BIBLIOGRAPHIC DATA SHEET	1. CONTROL NUMBER PN-AAJ-485	2. SUBJECT CLASSIFICATION (695) AC00-0000-0000

3. TITLE AND SUBTITLE (240)

Adoption of modern agricultural technology by small farm operators: an interdisciplinary model for researchers and strategy builders

4. PERSONAL AUTHORS (100)

Leagans, J. P.

5. CORPORATE AUTHORS (101)

Cornell Univ. Dept. of Education

6. DOCUMENT DATE (110)	7. NUMBER OF PAGES (120)	8. ARC NUMBER (170)
1979	56p.	630.72.L434

9. REFERENCE ORGANIZATION (130)

Cornell

10. SUPPLEMENTARY NOTES (500)

(In Cornell international agricultural mimeograph 69)

11. ABSTRACT (950)

12. DESCRIPTORS (920)

Agricultural technology
Technological change
Models
Innovations
Behavior
Farm mechanization
Modernization
Strategy
Farm management
Small farmers
Technology adoption

13. PROJECT NUMBER (150)

532004630

14. CONTRACT NO.(140)

AID/ta-BMA-8

15. CONTRACT TYPE (140)

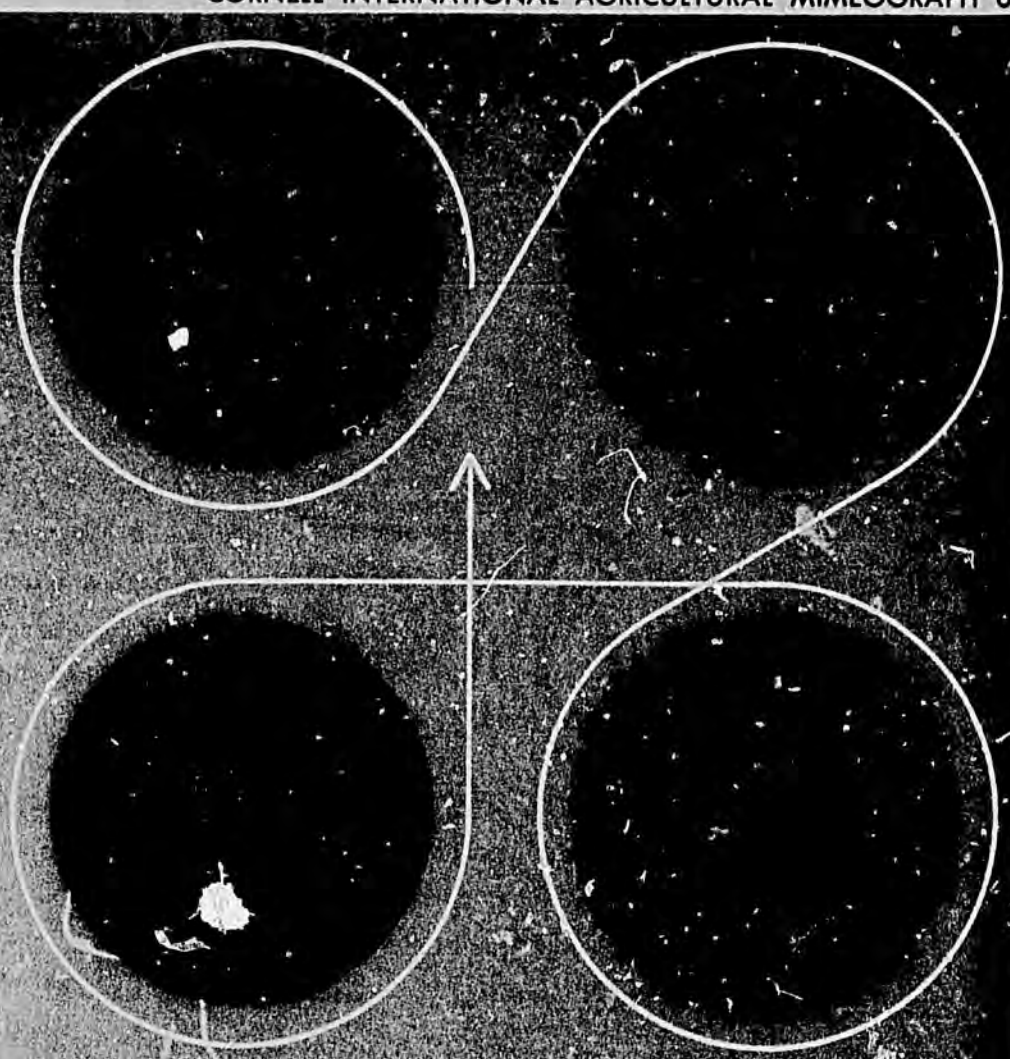
16. TYPE OF DOCUMENT (160)

AID 590-7 (10-79)

PN-AAJ-485

CORNELL INTERNATIONAL AGRICULTURAL MIMEOGRAPH 69

630.72
L434



ADOPTION OF MODERN [illegible] TECHNOLOGY BY SMALL [illegible]: AN INTERDISCIPLINARY [illegible] RESEARCHERS AND STUDENT [illegible]

by

J. Paul [illegible]

[illegible]

New York State College of [illegible]
[illegible]
Ithaca, New York

THE Program in International Agriculture publishes manuscripts resulting from international research and other activities of faculty and graduate students in the College of Agriculture and Life Sciences at Cornell University. A Bulletin Series and a Mimeograph Series include comprehensive and definitive topics relating to international agricultural and rural development. An annual Dissertation Abstract Series summarizes the Cornell Ph.D. theses concerned with agricultural and rural development abroad.

A list of topics published in these series may be obtained from the Program in International Agriculture, 252 Roberts Hall, Cornell University, Ithaca, New York 14853. Upon written request, educational, research and other public and private organizations will be placed on a mailing list to obtain future publications.

Single Copy Free
Additional Copies 25¢ Each

6/79 CU 1.3M

Adoption of Modern Agricultural Technology by Small Farm Operators: An Interdisciplinary Model for Researchers and Strategy Builders

J. Paul Leagans*

* Professor Emeritus of Extension Education, Department of Education, New York State College of Agriculture and Life Sciences, Cornell University, Ithaca, N.Y. Currently, Adjunct Professor, Department of Adult and Community College Education, North Carolina State University, Raleigh, N.C. 27650

CONTENTS

PREFACE 1

INTRODUCTION 3

Some hypotheses about strategy 5

Where we are 5

Nature of adoption behavior 6

Search for central behavioral theory 8

Theories advanced by social science disciplines 9

Theories from supportive sources 11

Behavior and environment 12

Law of minimum and maximum 13

Newton's first law of motion 14

Piaget's explanation of changes in structure 14

Theory of human needs 15

Conclusions about central theory 16

Search for a functional model 16

A concept of modeling 17

Some commonly used models 17

Technology model 17

Economic model 18

Institution-building model 18

Equilibrium model 18

Communication model versus conflict model 18

Problem-solving model 19

Interdisciplinary behavioral differential model 19

Theory model 20

Basic rationale 24

Examples of paradigm development 26

Some central points about the paradigm 30

Research model 35

Intervention model 40

Major findings and implications 44

Farmer "blame" to system "blame" 45

Incentives and disincentives 47

Final Test 49

Bibliography 51

PREFACE

The purpose of this publication is to summarize a new approach to research on behavioral response to technical innovation and determine how to accelerate such response. Supportive data are taken from 12 Ph.D. dissertations written by graduate students in a 10-year research program in extension education at Cornell University under my direction. These research studies focused on the central question: What do farmers with small holdings in low-production areas perceive as the compelling reasons for adopting or rejecting recommendations for the use of modern agricultural production technologies?

Primary motivation for the research program was the increasing need to reduce the time between availability and actual use of a growing number of agricultural production technologies and to alleviate the apparent dearth of effective strategies for accelerating their use, especially by small-farm operators in third-world countries.

A common research design was generally used; all projects concentrated on adoption behavior in response to specific technical recommendations. Data were collected through personal interviews with about 2300 carefully selected farmer respondents in 8 different countries. Semistructured interview schedules were employed to elicit and record responses. Data were analyzed in Cornell's Department of Computer Science.

The theory commonly employed and the design of the researches vary substantially from those of numerous similar studies conducted in the past. At that time, the characteristics of adopter-farmers were identified; this research centered on the reasons the farmers gave for their adoption behavior.

When a group of researches with a common design and focused on a common problem are available, what, one may ask, is left to report that cannot be more accurately obtained from the primary documents? Indeed, professionals interested in more detail than this summary provides will want to examine the original research documents. The purpose here is to: synthesize the results and present them in summary form; articulate a view of the variables currently influencing farmer use of modern production technologies that is larger than previous adoption research has revealed; characterize an innovative theory and a research design that concentrate on the differential cumulative valence of the incentives and disincentives regarded by respondent farmers as the primary determinants of their adoption behavior; and join the fray, thereby adding the interdisciplinary view of extension educators to those of the more discipline-oriented researchers who attempt to identify and explain the complex matrix of the adoption behavior of farmer innovators.

The researches were done largely as a part of Cornell's Program in International Agriculture, which helped finance the field work. In addition, the Ford Foundation, the Rockefeller Foundation, USAID, several national governments, and numerous other interested funding agencies provided support.

Constraints imposed by available space, the synoptical nature of this publication, and the personal and technical complexities involved in specifically acknowledging material taken from the individual researches make normal citation impractical. Each of the documents is listed in the bibliography. Suffice it

then, for the director and summarizer of the research to express special appreciation to each of his former doctoral students who successfully completed one of the individual projects included in this work and who were awarded the Ph.D. degree in extension education by Cornell University: E. Atayi, Togo; U. Buyukcolak Bakker, Turkey; T. Contado, Philippines; J. Dhillon, India; R. Dwarakinath, India; M. Lawdermilk, Pakistan; P. Misiko, Kenya; P. Sharma, India; F. Sheppard, USA; P. Salvi, USA; T. Terasart, Thailand; G. Vidyarthy, India.

This summary can offer, at best, only the essence of the theory, methodology, and findings of the work with which it deals. Consequently, interested readers are encouraged to examine the primary documents for more specific details.

Even though the ideas presented here have been carefully researched and are focused on the topic of innovative behavior, we view the formulations as tentative--points for creative pondering and hypotheses for further examination. Indeed, if this monograph evokes new questions and stimulates new approaches to the research and promotion of technical innovations in traditional agricultural systems, our efforts will have been justified.

J. P. L.

INTRODUCTION

The advantages of modern agricultural science and technology have not yet effectively reached at least a billion small farmers located throughout the world. A more sympathetic understanding of the conditions that persuade such farmers to accept technical agricultural innovations could facilitate increased food production as powerfully as the new technology itself. However, modern, sophisticated agricultural technology will not be able to serve the needs of small farm operators until they understand it and are willing to make use of it.

The telling fact is that agricultural science and technology, like all technologies, have no inherent value; their human value is manifested only by the results achieved when they are properly applied to serve the need for which they were created. Indeed, for new technologies to significantly influence agricultural production, the farmers--the real managers of the production function--must not only adopt them but use them correctly.

The development of a scientific, market-oriented agriculture involves many diverse factors and their related variables, all of which affect the behavior of the adopter-farmers when accepting innovative methods. Some of these factors are part of the farmer's attitude; the rest impinge on him from his environment. Efforts to adopt innovation bring these two sources of behavior influence into direct interaction, but only as they accommodate to one another can innovative action be successful.

The basic question in designing our research framework was: Why has the "Green Revolution", launched a decade ago to create and translate promising new agricultural technologies into increased food production in third world countries, not achieved anticipated results, especially among small farm operators? Obviously, the answer is not simple. Restructuring a subsistence, resource-scarce, tradition-oriented agriculture into a scientific, market-oriented system that feeds a nation and is an instrument of economic growth is one of the most complex development producures in any nation.

The problem is complex because the critical variables are extensive and heterogeneous, and their essential interrelatedness is demanding. It is also complex because building the infrastructure required to establish and maintain a dynamic agriculture is costly and time-consuming. Therefore, agricultural change in general, and agricultural production in particular, are often clogged within the infrastructure. These obstructions are usually the result of an incapacity to create and sustain an environment favorable to agricultural modernization. Such impediments are antithetical to agriculture and other socioeconomic developments in both the short and long run and must be dealt with at all levels of the system.

The growth of agricultural knowledge must be accompanied by efforts to synthesize and explain it to those for whom it is intended. Farmers' use of knowledge is a process whereby they put the "pieces" together in ways that seem possible, functional, and potentially rewarding. To achieve optimum results, farmers must properly combine single-factor panaceas, such as seed varieties, fertilizers, and disease and pest controls.

In graduate courses, seminars, and research activities focused on the extension education process, my doctoral students and I worked persistently to keep up with the research on the adoption process being conducted in various countries. During the mid-1960s, we grew skeptical of the focus of these studies and the apparent lack of influence on policy and programming. We concluded that there may be some important variables not yet recognized and researched. Most of the reports tended to focus on the attributes of the individual farmer, on the relationship of different personal variables to rates of adoption, and on stages in the adoption process. In short, most of the research was designed and implemented to identify the socioeconomic and sociopsychological characteristics of the adopter-farmers. This emphasis appears to overlook the critical fact that adoption of technical innovations requires a conducive environment and an overt act, as well as a favorable mental attitude.

This type of research is useful because it reveals information on "what the adopter-farmer is like". Indeed, hundreds of empirical studies of farmers' personal characteristics have been published. But in these studies, the immediate physical and resource constraints imposed by environmental conditions, which often determine why a farmer does or does not adopt a recommended technical practice, appear to have received inadequate attention. Not generally considered, for example, is the central question: Why farmers do what they do. Missing too, as a part of this question, is attention to the effect of variations in the availability of production essentials--a function of the system. Consequently, we have many answers to the "what" question, but do not know the real reasons why farmers do or do not complete the adoption act. To be able to answer the "why" question better, we needed "interpretive" information from farmers about localized constraints imposed by the system and to determine how to remove them.

These numerous supporting revelations led us to question the adequacy of what we now know and/or believe about the nature of the adoption process. We found that we were hypothesizing instead of accepting the current state of knowledge. In this process we arrived at several tentative propositions. The following are some we believed to be of major importance:

- Our current knowledge about adoption behavior and ways to influence it is significant and useful but needs to be expanded.

- Some innovations are needed in the focus of previous research designs and in the underlying theories that guided them.

- Adoption of technical innovations involves both a favorable attitude and an overt act; constraints on the latter need extensive investigation.

- The sources of influence (reasons) that functionally "trigger" adoption behavior are personal (internal) and environmental (external). Clarification of the components and the functional relationship of these two major factors should be expanded.

- Farmers reach adoption decisions through a system of judgmental trade-offs among positive and negative influences.

- Farmers express the influences on their behavior in the form of reasons for adoption (incentives) and reasons for nonadoption (disincentives).

- The adoption act requires that the cumulative valence of incentives be considered greater than the opposing cumulative valence of disincentives.

- Adopter-farmers are the most reliable source of reasons why they do what they do in response to new production technologies.

We concluded that to explore these and related propositions further might widen an understanding of the adoption act, help design more effective strategies for influencing innovations, and improve the quality of policy and programming decisions at various levels in science-oriented agricultural production systems.

The research program was conceived, designed, and implemented to explore the overall hypothesis that the critical variables currently influencing adoption behavior patterns constitute a significantly different and larger "package" of influences than is reported in adoption[1/] research up to now. This bulletin broadly summarizes what we attempted, what we found, and what we propose.

SOME HYPOTHESES ABOUT STRATEGY

Recent advances in agricultural science and technology have made it possible to vastly increase agricultural production. However, because of their complexity, they have greatly lowered the level of tolerable error in optimal use. Persuading farmers to adopt these new and more effective technologies involves the adopter-farmers in many perplexing behavior changes.

Where We Are

It was pointed out in the Introduction that we are relatively well informed about the nature of the adopter-farmer, but we know much less about why he does what he does and how to introduce innovative change into his established patterns of behavior. In third-world countries, promoters of the newly emerging "science of development", including those primarily concerned with increasing agricultural production, are becoming more skeptical about the intellectual and functional aspects of their strategies. The disappointing achievements of the Green Revolution have contributed extensively to this idea. The problem is especially related to strategies designed to accelerate the adoption of technical innovations by tradition-oriented farmers operating small holdings in low-resource areas. Among these uncertainties is growing recognition of the critical and ambiguous role of the human element--the behavior of the farmer-adopter, which is the ultimate dependent variable in the use of technology. The central question of how much we know or hypothesize as technologists is increasingly paralleled by the equally complex question: How can we induce tradition-oriented farmers to learn, accept, and put into practice what is believed to be technically useful to them?

