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EVALUATING DECISION RULES AND PLANNING TOOLS IN FARM
DECISION-MAKING: A CONCEPTUAL FRAMEWORK

By

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A DISSERTATION

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ABSTRACT

EVALUATING DECISION RULES AND PLANNING TOOLS IN FARM DECISION-MAKING: A CONCEPTUAL FRAMEWORK

By

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The major purpose of this research was to develop and test a model which would measure the potential value of planning tools to farm management. The systems approach was used to develop the Management Systems Research model as a methodology for measuring such potential. In accomplishing the primary goals other products were produced including a validated managerial effectiveness measure, common behavioral attributes of effective farm managers, use of economic tools by farm managers, information on the relationship between behavior, performance, and effectiveness, and information on the criteria for decision aid selection.

The measurement system developed included five major activities: 1. Selection of Farm System, 2. Behavioral Analysis, 3. Measuring Effectiveness, 4. Testing Behavioral Predictors of Effectiveness and 5. Quasi-Experiment.

Once the farm system was selected, an open-ended questionnaire was developed and administered to a group of successful cash grain farmers as identified by extension personnel in Ingham and Tuscola counties. Information from the interviews was used to develop a managerial index ques-

tionnaire, and helped in determining the appropriate effectiveness measure for the farm manager.

The farmers selected profitability as the most important criteria for evaluating a farm manager. Therefore, management income per acre was chosen as a measure of effectiveness, and this measure was tested for workability, reliability, and validity. The reliability test consisted of testing for consistency of the measure over time in identifying the TelFarm cash grain farmers in terms of managerial groups. Management income per acre was checked for validity by testing the relationship between the average management income per acre for each of the farmers against locational and farm size variables.

With a validated managerial effectiveness measure and a managerial index developed, the next step was to administer the index to the TelFarm cash grain farmers and test the relationship between behavior, performance and effectiveness. The results of the analysis demonstrated that managerial effectiveness could be predicted by a subset of managerial questions focussing on cost realization and financial decision-making.

Now that it is possible to make aprori predictions of managerial success using an index, the stage is set for using such an index for measuring the possible benefits of improved decision aids and planning tools.

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PART I

INTRODUCTION

The use of micro-computers by farmers as a management tool has become a real phenomenon in the last few years. The cost of micro-computers, unlike the cost of other agricultural production inputs, has been declining; thus placing the computer within the budgetary constraints of smaller operations. The question remains as to the possible implications of widescale adoption of this technology as it affects farm viability.

In the past, technological innovations have increased the concentration of production towards larger, more specialized units (James and Pugh, 1968; Holland, 1980; Osborn, 1981). The characteristics of computers would indicate that there may be significant economies of size associated with their adoption and utilization. If such technology imparts a significant competitive advantage to the farm user, then farmers who adopt and use the new technology effectively can be expected to have a greater probability of surviving and expanding their operations. Therefore, small farmers without access to computer power may be at a significant short and long-term disadvantage, which may imperil the existence of the smaller U.S. family farm and contribute to more concentration in agriculture.

However, the rate of adoption has not been as rapid as expected because of a number of factors. According to King (1985), these include: 1) the extraordinarily rapid rate of technological change in information technology has discouraged farm investment due to the fear of obsolescence; 2) widespread financial stress in the farm sector has reduced levels of investment in general; and 3) farm information systems and information services often do not meet the needs of farm managers. To ascertain what these needs are requires knowledge of the decision-making behavior of farmers.

Chapter 1

The Research Problem: Background and Objectives

Background

This research was motivated by a desire to develop computerized information systems and farm management tools adapted to the needs of small farmers. The level of adoption of such tools would depend upon their perceived benefits to farmers. It was hoped that by looking at how the computer benefited larger farms, inferences could be made for smaller operations. However, the studies available focused on qualitative and not quantitative benefits. Therefore, it was apparent that there was a need for research on the quantitative benefits of computerized decision aids.

Many of the computerized decision aids are merely computerized versions of the same decision aids advocated in the past by farm management professionals before the advent of microcomputers. Therefore, another approach explored was to examine research findings that had quantified the benefits of non-computerized farm management tools. However, this approach did not yield sufficient information in this area.

