricted to farm affairs is farming experience. It constitutes a positive source of influence on farmers' attitude (.132), but it is not statistically significant. This result indicates that over a period of years, the farmers still see themselves as stimulated by conditional elements to grow coffee.

From the whole set of hypothesized relationships between independent and dependent variables under the second specific hypothesis, four are supported by the data. Among them, one is in the negative direction. The coefficient of determination is R = .35, and 12 percent (R^2 = .12) of the total variance in the farmers' attitude toward coffee production is accounted for by the explanatory variables in the equation. In reality, the explained variance is very small, which shows that most of the explanation is accounted for by variables not included in the equation. The residual path coefficient

for this case is .94. It is necessary to point out that according to the regression output, the variable "productivity" was not included in the equation because of its low level of tolerance.

Dropping out the variables that are not statistically significant, the four variables left in the equation present R = .29 and R^2 = .08. With this reduced number of explanatory variables, a small amount of information with the restricted model was lost. Figure 9 shows the diagram after the deletion of those hypothesized paths that are not statistically significant.

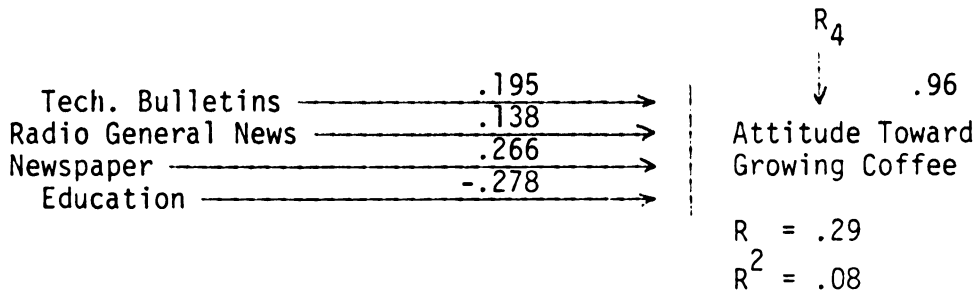
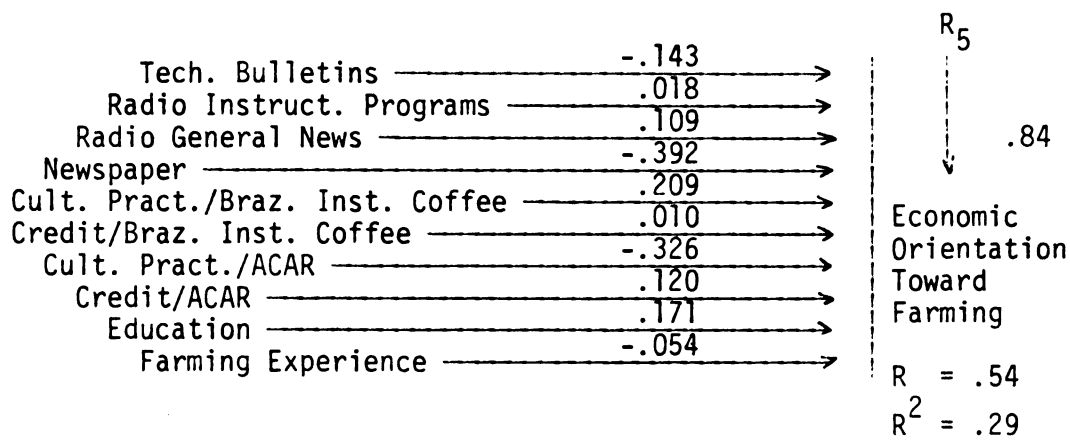


Figure 9: Second diagram for the adoption-behavior model with estimated path coefficients.

The next subject to be treated is the testing of the hypothesized relationships concerning the third specific hypothesis under the first general hypothesis. The relationships found for the sample of farmers in the study are indicated in Figure 10.

According to Figure 10, two sets of variables interfere with farmers' economic orientation toward farming--one negatively and the other positively. This result leads to the reformulation of some

hypotheses that exhibited positive influence of the independent variables on the dependent variable. From the variables that have a negative influence on farmers' economic orientation, two reflect mass media of communications.



Note: These coefficients were corrected for attenuation as noted above.

Figure 10: Third partial hypothesized model with estimated path coefficients.

Reading technical bulletins affects the dependent variable (-.143), and reading newspapers affects the dependent variable as well (-.392). The latter is the largest negative contribution and is statistically significant at the .01 level. The former is statistically significant at the .10 level. Reading of technical bulletins probably influences the farmers because of the advertisements that usually stress the adoption or use of certain products without consideration of their viability and economic implications for the farmers.

One additional finding refers to the strong negative effect (-.326) on the farmers' economic orientation by participation in meetings with the technical-assistance agents from ACAR about cultural practices. This result is statistically significant at the .01 level. From this result, it is possible to say that these technicians are probably more concerned with offering explanations about the skill necessary to use technologies than with approaching the problem of how to spend money more adequately in order to buy these technologies.

The last variable that has a negative influence on farmers' economic orientation is farming experience (-.053). The influence is small and statistically insignificant. This suggests that although farming experience is increasing, the farm is being run under less effective economic principles. Perhaps the farmers begin to regard farming as less than a business venture.

In regard to the variables that exert a positive influence on farmers' economic orientation toward farming, general news programs on the radio and rural instructive radio programs, with values of .109 and .018, respectively, are not statistically significant. The small influence of the rural instructive radio programs comes as a surprise, especially when compared with the content of general news programs on the radio. In addition, one interesting observation should be noted when listening to general news programs on the radio and reading newspapers are compared. The first has a positive effect on the dependent variable, but the second has a strong negative effect. An analysis of the correlation between these two sources shows that the coefficient is -.11, which indicates that those who

listen to general news programs on the radio tend not to read newspapers. Hence, the sources of general news (radio and newspapers) constitute an important influence on farmers' economic orientation, but the fact that a farmer reads a newspaper does not imply that he is equally subject to the other source of information; both relate to the dependent variable in question in opposite directions.

The analysis of the path coefficients related to participation in meetings with technical-assistance agents also yields interesting results. The meetings on cultural practices organized by the Brazilian Institute of Coffee directly affect farmers' economic orientation (.209); this value is statistically significant at .05. However, meetings on credit with these agents yield a low value of .010, which is not statistically significant. Participation in meetings about credit with the extension agents from ACAR is also small (.120) and statistically nonsignificant. From these variables, only participation in meetings about cultural practices with the agents from the Brazilian Institute of Coffee suggests that the agents care about how the farmers spend their money. This does not seem to be true for meetings with the agents from ACAR.

The last variable that positively affects farmers' economic orientation is formal education. It has little (.171) influence and is statistically significant at the .10 level. Considering the presence of the variables in the model, they account for .29 percent of the variation in the dependent variable; the coefficient of determination is .54. Here, the size of the residual path coefficient is also large, with a value of .84.

If only those variables that were statistically significant are maintained in the model, the explained variance is .27 and the coefficient of determination is .52. Moreover, considering that the number of variables was reduced from 10 to 5, there is no loss of information. Figure 11 displays the path model for this case.

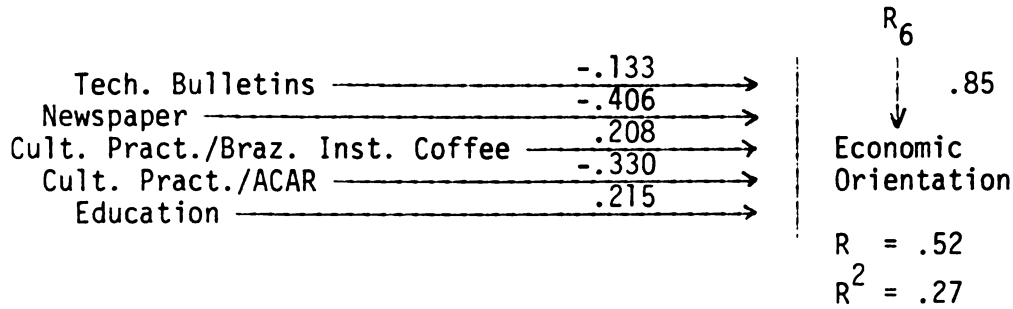


Figure 11: Third diagram for the adoption-behavior model with estimated path coefficients.