It is increasingly obvious that knowledge about the science of development, which could overcome achievement disparities common in traditional agricultural systems, entails much more than useful technology; it includes knowing the multiple variables that support a workable strategy for getting farmers to adopt

---

1/ In this report, the term "adoption" means: acceptance and full use by farmers of one or more technical agricultural innovations perceived by them at the time of decision as the best course of action available.

new technologies. It also involves questioning the assumption that technical innovations are widely relevant, the process of dissemination and use by all classes of adopters, and the validity and adequacy of all the purported "truth" about how increased agricultural production can be achieved.

Increasingly, too, we are learning that the agricultural production function in traditional systems is more untidy than we had recognized. We are discovering that we have not adequately identified the forces exerted by some of the critical variables lying beyond our physical and biological technologies. In short, we are learning that it is not our production technology alone, but what the farmer does, or does not do, with it that is the critical transcendent variable in the production function.

Designing workable technical systems and effective ways for implementing them are immensely complicated tasks; it now appears that we have done a better job solving the first problem than the second one. It may be simpler to create useful technology than to implant it in the minds and overt actions of tradition-oriented farmers, especially those with low resources. Plants and plots are docile; people are dynamic. New technologies are essential, but they are not enough; it is the nature and quality of the farmers' use that creates the pay-off in agricultural production.

The desire to understand more about the adoption process led Joe Bohlen to characterize adoption research by stating:

> In the past, research has analyzed adoption and the various stages prior to it on the basis of empirical evidence of the use of the practice and in further analyses relating personal and social characteristics to the adoption. Results of these efforts have not always shown clear-cut relationships.
> (Bohlen, 1967:210)

Hence, concepts of some of the critical elements in a strategy that promises optimum adoption behavior still appear to be fuzzy and diverse--a condition that prevails partly because the range of variables required at both the macro and microlevels to create ideal environmental conditions for farmer action are not yet adequately identified and functional. This theory is based on the idea that the adopter-farmer's interaction with his environment largely patterns his behavior, and that variances in adoption behavior can be largely accounted for by individual differences, the differential stimulus characteristics of forces in his environment, and the quality of interaction between the elements of each. Full exploitation of this principle is yet to be widely achieved in traditional farming systems. The lag exists largely because the methodological implications of the total system have yet to be fully identified and systematically exploited.

Nature of Adoption Behavior

The literature reveals that adoption behavior tends to be specific to particular innovations, individuals, and environments; but, additionally, it has some general characteristics that can be understood in general terms.

The first, fundamental, and somewhat obvious characteristic of adoption behavior is that it is adult behavior, and as such, idiosyncratic. The circumstances in which farmers learn about a new agricultural practice and decide whether to adopt it tend to be unique to each individual. But the individuality

with which agricultural innovations are considered and decided upon is the ultimate manifestation of numerous environmental influences. By recognizing and accepting the individuality of each farmer and the uniqueness of his particular circumstances, one can understand better how general principles of adoption behavior are developed and applied.

A second generalization drawn from recent investigations of this subject is that the effect of communication is a component. Obviously, when farmers are expected to utilize new technical ideas, they first must know what the idea is and why and how they should incorporate it in their farming systems. But communication has proved disappointingly weak so far, even when productive technology is its central message.

Our review revealed that communication is commonly defined as the process by which one person recommends an innovation to another, with the intent of favorably influencing his behavior. By including the term "process", this definition recognizes that persuasive communication is a multivariant process and not a univariate act. The researches, however, tend to assume a univariate focus. Empirical knowledge about how communication produces behavioral change opposes the single-act, one-exposure treatment except in highly emergency-charged situations. A one-time message to intended users, no matter how potentially productive, is only the first of several exposures required to move a potential adopter across the complex continuum of cognitive, attitudinal, and psychomotor intervals of cumulating favorableness ultimately strong enough to trigger adoption. In relatively free-choice situations, a cumulative effect can be achieved only through repeated exposure to an idea.

Currently, this broader concept of the persuasive communication component of adoption behavior appears to be inadequately researched. For example, the investigations tend to overlook the required cumulative effect of, and to give inadequate attention to, the functional quality of the succession of interrelated factors involved. Persuasive communication networks are a kind of chain reaction, at the end of which a fundamental principle of persuasive communication comes into play: the fidelity of the final message usually decreases in proportion to the number of times it has been relayed.

A third generalization about adoption behavior is that traditional socioeconomic factors such as size of farm and owner's age, education, income, and family size generally influence adoption behavior only indirectly. It is evident, however, that these factors do create conditions that may influence the adoption of subsequent agricultural innovations. Money and personalized information appear to be the most significant of the socioeconomic factors.

Recent researches reveal a fourth general area--sociopsychological factors--which significantly influence the adoption of agricultural innovations. Consistent with the idiosyncratic nature of adoption behavior, these factors suggest that a farmer's incentives and disincentives to adopt are determined by his personal beliefs about the permissiveness of his environment. Because his beliefs and disbeliefs are personal, his incentives or disincentives are also personal and idiosyncratic. Furthermore, it can be induced from the literature that the variability in adoption behavior can be ultimately attributed to the differential cumulative valence ratio of perceived incentives and disincentives.

In summary, we inductively arrived at the following preliminary propositions through a search of the literature on adoption behavior:

1. The problem of increasing adoption rates, especially of farmers operating small holdings, must be addressed from the standpoint of the farm, the farmer, and the institutional and service circumstances, as well as the agricultural research center.

2. Adoption behavior requires a favorable mental state (conviction) and a successful physical act: the first is internal and symbolic and achieved through technical knowledge and conviction of its value; the second is external and physical and achieved through ready availability of the requisite production inputs and services such as seed, fertilizer, credit, and markets.

3. Adoption behavior at optimum levels depends on a complex infrastructure--technically, physically, economically, socially, educationally, and politically--that establishes and maintains a macro and micro environment favorable to the adopter-farmers' translating their internal and external behavior influences into particular, overt action. The extent and quality of reciprocal accommodations achieved through interrelating these to major sources of behavior influence determines the success of innovative behavior.

4. Adoption of simple (usually singular) technical innovations is made at much higher rates and usually before adopting more complex practices, both singularly and in "packages".

5. Dissemination of technical information is a relatively easy task compared with achieving understanding, conviction, and the final overt act required to terminate the adoption act.

6. Optimum adoption of agricultural production innovations is achieved only when a farmer perceives the recommended practices to be, for him, technically sound, economically feasible, physically possible, and socially compatible.

The foregoing led to the tentative proposition that adoption decisions tend to be made on balance, that is, individuals reach them through a series of mental gymnastics involving trade-offs or compromises among recognized influencing variables that form two categories: reasons favorable to taking innovative action (incentives) and reasons favorable to nonaction or maintaining the status quo (disincentives). Accordingly, it seems important for those wishing to account for and facilitate the adoption of agricultural innovations to first, identify the incentives and disincentives perceived by farmers; and second, to implement a strategy to strengthen the influencing power of the incentives and, simultaneously, weaken the force of the disincentives.

SEARCH FOR CENTRAL BEHAVIOR THEORY

Consideration of the hypotheses about strategy summarized in the preceding section revealed the need for supportive theory beyond that commonly used in adoption research and a paradigm to express it. This section presents a survey of theory building; the next one focuses on model building.

Our search for theory was guided by the assumption that adoption behavior is generally patterned by multiple influences from two major sources: Internal

(mental and symbolic) and external (physical and environmental); that these influence-variables are mentally articulated by individuals in the form of perceived reasons for or against innovation; that these two categories of reasons constitute incentives[2/] or disincentives[3/] for action; and, finally, that it is only when an individual feels the cumulative valence[4/] of incentives to be greater than that of disincentives that he begins the act of adoption.

We began our search with the question: What are the theories advanced by some of the major social science disciplines to explain the process of innovative changes in human behavior? The review focused on educational psychology, sociology, cultural anthropology, economics, and social psychology.

Theories Advanced by Social Science Disciplines

During the mid-1960s, we felt a need for synthesizing the numerous theories purported to explain changes in human behavior in general and the adoption of technical innovations in particular. As expected, this search revealed numerous theories advanced by the social science disciplines, each purporting to explain the human behavior dimension of social, economic, and technical change. The singleness and lack of interrelatedness with which they were used to explain how changes in human behavior may be influenced was impressive. Also remarkable however, were some central, generally pervasive threads found in the various arguments. The following is the essence of our discovery.

At the broadest dimension, W. E. Moore suggests that a sense of time and a perception of change are inexplicably linked in human experience (Moore, 1963:22-23). The link works both ways; neither time nor change is a dependent variable. Although they do not completely agree on many concepts, educational psychologists attempt to explain how behavior and changes in behavior begin and are energized, sustained, and directed. Generally they believe that behavior changes because of a lack of harmony or an imbalance between a person's aspirations and his environmental accommodations. This condition produces tension, and a need to reduce tension induces a change in behavior. The process has three phases: disequilibrium (uneven tension or need), a goal, and action directed at achieving the goal.

This rationale implies that in all human activity except simple reflexive behavior there are recognized motives that direct a person toward certain goals. But the achievement of a goal may not bring complete freedom from tension, because the achievement of one goal usually leads to an awareness of others. Myriad forces may be at work; many of them create needs or disequilibria between an individual and his environment. Depending on the tension or the need that one deems most urgent, and therefore dominant, one chooses a suitable goal and acts to achieve it. This action involves new behavior and is therefore "behavioral change".

2/ Incentive: any condition or reason that a respondent feels motivated him to begin to use any or all of a recommended group of farm practices.

3/ Disincentive: any condition or reason that a respondent feels inhibited him from beginning to use any or all of a recommended group of farm practices.

4/ Cumulative valence: the degree of influence on a behavior tendency that a respondent feels was exerted by the components of incentives and/or disincentives.

Sociologists suggest that change occurs by the alternation of goals, structures, or processes in a social system (Miles, 1964:13). Change, therefore, from the sociologists' point of view, is basically a group behavioral change--change in group goals, norms, values, relationships, and structures. Cultural anthropologists view it as "spontaneous change" caused by the diffusion process. They suggest that change is inevitable as long as there is contact and when there are elements (culture, facts, materials, social structures) to be diffused. "Diffusion of discovery and invention are the obvious starting points for any study of cultural growth and change, since it is only by these processes that new elements can be added to the total content of man's culture" (Linton, 1963:334). A discovery is described as "any addition to knowledge" and an invention as "a new application of knowledge" (Ibid., 1963:306).

Many economists support a theory of economic determinism. They view man as an economic being and regard his economic need as a motivating basis for change. "The mode of production in material life determines the general character of the social, political, and spiritual processes of life. With change of the economic foundation, the entire immense superstructure is more or less rapidly transformed" (Etzioni and Etzioni, 1966:7).

Interaction among human beings, according to social psychologists, is the basis for social change. Interaction is dynamic--change is its product. Interaction is described as "the process by which people influence one another through mutual interchange of thoughts, feelings and reactions" (Lambert and Lambert, 1966:84). "Behavior X on the part of one person is likely to be followed by behavior Y on the part of another" (Newcombe, 1965:1), and this results in change. Ronald Lippit recognizes three types of such forces:

> (1) Change forces, that motivate people to change by creating dissatisfaction with the status-quos, and favorable judgement of potential future situations; (2) resistance forces, which motivate people not to change, that rise from uncertainty of the unknown and inability to change, and (3) interference forces, which obstruct change without being directly related to it. (Lippit, 1953:6)

According to H. F. Lionberger (1960:chs. 1-3), social factors, such as neighborhoods, communities, family social cliques, reference groups, and formal groups; cultural factors, such as values and attitudes; personal factors, including age, education, psychological characteristics; and situational factors, including farm income, size of farm, tenure status, community prestige, and level of living are among the forces that encourage or discourage changes in behavior by rural people.

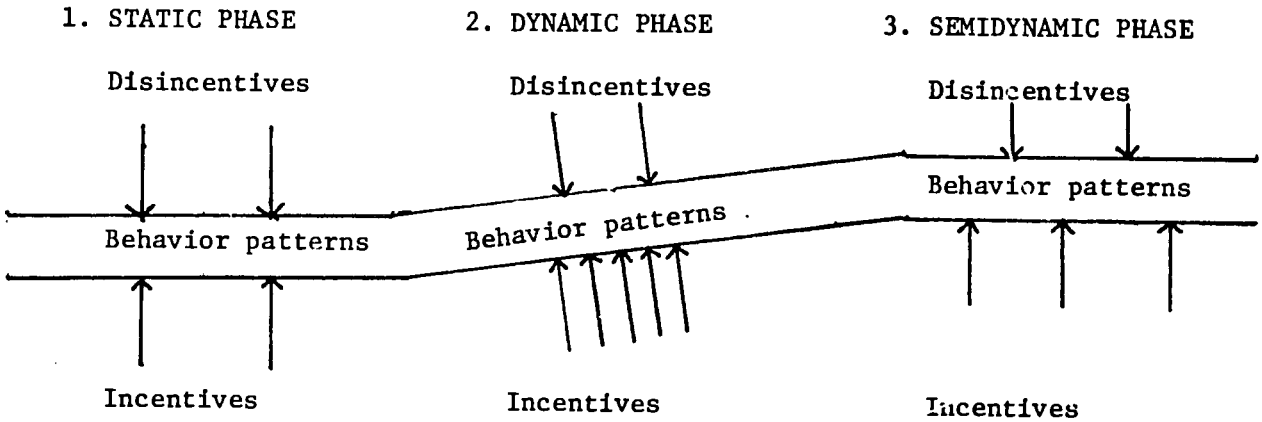
Dealing with the methods of change, Warren Bennis (1961:2) mentions "the law of nonintervention" and "the law of radical intervention". He argues that planned change is "the only feasible alternative to these methods" and defines planned change as "a conscious, deliberate and collaborative effort to improve the operations of a system, whether it be self-system, social system, or cultural system, through the utilization of scientific knowledge."

The foregoing theories and concepts of the behavioral change process are projected from a wide range of vantage points and assumptions. Identifiable in them, however, is an almost pervasive proposition, expressed or implied, that the essence of the behavioral change process is the dynamic interaction of two sets of opposing forces perceived cumulatively as incentives for change and disin-

centives for change. These opposing influences create tensions that motivate action. Each set of influences, at a given time and in a given situation, may consist of certain manifestations of many and various forces. Hence, to identify the referents of these two clusters of opposing influences, and the perceived cumulative differential force exerted by each, is to identify the central dynamics of behavioral change.

We tentatively concluded that the nature and extent of behavioral change in a given situation and time frame will be proportional to the cumulative valence of change incentives and inversely proportional to the cumulative valence of change disincentives that farmers perceive as having influenced them. This proposition may be visually represented by a behavioral continuum with three major phases: static, dynamic, and semidynamic (fig. 1).

Figure 1. Major phases of the behavioral change continuum.



1. STATIC PHASE	2. DYNAMIC PHASE	3. SEMIDYNAMIC PHASE
The force of *incentives* and *disincentives* are equal and opposite, resulting in a static condition.	New forceful program inputs, technology, education, etc., create an imbalance, with the force of incentives being greater than that of disincentives, resulting in adoption of innovations.	Change curve tends to level over time as optimum effect of innovations are achieved. Adoption rates at higher levels require new, advanced technology, education, etc.

At this point, the phrase "interdisciplinary differential behavioral theory" was coined to describe the findings. The embryonic status of our preliminary conclusion, which was based on the theories already considered, made the need for additional supportive theory obvious.

Theories from Supportive Sources

The search for theories to support our preliminary rationale, which was derived from a synthesis of the discipline-oriented theories, was wide ranging and productive. As previously stated, from these theories we derived the central

hypothesis that the core dynamics of adoption behavior consist of the potential innovators' perceptions of the cumulative differential valence of influences in their individual situation for and against the adoption act. With this orientation we began a comprehensive search for potentially centralizing theories. We soon found this relevant proposition:

> Each society can be thought of as a host to two kinds of forces: those who seek to promote change, and those that strive to maintain the status quo. The forces are locked in perpetual combat. The former, trying to throw the latter off balance, to gain the ascendancy; and the latter, trying to prevent this from happening. (Foster, 1962:58-59)

The two foregoing propositions are clearly harmonious. We examined numerous additional sources of theory related to explaining the forces that cause systems--including human, biological, and physical systems--to change. In the following areas we found centralizing theories to support our preliminary theoretical construct: the relationship between human behavior and environment, the law of the minimum and the maximum, Newton's first law of motion, Piaget's explanation of why structures change, and the nature of human needs. A highly briefed and dangerously simplified account of what we found follows.

Behavior and Environment

What is known today about why people behave as they do suggests that man is an independent living system surrounded by an environment with which he constantly interrelates. He is surrounded by other human beings, physical items, social and cultural norms, and economic, technological, and political systems. These environmental forces exert a continuous influence over people's behavior, which in turn, can or may influence the forces. People are rarely in a position to act totally as they choose, because, being social creatures, they do not wish to live alone. Consequently, they are concerned for their environment from both the standpoint of how they may affect it and what it may contribute to their welfare.