Since the subject matter information on quantified benefits of computerized or non-computerized farm management tools was not available, the next step was to determine how

to develop such information. This led to a search for the appropriate methodology for determining the value of such tools. Focus now centered on the literature pertaining to the value of information. Previous attempts at determining such value can be categorized into the bayesian approach, the production function approach, the residual analysis approach, and the experimental approach. These approaches along with their strengths and weaknesses are presented in the main body of this text. However, none of these approaches seemed sufficient to determine the value of information or an information system in a multi-decision environment.

In the process of investigating the different approaches to measuring the value of information, it became apparent that there was a need to clarify the concept of "management" which is at the center of the measurement problem. Therefore, managerial behavior itself became a primary subject for investigation.

Objectives

Therefore, this research focuses on developing the methodological framework for answering such questions on the potential value of computerized decision aids for farmer managers. The specific objectives of this research are:

1. To develop a model of procedures to determine the potential value of planning tools in farm decision-making, and

2. To test the model by using cash grain farmers in Michigan as subjects.

Chapter 2

Methodology: The Systems Approach

Type of Research

The problem is very ill-defined and nebulous, and therefore calls for an approach that will help to give it a form that can be modelled. The "systems approach" will be used to identify and structure the problem and develop the model of the measurement system.

This study can be considered disciplinary research. According to Johnson (1982), disciplinary research in economics consists largely of research to develop and improve economic theories, quantitative techniques and the measurement of basic economic phenomena. This research is designed to develop a measurement system to determine the value of information or an improved information system as it supports farm decision-making. The technique will be used to evaluate micro-computers, however the method developed will be appropriate to the generic problem of determining the value of information in any non-static, multi-decision environment.

The Systems Approach

The "systems approach" is defined as a problem solving methodology which begins with a tentatively identified set of needs. It has as its result, an operating system for

efficiently satisfying a set of needs which are acceptable or "good" in light of trade-offs among needs and the resource limitations that are accepted as constraints in the given setting (Manetsch and Park, 1982). There are two prominent attributes of the approach: 1) it overtly seeks to include all factors which are important in arriving at a "good" solution to the given problem; and 2) it makes use of quantitative models, and often computer simulation of those models, to assist in making rational decisions. This research will attempt to focus on the first attribute by involving both managerial professionals and the managers themselves in developing a useful model. However, instead of producing a quantitative model, the technique will be used to develop a conceptual framework and a working system of procedures to use in evaluating planning tools in farm management.

The major phases of the approach are: feasibility evaluation, abstract modelling, implementation design, implementation and system operation. As seen in Figure 1 reproduced from Manetsch and Park (1982), the movement of the process is from a set of needs to be satisfied (at the top) toward an operational system (at the bottom) capable of satisfying the needs which exist. The solid lines and arrows indicate the path of flow through the process as you move through the sequence of functions which must be carried out in order to achieve system objectives.