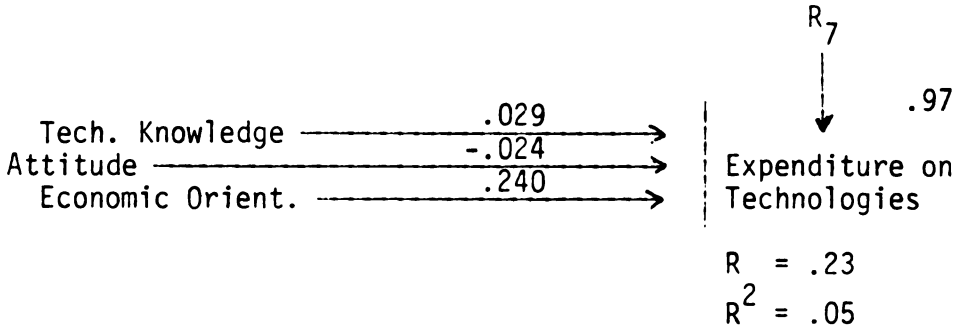
The general hypothesis concerning the relationship between the structure of the situation and the variables expressing farmers' entrepreneurial characteristics may be reformulated for the study sample based on Figures 7, 9, and 11. Some of the hypothesized relationships are statistically rejected; the direction of the effects varies in terms of positive and negative; and the elements of the situation are not equally important in determining the three different dependent variables in question. For instance, participation in meetings with technicians from the extension agencies may be important for acquiring technical knowledge, but such participation may not affect either the farmers' attitude toward growing coffee or the farmers' economic orientation toward farming.

From the three variables expressing farmers' entrepreneurial characteristics, technical knowledge is most largely determined by the set of independent variables reflecting situational conditions (R^2 = .62). The least determined is attitude toward growing coffee (R^2 = .08). Based on Tables 4, 5, and 6, describing farmers' entrepreneurial features, despite farmers' low level of technical knowledge, the variance in this variable is the one most largely accounted for by the independent variables in question. In relation to attitude toward growing coffee, the sample of farmers demonstrates high scores, but the independent variables explain only a slight variance. In relation to economic orientation toward farming, the farmers are not sufficiently economically oriented and the independent variables in the study do not account for most of the variance in this dependent variable. Hence, two aspects may be noted: (a) the variables reflecting farmers' entrepreneurial characteristics do not present an integrated system of relationships among themselves, and (b) the variables designated as mechanisms of the structure of the situation were not able to account for most of their variations, with the exception of technical knowledge.

The next subject to be discussed is the specific hypothesis predicted under the second general hypothesis. Figure 12 shows the path model for this case.

According to Figure 12, the independent variables in the equation account for 5 percent of the variance in expenditure on technologies. This finding is very disappointing since the residual path coefficient is the largest of any analyzed so far, .97.

Theoretically, the variables expressing farmers' entrepreneurial characteristics were supposed to be better in explaining the variation of this dependent variable. From these three variables, only farmers' economic orientation toward farming makes a statistically significant contribution (.240) at the .01 level.



Note: These coefficients were corrected for attenuation. According to Hunter (n.d.), one-sided correction for attenuation may be applied in the following way:

$$r_{yx} = \frac{r_{yx}}{\sqrt{r_{xx}}}$$ where

r_{yx} = corrected correlation coefficient

r_{yx} = observed correlation coefficient

$\sqrt{r_{xx}}$ = square root of the reliability of X (independent variable)

Figure 12: Fourth partial hypothesized model with estimated path coefficients.

In relation to the farmers' attitude toward growing coffee, this variable negatively affects technological adoption (-.024). Despite its statistical insignificance and small effect, this finding

suggests that the farmers are not buying technologies as they are highly favorable to exploiting the coffee plantation as an economic activity. Such a result is in a contrary direction to the one that was hypothesized.

Another research finding concerns the small effect of technical knowledge on technological adoption (.029). Here the direction of causation is positive, but it is not statistically significant. Knowledge of the technical aspects related to the means of production does not constitute a factor relevant in determining farmers' expenditure for technologies.

Figure 13 indicates the path model for this set of hypotheses in view of the results obtained. According to this model, the values for the coefficient of determination and the explained variance are the same as they were for the last model. This indicates that there is no loss of information when the model is reduced from three to one explanatory variable. Here, most of the variance (.95) in technological adoption is still to be accounted for.

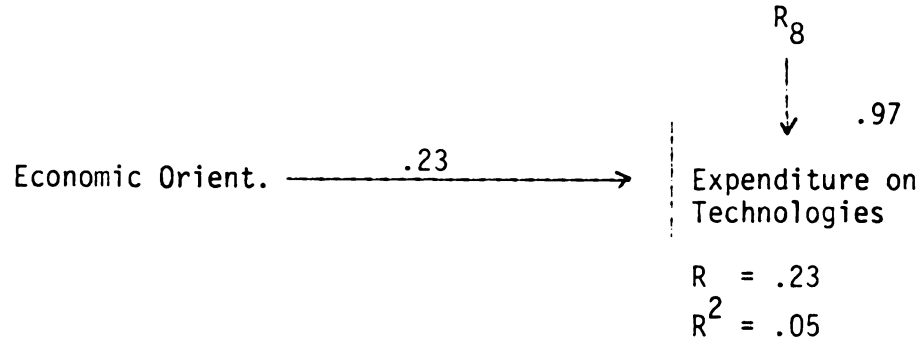


Figure 13: Fourth diagram for the adoption-behavior model with estimated path coefficients.

The second general hypothesis states that there is a relationship between variables expressing entrepreneurial features and acquisition of means applied to the farm production system. As shown in Figure 13, only economic orientation follows the argument stated under the second general hypothesis. It is possible to say that the means are adapted only to one of the three aspects considered in this study. One important point is that the technologies being studied are applied to a phase when the coffee trees are in production, and that in this phase the farmers' ability to take care of the plantation was considered to be a crucial factor in determining the expenditure on technologies. What was unexpected is the insignificance of the technical knowledge variable in relation to the acquisition of technologies. In addition, although farmers have a favorable attitude toward growing coffee, this factor is also not significant in determining the dependent variable in question.

Until now, what has been observed is that the farmers in the study do not present a well-integrated value system as rural entrepreneurs. This value system is not sufficiently molded by the conditional elements of the situation, and, in addition, the farmers' value systems are not enough to account for the variation in the expenditure for technologies. For the moment, it is important to call attention to these findings, leaving a more detailed theoretical explanation to the next chapter. Such findings permit further elaboration of the theoretical model, which accounts for more variability in the expenditure for technology.

The following discussion concerns the evaluation of the findings related to the specific hypotheses that fall under the third general hypothesis. These hypotheses appraised the effects of the expenditure for technological adoption on the achievement of given economic outcomes. Thus, in one sense, the focus of the hypothesis is on the evaluation of the consequences of technological adoption. Figure 14 depicts the findings for the sample of farmers studied.