One of the assumptions made in science is that the world of man and things is inherently systematic and predictable, and that people generally are not slaves of the forces in their environment; rather, they have the ability to shape them to serve human ends.

> To the extent that relevant conditions can be altered or otherwise controlled, the future can be controlled. If we are to use the methods of science in the field of human affairs, we must assume that behavior is lawful and determinate. We must expect to discover that what a man does is the result of specifiable conditions, and that once the conditions have been discovered, we can anticipate, and to some extent, determine his actions. (Skinner, 1953:6)

Studies of societal structures indicate that cultures (people) tend to institutionalize at least seven primary functional systems: economic, social, political, religious, physical, educational, and more recently, technological. Analyses of the role and functional relationships of these elements indicate that in the present context, people tend to be central among the societal subsystems, simultaneously influencing, and being influenced by, these elements. Environmental factors exert constant influence over people's behavior in varying degrees of favorableness to qualities of living. Hence, regardless of one's

economic and social conditions or the ability to cope with them, survival and progress depend on one's ability to deal with them successfully. Consequently, people are concerned about their environment because physical, economic, and social needs emerge largely from maladjustments between what they want and need and the environmental forces that affect achievement. Two primary alternatives can improve the balance: adjust to and try to improve favorable environmental conditions, and seek to modify "hostile" environmental forces. Science and technology properly applied are basic to this process.

The foregoing suggests a central idea: The behavioral dynamics of the interplay between one's behavior and the environmental elements that create a satisfactory state of equilibrium determine the quantity, quality, and speed of developmental change. Empirical evidence suggests that for positive developmental change, major societal elements must have quality and continuity, function with inseparable interrelatedness, and operate in reasonable balance.

Law of Minimum and Maximum

Biological scientists have long used the laws of the minimum and the maximum, often referred to as "limitational factors", to explain the forces influencing plant growth. Applied to soils and plant growth, this theory proposes that "if one of the participating nutritional constituents of the soil or atmosphere be deficient or wanting or lacking in assimilability, either the plant does not grow or its organs develop only imperfectly" (AAAS, 1972:71-72). In this theory, plant behavior, such as growth and yield, is viewed as the dependent variable in the growth-change process.

This theory can also be applied to human behavior except, of course, that the influencing variables are different. The rationale is somewhat as follows: Like plant behavior, human behavior is the dependent variable. The assumption is that man can influence the economic, biological, and other forms of change to the extent that he controls the forces (nutrients) that influence change and the status quo. In this context, it can be argued that people see one or more inhibitors (limiting factors) and one or more incentives to innovation simultaneously in any given situation; that these variables contain and exert varying force or valence on the dependent variable--human behavior--and that when the deficiencies (inhibitors) are weakened or removed, thus altering the balance or equilibrium of opposing influences, change will occur.

Changes in human behavior then may be expected to be proportionate to the amount of cumulative influence or valance exerted by the change incentives present, less the sum of the counteracting influences of the change inhibitors operating in the situation. This relationship may be expressed by the equation:

$$\underline{BC} = \underline{Iv} - \underline{Dv},$$

in which

$\underline{BC}$ represents behavioral change,

$\underline{Iv}$ = change incentive valence, and

$\underline{Dv}$ = change disincentive valence.

It may be expected, however, that this input-output function will not always be linear. This probability derives from the fact that the nature of influencing variables usually differs by situations, by the order of perceived influences and their cumulative valence, and by the direction of change, whether negative or positive.

Newton's First Law of Motion

Isaac Newton's first law of motion states that "every body perseveres in its state of rest or of uniform motion in a straight line, unless it is compelled to change that state by forces impressed thereon." Some force must be applied to a moving object to make it turn from the straight course it is following. For example, during a change of course, the wing tip on the inside of the turn of an airplane will be down--the one on the outside, up. In each case, a new force is initiated from external sources; namely, change in air pressure resulting from a change of wing angle. Only by presenting the bottom side of the flight wing surfaces to the oncoming air can pressure be differentiated and the plane achieve a turn. As it pushes against the air, the air pushes back, exerting the extra force necessary to turn the airplane from its straight course. The combination of forces for a turn--change--are greater than those for continuing in a straight line or on the present course; thus, change of direction (behavior) results.

Thus, Newton's first law of motion can be applied to human behavior through programs designed to promote agricultural modernization. Like airplanes or cars, people tend to continue in a state of uniform motion (equilibrium) in a straight line, largely because of adherence to custom and tradition, until they are influenced by the introduction of new forces that change their pattern of action or behavior.

In principle, this phenomenon challenges agricultural scientists, educators, and other change agents when they want to repattern people's behavior. They must introduce new influences, not in the form of fuel combustion in a jet engine but in the form of "power" accruing from such potential benefits as new technical ideas, modified physical resources, and institutional arrangements. These must be strong enough to turn the farmers away from their uniform (traditional) motion (behavior), which limited them by adherence to such forces as custom and tradition and a lack of new knowledge, adequate resources, and innovative attitudes.

Piaget's Explanation of Changes in Structure

Basic in Piaget's theory of structural change are the processes of assimilation and accommodation. Every behavioral act includes both assimilation and accommodation, but not in equal proportion. For example, in the early stages of the sensorimotor period, human activity consists primarily of the repeated application of reflexive behaviors. With human development, these activities become differentiated and coordinated and tend toward a state of equilibrium perceived as the compensation for external environmental "intrusion" by means of the activities of the individual (Piaget, 1967:113).

The equilibration process, then, is considered by Piaget to be the major determinant of the development of structures. This does not mean that factors of heredity and maturation, the physical environment, and the social environment are ignored in his theory. He maintains that, while each of these factors is a necessary condition for development, they are neither individually nor as a group

sufficient for the explanation of development. Development is defined by Piaget as "a progressive equilibration from a lesser to a higher state of equilibrium" (Piaget, 1967:4). The stages are conceptualized as levels of equilibrium.

The development of an equilibrium between assimilation and accommodation plays a major role in Piaget's explanation of structural change. He argues that equilibrium is an intrinsic property of all biological and mental life (Piaget, 1967:102), and as such it constitutes ghe basic explanation for structural change. The function of adaptation in general terms is to further enhance survival by achieving "an equilibrium between assimilation and accommodation" (Piaget, 1963:5). Thus, the how of structural change is given through the activities of assimilation and accommodation, whereas the answer to why they change is given through the postulated tendency toward a state of equilibrium.

He argues that all behavior represents an interaction between the intrinsic functions of the organism and the external environment. As a consequence, behavior can never be attributed to either "nature or nurture"; rather, it is always an assimilation of reality to prior schemes and an accommodation of these schemes to the environmental situation (Piaget, 1963:103).

In summary, Piaget suggests that all behavior represents an interaction between internal and external factors, yet none of these factors can individually explain development. Since development tends toward the establishment of an equilibrium of these factors, equilibrium, or more generally the equilibration process, is required for a complete explanation of development.

Theory of Human Needs

In every human and physical situation there are always these components: the facts, people's perception of the facts, their attitude or value judgments about the facts, and their action related to the facts as they perceive them. Probably the most powerful attitudes people hold are those related to what should and what should not be in their situation. Hence, people tend to either approve or disapprove facts (as they see them) in relation to some desirable new condition. The process of merging useful technology from the physical and biological sciences with that from the behavioral sciences and applying the product to the problems of behavioral change is, therefore, the essence of developmental change and the context in which people's needs play the major role. Needs always represent a "gap" between two conditions: what is--current situation, and what should be--value judgments.[5/]

Current educational theory and practice suggest that the concept "need" is used by social scientists and others in at least two major senses: prescriptive and motivational. Use of the concept in a prescriptive sense implies the conditions required to overcome the assumed deficiencies of the current situation and, hence, an obligation to achieve a new, more desirable state of affairs. Under these circumstances, at least three questions may be asked: What objective is sought? Is removal of the identified deficiency necessary to achieve the

---

5/ For a comprehensive elaboration see: J. P. Leagans, A Concept of Needs. Cooperative Extension, Summer 1965, pp. 89-98. J. P. Leagans, Continuing Education: A Fourth Dimension, *In* A new look at progressive education, A.S.C.D. Yearbook, 1972, pp. 267-268. Also, A. Maslow, New Knowledge in Human Values (N.Y.:Harper, 1959)

objective? To what degree is achievement of the objective mandatory or desirable?

Use of the term need in a motivational sense suggests perception of a deficient state which initiates a motive (felt need) and creates a tension that makes a person want to achieve a new condition. It represents a dearth that a person feels must be filled. This use is similar to the concept drive or want, which refers to a bio-psychological state of tension that causes gratification-seeking behavior--when the absence of something stimulates a desire for what will restore equilibrium between one's internal desires and environmental accommodations.

Since people always live in an environment which constantly exerts forces that tend to pattern behavior, human well-being depends on keeping a balance between internal forces produced by human energy (from food intake) and external conditions produced by the environment. Hence, to keep the human system in equilibrium with external systems certain "needs" must be met. Every person is continuously trying in varying degrees to attain those conditions of living that make for satisfaction (balance). To the extent that relationships between individuals and their environment are out of balance, there will be needs. The nature and extent of needs, therefore, depend on the nature and extent of the imbalance. Hence, man's attempts to attain and maintain a satisfying equilibrium represent his real struggle for survival and improvement. People's most critical choices emerge from their perception of three conditions: the actual, the possible, and the valuable. Progressive choices are those perceived to be the most valuable and possible to achieve in a given situation.

Conclusions about Central Theory

Analyses of the arguments and implications of the foregoing wide-ranging formulations led us to conclude that, singly and collectively, they provide clear support to our proposed behavioral differential cumulative valence theory induced from the various discipline-oriented theories.

Briefly stated, this thoery proposes that farmers' adoption behavior is primarily influenced by the creation of an imbalance (differential) between the cumulative valence of incentives and disincentives for adoption perceived by them as exerting primary influence on their behavior. The incentives and disincentives are manifestations of a variety of conditions that farmers see as cumulatively favoring adoption or nonadoption. The adoption step will be taken only when the first condition seems possible and significantly more rewarding than the second.

Encouraged by the results of our search for a central theory to explain the adoption act, we hypothetically accepted the foregoing formulation as supportable, functional, and promising for the design of adoption research and for strategies that promote farmers' technical innovations. Our next task was to construct a paradigm that would accommodate the major elements in a functional relationship to each other, to the whole of the concept, and to the adoption problem.

SEARCH FOR A FUNCTIONAL MODEL

The formulations of a theory, a framework for designing adoption researches and explaining the adoption act, led to the need for a paradigm to functionally express our tentative propositions. Beginning with a concept of models and their use, we searched wide-ranging literature in both the social and biological sciences. This section reports the essence of our preliminary formulations.

A Concept of Modeling

Modeling is not intended to produce a procedure or a recipe for action; rather, the purpose is to design a way of perceiving the major elements in a process as parts of the larger concept, and their relationship to each other and to the problem solution for which they are designed. The purpose is to establish a rationale within which one can integrate and explain his knowledge and hypotheses, develop an ability to process information, and expand a capacity for reasoned thought and a capability for analyzing complex, value-laden problem solutions.

Much of the significance of model-building stems from the close relationship between the clarity of one's concept of a complex process and the objective ability to deal rationally rather than intuitively with its subelements. Model-building, therefore, is a tool for thinking--a shorthand for expressing the critical elements of a process and their functional relationships.

Current efforts to design models for promoting changes in human behavior seem to be anchored to the central question: How can one identify, rearrange, or order the critical variables or forces assumed to be operating at all levels so that the response takes a desirable form? Clearly, further study of this question is needed. Hence, current models, constructs, or paradigms should not be regarded as an ideal part of the process, but rather as tentative guides to systematic conceptual analyses, always subject to revision.

Some Commonly Used Models

Because of the growing awareness of the complex structure of variables commonly involved in adoption behavior, no theory or model has yet been offered by researchers or change agents that seems adequate, even to the designers. Theories and models covering a wide range have been developed in efforts to conceptualize, understand, and explain the process of promoting technical innovations for agricultural modernization. A few of these, in an extremely briefed form, are described here.

Technology Model

This concept is old, but it reemerged, especially in the 1960s, among biological researchers who made breakthroughs in the genetic quality of new and widely promising hybrid seed varieties. The proposal suggests that when powerful new technologies produce such results as the recent hybrid varieties of wheat and rice, the attractiveness of the new technology alone is sufficiently strong to induce wide diffusion, acceptance, and adoption by farmers. Consequently, it tended to be assumed that farmers would use these new seeds and the requisite related parts of the "package" of technology successfully, without such other persuasions as those offered by an organized extension education system. Recently however, this model has proved highly inadequate, especially when the purpose of a program requires action by large numbers of small farm operators rather than by the elite, self-motivated few and some relatively able entrepreneurs.

To expect an uneducated, tradition-bound, subsistence-oriented farmer to be sufficiently self-motivated to understand and effectively incorporate new production technology and its requirements into his long-practiced farming system approaches sheer romanticism.

Powerful new "packages" of production technology clearly are essential to agricultural modernization. They can make profitable adoption possible, but alone they are inadequate to achieve optimum results. They comprise only one of the elements necessary to successful innovation and may be considered an independent variable in modernization and not the dependent variable, as widely assumed.

Economic Model

This model suggests that the economic incentive is not only always present but also provides a sufficiently strong motive to induce farmers to accept and adopt innovations that promise significant economic gain. It is a useful model, but, like the technology model, is clearly inadequate. All farmers do not accept the implicit assumption on which the model rests--that economic gain is the overriding variable in their value system.

Institution-Building Model

This approach suggests that the primary instruments for initiating and promoting progressive change are societal institutions. Consequently, institution building should be the first major step in modernization programs. Institutions clearly are essential instruments in promoting societal change and must be established early in the process; but, like the other models, they are inadequate alone. Since they are designed and managed by people, institutions are instruments subject to the limitations of the people who control them. An institution is primarily a means, a useful instrument, not an end in itself. Viable institutions are essential in modernizing patterns of behavior, once the potential user is educated to develop and manage them for the purpose of achieving progressive change.

Equilibrium Model versus Conflict Model

In this approach, equilibrium is regarded as an instrument for achieving balance, while conflict is an instrument for applying pressure. It is conceivable that some combination of these divergent approaches may be useful, and in fact operate in most models as a force for motivating people to adopt new patterns of behavior.

Communication Model

The main steps in the "classical" model of the agricultural innovation process generally consist of making a new technological discovery, delivering it to potential adopters through various communication channels, and then its being understood and acted upon by recipient farmers. In the 1960s, accumulated knowledge about the complex adoption act began to reveal inadequacies in this model, especially the simplistic attention to the essential, overt act. This model provides the skeleton but not the body; the macro-, but not the cluster of micro-variables affecting adoption. Among the conceptual and methodological considerations needing more attention are:[6/]

6/ For a similar appraisal of this model and related issues see: M. Rogers, Where We Are in Understanding Innovation. (Paper for East-West Commun. Conf. on Communication and Change: Ten Years Later, Jan. 1975).

- Greater process orientation continued over time versus a "one-snapshot" orientation.

- Greater attention to causality versus a pro-"trickle-down" assumption.

- Recognition that adoption requires a physical or overt act in addition to a favorable socioeconomic and sociopsychological attitude.

- Recognition that the physical or overt terminal phase of the adoption act requires ready availability of production requisites and related services to make this critical step possible, practical, and rewarding for the adopter.

Problem-solving Model

This approach has long been promoted and widely used in various situations. Supported by John Dewey and many other leading researchers, it emphasizes problems, not subjects. This model tends to be interdisciplinary and hence can accommodate elements from many others. Its flexibility is extensive and promising. Its usefulness rests on the following major steps:

- Hypothesize an explanation of the troubled situation.

- Test the hypotheses with logic developed from the best data available and put the results into a model.

- Formulate hypotheses for solving the problem on the basis of alternative solutions.

- Test the proposed solutions by implementing programs and evaluations of the consequences, including both means and ends.

In summary, we concluded that each of the foregoing constructs and several others we examined have significant roles to play in strategies designed to stimulate farmer adoption of useful technologies. Alone, however, none of them appear adequate to accommodate or explain the growing cluster of variables manifested by the problem of moving farmers from a traditional, subsistence-oriented production system into a modern, scientific, market-oriented agriculture.

The challenge, then, was to design a conceptually new interdisciplinary model which, at least hypothetically, would accommodate the increasing cluster of complex variables, critical to the design of ongoing researches and strategies, for promoting farmer innovation. The task, too, was to reflect our "interdisciplinary differential behavioral model". A brief representation of the preliminary formulations that emerged from our investigations follows.