Feasibility Evaluation has as its goal the generation

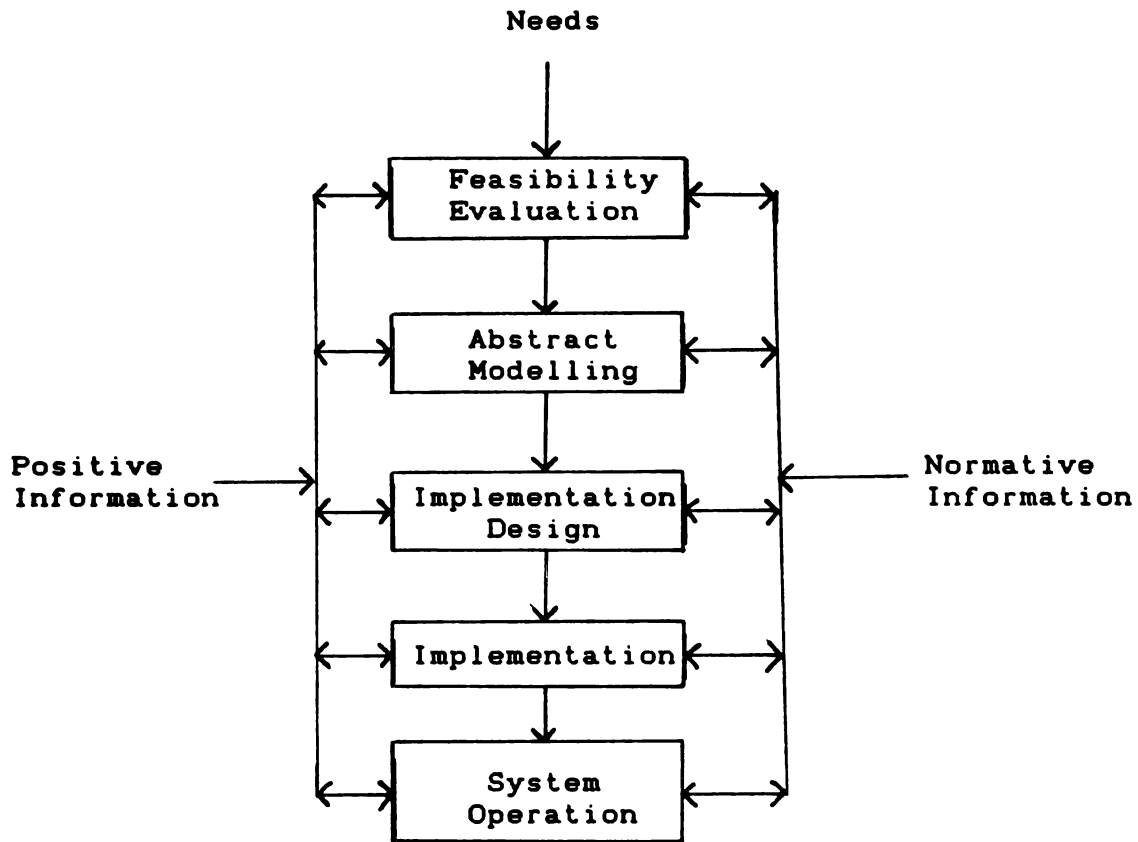


Figure 1: The Systems Approach as a Problem Solving Methodology

of a set of feasible system "alternatives" capable of satisfying needs which have been identified (Manetsch and Park, 1982). The steps in feasibility evaluation are reproduced in Figure 2. Feasibility evaluation begins with a careful analysis of needs to determine whether the needs do, in fact, exist and if they do, to state them in an operationally useful form. The "output" of Feasibility Evaluation is a set of realizable alternatives which appear capable of satisfying the identified needs.

Modelling receives as inputs, the feasible alternatives of Feasibility Evaluation and has as its output, the broad specifications for a system design and/or management strategy to be implemented in the real world. In this case, the model will consist of procedures or methods to follow in evaluating the role of planning tools in farm management. This phase begins by sifting through the different conceptual alternatives and the selection of the concept to be modelled.

Implementation Design has as its purpose to completely specify the details of system and/or management strategy designed in the abstract during the modelling phase. "Completely specify" means developing a complete set of instructions that will lead to the operationalization of the desired system. This would include specifying the necessary preparations for implementation including data and budgetary needs along with the procedures for accomplishing specific functions.