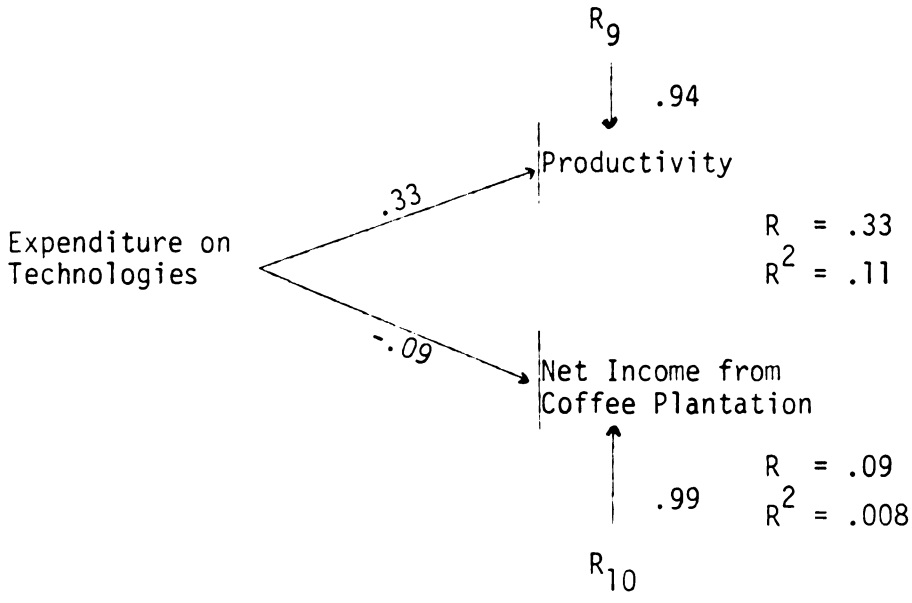


Figure 14: Fifth partial hypothesized model with estimated path coefficients.

The variable "expenditure for technological adoption" explains 11 percent of the variance in productivity. The path coefficient is equal to .33, and it is statistically significant at the .01 level. Despite this, the residual path coefficient is still

large, namely, .94. However, expenditure for technological adoption makes very little contribution (only .09) to the variability in the dependent variable "net income from the coffee plantation." It is interesting to add that the direction of causation for this case is negative, contrary to what was hypothesized. Therefore, it is possible to assume that expenditure for technological adoption is leading only to the fulfillment of one of the study's economic outcomes, which is directed toward the increment of productivity level. Figure 15 presents the path model for this case.

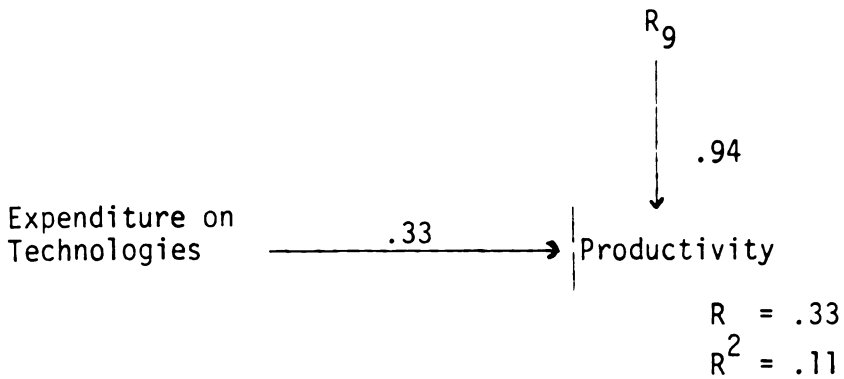


Figure 15: Fifth diagram for the adoption-behavior model with estimated path coefficients.

The partial hypothesized models have been presented and discussed in order to build several diagrams for the adoption-behavior model. The last part of this chapter presents the basic adoption-behavior model. Such a model is based on the aggregation of the diagrammed parts already discussed, which represent the set of

hypotheses that are supported by the data. Figure 16 displays this path model.

In general, some of the hypothesized relationships for the theoretical adoption-behavior model were confirmed. However, this does not mean that the model is adequate. On the contrary, the failure of the expected linkage between farmers' entrepreneurial variables with the adoption act is disappointing. Moreover, since the characteristics of the farmers as rural entrepreneurs are the key in the model, more attention will be given to these characteristics later on.

It is important to stress that the focus of the analysis developed so far centered on the evaluation of the specific hypotheses for the sample data in the study. The objective in this chapter is restricted to the presentation of what this model looks like, leaving its theoretical interpretation to be discussed in the next chapter.

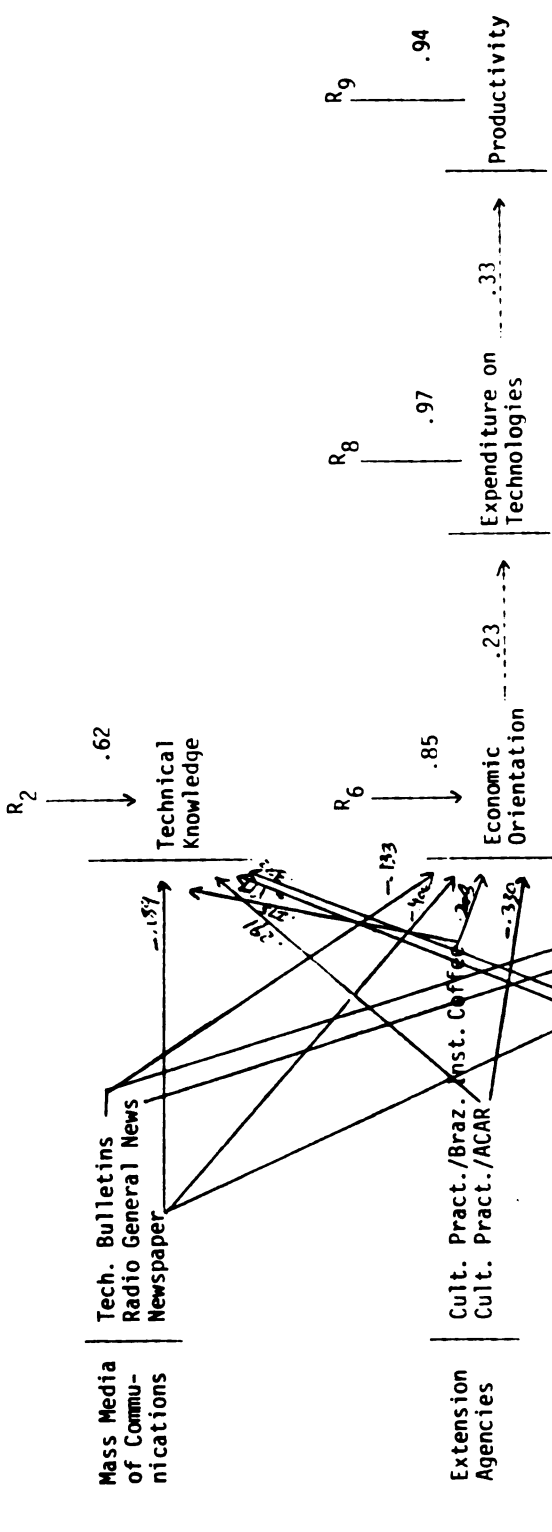


Figure 16: Basic adoption-behavior model with estimated path coefficients and residual paths.

CHAPTER VI

REVISION OF THE BASIC ADOPTION-BEHAVIOR MODEL

The focus of the analysis in this section is on the basic adoption-behavior model presented in Figure 16, Chapter V. The analysis is centered on the causal structure of the path model and its meaning from a theoretical point of view. The basic adoption-behavior model illustrated in Figure 16, in contrast to Figure 3, Chapter III, presents a reduced version of the hypothesized model. The mechanisms of the structure of the situation are reduced to reading of technical bulletins, listening to general news programs on the radio, reading newspapers, participation in meetings about cultural practices with extension agents from the Brazilian Institute of Coffee and from ACAR, farming experience, and formal education.

In other words, mass media of communication, contact with technical-assistance agencies, and individual attributes proved to be the most significant factors affecting (positively or negatively) the farmers as rural entrepreneurs. However, only one of these characteristics makes a meaningful contribution to the adoption act, which also leads to one of the proposed economic outcomes, namely productivity.