INTERDISCIPLINARY BEHAVIORAL DIFFERENTIAL MODEL

One of the most profound discoveries about the nature of conditions conducive to changes in human behavior, especially when related to technical innovations by farmers, is that the laissez-faire approach will not do the job. Leaving people to their own initiative and resources is not enough; and, diametrically, external stimuli must be introduced to activate people's natural tendencies to improve themselves and their living conditions. To accelerate the proper use of farm production technologies requires intervention into the lives and farming systems

of potential innovators. This is one of the most delicate and significant of all social, economic, and political processes because, when successful, it repatterns the lives of respondents.

The primary problem in the intervention process is designing and executing effective strategies. Creating internal (mental) and external (environmental) conditions that influence optimum innovative behavior is a central task for the promoters of the newly emerging "science of agriculture modernization", especially in third-world countries.

The design and execution of intervention strategies that trigger the adoption act are interdisciplinary and immensely complex because influencing the human mind is often a circuitous process. Difficulties associated with a number of other aspects of the process also complicate it, for example: identifying the most significant objectives and the technology to obtain them; the heterogeneous characteristics of adult audiences; the intricacy and high cost of communication channels between influencers and influencees; freedom of farmer respondents to believe what they wish about propositions and to respond accordingly. Wide social and political acceptance of the intervention process underlies all successful efforts to modernize agricultural systems.

At this point, three critical tasks were posed: to design an interdisciplinary paradigm that would reflect our central theory as described in the foregoing section; to develop a research design that would identify and relate the central influencing macro and micro variables and thus reflect our central theory; and to design an intervention strategy for helping potential adopter-farmers identify, understand, and appraise the differential cumulative influence of variables that they consider favorable and unfavorable to the adoption act. The next section summarizes the actual and exemplary manifestations of our paradigm formulations.

Theory Model[7/]

The foregoing sections make it clear that social scientists and other have made wide-ranging efforts to develop theories to identify and explain the relationship and the use of innovative ideas. However, most of them understandably tended to limit explorations to their respective areas of professional interest. The natural result has been a strong, discipline-oriented approach; hence, attention to a functional or problem-solving approach to adoption behavior has been inadequate.

Discipline-oriented theories and models increasingly appear to be inadequate to explain the modern technically charged cluster of variables influencing innovative farmer behavior. Recognizing the shortcomings of such approaches, C. M. Coughenour points out that:

7/ Special acknowledgement is extended to Dr. Unal Buyukcolak Bakker, my latest post-doctoral student and research assistant, for help in the preparation of this section.

> Research on diffusion and on other substantive problems indicates that significant detail is being ignored or glossed over in the overly simplified approach engendered by the sociopsychological approach. In the first place, it is apparent that adoption should be conceptualized as a complex set of processes rather than as a single or unitary one. (Coughenour, 1968:5)

T. Parsons and N. J. Smelser go further in appraising the traditional, discipline-oriented approach, suggesting that:

> If economics is to retain and build on the theoretical achievements of its great tradition and at the same time achieve greater empirical determinancy, it must extend beyond its traditional range of theoretical interests and resources. Conversely, if sociology, social anthropology and social psychology are to develop sophisticated bodies of theory, they must take advantage of the model which has ordered an extremely important range of determinants of human behavior which impinge directly on their work at many points. (Parsons and Smelser, 1956:309)

These appraisals express the consensus of many social and behavioral scientists that adoption researchers should not overlook what lies beyond disciplinary boundaries. Indeed, current literature frequently acknowledges the need for: a more interdisciplinary approach to theory building, the design of models for researching adoption behavior, and strategy formulations to influence technical innovations by target audiences. For example, John W. Mellor suggests that farmers' adoption of new technology and implementation of the necessary programs depend on several factors that are major prerequisites of technological change in agriculture:

> (1) An incentive system that encourages acceptance of innovations; (2) a set of improved production processes created for local conditions; (3) an educational system to teach farmers how to choose and adapt technology to specific conditions; and (4) efficient supply to farmers of added inputs in which technological change is embodied. (Mellor *et al.*, 1968:30)

Researchers in the adoption-diffusion process should be aware that numerous variables usually intervene and that they are highly situational in kind, relationship, and the relative influence they exert on the adoption behavior of respondents.

Just as discipline-limited approaches now appear to be inadequate alone, so may the emerging interdisciplinary formulations also be insufficient. The first is needed to validate the latter; the latter is required to put the "pieces" of the first together in a functional strategy. As always, it is not the chicken *or* the egg, but a proper combination of both that is necessary for a functional explanation of the complex adoption act. Indeed, the theory we evolved is an attempt to accommodate these factors: the wide-ranging, discipline-oriented variables commonly associated with adoption behavior; the interrelationships among these and environmentally oriented independent or influencing variables; the intervention effect caused by the cumulative valence (influence) of these variables reflected through two intervening variables described as the incentives and disincentives related to adoption behavior; and the differential cumulative valence of incentives and disincentives that farmers see as determining their final decision whether to adopt a technical innovation.

We have tentatively chosen the term "interdisciplinary behavioral differential model" to describe our proposed theory of the process through which innovative behavior may be researched, initiated, energized, and directed. A hypothetical model of the theory is given in figure 2.

The design of this model involves a wide range of theoretical considerations from various interdisciplinary fields. Many of these considerations have been summarized in the preceeding sections and are employed to formulate the independent variables (major interdisciplinary dimensions of environment). Investigation of all the relative effects of these environmental conditions on adoption behavior is desirable.

Since these factors vary in relevancy to different innovations under different circumstances, it is necessary to employ only those that are primary and most relevant. Our current adoption research has provided fairly conclusive evidence to formulate three primary environmental factors (independent variables) as economic, social, and communicational. Also, current research techniques create limitations on the number of independent variables that can be successfully investigated. Our model includes five major components along a unidmensional perspective:

- General environmental factors related to adoption of agricultural technology: technological, economic, social, physical, etc.
- Primary environmental factors related to adoption of innovations by farmers: economic, social, and communicational.
- Primary mental set factors (intervening variables) related to adoption of innovations: incentives and disincentives.
- Adoption behavior-change factors as a central focus (dependent variable): static, dynamic, and semidynamic.
- Adoption/nonadoption as observable results of adoption behavior change.

The third component in the model was formulated as a result of our efforts to bring more conclusive answers to the adoption research questions and problems. The model also includes a network of relationships that exist among the major components. These relationships are illustrated by arrows with the following meanings:

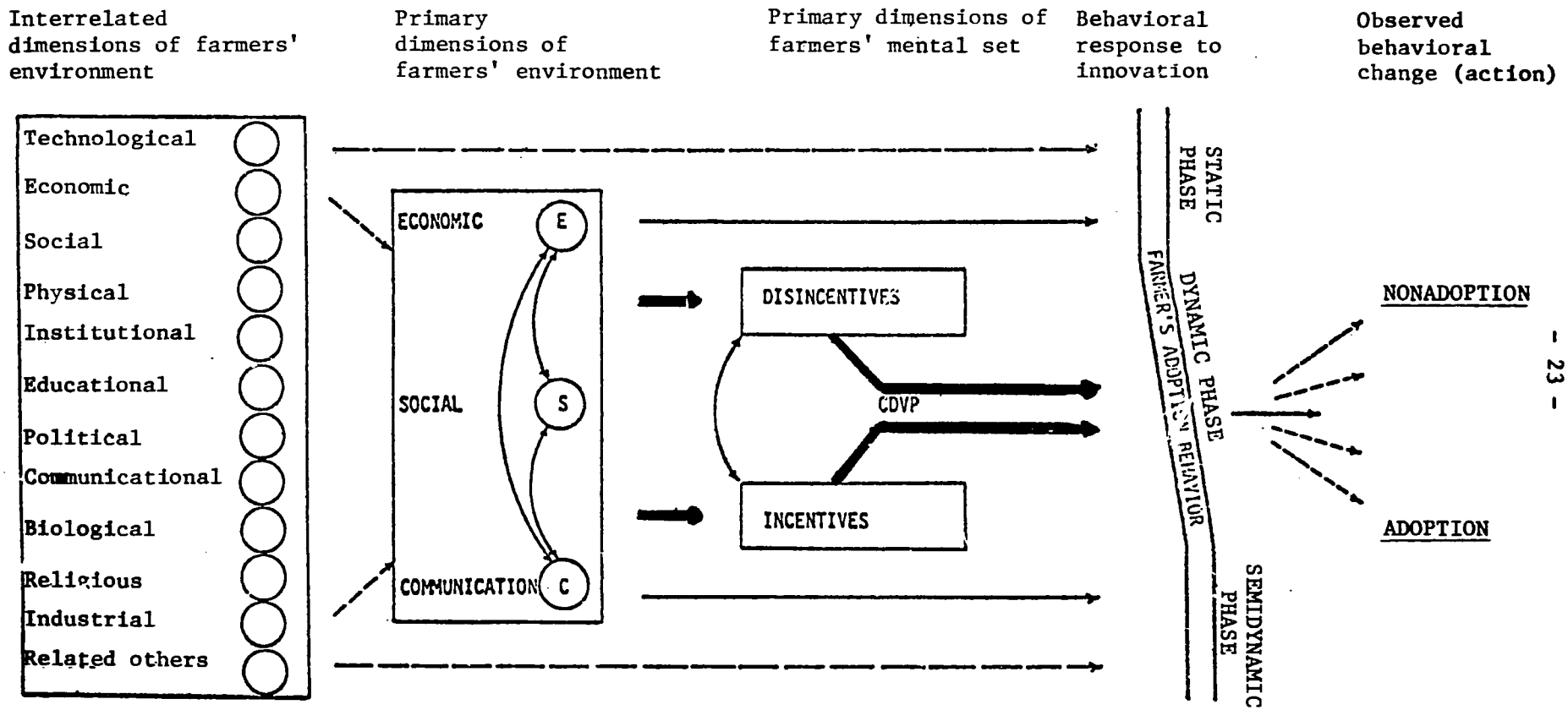
Interrelationships between two major factors

Direct and primary causal relationship (influence) of the prior variables on the following variables

Indirect and secondary causal relationship of the prior variables on the following variables

The rationale and the theoretical and empirical relevancy of these three major components and the relationships in the model are explained in the following sections.

Figure 2. Hypothetical interdisciplinary behavioral differential model of farmer response to technical innovations



Basic Rationale

The need for a new formulation of central theory to explain the nature of adoption behavior, how innovative changes in behavior get started, are energized, directed, and supported arises largely from these sources: the growing number and essential interrelatedness of technically charged variables involved in optimum use of modern production technology by farmer respondents; the widely recognized inadequacy of the traditional and largely discipline-oriented models advanced to this time; and the consequent need for a more interdisciplinary construct that can accommodate a wider range of significant variables and, hence, provide a more functional theoretical framework for designing researches, analyzing data, and deriving implications for policy and program decisions.

In short, we saw a critical need to synthesize from the extensive body of empirical data about the nature of behavioral change and the scattergramlike theories purported to explain the innovative act, a more comprehensive and functional theoretical framework for researching and explaining the complex troubled situation now characterizing our state of knowledge about strategies for accelerating the use of new agricultural technologies by farmer respondents. In this venture we were guided by several fundamental assumptions--among them these primary propositions:

1. Human beings are able to educate themselves and alter their physical environment, and they constantly try to achieve and maintain a balance between the internal forces of inherited and developed human traits and the external forces of the environment. This adjustment requires interaction between internal and external forces and results in behavioral change.

2. All social, economic, physical, technical and political systems tend to be interrelated. Agreement or disagreement about why certain units exist and function as they do are largely based on value judgments. Developmental change is not achieved piecemeal, by any single element, or in a vacuum. There is interdependence, both perpendicularly and horizontally, among all developmental resources and their use. These usually involve a complex variable map.

3. People live in a multifaceted environment and are usually subject to a galaxy of forces, their response to which patterns their behavior as individuals, groups, or governments. This pattern of behavior determines the nature and quality of their living and their livelihood.

4. Behavior change conditions and in turn is conditioned by patterned relationships in economic, social, and political realms, such as institutional structures, available technology, economic resources, and the allocation of resources which make change possible and valuable. Hence, the focus must be on changing people, institutions, and related instruments conducive to modernization. These points of emphasis are inseparably related.

5. Behavioral change results from the interaction of two sets of opposing forces--change incentives and change inhibitors--which creates the tension-motivated action that leads to change. Each set at a given time and in a given situation may be a manifestation of one or more of a variety of forces. The cumulative differential valence (influence)

exerted by the interaction of these sets of forces shapes and controls the nature of behavioral change.

6. To change the balance or valence of cumulated internal (human) and environmental forces toward innovative behavioral change requires intervention from without or the introduction of new forces for change, such as new technology, new social institutions, extension systems, or production requisites, designed to influence change in desirable directions.

7. Changes in behavior patterns are the ultimate determinants of the quantity, quality, and speed of progressive innovation. They are the ultimate dependent variable, that is, people are the "gatekeepers" in the innovative process, especially in free-choice societies. The use of technology and other means, therefore, is dependent upon understanding, acceptance, and application by those in a position to use them, and hence should be viewed as an independent, not a dependent, variable in the change process.

The foregoing propositions are supported in the work of W. W. Reeder, who has studied many kinds of behavior with a focus on reasons that enter into decision-making. A summary of certain of his central findings are as follows (Reeder, 1976:1-23):

1. Each person in every decision-making situation has a cluster of reasons. A population of individuals will have a cluster of 10 to 15 most frequently used reasons.

2. Each problem, being unique and having a unique cluster of reasons, requires a separate diagnosis. The findings for one behavior will not completely explain another.

3. A socioeconomic characteristic relevant to a given behavior will have a cluster of meanings in relation to that behavior and a different set for some other behavior.

4. Objects in the environment relevant to a given problem will also have a cluster of meanings related to that problem.

5. Individuals in a community will vary greatly in how they perceive what is presumably one set of environmental conditions and program components.

6. An individual brings an array of beliefs and disbeliefs about the referents or elements involved in any decision-making situation.

7. A decision-maker's response to a given situation will be so stereotyped that his attitudes and nonverbal behavior will nearly always be consistent.

8. One's beliefs and disbeliefs about a situation become one's facts about it and therefore become one's justification for it.

9. Beliefs, disbeliefs, and social acts interactively influence one another. Decision and action are based on belief and disbelief, but as one acts, so one also comes to believe.

In the development of our theory model, four central questions guided our efforts: Whose behavior is to be changed at both the micro and macro levels? In what ways should current behaviors be modified? What are the forces influencing behavior at a given time and place and considered to be incentives or disincentives for change? What can be done to increase the cumulative force of incentives to change, and simultaneously, weaken the influence of disincentives to change behavior? Our theory model was induced from the foregoing rationale.

Examples of Paradigm Development

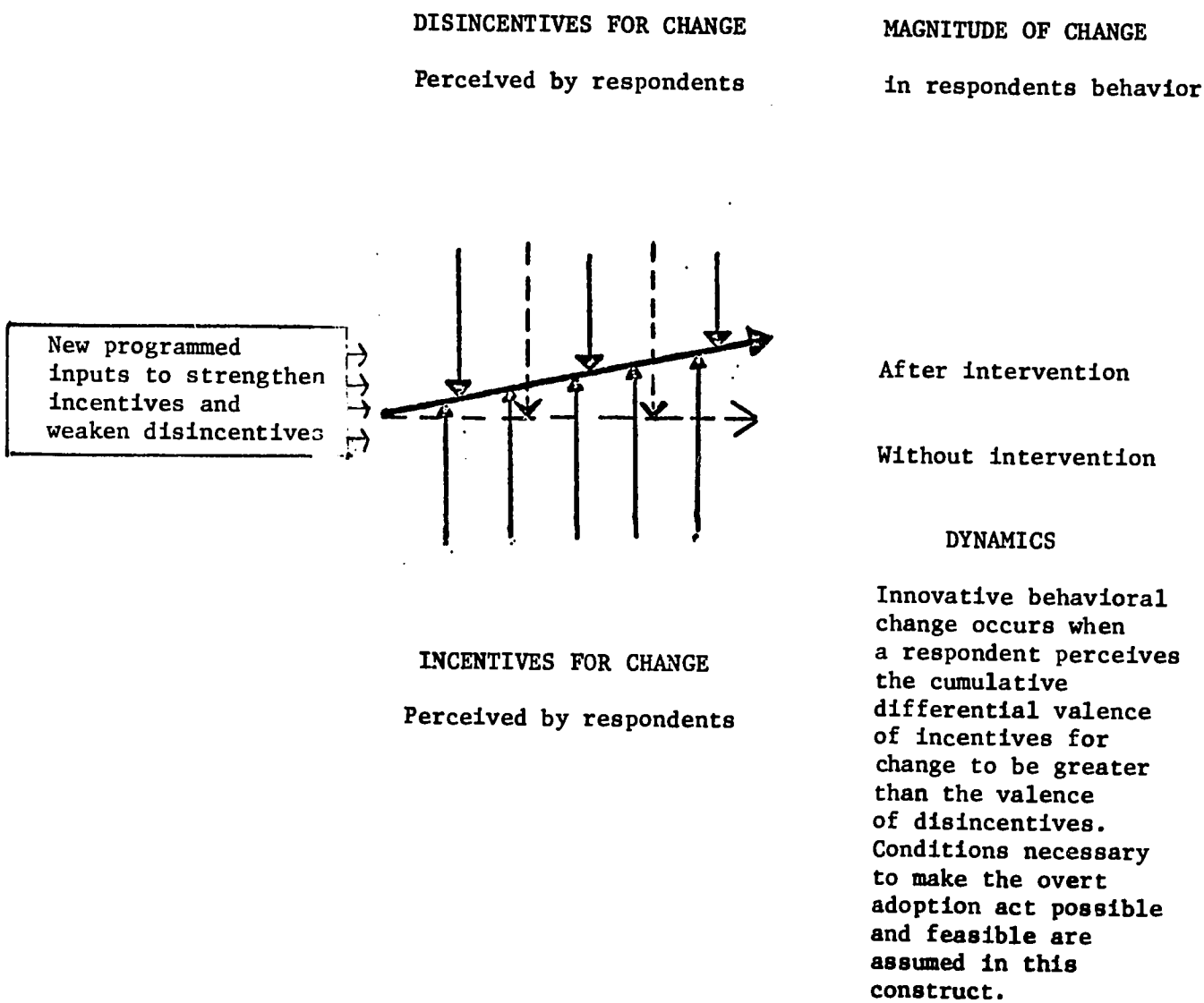
These formulations are presented in what we regard as a developmental sequence, broadly representing the emergent period of our work. Two stages on the developmental continuum are illustrated: the hypothetical--a paradigm of behavioral change, based on our extensive review of diffusion and adoption researches and the literature that explains the nature of human behavioral change (fig. 5), and a paradigm of adoption behavior change, based on literature that examines why people change their behavior patterns (incentives and disincentives), and on the findings in our initial field researches which utilized the incentive-disincentive model in the design of methodology (fig. 6). A cross-cultural analysis was made of the primary field data collected from six different cultures in seven different studies (table 1).