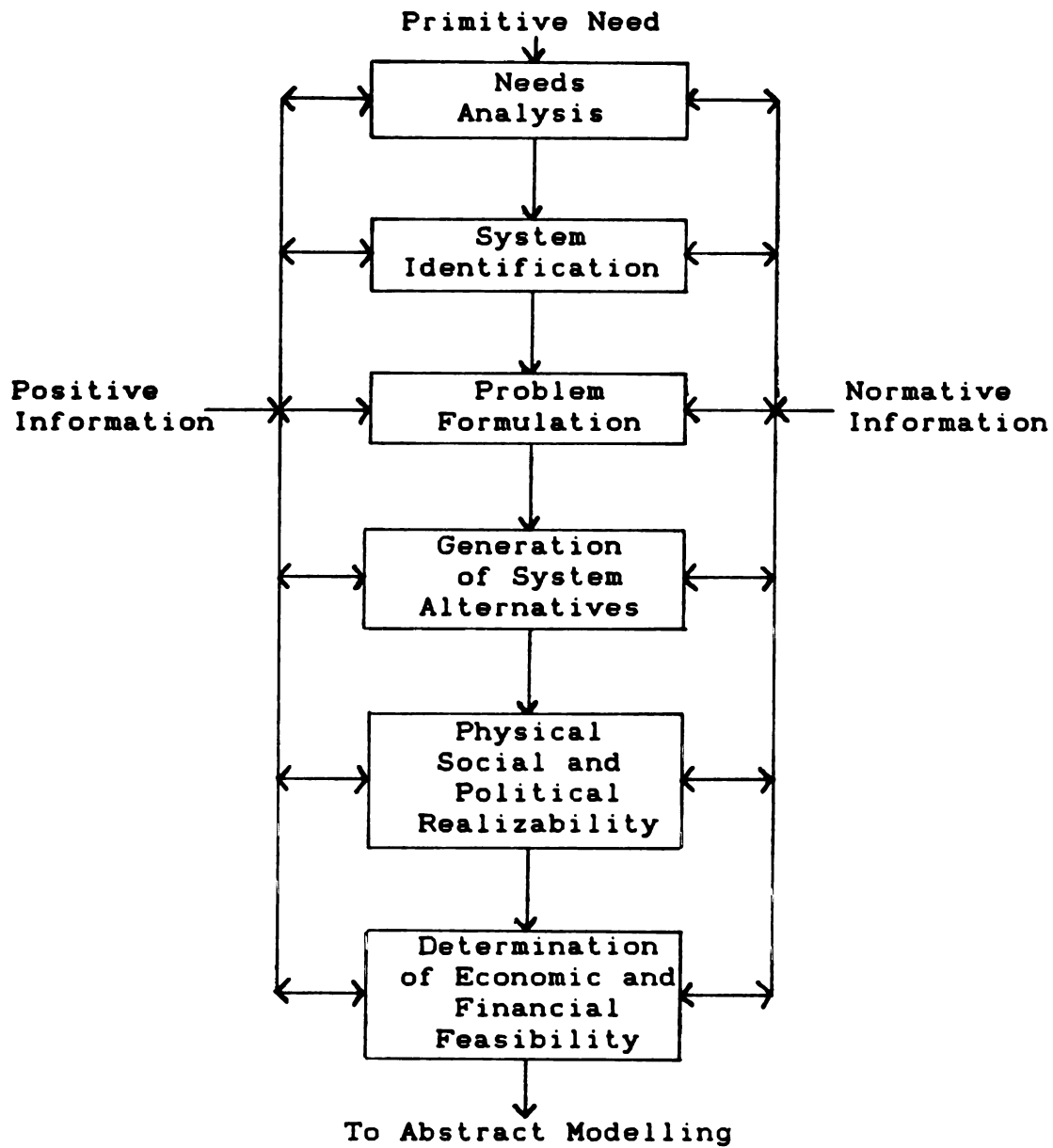


Figure 2: Feasibility Evaluation

Implementation is to give physical existence to the desired system. In this research, the procedures developed will be tested by using a specific farm type as an example of the measurement system in use. Since the systems approach is iterative, information developed in this phase on the workability of the system would act as feedback for the modifications needed for implementation of a Working System.

Similarities between the steps in the systems approach and Johnson's (1977) problem solving model (Figure 3 below) indicate the generic nature of both processes. Also, the systems approach can be observed to coincide with the basic thesis development i.e., problem statement (feasibility evaluation), investigating how others have brought light to the problem in the form of a literature review (developing a set of feasible solutions), developing of model to be tested (abstract modeling), statistical methods and hypothesis testing (implementation design), analysis and recommendations (implementation). However, the systems approach goes further and actually involves the decision-maker or those who will be affected by the system to participate in its development. Plus, the approach goes toward development of the working system to which much academic research falls short.

The systems approach makes the assumption that it is the end user and not a so-called "expert" that will determine the adequacy of the system outputs. This is important