In general, the initial attempt to represent farmers' adoption behavior as a process is permissible, but one reservation

must be made. The explained variance for some of the key intervening variables in the model is much less than that expected. Without going into a more detailed analysis of this point, one must initially consider the importance of the variables in the causal scheme supported by the data, decomposing the effects of the independent variables on the dependent variables used in the study.

The decomposition of effects refers to the partition of the influence of one variable on another in some components. The approach developed by Alwin and Hauser (1975) makes a distinction between associations and effects, stressing the decomposition of effects into direct and indirect elements. For those authors, total association between two variables is given by the zero-order correlation, which is different from the total effect. This one is a part of the total association. More specifically, the total effect indicates the direct and indirect influence of one variable on another one. The direct effect is part of the total effect that is not mediated by intervening variables, and the indirect effect is transmitted by means of intervening variables. Moreover, depending upon the researcher, one variable may have just a direct effect on the other, or just an indirect effect, or even both effects. Another important aspect in Alwin and Hauser's approach is their distinction between causal and noncausal components of association, equating the total effect to the main causal components of a model. An interesting point is that such a perspective allows one to avoid calculating a large number of noncausal associations that are insignificant and meaningless for the goals of one's study.

From this point on, the analysis will be centered on the antecedents of the model determining farmers' economic orientation toward farming and its influence on the expenditure made in acquiring technologies. In addition, because this last variable is the least explained in the adoption-behavior process formulated here, some attempts will be made to increase its explanation, leading to a reformulation of the hypothesized model. Considering the simplicity of the path model depicted in Figure 16, the indirect effects of the independent variables on the expenditure for technologies, which is mediated by economic orientation toward farming, may be computed only by inspection of the path diagram. Table 8 indicates these results.

Table 8: Identification of the indirect effects on the expenditure for technologies.

Dependent Variable	Independent Variable	Indirect Effect via Economic Orientation
Expenditure for technologies	Tech. bulletins	-.031
	Newspaper	-.093
	Cult. Pract./ Braz. Inst. Coffee	.048
	Cult. Pract./ACAR	-.076
	Education	.049

The results presented in Table 8 reveal that reading technical bulletins, reading newspapers, participation in meetings about cultural practices promoted by the Brazilian Institute of Coffee and by ACAR, and formal education have very small indirect

influences on the expenditure for technologies. One result that was not expected is the negative contribution of certain mechanisms in the structure of the farmers' situation. Specifically, reading technical bulletins, reading newspapers, and participation in meetings with technicians from ACAR do not positively influence the farmers' economic orientation toward farming; these results imply a negative effect on the ultimate dependent variable.

To gain a better understanding of the role of these independent variables in relation to the expenditure for technologies, one alternative is to link these variables directly to the last one. As a consequence, there is the first change in the hypothesized model. Figure 17 illustrates such a reformulation.

The revised model shows the direct effect of the same variables expressing the structure of the situation on the expenditure for technologies. With such modification it may be observed that the explained variance in the dependent variable is now .14, and the coefficient of determination amounts of .37. From the observed set of independent variables, the more substantial direct effects come from reading newspapers (.307) and economic orientation toward farming (.379).

One interesting feature of these findings is that the variables having a negative influence on farmers' preparation to cultivate coffee (reading technical bulletins, reading newspapers, and contact with agents from ACAR) have a direct positive effect on the expenditure for technologies. In the same way, the variables positively contributing to the farmers' economic orientation toward farming have

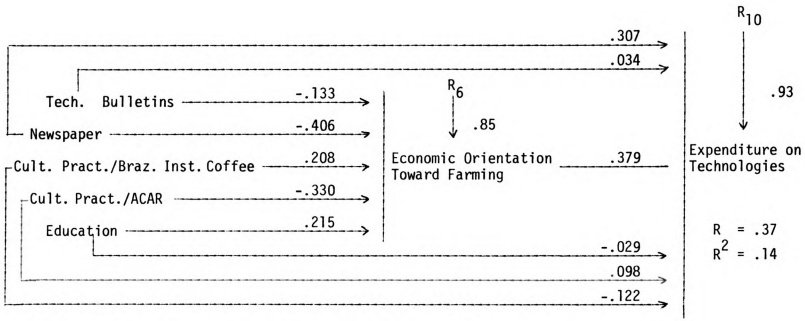


Figure 17: First revised model with estimated path coefficients and residual paths.

a negative direct impact on the expenditure for technologies. There is an inversion of signs when the effects change from indirect to direct. From the set of variables considered at this stage, reading technical bulletins, reading newspapers, and participation in meetings about cultural practices with technicians from the Brazilian Institute of Coffee and from ACAR make a greater direct than indirect contribution. At the same time, formal education has a more indirect than direct contribution. These results may be observed in Table 9.

In spite of the small contribution of most of the variables to the dependent variable, the interpretation of the sign of their effects is still very important. Among these variables, only formal education and participation in meetings with technicians from the Brazilian Institute of Coffee proved to be the most important for the farmers' preparation in terms of economic orientation toward farming. Most of the other variables seem not to be concerned with this issue. One important aspect is that the first revised model presents a small change in the theoretical model initially proposed in this study. However, the first reformulation is not sufficient because much of the unexplained variance still remains in the key variable in the model, designated as expenditure for technologies. Therefore, a second attempt to further elaborate the model is made. Figure 18 shows the second revised model for the case in question. It presents a different version of the proposed adoption-behavior model. Initially we will see what it reveals in terms of relationships, and later we will discuss it from a theoretical point of view and suggest what this different version represents.

Table 9: Decomposition of the total effect on the expenditure for technologies.

Dependent Variable	Independent Variable	Indirect Effect via Economic Orientation	Direct Effect	Total Effect
Expenditure for technologies	Tech. bulletins	-.031	.034	.003
	Newspaper	-.093	.307	.214
	Cult. Pract./ Braz. Inst. Coffee	.048	-.122	-.074
	Cult. Pract./ACAR	-.076	.098	.022
	Education	.049	-.029	.020
	Economic orientation	none	.379	.379