A general description of the models may help the reader understand them. First, each of the constructs has three phases: static, dynamic, and semidynamic. Phase 1 depicts a static behavioral situation assumed to exist before incentive-oriented programmed inputs are introduced--a condition that generally prevails before public programs are started. Such an equilibrium or status quo exists when the cumulative behavioral tendencies of people influenced by the cluster of acknowledged change incentives are equalized and, consequently, offset by an equal force exerted by an opposing cluster of perceived change disincentives. When the valences of these forces for and against behavioral change are judged by respondents to have little or no differential, and thus to offset each other, a static or status-quo situation prevails.

To create a dynamic situation (stage 2 in paradigms) requires introducing enough change incentives to create an imbalance--or a greater force for behavioral change than is exerted against it by the existing disincentives. To create such an imbalance and thus cause behavior to change, at least four major steps are necessary: through programmatic designs, introduce a cluster of forceful new incentives for change; strengthen those incentives already present; improve the complementarity of the change incentives; and weaken or remove the change disincentives that respondents regard as inhibitors of change. These processes are educational, involving a wide range of content.

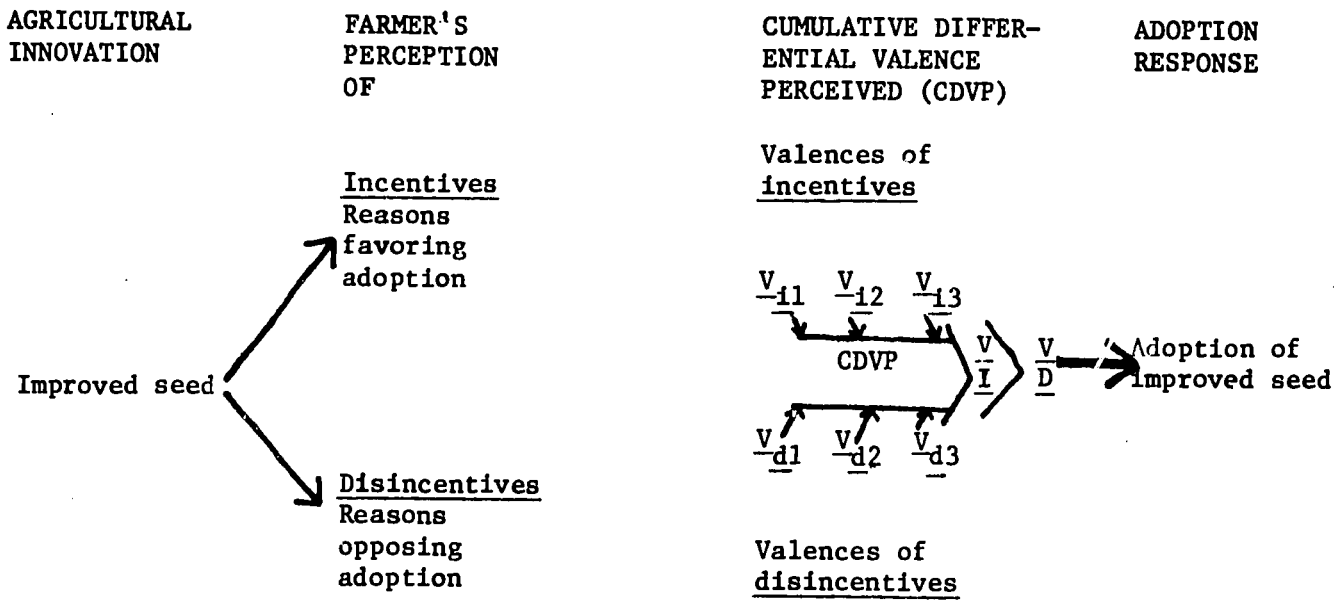
The rates of change, illustrated by the rising behavioral curve in phase 2, is assumed to be largely determined by the number and kinds of change incentives introduced, the perceived valence of these incentives singly and cumulatively as reflected by anticipated moves toward attaining change objectives, the attainability and complementarity of the inputs, the speed with which production inputs are introduced, the effectiveness with which the newly introduced incentives are internalized by respondents, and the magnitude of the differential cumulative valence between incentives and disincentives as perceived by respondents. A hypothetical representation of the dynamic phase isolated from the general framework is given in figure 3.

Figure 3. Visual representation of the cause-effect process in the dynamic phase of the interdisciplinary behavioral differential model.



The dynamics of response to the cumulative differential valence of incentives and disincentives perceived to be associated with a specific technical innovation are illustrated in figure 4.

Figure 4. Dynamics of behavioral response to the cumulative differential valence of incentives and disincentives perceived by respondents to be associated with a specific innovation.



The dynamic process involved in this phase is a primary result of the cumulative differential valence perceived (CDVP) by the farmers. It was suggested earlier that the valence of each incentive and disincentive in opposite directions influences the adoption behavior. Thus, the adoption response is a result of the differential force (influence) between the accumulative valences of these two forces. In a mathematical concept, the change (adoption response) can be formulated as:

$$\underline{V_I} = \underline{V_{i1}} + \underline{V_{i2}} + \underline{V_{i3}} + \ldots + \underline{V_{in}}$$ $\underline{V_I}$ = accumulated valence of incentives perceived

$$\underline{V_D} = \underline{V_{d1}} + \underline{V_{d2}} + \underline{V_{d3}} + \ldots + \underline{V_{dn}}$$ $\underline{V_D}$ = accumulated valence of disincentives perceived

$\underline{V_I} < \underline{V_D} \longrightarrow$ nonadoption

$\underline{V_I} = \underline{V_D} \longrightarrow$ static adoption

$\underline{V_I} > \underline{V_D} \longrightarrow$ adoption

Phase 3, the semidynamic phase, suggests that a positive, innovative behavioral trend tends eventually to become a static situation. However, it remains at a higher level of cumulative behavior change than in phase 1, and the upward trend continues with a slight incline. This behavioral pattern results from accumulation or a multiplied effect, that is, when a good idea becomes widely accepted, it tends to slowly diffuse by its own merit. This situation occurs when various program inputs gradually reach optimum levels of effect. To redynamize the situation at this point requires introducing advanced technological elements and related change incentives with greater cumulative valence or "pull power" than those in the current situation. To increase the incline of the behavior curve also requires introducing other incentives to further minimize the valence of change disincentives. In this process, the role of technology, education, and related factors is to change the semidynamic situation into a continuously dynamic one (phase 2) through the influence of new, required elements, which increases the cumulative valence of incentives, while simultaneously reducing the total valence of disincentives as seen by respondents.

The behavioral pattern in each of the three phases of the paradigm is viewed as an overall manifestation of variations perceived by respondents in the cumulative differential valence or strength of incentives and disincentives influencing their response to proposed technical innovations. In brief, the nature of the three phases is about as follows:

Static phase: A cluster of incentives and disincentives are seen as exerting essentially equal amounts of valence, force, or importance. Hence, the behavioral pattern remains in a passive or status quo state.

Dynamic phase: This is the primary concern of professionals who promote all forms of innovation. To activate the process, a cluster of influence variables, such as technology and education, must be introduced at levels of intensity sufficient to imbalance the force of existing behavior influencers and, thus, trigger innovative responses. As previously mentioned,

the required disequilibrium can be created and sustained by four kinds of action: Introducing forceful new incentives, strengthening the incentives already present, improving the complementarity of incentives, and weakening or removing the force of disincentives. Education is required for these steps.

Semidynamic phase: This phase assumes that a given cluster of actions eventually reach optimum levels for effecting further progress; that is, large numbers, but usually not all, of the respondents increasingly over time adopt changes and, additionally, the capacity for inputs is reached. At this point--commonly requiring from a few years to decades to achieve--the slant of the behavioral curve tends to decline, although it remains somewhat inclined, owing to the multiplied effect of inputs, and higher than at the beginning of the dynamic phase. To redynamize this condition, new and more advanced, necessary behavioral influences must be introduced into the situation (see figs. 5 and 6).

In summary, these three phases describe our central concept of an intervention strategy that will move farmer response to available modern agricultural innovations from a static situation to a dynamically progressive pattern of adoption behavior and will sustain this condition at optimum rates of rising innovative response to a time when an agricultural production system may be described as optimally modernized. We believe the time-frame normally required for such an achievement spans decades. As with other developments, we consider agricultural modernization a cumulative process: at any time and place the stage of development is relative, not absolute, and hence always open to the introduction of new and more-advanced influences on production.

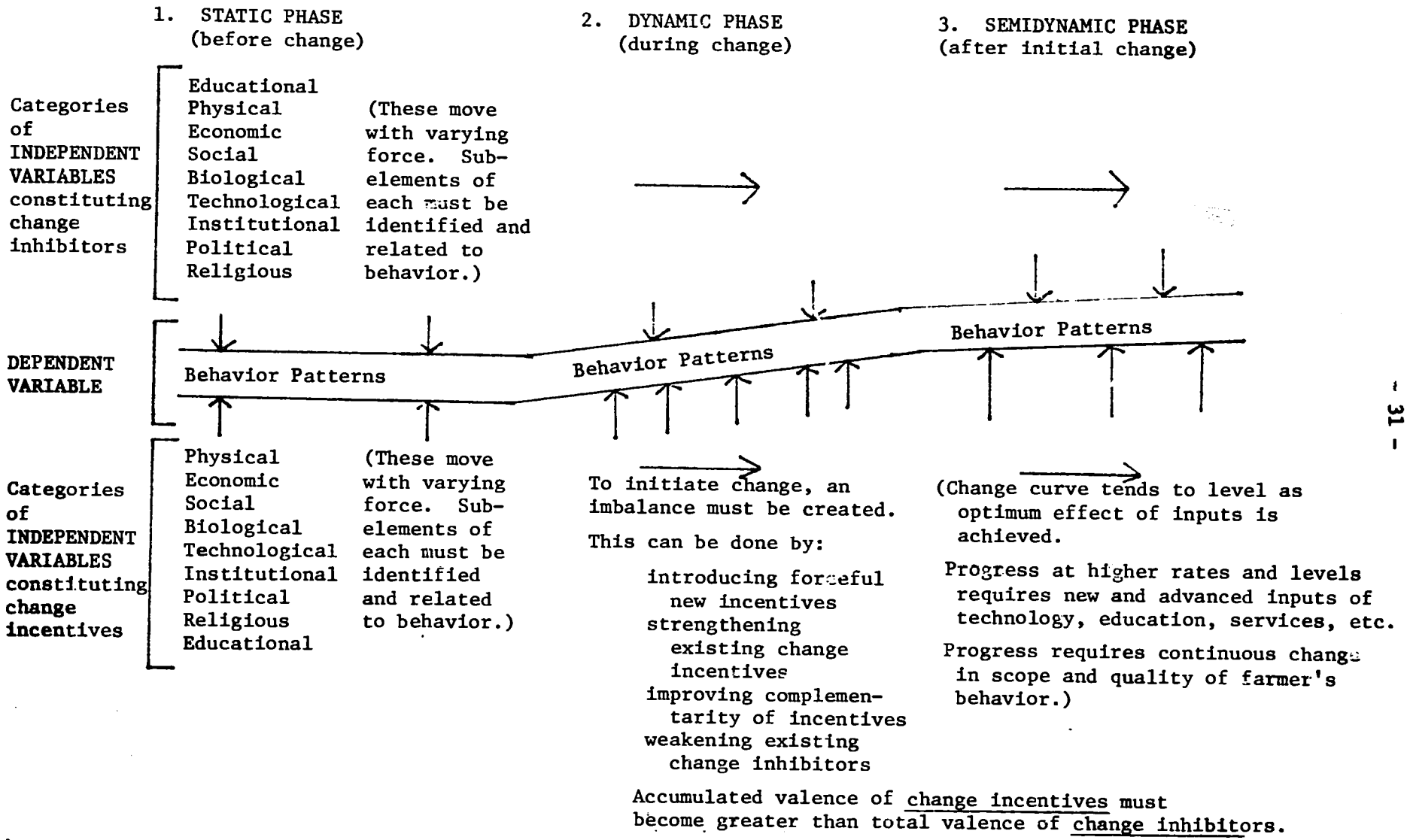
Unlike academics, who organize around activities, hierarchies, departments, and disciplines, farmers organize around their work problems. Since farmer respondents constitute the ultimate dependent variable in the agricultural modernization mix, they must make the final integration of a wide range of factors and their individual farming systems. They must make the pieces function together. This task involves the essence of making decisions about adoption behavior.

We have concluded that the interaction between the incentives and disincentives in the three progressive phases of our model and the consequent perception by respondents of a cumulative valence differential between them constitute the central dynamics of behavior change related to technical innovations. Consequently, we believe the proposed paradigm is at least indexical to a critically needed modern, interdisciplinary, problem-focused theory for researching and explaining adoption behavior and for strategy building to shorten the time span between knowledge availability and its effective utilization by farmer respondents.

Some Central Points about the Paradigm

The foregoing paradigm rests first, on the assumption that the essence of promoting technical innovations by farmer respondents is the process of synthesizing useful technology from physical and biological sciences with that from the behavioral sciences and applying the results to the problems of planned agricultural modernization, and second, that the behavior of farmers is central in the process. Hence, the model is posed as a framework of theory for research design and for programming developmental change.

Figure 5. Hypothetical paradigm of interdisciplinary behavioral differential theory.*



* Derived from researches on adoption behavior and literature on the nature of human behavioral change.

Figure 6. Semihypothetical paradigm of interdisciplinary behavioral differential theory.*

Extension education changes the "valence" of these

1. STATIC PHASE

Traditional value
Low education
Lack of physical resources
Low technology
Low economic status

CHANGE INHIBITORS

PEOPLE'S BEHAVIOR

CHANGE INCENTIVES

Innovativeness, etc.
Rising education
Desire for social improvement
Modern technology
Desire for economic gain

2. DYNAMIC PHASE

Traditional value
Low education
Lack of physical resources
Low technology
Low economic status

CHANGE INHIBITORS

ADOPTION BEHAVIOR

CHANGE INCENTIVES

Innovativeness, etc.
Rising education
Desire for social improvement
Modern technology
Desire for economic gain

+ + + + +

- *Well-Designed Program*
- *Improved Communication*
- *Increased Technology*
- *Expanded Opportunity*
- *High Staff Competency*

3. SEMIDYNAMIC PHASE

Traditional value
Low education
Lack of physical resources
Low technology
Low economic status

CHANGE INHIBITORS

PEOPLE'S BEHAVIOR

CHANGE INCENTIVES

(Change curve levels as optimum effect of inputs is achieved.

Progress at higher rates and levels requires new and advanced technology and education.

Progress requires continuous change in scope and quality of people's behavior.)

* Adapted from: J. Paul Leagans, "Extension Education and Modernization", in Behavioral Change in Agriculture: Concepts and Strategies for Influencing Transition, (J. P. Leagans and C. P. Loomis, eds.), p. 126. (Cornell Univ. Press, 1971). Derived from literature on why people change behavioral patterns, and from findings in our initial field researches on adoption behavior, where incentive-disincentive model was used in methodology design.