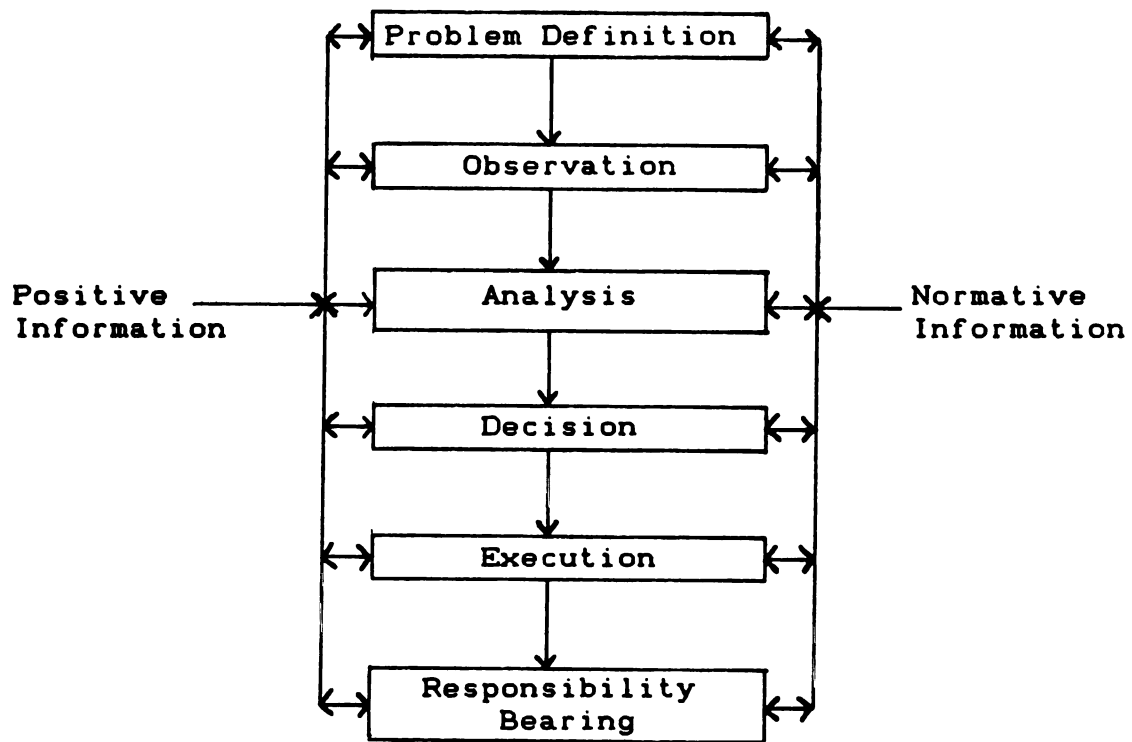


Figure 3: Johnson's Problem Solving Model

when dealing with a normative discipline such as economics where the role of the professional is to educate the manager, but learn from other theorists. This research assumes that there is such a thing as a "successful farm manager" and that we can learn from what they do and not just expect them to accept what we teach. Although the measurement system developed by the systems approach will be used primarily by other economists, the methodology should not be so abstract as to render the values measured devoid of correspondence to the real world conditions that the farmer faces.

Another benefit of the systems approach to very unstructured problems is the introduction of detailed diagrams which guides the research and helps to prevent the exclusion of necessary parts to complete the working system. This does not mean that no parts can be omitted either knowingly or unknowingly, but diagramming the process helps to focus on the essentials.

PART II

FEASIBILITY EVALUATION

As stated previously, Feasibility Evaluation begins with some expressed or unexpressed need, and ends with a set of feasible alternatives. This phase parallels the Literature Review and Problem Statment phases of the conventional thesis format. This phase will include: 1)Needs Analysis, 2)System Identification, 3)Problem Formulation and 4)Generation of System Alternatives.

Chapter 3

Needs Analysis

Feasibility Evaluation begins with the analysis of the needs the system under consideration must satisfy. Needs analysis attempts to penetrate the veil of "apparent" needs and identify underlying actual needs. Needs analysis must carefully consider the needs of all persons and institutions which will be involved with the proposed system.

3.1 Technology and The Structure of Agriculture

A review of literature suggests that although the definition for a small farm is not settled (Fiske, 1983), the facts show that by whatever definition their numbers are declining. However, there are conflicting opinions both inside government and academia on the implications of this decline. Since Thomas Jefferson, the expressed intent of the nation's agriculture has been to support the model of the self-sufficient farmer who owned his own land. The emphasis, however, has shifted over time to the more commercially oriented larger farms (Fiske, 1983). This pattern was probably accelerated by the need for increased output per worker necessary to sustain a major war effort such as World Wars I and II. Increased output and productivity even after the war years has been equated by many as a national symbol of progress (James and Pugh, 1968). Even the presence

of small farms was considered a "consternation" to commercial farmers through their influence on resource prices and agricultural policy (Brannen, 1968).