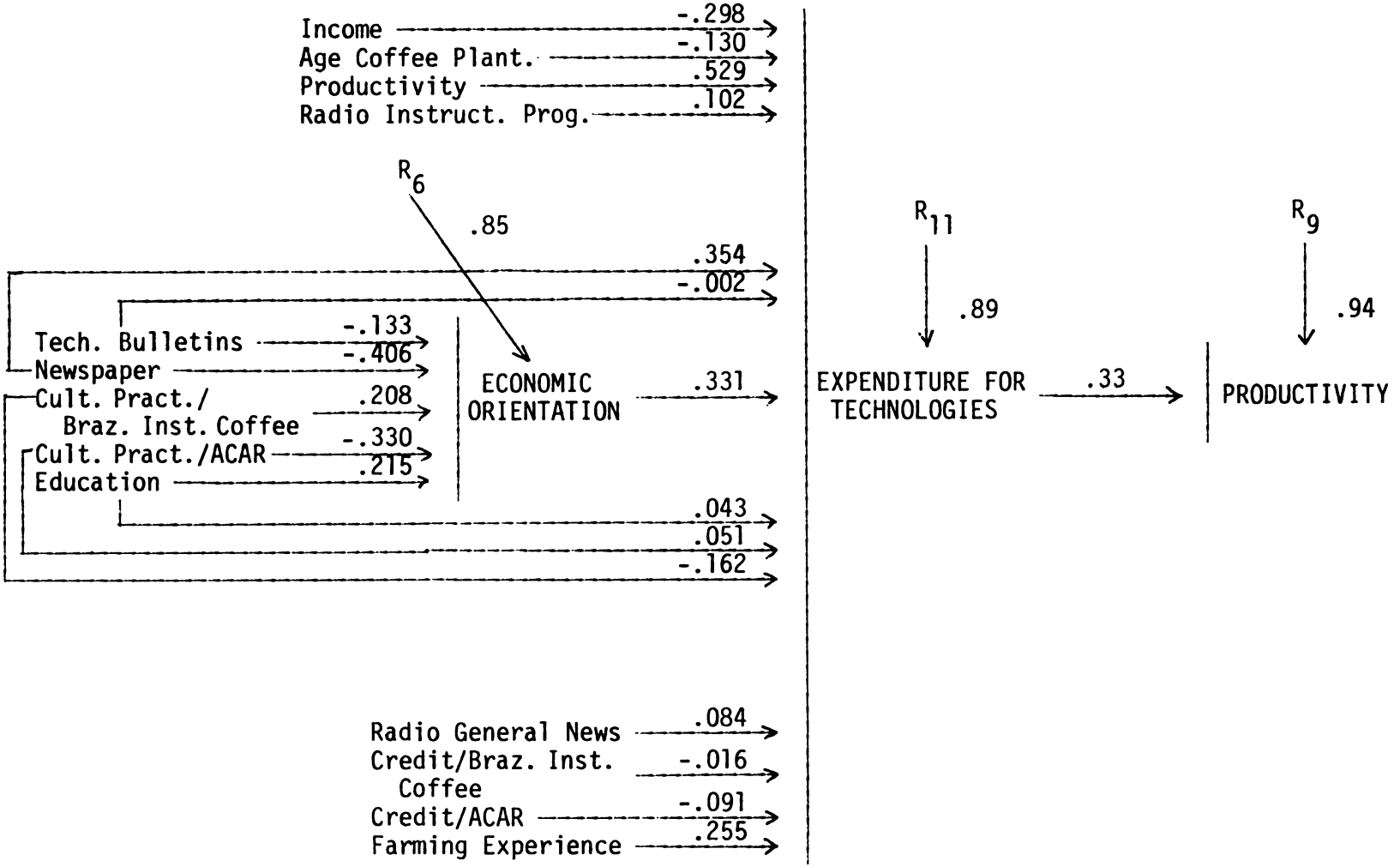


Figure 18: Second revised model with estimated path coefficients and residual paths.

The set of variables inserted as directly affecting the expenditure for technologies produces the largest value for R^2. These variables account for 20 percent of the variation in the dependent variable in question, with R = .45. Nevertheless, the size of the residual path is still troublesome, .89. This indicates that most of the variation in expenditure for technologies depends upon variables not included in the model.

Income from coffee plantation and age of the coffee plantation have negative direct effects on the expenditure for technologies, -.298 and -.130, respectively. However, productivity has the largest effect on that dependent variable, .529. This indicates that money generated by the coffee plantation in the last periods of cultivation and the age of the plantation itself do not constitute mechanisms that stimulate spending more money for technologies. Hence, two aspects of the coffee plantation inhibit its development. However, the other factor related to the coffee plantation, its productivity, is the major incentive for buying technologies. At this point, it is important to note the coherence of the model. Productivity in the last two periods of coffee cultivation is determining the expenditure for technologies, which also is leading to the productivity for the next period of activity. Nevertheless, it is important to stress that none of these three variables was statistically significant in determining farmers' attitude toward growing coffee.

In regard to the variables expressing mass media of communications, reading technical bulletins has a small and negative

direct effect (-.002) on expenditure for technologies; listening to general news programs on the radio also contributes very little (.084) to that dependent variable. In addition, it is interesting to see the relationships of these variables concerning the entrepreneurial characteristics considered in the study. Reading of technical bulletins has more negative than positive effects on these dependent variables, being statistically significant with two of the three variables. Listening to general news programs on the radio was statistically significant only in relation to farmers' attitude toward growing coffee, affecting more positively than negatively the farmers' characteristics as rural entrepreneurs. However, reading newspapers and listening to rural instructive programs on the radio have larger direct positive effects on expenditures for technologies, .354 and .102, respectively. These two sources constitute important mechanisms of information to determine the dependent variable in question. Nevertheless, reading newspapers contributes negatively to the acquisition of technical knowledge and to economic orientation toward farming--two of the characteristics of the farmers as rural entrepreneurs. Only in relation to attitude toward growing coffee does reading newspapers have a positive direct effect. Listening to rural instructive programs on the radio is not statistically significant for any of the entrepreneurial characteristics considered in the study. They act more negatively than positively.

Participation in meetings about credit promoted by the Brazilian Institute of Coffee and by ACAR both have small and negative direct effects on the expenditure for technologies, -.016 and -.091,

respectively. This does not mean that credit is not relevant in determining expenditure for technologies. It is important to see that credit is here measured simply by the participation in meetings. If credit were measured in a different way, such as money received, the result might well be different. It is most important to note that credit defined as participation in meetings is more useful, since it was hypothesized to impinge directly on the farmers' characteristics as rural entrepreneurs. However, this variable was not statistically significant for any of the categories here analyzed, acting more positively than negatively on them.

In relation to participation in meetings about cultural practices, contact with technicians from the Brazilian Institute of Coffee has a negative direct effect (-.162) on expenditure for technologies, whereas contact with agents from ACAR has a small and positive effect (.051) on that dependent variable. Considering that the effects of the participation in meetings about cultural practices on farmers' economic orientation toward farming were positive for agents from the Brazilian Institute of Coffee and negative for technicians from ACAR, it is permissible to say that the first technicians care more about farmers' preparation to cultivate coffee in terms of economic orientation than do the other technicians. But in relation to acquisition of technical knowledge, both extension agencies contribute positively to farmers' preparation.

Farming experience has a positive effect (.255) on the expenditure for technologies. This indicates that farmers' own experience in cultivating coffee constitutes a mechanism that does

not inhibit the expenditure of money in buying technologies. Considering that the farmers in the study have a favorable attitude toward growing coffee, the continuing expenditure for technologies by the farmers seems to be a reasonable research finding. One point that arises is that considering the small effects of the participation in meetings with technicians from the extension agencies, the farmers seem to rely more on their experience as coffee growers to acquire technologies. Another interesting aspect related to farmers' experience is that this variable was not statistically significant in affecting any of the three characteristics of the farmers, but farmers' experience exerts more negative than positive influence on them. For instance, it impacts negatively on the variables designated as technical knowledge and farmers' economic orientation toward farming, and positively on attitude toward growing coffee. Hence, through the years of coffee cultivation, farmers still are favorable toward cultivating coffee and probably tend to spend money in accord with the results achieved during the years of cultivation.

In regard to formal education, this variable contributes very little (.043) to the expenditure for technologies. As already observed, formal education is a variable that contributes more to the farmers' preparation as rural entrepreneurs. Formal education affects positively the variables "technical knowledge" and "economic orientation toward farming," but formal education makes a negative contribution to farmers' attitude toward growing coffee.

The last variable to be considered here is economic orientation toward farming. This variable has a positive direct effect

(.331) on the expenditure for technologies. In reality, one of the farmers' characteristics as rural entrepreneurs was shown to be meaningful in determining the dependent variable in question. On one hand, this result indicates that the linkage between farmers' entrepreneurial characteristics and the expenditure for technologies is very weak. The crucial point is that Figure 18 reflects the adoption-behavior model suggested by the data, and from a theoretical point of view, this model suggests that the expenditure for technologies is directly more subject to the mechanisms of the structure of the farmers' situation than to the farmers' own characteristics as rural economic agents.

One interesting result is that some of the important variables directly affecting the expenditure for technologies did not have the same trend in relation to the variables expressing farmers' entrepreneurial characteristics. For instance, reading newspapers and farming experience influenced more negatively than positively these dependent variables, but reading newspapers and farming experience directly and positively affected the expenditure for technologies. This may indicate that these variables do not lead to farmers' preparation to grow coffee in such a way as to elicit their adoption acts.