Table 1. Summary of findings of perceived valences related to incentives and disincentives in 7 adoption research studies*

Receiving highest valence scores	Salvi (U.S.A.) 1971	Lawdermilk (Pakistan) 1972	Dwarkinath (India) 1973	Sharma (India) 1975	Teasart (Thailand) 1976	Misiko (Kenya) 1976	Buyukcolak (Turkey) 1977	Results t/
Incentives								
Availability of tech. guidance	S	S		S	S	S	S	6/6
More income	S		S	S	S	S	S	6/6
Availability of prod. inputs	S	S	NS	S	S	S	S	6/7
Used by neighbors	S		S	S	S	S	NS	5/6
Availability of credit	S	S		S		S	NS	4/5
Increase in crop yield	S		S	NS		S	S	4/5
Availability of irrigation		S		S	S			3/3
Prevention of loss			S	S	S			3/3
Better quality grain		NS	S		S		NS	2/4
Recognition in community	NS						S	1/2
Matures early				NS		S	NS	1/3
Disincentives								
Lack of technical guidance	S	S	NS	S	S	S	S	6/7
Lack of production inputs	NS	S	S	S	S	S	S	6/7
Lack of credit	S	S	S	S	NS	S	S	6/7
Lack of knowledge	S	S	S		S	NS	S	5/6
Very expensive	S		NS			S	S	3/4
Poor quality			NS	S		S	S	3/4
Lack of irrigation		S		S	S			3/3
More labor required		S				S		2/2
More disease problems						S	S	2/2
No real benefit			S			NS		1/2
Extensive management							NS	0/1
Very complex to understand			NS			NS	NS	0/3

S = significant
NS = not significant

t/ Numerator = number of studies with significant findings.
Denominator = number of studies that evaluated validity of the variable.

*/ This table was constructed through a comparative analysis of research studies, operationalizing incentives, and disincentives in 6 different cultures. The cross-cultural validity of each incentive and disincentive is shown in the last column in the table (Bakker, 1977:31).

The problem for students of agricultural development is that of inducing from diverse points of view an understanding that can be synthesized into a model with the capacity to accommodate most of the complexities of influencing adoption behavior Such a model should include the role and functional relation of all the various and related forces that affect the adoption behavior of farmers.

It can be understood that within the context of agricultural development, the term "adoption behavior" has a set of specific referents--reasons for action. Adoption can be thought of as both a mental process and a physical act--symbolic and overt. In both cases it refers to the initial trial and continuing use of an innovative agricultural product or practice. The referent of behavior in this instance is intentional action on the part of an adult. Used as a compound term, adoption behavior can be understood to mean a process by which a farmer carries out his intention to use an agricultural innovation.

The model assumes that the farmers' change in behavior is the ultimate dependent variable in the process of adoption. It proposes that the farmers' adoption behavior is influenced by an imbalance between the perceived and measurable cumulative valence of the incentives and disincentives for behavioral change (adoption) by a particular person in a specific environmental situation.

For practical purposes, the terms <u>incentives</u> and <u>disincentives</u> can be considered the reasons why a farmer decides to adopt, or not to adopt, an agricultural innovation. For the purpose of definition, an incentive is "any factor perceived by a farmer as a motivation to adopt an agricultural innovation." Disincentives, then, are "any factors perceived by a farmer as inhibitors to adoption of an agricultural innovation." They include a large number of factors that are perceived as important.

The valence of an incentive or disincentive refers to its strength as each farmer sees it. If, for example, the valence of each incentive and disincentive is given a value by the respondent on a three-point scale, their relative cumulative valence or weight can be computed. By so doing, it is possible to estimate their perceived relative importance or their differential force in the eventual adoption or nonadoption of an agricultural innovation.

In this context, the theory supporting the behavioral differential model suggests that the primary factors influencing adoption of agricultural innovations are not the social, economic, psychological, and communicational variables as such. Rather, the total situation created by the combination of these and other factors establishes conditions that constitute incentives and disincentives perceived by the farmer as determining his adoption or nonadoption response to influences.

The paradigm further assumes that, since the traditionally used variables individually explain only a portion of the symbolic element of adoption behavior, using them alone or in combination to provide information for predicting farmers' adoption behavior is inadequate and therefore risky. The force of these variables is mentally integrated into, and therefore reflected through, incentives and disincentives for behavioral response. When one has identified the incentives and disincentives and their resulting cumulative differential valence as perceived by the farmers in question, one then has functional information for predicting the pattern of adoption behavior and for designing strategies to influence innovative change.

Our major concern was to develop a theory, and a research strategy to implement it, that would usefully identify the manipulatable variables--those that policy makers and programmers could significantly influence or usefully control. Within this framework, we thought it important to identify the sources and nature of variables that farmers believe had a major influence on their adoption behavior as well as the flow of technology through the several organizational levels. Specifically, our interest focused on innovative ways to examine the major decision intersections in the linkage system, especially the last one--the farmer and agricultural technology.

Our concept in model form reflects a new compilation and relationship of variables seemingly important in the adoption process. This was a bold research undertaking. Certainly we have not finished it; our proposal needs much further testing. But from what is already done, our work appears to have the essential qualities in both theory and application that warrant high confidence in its capacity to guide research and to provide a functional framework for explaining the technical innovation process. The research model with evidence of its functionality is presented briefly in the next section.

Research Model

The formulation of a central framework for explaining adoption behavior led to the problem of structuring a research model to set the guidelines for further researches.

Considering the assumptions of the theoretical framework, a useful research model should provide empirical evidence of the relationships between the proposed variables, causal associations of these variables, and the predictive value of the major variables in the model. Furthermore, the research model should accommodate interdisciplinary factors. This meant that, in different research situations or within cross-sectional studies, various relevant interdisciplinary factors could be made operative within the model. Our research model involved these considerations, being designed to accommodate the specific assumptions on which the interdisciplinary differential behavioral paradigm rests. The major assumptions of our proposed research model are:

- Change in behavior is influenced by several interdisciplinary factors in a person's internal mental set and external environmental situation.

- Internal influences are the specific forms on one's mental set (knowledge, attitude, skills) and perception of the relative accommodating importance (valence) of critical external factors in one's environment. People mentally articulate these specific factors in two forms: reasons favoring behavioral change (incentives) and reasons against behavioral change (disincentives).

- External influences are those interdisciplinary factors found in the biological, educational, economic, communicational, industrial, institutional, physical, psychological, political, religious, social, technological, and related dimensions of one's environment.

- The behavioral effects of the internal and external factors perceived as being influenctial are "intercepted" and modified by the valences of incentives and disincentives, eventually determining at least three phases of behavior: static, dynamic, and semidynamic.

- The two sets of perceived reasons for behavioral responses appear with different degrees of relative importance (valence) within each set, and the valence of each incentive varies as the situation and time change. Therefore, the differential cumulative valence of incentives and disincentives within a given time frame determines the behavioral response to proposed technical innovations.

- Behavioral change can be predicted on the basis of the valences attached by a respondent to the units in a cluster of perceived incentives and disincentives.

- Desired behavioral change (adoption of technical innovations) is achieved by modifying the differential cumulative valence of incentives and disincentives, in opposite directions, as perceived by the respondent, that is, the total valence of the cluster of incentives must be perceived to be greater than the total valence of the cluster of disincentives. The extent and speed of adoption, individually and collectively, is then determined by the magnitude of the cumulative valence of perceived incentives less that of perceived disincentives.

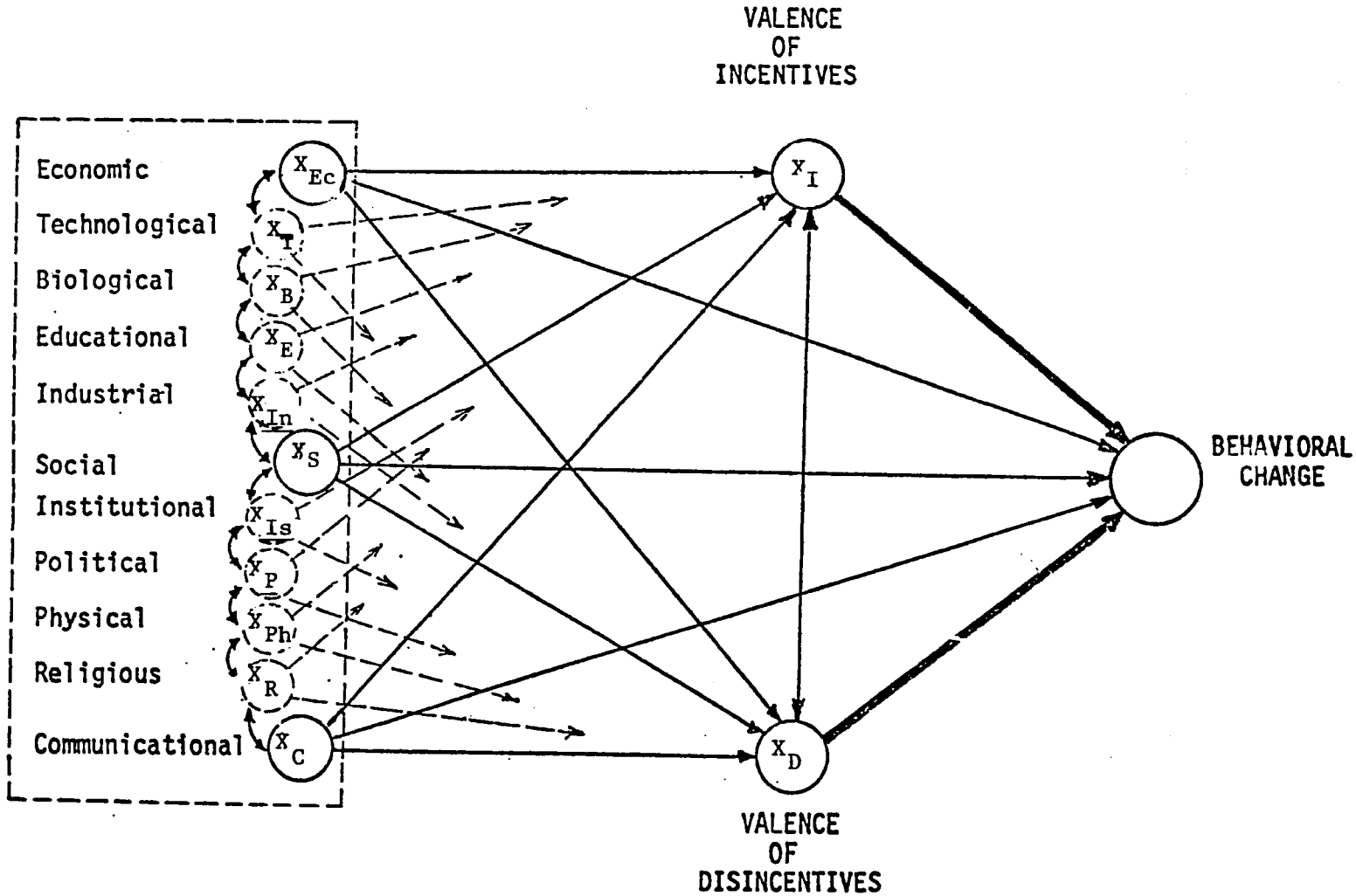
- The magnitude of the differential cumulative valence of the two sets of opposing influences is increased by the introduction of programmed inputs designed to: provide new incentives for behavior change, strengthen the incentives already present in the situation, increase the complementarity of change incentives, and weaken or remove the change disincentives in the situation.

Employing these assumptions and the promising components of preliminary models, we designed a hypothetical research model (fig. 7). The model proposes that a general and primary set of interdisciplinary factors (independent variables) and a set of incentive/disincentive factors (intervening variables) exert the primary influence on farmers' adoption behavior. The complex network of influences occur as a result of bivariate and causal relationships that the respondents perceive among the variables. It should be noted that research models alone do not establish the validity of the assumed relationships of components, they merely illustrate that such relationships exist; thus, they must be investigated to explain what, why, and how questions of adoption behavior relate to the transfer of technology from a source to a user.

The research model proposed here contains the major factors that apparently operate in most behavioral research settings involving technical innovative action. In real life situations, however, some of the environmental factors assume a role more relevant and important to a particular technology (innovation to be adopted). It was proposed earlier that previous models generally used for researching adoption behavior limit approaches to a selected minimum number of major factors of the phenomenon under investigation. Considering the limitations on variables and the findings of previous researches of farm practice adoption, we have designed a more comprehensive framework (fig. 7) that accommodates the critical, interdisciplinary nature of the cluster of variables that commonly influence modern, innovative, technologies.

The research design in figure 8 is not purported to be conclusive. However, it is supported by at least six of our studies as a cross-culturally applicable model and accommodates most of the factors we found relevant to adoption of agricultural technology and related behavior changes. A major advantage of this model

Figure 7. Hypothetical interdisciplinary research model of differential behavior of change.



is the ability to test the direct and indirect effects of its major elements; additionally, it enables a researcher to measure the intervention effect of incentives and disincentives. The factor approach, each factor consisting of a set of interrelated variables, is employed to determine the relevant major factors (independent variables and intervening variables) of adoption behavior. In general, the independent variables can be replaced by the relevant factors, which the respondents perceived as incentives and disincentives (intervening variables), without changing the structure of the model.

We found ample empirical evidence to support the validity of the research model among the research studies we examined. Refinements have been derived from its use in several similar field studies in wide-ranging cultural situations. Findings in the most recent studies done with our model in its most refined stage indicate that social, economic, and communicational factors are the most relevant of the primary influences of the farmers' near environment. For example, in an adoption study in Kenya, Peter Misiko found that these factors were positively related to the adoption behavior of the farmers (respectively, $r_S = .32$, $r_E = .41$ and $r_C = .47$). This study does not contain data for the predictive value of these three factors (in terms of amount of variance explained in the adoption behavior by these variables). However, the partial correlation analysis technique employed clearly indicates that the incentives and disincentives significantly intervene in the relationships among social, economic, communication variables and adoption behavior.

The findings in another recent study done in Turkey by Unal Buyukcolak Bakker (1977) provided evidence of the cross-cultural applicability of our model. This study provided further evidence that the intervention effect of incentives and disincentives (CDVP) significantly increases the amount of variance explained in adoption behavior. Furthermore, the path analysis we used indicates that the indirect effect of incentives through disincentives, hypothesized as CDVP, constitutes over 51 percent of the causation in adoption behavior. Comparison of the cause effect of CDVP with the remaining causal effects (only 2%) strongly supports the proposition that CDVP is the critically significant influence that triggers adoption behavior. Found also in this study was support for one of our central theoretical assumptions: incentives and disincentives conceptualized as intervening variables are specifically perceived forms of independent variables. This study tested the interdisciplinary validity of our research model and strongly confirmed our proposal.

Findings in the selected research studies firmly support our theoretical and research framework. However, variations in the design of statistical analysis limited our use here of comparative statistical evidence. We believe the evidence summarized here and available in the primary research reports is sufficiently supportive of our proposed research model to offer it as a highly promising, cross-culturally useful, and statistically significant interdisciplinary model for researching behavioral change related to technical innovations.