Considering the research findings of this investigation, one question arises: To what possible empirical consequences would the farmers be subjected since the initial theoretical model was not completely confirmed by the research data? At this point it is not our purpose to simply give up one perspective for another one. The

key question is just how to look at a course of behavior that deviates from the one postulated theoretically. Several consequences might be pointed out. For the moment, only one is of interest. The observed farmers' adoption behaviors are perpetuated and more conditioned by the component elements of the situation while those adoption acts lead to the achievement of a given economic outcome. In this instance, most of the adoption acts might simply become reflexes and habits, a condition very typical of the farmers' acts in performing economic activities in Brazil. Farmers usually do what their parents or neighbors have already done, and continue to perform the adoption acts since positive outcomes are being achieved.

This tendency may work very well with coffee growers, specifically because coffee has been a very important commercial crop in the country for many years. However, it is possible that our results may be characteristic only of coffee growing. It does not necessarily mean that such a perspective would also account for the variation in the adoption behavior for other kinds of farmers' economic activity. One concern is that when coffee growing starts to lose its commercial importance to Brazilian development, which seems to have been observed already, the emphasis on the farmers as merely consumers or buyers of technologies probably will bring serious economic consequences for them. It is important to understand that the approach to these problems does not reflect any intention to justify the partial absence of empirical support for the theoretical frame of reference in this study. As was stated, the argument centers

around the interpretation of the course of an adoption behavior considering one of the farmers' needs as economic agents: their background as rural entrepreneurs.

CHAPTER VII

SUMMARY AND CONCLUSIONS

This chapter represents an attempt to present general statements that may be useful to an understanding of the importance and implications of this investigation. No attempt will be made to reiterate each finding presented earlier.

In general, adoption research has placed strong emphasis on studying specific elements in the adoption process. Despite Rogers and Shoemaker's (1971) theoretical elaboration of the paradigm of the innovation-decision process, the term "process" in this investigation is seen from another perspective. The term "process" involves the notion of a sequence of steps, stages, or phases, but this sequence is not related to decisions. Rather, process is related to behavior, where the term "adoption behavior" is hypothesized to be performed in a situation under constraints. These constraints, deriving from the economic and socio-cultural context as well as those related to the farmers' entrepreneurial ability, determine the farmers' combination of means of production in order to achieve some economic result.

Under this perspective, two main questions were proposed for this study: (1) How do some of the farmers' entrepreneurial characteristics affect the adoption act, and how are they affected by

the variables in the structure of the situation? and (2) What are some of the economic outcomes achieved by the adoption act? One important consequence of focusing upon the adoption problem in this way is that two main assumptions concerning adoption research are plausible for investigation. That is, the assumption that adoption leads to positive results is investigated, as is the assumption that farmers' personal characteristics do not require modification. Nevertheless, one point needs to be made clear. Unlike the usual adoption research, the emphasis in this work is on variables that reflect features of farmers as rural entrepreneurs.

The goal of this study, therefore, was to develop a model for the farmers' adoption behavior. Here, the term "model" expresses the existence of a group of concepts nominally defined and corresponding to a type of empirical phenomenon. Considering that models are never exhaustive, the model developed here is mainly derived to accomplish the purposes at hand and is restricted to the amount and nature of available data.

The rationale for the model derives from Parsons' social-action theory or, more specifically, from the actor-situation frame of reference. This scheme is easily understood as depicted in Figure 1, page 11. However, it may be observed from that figure that much of Parsons' theoretical content is missing. Parsons' language and its diagrammatical representation are not isomorphic. Therefore, an evaluation of Parsons' conceptual scheme is possible if the concepts and their relational statements are considered in a more logical way. Chapter II shows how this translation is made, and Figure 2, page 16,

depicts the proposed course of adoption behavior. It will be noted that this figure is less abstract than Figure 1 and is composed of concepts and relational statements of empirical reference, allowing testable propositions.

The level of analysis in this study is the individual. The unit of analysis is the coffee grower. The sample consisted of 108 farmers who were interviewed by technicians from ACAR. The data were collected in 1975. Because of the amount of information embracing economic and social aspects of coffee planters, the data seemed very useful for the kind of analysis undertaken. The area studied was South Minas, in the state of Minas Gerais, Brazil.

In addition, it is necessary to point out that the term "innovations" was not applied in this dissertation. Usually, its connotations have several implications. To avoid them, the term "technology" was preferred to reflect the means of production applied to coffee cultivation. Because this activity extends for many years, the technologies considered in the study were those related to the care and maintenance of the coffee trees after the fifth year of cultivation. These technologies were discussed in Chapter IV. For the moment, it is enough to say that to be applied, they are highly dependent on the farmers' ability as rural entrepreneurs, and that the assumption concerning these technologies is that they are sufficiently available in the market.

The definitions of the variables and how they were operationalized were presented in Chapter III. Two categories of variables were introduced in this study, namely, theoretical and empirical. The

first category relates to the middle-range conceptual schema, and the latter refers to the indicators on which the analysis was carried out. Four theoretical variables and 21 indicators were considered in this investigation. In defining the hypotheses, there was an attempt to work with the variables at two levels. That is, general hypotheses were formulated from the theoretical variables, and specific hypotheses were defined for the empirical variables. Figure 3 (page 37) shows the causal relationships for the hypothesized adoption-behavior model.

The statistical technique applied to test the theoretical model was path analysis. The main research findings are shown in Figure 16 (page 81), which presents the basic adoption-behavior model, with estimated path coefficients. The analysis was developed through a comparison of the figures showing the hypothesized model (Figure 3, page 37) and the basic model (Figure 16, page 84). Several hypothesized relationships were not supported by the data. Some negative effects between variables were also found to be contrary to what was hypothesized. The percentage of the explained variance by the variables in question was not sufficient to account for most of the key intervening variables. These variables are: economic orientation toward farming, farmers' attitude toward growing coffee, and expenditure for technologies.

Expenditure for technologies is least well explained by the variables expressing farmers' characteristics as rural entrepreneurs, and attitude toward growing coffee is least well accounted for by the independent variables linked to the structure of the farmers'

situation. Mainly as a consequence of the first results, alternative models are suggested. The rationale for suggesting the revision of the basic adoption model comes from a statistical goal, namely to increase the variance explained. That is, there is an attempt to look for variables that may increase the explained variance in expenditure for technologies. Within this perspective, the first alternative model was built; it is depicted in Figure 17 (page 89)--the first revised model with estimated path coefficients. Because this model proved to be ineffective in explaining farmers' expenditure for technologies, a second revised model was suggested, as depicted in Figure 18 (page 89). This model proved more effective in explaining the expenditure for technologies for the sample of farmers in the study. However, the residual path is still very large. This means that most of the variance in expenditure for technologies is accounted for by variables not included in the model. Even though this is true, and not uncommon in sociological research, one plausible conclusion may be derived from the model. The expenditure for technologies is more explained for the elements existent in the structure of the farmers' situation than by farmers' own features as economic agents. In addition, it is possible to distinguish variables that have more influence on farmers' preparation to grow coffee than on expenditure for technologies and vice-versa. For instance, formal education, participation in meetings about cultural practices with technicians from the Brazilian Institute of Coffee, reading technical bulletins, and listening to general news programs on the radio are variables that mainly prepare farmers as coffee growers. However,

reading newspapers and farming experience exert more direct influence on the expenditure for technologies. In one way or another, the farmers' characteristics to grow coffee do not elicit their adoption behavior, which is leading to one of the proposed economic outcomes.

For the farmers, the implication of this result does not seem very favorable for medium and longer periods of time. Although one economic outcome has been achieved by the farmers in the study, this may not be the case for a long time period. It is important to recall that in addition to coffee being a commercial crop, it is also an important source of wealth for the country in terms of foreign commerce. The economic situation has shown signs of change, however, and coffee exportation has decreased during recent years. If this trend continues, the farmers may suffer severe economic consequences due to their behavior as consumers and in traditional ways. Both attributes appear to be very characteristic of Brazilian farmers.

Considering that the statistical results were not as strong as anticipated, some practical suggestions might be deduced from this study. The main suggestion concerns the farmers' background preparation for the cultivation of coffee. This implies that technical extension agencies prepare themselves to act on this problem, dedicating more time to working with the coffee growers. This would necessarily imply an incremental increase in the number of technical agents in each agency. Another source of information could also be reorganized in such a way as to exert more influence on the farmers' background as rural entrepreneurs in the production of coffee. These

sources are reading of technical bulletins and listening to the rural instructive radio programs.

Despite these observations, the utility of the framework used here cannot be over or understated. If this research was not completely adequate in explaining the course of adoption behavior under the particular circumstances studied, this does not mean that the same results would be found if conditions were to vary, perhaps if farmers producing different types of agricultural products were studied. It is also necessary to consider that this research was based on data already collected and that some restrictions were imposed because of the amount and quality of the available data. Hence, the results must be appraised within the context and limitations under which this research was developed, and they must be seen as a consequence of an effort to change the way of looking at the adoption phenomenon.

At this moment, it is important to stress that such a perspective was only possible because of the type of rationale involved in representing the adoption-behavior model. Even though Parsons' theory is vague in its concepts and in the statements of the relationships between them, it seemed to be a helpful theoretical device in defining farmers' adoption behavior in terms of a process. This process was then objectively stated through the definition of some middle-range concepts. Moreover, as a matter of suggestion for further research, this type of approach might be improved in different ways: First, more reliable variables reflecting entrepreneurial attributes of the farmers should be identified and used; second,

different characteristics of the rural entrepreneur might be considered; third, the model needs to be tested on farmers who grow other crops not including coffee; fourth, the introduction of some causal loops might also be helpful in better understanding the pattern of determination between the variables included in the model; and fifth, more sophisticated causal models with unmeasured variables might provide information not only about the relationship between more abstract concepts but also about the underlying empirical dimension of these abstract concepts.

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APPENDICES

APPENDIX A

SELECTED REFERENCES OF SOME CHARACTERISTIC STUDIES ON DIFFUSION AND ADOPTION OF INNOVATIONS

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SELECTED REFERENCES OF SOME CHARACTERISTIC STUDIES ON DIFFUSION AND ADOPTION OF INNOVATIONS

The objective of pointing out these studies on diffusion and adoption problems is merely an attempt to show the effort of some researchers in the search for variables that determine the adoption outcome. One necessary remark is that those variables vary in terms of conceptualization and measurement procedure, but that the way of looking at adoption itself is the same for all. Some examples of these studies are:

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APPENDIX B

QUESTIONNAIRE USED FOR DATA COLLECTION

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QUESTIONNAIRE USED FOR DATA COLLECTION

"Production System for the Coffee Culture in the South Region, Minas Gerais State"

1. Questionnaire identification

Questionnaire no.: _____

Interviewer's name: _____

Interview date: _____ / _____ / 1975 _____

Starting time: _____ hr. Ending time: _____ hr.

Conferred by: _____ Date: _____ / _____ / 75

2. Farmer's Identification:

Interviewer's name: _____

Owner: Yes No

Interviewer's position in relation to the farm:

Owner:

Administrator:

Others:

Instruction Level: Illiterate:

Primary school:

First grade:

Second grade:

College:

Farming experience: _____years

3. Farm identification:

Municipality: _____ District: _____

How far is the farm from the downtown (km): _____

Farm area (ha): _____ Land price Cr$/ha: _____

Area used with: Pasture (ha) _____ Annual Culture (ha): _____

Perennial culture (No coffee included) (ha): _____

Coffee area (ha): _____

Total of coffee trees planted: _____ coffee trees

Income from the farm (Cr$):	72/73	73/74	74/75
Coffee:			
Milk:			
Annual Culture:			
Others:			
Subtotal (1):			
Income from outside farm			
Agricultural:			
Subtotal (2):			
Total (1 + 2):			

4 - Coffee Production Cost (Locality no.)

Part A

Specification	72/73				73/74				74/75			
	Unit	v/unit	Quantity	Total Value	Unit	v/unit	Quantity	Total Value	Unit	v/unit	Quantity	Total Value
1. Inputs												
Liming	t				t				t			
Sulphate of ammonia	kg				kg				kg			
Calcium nitrate	kg				kg				kg			
Urea	kg				kg				kg			
Single superphosphate	kg				kg				kg			
Triple superphosphate	kg				kg				kg			
Chloride of Potassium	kg				kg				kg			
Primary nutrients: Formula NPK ( )	kg				kg				kg			
: Formula NPK ( )	kg				kg				kg			
: Formula NPK ( )	kg				kg				kg			
Sulphate of zinc	kg				kg				kg			
Boron acid	kg				kg				kg			
Oxichloride of copper	kg				kg				kg			
Insecticides	L				L				L			

Coffee Production Cost (locality no.)

Part A

Specification	72/73				73/74				74/75			
	Unit	v/unit	Quantity	Total Value	Unit	v/unit	Quantity	Total Value	Unit	v/unit	Quantity	Total Value
Adhesive spreader	L				L				L			
Organic manure	kg				kg				kg			
Subtotal (1)	-				-				-			
• Cultural Practices												
Mechanical ground cleaning: Tractor ( )	h/tr				h/tr				h/tr			
: Animal ( )	h/ta				h/ta				h/ta			
: Manual ( )	D/h				D/h				D/h			
Chemical ground cleaning: Tractor ( )	h/tr				h/tr				h/tr			
: Manual ( )	d/h				d/h				d/h			
Cleaning under coffee tree: Manual ( )	d/h				d/h				d/h			
Sweeping: Manual ( )	d/h				d/h				d/h			
Spreading after harvesting: Tractor ( )	h/tr				h/tr				h/tr			
: Manual ( )	d/h				d/h				d/h			
Calcium distribution: Tractor ( )	h/tr				h/tr				h/tr			
: Manual ( )	d/h				d/h				d/h			

Coffee Production Cost (locality no.)

Part A

Specification	72/73				73/74				74/75			
	Unit	v/unit	Quantity	Total Value	Unit	v/unit	Quantity	Total Value	Unit	v/unit	Quantity	Total Value
Foliar manuring: Tractor ( )	h/tr				h/tr				h/tr			
: Animal ( )	h/ta				h/ta				h/ta			
: Manual ( )	d/h				d/h				d/h			
Pulverization: Tractor ( )	h/tr				h/tr				h/tr			
: Animal ( )	h/ta				h/ta				h/ta			
: Motor used in the back ( )	d/h				d/h				d/h			
: Manual used in the back ( )	d/h				d/h				d/h			
Soil conservation: Tractor ( )	h/tr				h/tr				h/tr			
: Animal ( )	h/ta				h/ta				h/ta			
: Manual ( )	d/h				d/h				d/h			
Subtotal (2)												

5. Coffee Production and Production Value

Part D

Localities in Production	Age (Years)	Area (ha)	No. hole	Declivity (a)	Seed Variety	Spacing (m)	Soil Quality (b)	Production in bean bags (60 kg)			Price by bag (60 kg)			Production Value		
								1973	1974	1975	1973	1974	1975	1973	1974	1975
Locality 1																
Locality 2																
Locality 3																

A) Flat: until 10% of declivity

undulated 10 - 30% "

Highland + 30% "

b) good, moderate, weak (having soil analysis, write down)

Analysis date: ____/____/ 19____

pH water: _____

ca + Mg _____ eq. mg/100 ml; Phosphorus (P) _____ppm;

Potassium (K) _____ppm.