The model given in figure 8 illustrates the hypothetical network of relationships within the complex process of adoption of agricultural innovations. The model provides for the multiple dimensions involved in the adoption process. Three major dimensions of the process are identified as follows:

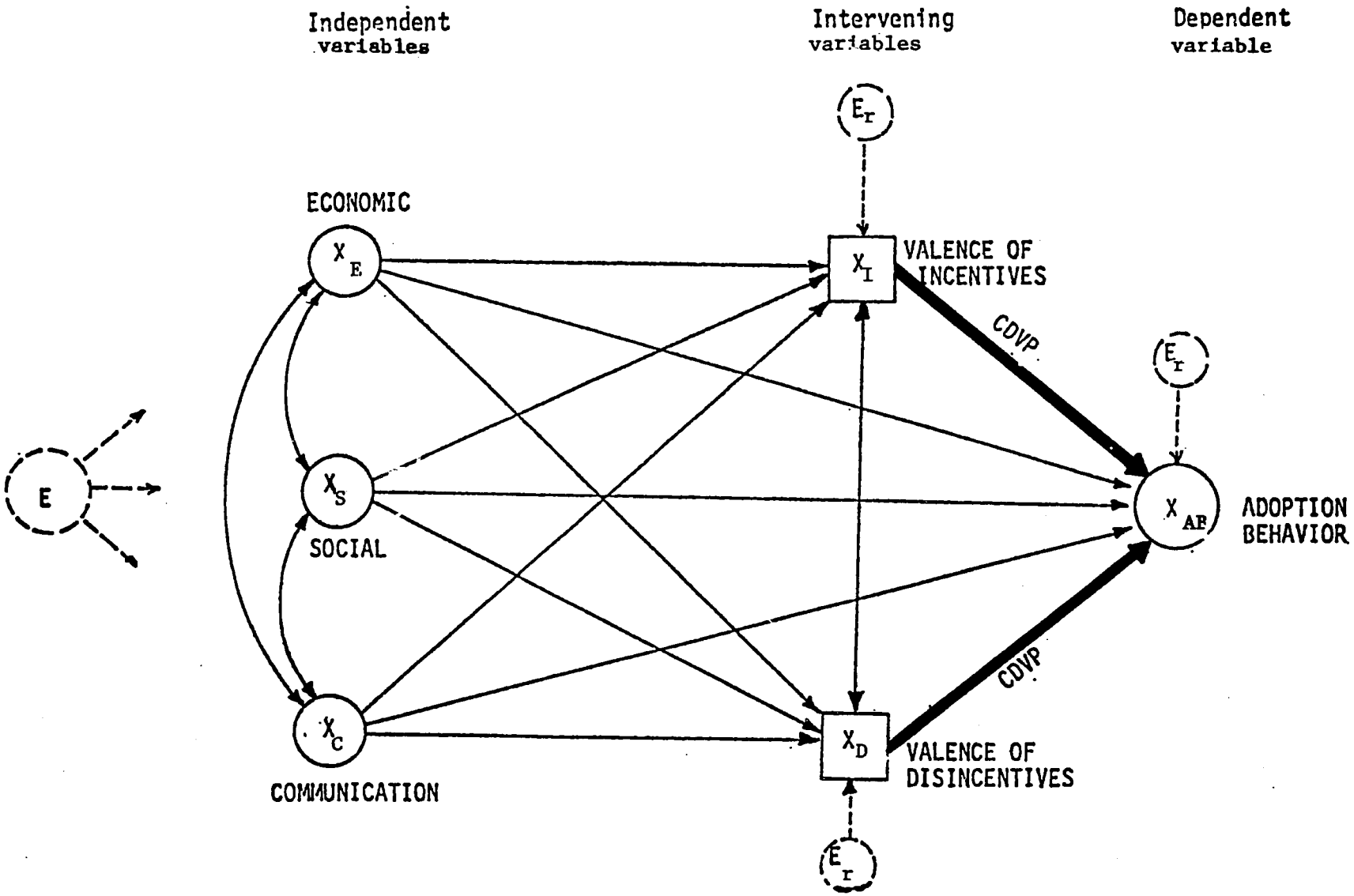


Figure 8. Proposed research model for behavioral response to farm practice adoption. E = environmental factors from which primary independent variables are derived. E_r = residual or unexplained influence of other relevant secondary factors. CDVP = cumulative differential valence perceived by respondents.

1. The types and number of environmental factors that are most relevant to the adoption phenomenon. These factors contain two subdimensions: (a) primary factors of farmers' environment (social, economic, communication, etc.) and (b) primary factors of farmers' mental set (incentives and disincentives).

2. The types and the direction of relationships among the factors that affect the magnitude of the change involved in the process of adoption. Four subdimensions of these relationships included in the model are: direct effects, indirect effects, interrelationship effects, and intervening effects of the mental-set factors.

3. The third dimension included in the model involves and illustrates that, before the physical act of adoption, a mental (behavioral) change takes place. Three subdimensions of behavioral change within a given time continuum are the static, dynamic, and semidynamic phases.

The fourth dimension of the model is, of course, the dependent variable--adoption of a recommended technical innovation.

Intervention Model

One of the major stumbling blocks embedded in the "transfer of technology" to farmers is getting them to accept and practice the agricultural innovations. On the basis of our adoption differential behavior studies, we have accumulated convincing evidence that the adoption/nonadoption of new agricultural technology is primarily dependent on the differential effect of the perceived cumulative valences of incentives and disincentives related to adoption. The cumulative differential valence perceived (CDVP) by farmers significantly and ultimately influences their adoption behavior, which is to accept or reject new agricultural practices. Our studies also showed that the inadequacy of programmatic (institutional) factors relevant to farmers' perceived incentives and disincentives has been a major reason why most of them continue their present cultural practices rather than adopt the recommended ones.

Considering these findings and the assumptions of the differential behavior framework, we have designed a new intervention model (fig. 8). Since change in farmers' behavior results primarily from the cumulative differential valence of their perceived incentives and disincentives, an intervention model should focus on these intervening variables and their influence (CDVP) on adoption patterns. Hence, the independent variables (fig. 8) are not included in the intervention model, because our evidence indicates that the direct influence on adoption behavior of these factors alone is relatively weak, and that their significant influence is exerted directly through the incentives and disincentives articulated by respondents. The intervention model provides a strategy of programmed inputs specifically related to the perceived incentives and disincentives of farmers in a sample population. The intervention strategy or designed program inputs should therefore favorably change the CDVP. The design of such programs must be based on the relevant incentives/disincentives and their perceived valences in order to remove the equilibrium in the static phase and thus create a disequilibrium or dynamic phase leading to the adoption act.

The proposed approach also satisfies the primary objective of adult education programs concerned with the needs and goals of their chosen audiences. Once such findings are obtained, a functional intervention strategy can be designed and

imposed on the situation to upset the static phase in favor of dynamic adoption. The primary objective of the intervention strategy is to increase the rate of change in adoption behavior by weakening the valences of disincentives and increasing the valences of incentives.

At this time, we have only one example of the use of our intervention model in designing program inputs (see fig. 9). It indicates how our model can help establish the objectives of programs to promote technical innovations among farmers. The exemplary intervention strategy shown here, however, appears to focus primarily on strengthening the valence of incentives and thus overlook the effect on behavior achieved by focusing some inputs specifically on weakening the valence of disincentives.

It is possible to upset the equilibrium (static phase) caused by CDVP of incentives and disincentives by concentrating on increasing the valences of incentives alone. However, this type of intervention strategy would employ a unidimensional solution to solve a multidimensional problem. A "unidimensional" approach would have strong program-building value when or if incentive and disincentive valences are found to be negatively and highly related to each other. Under such circumstances, the incentive valence increasing program inputs would have an indirect, but significant, decreasing effect on the disincentive valences. However, programmed inputs specifically designed to weaken or remove the valence of disincentives should significantly increase the differential. Bakker's study, for example, found that the relationship between incentives and disincentives was negative but rather low ($r = -.25$), indicating that incentives and disincentives are not simply the same variables with opposite influences, but are interrelated factors that constitute two different dimensions. It is therefore evident that a unidimensional approach that may concentrate on incentives or disincentives alone would not facilitate the anticipated desirable and possible programmed results (adoption of innovations) as well as a multidimensional approach would.

Supported by our theoretical and empirical evidence, we recommend a multidimensional approach to behavioral intervention. The general outline of the proposed intervention strategy is given in figure 10. This model is not a blueprint or specific program to be adopted; rather it is designed on the basis of empirical data that support its cross-cultural validity. Such strategy for intervention must include data about the static phase in order to build intervention programs that would modify the valences of incentives and disincentives so as to create a dynamic phase and thus increase the rate of adoption among farmers.

Since we are proposing a general and cross-culturally applicable intervention model, it is not possible to pinpoint specific incentives and disincentives and the types of innovations in this design. However, the incentives and disincentives listed in table 1 would be particularly relevant to our model of intervention to set general and reliable guidelines for adoption programs. Data indicate that some incentives and disincentives are perceived as having higher valences than others in a specific innovation package. As indicated in both Bakker's study and others, such valences establish primary and secondary forms within the clusters of incentives and disincentives. Therefore, to achieve optimal results, the primary sets of incentives and disincentives essential to the design of sound policies and programs of adoption must be identified.

We recognize that in many situations adequate resources are not available for providing inputs related to all incentives and disincentives perceived by respondents Therefore, one must be concerned with selecting for initial emphasis

Figure 9. A specific example of an intervention model.
Source: M. K. Lowdermilk, A. C. Early, and D. M. Freeman; Farm irrigation constraints and farmers' responses: comprehensive field survey in Pakistan (3 vols.). Ft. Collins, Colo., Water Management Research Project Report, Engin. Res. Cent., Colo. State Univ., 1977. Used by permission of authors.

1. STATIC PHASE

Lack of adequate:

- water-management policies, codes, and programs
- water supplies
- land and tenure reforms
- institutional services (extension)
- farmer organizations
- farm practices
- capital, credit, inputs

CHANGE INHIBITORS

FARMER IRRIGATION BEHAVIOR

CHANGE INCENTIVES

Existence of:

- demand for more water
- demand for educational change
- private tubewells
- informal organizations and local leadership
- cooperation within brotherhood groups

2. SEMIDYNAMIC PHASE

(Change inhibitors from phase 1 become fewer in number and weaker)

CHANGE INHIBITORS

FARMER IRRIGATION BEHAVIOR

CHANGE INCENTIVES

National policies and incentives
Water-management technologies
a) water course rehabilitation
b) precision land leveling
c) water management advisory service
d) farmer organizations
Credit and input services
Reforms in water laws and codes
Land and tenure reforms
Adaptive research
Improved production incentives
Small-farmer programs

3. DYNAMIC PHASE

(Change inhibitors from phase 3 become fewer and less strong, but beware of other exogenous and endogenous sources that can produce bottle necks)

CHANGE INHIBITORS

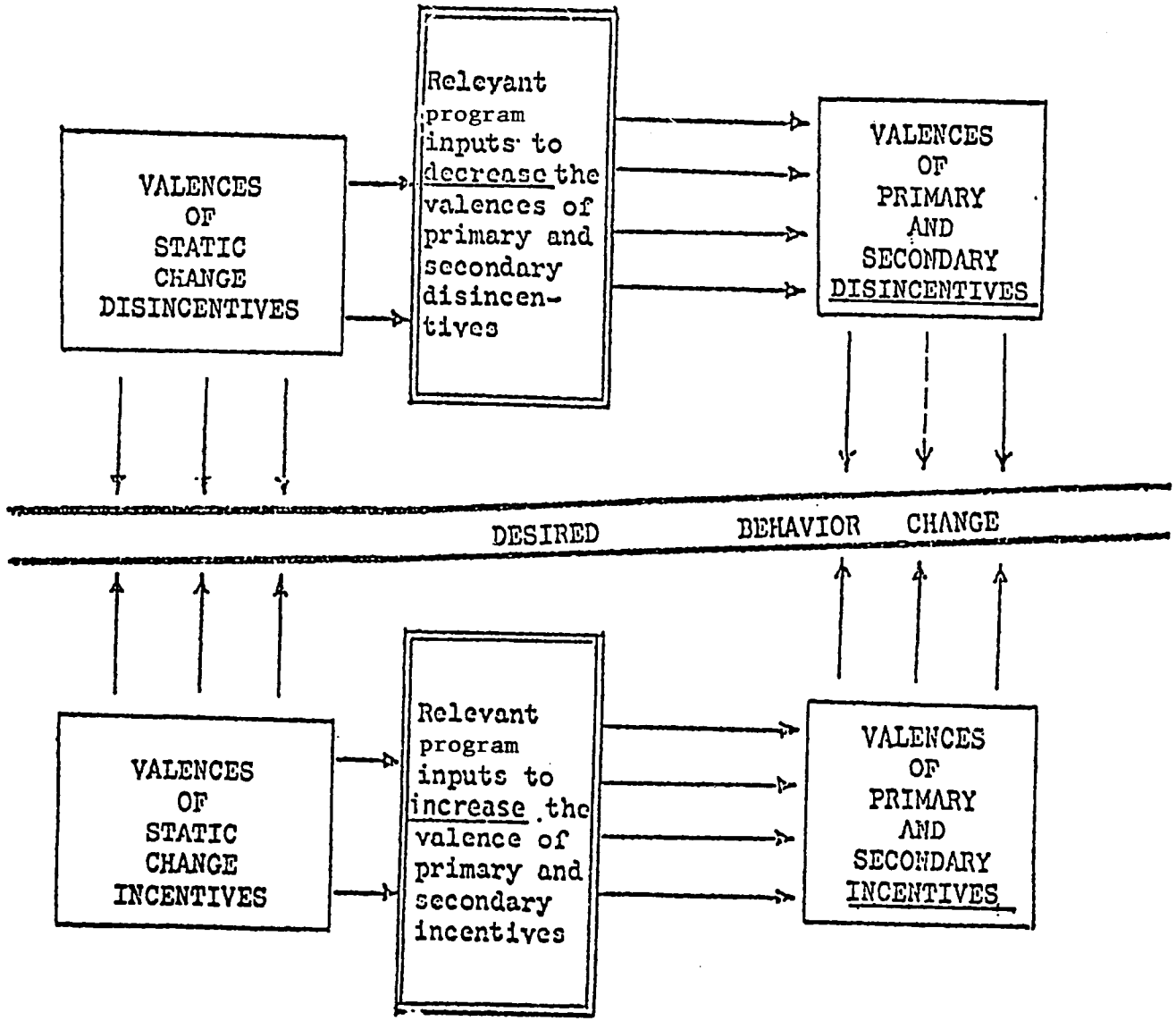
FARMER IRRIGATION BEHAVIOR

CHANGE INCENTIVES

(Continue to stress incentives in phase 2 and add others as new change inhibitors are identified). Continuous evaluation and improvements are necessary in the following:

- Water management research
- Extension programs
- Expansion in facilities and incentives for field workers
- Field staff in-service training
- Monitoring and evaluation

Figure 10. A proposed intervention strategy for adoption-behavior change.



the most valuable among the possible courses of action. We believe that our intervention model can be successfully employed to design adoption strategies for optimal benefits, not only for the farmer, but for those involved in the process of transferring technology from a source to a user.

MAJOR FINDINGS AND IMPLICATIONS

Limited by its summary nature, only the findings indexical to the data at hand are presented here. Perforce, too, the generalizations include little of the supporting statistical data. Detailed findings, research methodology, statistical treatment and supporting data may be found in the bibliography.

Several major elements of the rationale that motivated and guided the research program and that field-tested the theory and research design were convincingly supported by the findings.

- Current knowledge about the adoption process needs modification and expansion to make it more functional. Comparatively, we seem to know more about how to favorably influence the behavior of plants than of the farmer respondents on whom increases in food production ultimately depend.

- The influences affecting optimum use of modern technical agricultural innovations constitute a significantly larger and more complex cluster of variables than is now generally recognized; they are interdisciplinary in range and thus require high interrelatedness for optimum achievement.

- Optimum adoption of agricultural production innovations is achieved only when a farmer is persuaded to accept a technical innovation as being for him technically sound, economically feasible, physically possible, and politically and socially compatible.

- The problem of increasing the adoption rate of farmers, especially those operating small holdings, must be approached from the standpoint of the farm, the farmer, the institutional and service circumstances, as well as the agricultural research center.

- Adoption behavior requires a favorable mental attitude and a successful physical act: the first is internal and symbolic and achieved through technical knowledge and conviction of its value; the second is external and physical and achieved through ready availability of requisite production inputs and related services such as seed, fertilizer, credit, markets, and education--a function of the system.

- Adoption behavior at optimum levels depends on the presence of a complex infrastructure that establishes and maintains a macro and microenvironment conducive to the translation by adopter-farmers of their internal and external behavior influences into particular overt action.

- Adoption decisions tend to be made on balance and are reached by individuals through a pattern of mental gymnastics involving trade-offs or compromises among recognized influence-variables perceived to form two categories: reasons favorable for taking innovative action (incentives) and reasons favorable for nonaction or maintaining the status quo (disincentives).

Variability in adoption behavior of farmers can be ultimately attributed to the differential cumulative valence of perceived incentives and disincentives related to the proposed object of innovative behavior.

Farmer "Blame" to System "Blame"

The most pervasive finding in these researches is that neither the socio-psychological, economic, or communicational set of farmer influences nor the dearth of available technology currently constitute the primary barriers to wider diffusion and adoption of modern agricultural practices. Instead, the primary barriers are perceived by a majority of respondents to be system-associated, which does not provide a macro or microenvironment adequately conducive to triggering wide, innovative action. A survey of findings induced from the gross data is presented in figure 11.

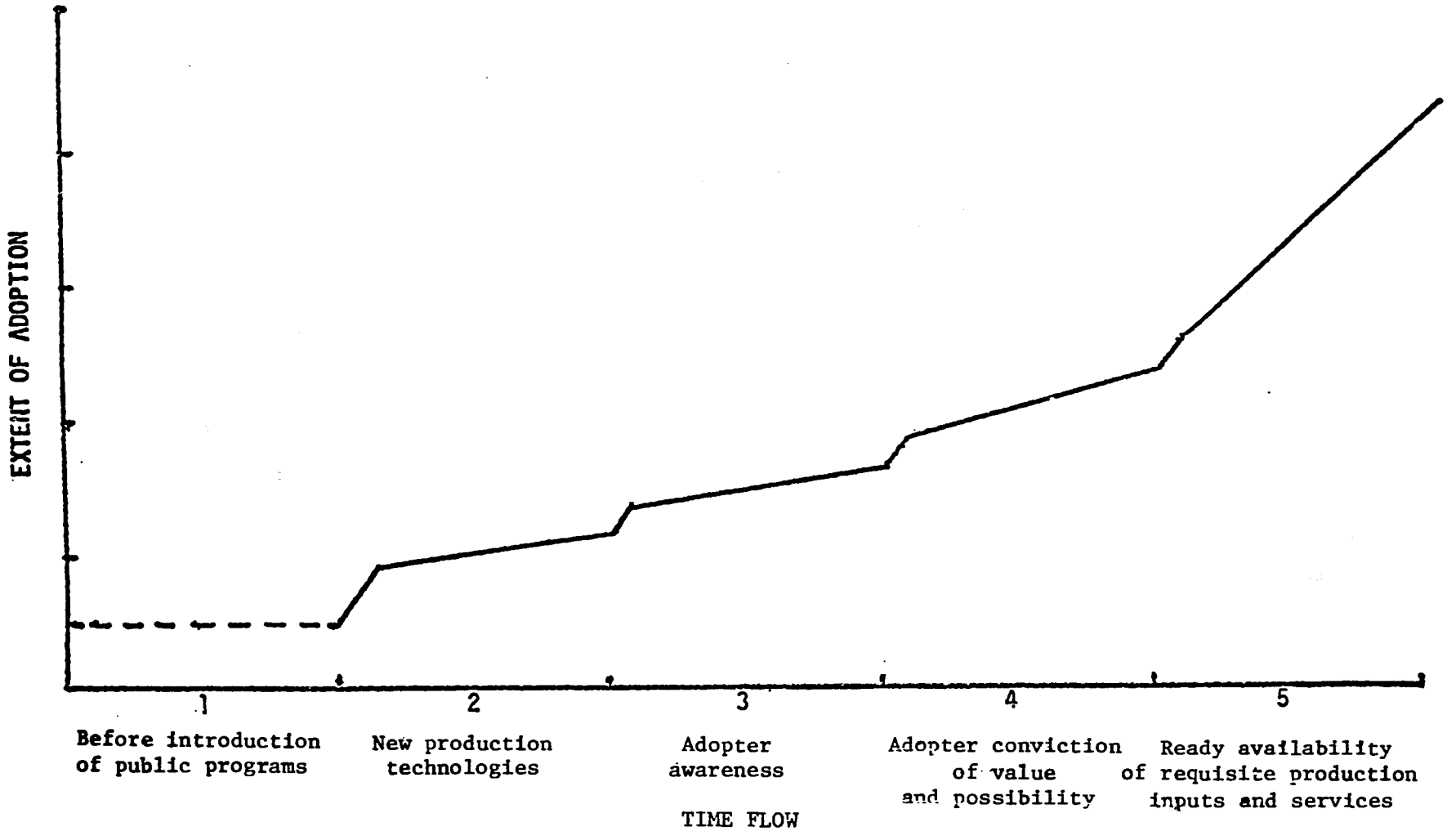
Highly useful technical "packages" are in fact available in all of the sample areas studied (fig. 11, stage 2). Likewise, through extension education, mass media, the "grapevine", and other information delivery systems, "adopter awareness" (stage 3) was achieved almost everywhere, often approaching the saturation point. Similarly, "adopter conviction of value" (stage 4) was widely found. It was evidenced by adoption of one or more technical elements by about a third of the respondents and by numerous others with value convictions who had not acted overtly because of adverse situations. Overt action not only requires positive mental attitudes but favorable conditions, such as ready access to required production inputs and the related services that make adoption possible, successful, and valuable. Stage 5, "ready availability of requisite production inputs and services", compositely, was perceived by respondents as the prevailing disincentive for technical innovations.

In summary, the central problem in achieving significantly wider adoption of new production technologies in the areas sampled begins at about stage 4 and then accelerates very rapidly through stage 5 (fig. 11). Accelerating the emphasis on these stages was found to be needed and, at least implicitly, to be a central point that required more functional policy and programming structures at all levels.

We do not interpret this general finding to suggest that most farmers have now effectively attained a knowledge of useful new production technologies, skills needed for optimum application, and conviction of the physical, economic, and social values that could accrue to them through adoption. Rather, we believe that the bottle neck, especially for small-holders, is more explicitly in the system than in the widely alleged "uneducated", "passive", "tradition-bound" farmer.[8/] Our data strongly imply that these small holders remain low producers more because they lack the requisite means of production than because they are unwilling to make technical innovations when they first become available or, later, profitable.

8/ The term "system" is used here to mean: the mechanism(s) by which requisite production needs of a farmer are transformed and conveyed by the sources of knowledge and services in a form capable of being utilized by farmer respondents. It then becomes possible to think of the process of flow between sources and consumers as a resource utilization system with inputs, transmission, and utilization evidenced by favorable innovative behavioral change.

Figure 11. Sequences of macrostages and extent of farmer adoption of technical agricultural innovations.



Note: Line representing "extent of adoption" is illustrative only. Extent and quality of inputs into stages 2 to 5 determine adoption level.

Hence the problem of promoting wider use of modern technical innovations seems no longer to be centeredon the adopter. When a change agent attempts to convince a farmer to begin using new technical practices that require associated inputs, success demands that he also assure ready availability of the essential auxillary supplies and services in adequate amounts and on time. Hence, provisions must be built into programs as an integral element of the macro and micro strategy of agricultural modernization. Furthermore, all requisite innovative inputs and services must be available on a continuing basis, if success is to be achieved and sustained.

Incentives and Disincentives

In addition to the nature and range of incentives and disincentives reported by adopters and nonadopters in the several studies, we were interested in identifying the general pattern of the motivating forces. For this, we selected one study from each of five countries and processed the data in summary form.[9/] In each study, the dependent variable was adoption behavior as currently recommended to farmers by researchers and field practitioners. Each study focused on one to three of these practices: improved seed, fertilizers, insecticides, soil testing, strip-cropping, land preparation, and dry-season cropping.

In five studies, 860 sample respondents were personally interviewed by the respective researchers using a semistructured response schedule. Responses to only three of the questions in the interviews are relevant to our purpose here. In modified form, these were: Do you know about the (appropriate practice(s) inserted here) being recommended to farmers in the region? Yes____ No____. Are you now using one or more of the practices recommended for use in this "area"? Yes____ No____. If yes, which practice(s)? (recorded). Following responses to some verifying, probing questions, a "yes" answer to question 2 classified a respondent as an adopter and a "no", as a nonadopter. Accordingly, 276 of the 860 individual respondents were recorded as adopters of one or more recommended practices in the technical package, and 584 were recorded as nonadopters.[10/]

The two groups of respondents were then asked for a third kind of information: a. (adopters); What were your reasons for using the new practice(s) (reasons recorded); b. (nonadopters); What were your reasons for not using the practice(s) recommended (reasons recorded). In response to a, 276 adopters gave 585 reasons why they began to use 1-3 new practices. In answer to b, 584 nonadopters gave 690 reasons for their passive response.

Responses to question 3 were then analyzed to eliminate duplicating ideas in the individual responses given by the two categories of respondents. With some appropriate editing, the statements were then categorized as incentives and disincentives. Table 2 presents a combined summary of reasons given by respondents

---

9/ The country studies and authors used for this analysis included: Kenya (P. Misiko), India (P. S. Sharma), Thailand (T. Terasart), Trinidad, W. I. (J. P. Andrews), and New York State U.S.A. (P. V. Salui).

10/ The term adoption was used here to mean: acceptance and use of one or more of the specific recommended technical innovations. The term nonadoption was used to mean: acceptance and use of none or substantially none of these practices.

Table 2. Combined summary of major incentives and disincentives perceived by 860 farmer respondents as primary influences of their response to recommended technical innovations
- 5-country studies -

	Mentions	
Incentives* (N=585)	no.	%
Increases crop yield	424	72.5
Increases income	330	56.4
Used by neighbors	261	44.6
Labor available	235	40.2
Technical guidance available	231	39.5
Credit available	117	20.0
Better quality of seed	110	18.8
Supply of inputs on time	98	16.8
Saved labor	73	12.5
Not risky	70	12.0
Innovation simple to adopt	60	10.3
Irrigation water available	37	6.3
Recognition in community	32	5.5
Disincentives t/ (N=690)		
Lack of technical guidance	258	37.4
Lack of irrigation water	220	31.9
More labor required	208	30.1
Lack of knowledge	196	28.4
Lack of credit	181	26.2
Too many pests and diseases	176	25.5
Supplies not on time	161	23.3
Inadequate equipment	145	21.0
Too expensive	135	19.7
Very complex to adopt	101	14.6
Neighbors do not use	79	11.5
Land not adequate	66	9.7
Labor not available	65	9.4
Risky to adopt	64	9.3

* Any condition or reason perceived by a respondent as a motivation to adopt all or part of the recommended technical practices.

t/ Any condition or reason perceived by a respondent as a motivation not to adopt the recommended technical practice(s).

in the form of major incentives and disincentives perceived by them to have significantly influenced their adoption behavior.

The combined incentives and disincentives given by the respondents in the five-country studies (table 2) is generally indexical of the nature of findings from the seven additional studies in the program. For example, an examination of the nature and order of the list of disincentives given by nonadopters reveals that systems constraints were overriding in determining responses. This observation supports our central finding reported in the previous section. The critical implication here is that nonadopter respondents expressed the conviction that the system has not yet established the conditions that make it possible and potentially rewarding for them to use the recommended technical innovations. Whether the farmer respondents or the "managers" of the system are in fact correct, it is largely incumbent on the system to establish strategies that will favorably change this prevailing attitude.

Additionally, researchers and field practitioners acquainted with the general pattern of findings in previous studies of adoption behavior will note that the nature of behavior influencers reported here, in the form of incentives and disincentives, is in high contrast. By implication, these findings reflect many of the socioeconomically and sociopsychologically inclined findings predominant in previous researches, but they document a wider range and a more functional set of behavior predictors. These findings are in the nature of intervening variables that can be realistically modified or manipulated, individually and jointly, by the farmer respondents and the leaders of the program.

Until now, this massive group of farmers seem to feel that they have been largely deprived of the requisite means of production fitted to their systems and resources. The production focus may, indeed, have become largely synonymous with modernizing agriculture by providing progressive farmers with powerful technologies to be adopted in packages to achieve optimum results. The quest for agricultural progress may thus have been inadvertently transformed into a relatively narrow technical, economic, and educational problem beyond the reach of most of the small-farm operators.

Increased agricultural production always needs some combination of land, equipment, technology, money, purchasable inputs, services, and related resources. Without special help, this fact alone tends to eliminate many small, low-resource, subsistance farmers from using technological methods, regardless of their willingness to do so.

THE FINAL TEST

Searches of relevant literature, formulations of theory, research designs, intervention paradigms, and supporting data collected with the use of these models, led us to the preliminary proposition that, at most, our proposals provide strategies for a new era of knowledge accumulation, comprehension, and use of the major influences in the adoption process; or, at least, stimulate new questions, some creative pondering, and new hypotheses for approaching a complex phenomena.

We believe our formulations to be theoretically and methodologically sound, and to have reached a point of refinement where further tests of their functionality will be positive. This step requires the design and execution of policies and programs specifically concerned with the incentives and disincentives pre-

viously identified by respondent-farmers as determining their action in particular situations.

In addition to studies designed to determine why farmers do what they do when technical innovations are suggested, more researches are needed to identify the bottle necks, whether they exist in central government, an intermediary unit, or at the farm level. Our data indicate that a great many additional farmers will use the new technologies when the conditions necessary for making innovative action understandable, possible, and favorable are readily available. Most of the 2,300 respondent farmers stated that such conditions have yet to be functionally established by the system.

Recognition of the critical influences on adoption in a given situation, precise identification of related implementing variables in the system that can be manipulated to accelerate farmer use of new kinds of production inputs, and weaving these elements into an integrated strategy[11/] appear to be the factors essential to accelerating technical innovations, especially among small-farm operators.

This kind of recommendation would help eliminate previous tendencies to promote the use of new technologies because they were there—starting with the technology instead of with the purpose, providing a solution before adequately identifying the technical and nontechnical elements of the problem. As agricultural technologists, policy makers, and production programmers become more aware of, and responsive to, the critical human element in the technology utilization process, as indeed they now are, technology will cease to be the only determinant of what they think and do.

11/ The term strategy here means: the most promising long-range plans for mobilizing existing, and creating additional, resources and services for accelerating progress toward the goals of agricultural modernization.

BIBLIOGRAPHY

Primary Ph.D. Dissertations

Atayi, Emmanuel A. Incentives and disincentives related to adoption of agricultural innovations: The case of small farmers in Aneho District, Togo. 1977.*/

Bakker, Unal Buyukcolak. Factors influencing small farmers in the adoption of modern agricultural technology related to high-yielding varieties of wheat in Turkey. 1977.

Contado, Tito E. Communication fidelity between farm management technicians and rice farmers in Leyet, Philippines. 1969.

Dhillon, Jogindar S. Effects of various message treatments on the decoding fidelity of verbal messages by farm decision makers in India. 1970.

Dwarakinath, Rameswamy. Adoption incentives related to packages of practices of high-yielding varieties in Mysore State, India. 1973.

Lawdermilk, Max K. Diffusion of dwarf wheat production technology in Pakistan's Punjab, 1972.

Misiko, Peter. Incentives and disincentives influencing farmers in the adoption of agricultural innovations: The case of Bungoma District, Kenya. 1976.

Salvi, Pratap V. Characteristics of low-income farmers in south central New York State with special reference to incentives and disincentives for adoption of agricultural innovations. 1971.

Sharma, Prakash. Incentives and disincentives related to adoption of agricultural innovations by small farmers, Madhya Pradesh, India. 1974.

Sheppard, Frank. Designing agricultural modernization strategy through systems analysis. 1970.

Terasart, Thanya. Incentives and disincentives for behavioral change by farmers related to adoption of dry-season cropping, northeast Thailand. 1977.

Vidyarthy, Gapal. Farmer's incentives for adoption of recommended farm practices in wheat crop in Aligarh intensive agricultural district, India. 1967.

---

*/ Years given are when principal thesis research was done.

Supporting Ph.D. Dissertations

Awa, Njoku. Some factors related to communication and social participation in low-income, low-density populations, New York State. 1973.

Andrews, Jesse. Factors related to the adoption behavior of food crop farmer Crown Lands Development Programme, Trinidad, W.I. 1975.

Kahn, Ghulam. A communication model for extension education. 1969.

Sing, Raghuhar. Adoption of nitrogenous fertilizers as related to selected factors and use of information sources in adoption process. 1967.

References Cited

American Association for the Advancement of Science
1972. Liebig and after Liebig: A century of progress in agricultural chemistry. A.A.A.S. Bul. 16.

Bennis, W. J., et al.
1961. The planning of change. Holt, Rinehart, and Winston, New York.

Bohlen, J.
1967. Research needs on adoption models. In Diffusion research needs. Univ. of Missouri. North Cent. Reg. Res. Bul. 186.

Caughenour, C. M.
1968. Some general principles. In Diffusion research needs. Univ. of Missouri Agr. Exp. Sta. Bul. S. R. 89.

Etzioni, A., and Etzioni, E. (editors)
1966. Social change: Sources, patterns and consequences. Basic Books Inc., New York.

Foster, G. M.
1962. Traditional cultures and the impact on technological change. Harper and Row, New York.

Lambert, W. W., and Lambert, E. E.
1966. Social psychology. Prentice Hall, Englewood Cliffs, N. J.

Linton, R.
1963. The study of man: An introduction. Appleton-Century-Croftes, Inc., New York.

Lionberger, H. F.
1960. Adoption of new ideas. Iowa State Univ. Press, Ames.

Lippit, R., et al.
1853. Dynamics of planned change. Bruce and Co., New York.

Mellor, J. W., et al.
1968. Developing rural India. Cornell Univ. Press, Ithaca, N. Y.

Miles, M. B. (editor)
1964. Innovation in education. Teachers College, Columbia Univ., New York.

Moore, W. E.
1963. Social change. Prentice Hall, Englewood Cliffs, N. J.

Newcomb, T. M.
1965. Social psychology: The study of human interaction. Holt, Rinehart, and Winston, Inc., New York.

Parsons, T., and Smelser, N. J.
1956. Economy and society: A study in the integration of economic and social theory. The Free Press, Glenco, Ill.

Piaget, J.
1963. The origins of intelligence in children. W. W. Norton, New York.
1967. Six psychological studies. Random House, Inc., New York.

Reeder, W. W.
1976. Theories from a 25-year research program on directive factors in beliefs, disbeliefs and social action of persons and organizations. Dept. Rur. Soc., Cornell Univ. Unpub. paper.

Skinner, B. F.
1953. Science and human behavior. MacMillan, New York.