Carbon (C) _____%.

8. SOURCES OF INFORMATION

8.1. Radio

Which radio programs are directed to the agriculture that you listen to?

Program's Name	Radio Station	Time	Frequency

(8.1.)

+ Interviewer:

Daily - 5
Sometimes per week - 4
Sometimes per month - 3
Sometimes per year - 2
Never - 1

(Subtotal 8.1.)

8.2. Newspaper and Magazines

8.2.1. Do you read newspaper or magazines?

2 - Yes
1 - No

(8.2.1.)

8.2.2. Which newspaper or magazines do you read?

Newspaper's Name	Subject's Content (a)	Frequency (b)	Subscription (c)

(a) (8.2.2.) (b) (8.2.2.) (c) (8.2.2.)

a) Subject's Content:	b) Frequency:	c) Subscription·
1 - sport	4 - daily	2 - yes
2 - religion	3 - sometimes/week	1 - no
3 - farming issues	2 - sometimes/month	
4 - international issues	1 - sometimes/year	

(Subtotal 8.2.)

9. TRAINING

9.1. Technical meetings about coffee culture

a) Do you take part in these meetings?

2 - yes

1 - no

(9.1.a)

b) Information about the technical meetings.

Place (b_1)	Subject's Content (b_2)	Frequency (b_3)

($9.1.b_1$) ($9.1.b_2$) ($9.1.b_3$)

Interviewer		
b_1) Place	b_2) Subject's Content	b_3) Frequency
1 own farm	1 credit	1 annual
2 downtown	2 cultural practices	2 once by semester
3 other municipality	3 commercialization	3 monthly
	4 Cooperativism	

(Subtotal 9.1)

9.2. Contact with technical assistance agents

a) Did you contact agricultural technicians? 2 - Yes 1 - No (9.2.a)

Place (a_1)	Subject's Content (a_2)	Frequency (a_3)	Institution (a_4)

($9.2.a_1$) ($9.2.a_2$) ($9.2.a_3$)

Para o entrevistador			
Place (a_1)	Subject's Content (a_2)	Frequency (a_3)	Institution (a_4)
1 - Own Farm	1 - Others	1 - Annual	(write down the name of the institution
2 - Neighboring Farm	2 - Credit	2 - Monthly	to which the technician belongs to)
3 - Downtown (on the street)	3 - Cultural practices	3 - Weekly	(a_4) MBC, ACAR, Coop., Private Entre-
4 - Downtown (in the office)	4 - Commercialization	4 - + once per week	prise.

(Subtotal 9.2.)

9.3. Cooperativism

a) Are you a member of any cooperative? 1 - No 2 - Yes (9.3.a)

b) Do you take part in the directory board? 1 - No 2 - Yes (Subtotal 9.3.) (9.3.b)

10. KNOWLEDGE TEST ABOUT AGRICULTURAL PRACTICES RELATED TO THE COFFEE CULTURE

I would like to ask you some questions about the culture of coffee. You need to indicate the right answer for each question.

10.1. Selection of the Place

When selecting a place to plant coffee, you have preference for:

___ Lower level place

___ Declivity above 50%

___ Place subject to frost

___ Place subject to much sun

(10.1.)

10.2. Planting

A coffee tree must be planted:

___ Below the soil level

___ In the level of the soil

___ Above the soil level

(10.2.)

10.3. Spacing

The distance between rows and the distance between holes must be done according to:

___ As the farmer likes

___ As usually the farmer plants coffee tree

___ The seed variety

___ The size of the available area

(10.3.)

10.4. Lime application

Lime must be applied according to:

___ The vegetation existent

___ The farmer's experience

___ The soil analysis

___ The lime price

(10.4.)

10.5. Manuring with boron and zinc

The manuring must be made:

___ Only when you observe that the coffee tree presents deficiency of these elements

___ Together with soil manuring

___ With foliar pulverization and annually

_____ (10.5.)

10.6. Coffee borer

Its control must be made:

___ Every year, before it comes up

___ Together with other pulverizations

___ When 5% of coffee beans are attacked by it

_____ (10.6.)

10.7. Rust leaf

Its control must be made:

___ Through several pulverizations during the year

___ Through some pulverizations between November and April

___ Through some pulverizations between June and August

_____ (10.7.)

10.8. Rust leaf

Which of the following formulas is more indicated to combat rust leaf:

___ 4.0 to 5.0 kg of fungicide for 10 plants

___ 10.0 to 15.0 kg of fungicide for 1,000 plants

___ 4.0 to 5.0 kg of fungicide for 1,000 plants

_____ (10.8.)

Knowledge test subtotal = _____

11. ECONOMIC ORIENTATION

Interviewer (put an "X" in each row below)

. I am going to present you some statements and ask you if you: agree, undecided, or disagree.

. Interviewer:

. If the answer is "disagree," ask: Do you strongly disagree or just disagree?

. If the answer is "agree," ask: Do you strongly agree or just agree?

	Strongly disagree	Disagree	Undecided	Agree	Strongly agree
1. The amount of manure that you use per hectare is that one which allows you to get the maximum production	1	2	3	4	5
2. The manure that you buy has been shown to be the one which produces more	1	2	3	4	5
3. It would be preferable that your sons would continue doing the same thing you do	1	2	3	4	5
4. If your land would produce more than it is now, your son must continue working more	1	2	3	4	5
5. The amount of manure that you apply by hectare is that one which gives you more profit	1	2	3	4	5

	Strongly disagree	Disagree	Undecided	Agree	Strongly agree
6. What was learned from your father is very important in your decision making related to coffee plantation	1	2	3	4	5
7. The manure that you buy is the cheapest that you can find	1	2	3	4	5
8. You buy the manure that the salesman or agricultural technician indicates to you	1	2	3	4	5
9. At the moment that you decide what to plant you take into account how much you may profit	1	2	3	4	5
10. The "minimum price" paid by the government is sufficient to respond to the farmer's needs	1	2	3	4	5
11. The needs of manure for your plantation are determined according to your point of view	1	2	3	4	5
12. Your economical situation does not have influence on your decision about buying or not buying manure	1	2	3	4	5
13. There is an exploitation of this city on the rural people	1	2	3	4	5
14. The salesmen try to sell the maximum to you without worrying if this can bring profit to you or not	1	2	3	4	5

12. ATTITUDE TOWARD CULTIVATING COFFEE

Interviewer (put an "X" in each row below)

. I am going to present you some statements and ask you if you: agree, undecided, disagree.

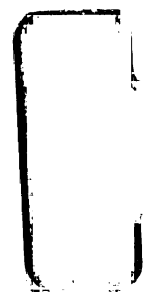
. Interviewer:

. If the answer is "agree," ask: Do you strongly agree or just agree?

. If the answer is "disagree," ask: Do you strongly disagree or just disagree?

	Strongly agree	Agree	Undecided	Disagree	Strongly disagree
1. If the government continued with loans for the coffee growers at 2% interest per year, you would plant more coffee . . .	1	2	3	4	5
2. It is very important to make the book-keeping of the coffee plantation	1	2	3	4	5
3. If you had to pay a minimum wage for your employees, if would be preferable to sell the farm	1	2	3	4	5
4. It is important to pay a good administrator very well	1	2	3	4	5
5. Despite the fact that mechanical cultivation is economically cheaper, I prefer manual cultivation because it is easier . .	1	2	3	4	5

	Strongly agree	Agree	Undecided	Disagree	Strongly disagree
6. A newspaper subscription is important because it allows you to follow what is happening in Brazil and in the world	1	2	3	4	5
7. The time dedicated to newspaper and magazine reading, besides listening to radio programs, does not compensate what may be learned	1	2	3	4	5
8. You adopt an innovation recommended by the agricultural technician only if your neighbors have already adopted it	1	2	3	4	5



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