Within this question over national priorities, comes the question of efficiency verses equitable distribution of income. Murphree (1968) has pointed out that increased farm size in areas of limited alternative employment opportunities results in stagnation of those rural communities undergoing this transformation. Since the result of increased farm size has been the displacement of farm workers into the unskilled labor market, if all factors are accounted for, there may not be a net social benefit to increased labor productivity. Murphree (1968) further points out that while land values have been appreciating -- due to increased land productivity -- with the increased trend of absentee land-ownership, income transfers through land may be accruing to a largely non-agricultural sector.

Different explanations have been given for the disproportionate rate of small farm failures. A number of these reasons center around increased capital requirements due to the increased use of purchased inputs (James and Pugh, 1968; Brannen, 1968; Babb, 1979). The increased use of purchased inputs has been a result of the successful efforts of the USDA and Land Grant Institutions to advocate the use of improved technology. However, as some farmers have discovered the rewards for the incorporation of innovations on the farm accrue only to the early adopters, usually larger

farmers (Holland, 1980; Osborn, 1980), then the rewards accrue to the consumer (Steichen, 1968). In fact, there are suggestions that the benefits of employing the new technologies do not cover their high market cost when compared to the replaced technologies (Steichen, 1968).

Reasons for small farm survival and demise have been attributed to the characteristics of the farmers themselves and their decision-making processes. Olson (1978), in his investigation of the information needs of small farmers in Michigan, discovered that small farmers were indeed different in both physical and human resources available to them, technology appropriate to them, and the formulation of goals and identification of problems by them. White and Boone (1976) in their investigation into the decision-making processes of limited resource farmers in eastern North Carolina found that small farmers did, in fact, rely on more interpersonal sources for production and marketing information, while larger farmers had more contact with what Rogers (1971) would call "change agents". However, White and Boone also found that within this limited information structure, small farmers behaved rationally in their decision-making processes. That is, they followed the five steps of rational decision-making defined as: 1)Orientation, 2)Observation, 3)Analysis, 4)Implementation, and 5)Feedback and Adjustment (White and Boone, 1976). They concluded that small farmers could, in fact, be helped towards better levels of production and standards of living if they are

steered to "unbiased" sources of information.

3.2 Adoption of Technology

The problem of evaluating the effects of technology centers around the question of adoption or nonadoption and subsequent consequences. To evaluate the adoption potential for a given technology requires knowledge of the characteristics of the technology and of the potential adopter. Leagans (1979) observes that to determine how farmers will accept change one must understand why farmers do what they do. The burden of blame for the non-adoption of technology should be directed away from the farmer towards the shortcomings of the society or change agent to affect the perceived attributes of the technology favorable to adoption. Adoption depends on the cumulative valence of incentives versus disincentives (Leagans, 1979). In other words, people observe both limitations and incentives to innovate simultaneously (Leagans, 1979). Drucker (1977) also emphasizes the importance of perception in changing behaviour. Communication begins with the receiver not the sender. For effective communication of an idea, the sender must put himself in the shoes of the receiver to understand his point of view to ensure that the idea is expressed in terms emotionally acceptable to the receiver (Drucker, 1977).

Rogers (1971) confirms the dichotomous nature of the problem as he explains adoption in terms of both the attributes of the technology and the potential adopter. The

external factors affecting adoptions include: perceived attributes of the innovation, type of innovation-decision, channels of communication, nature of the social system, and extent of the change agents' promotion efforts (Rogers, 1971). Internal factors which are characteristics of the adopter are: socio-economic variables, personality, and communication behaviour (Rogers, 1971). This format takes both the attributes of the technology and the adopter as the independent variables affecting adoption. However, micro-computer technology as a planning tool is not set. Its attributes change as its capabilities increase and cost decreases. Both of which are continuing at accelerated rates.

In the Organization for Economic Development's (OECD) study on the "Social Assessment of Technology" (1978), attention is drawn to the dynamic nature of new and yet partially evaluated technology. The report emphasizes the importance of an iterative process in determining the impact of a new technological development (OECD, 1978). They suggest that:

"...the most satisfying approach seems to be a convergent investigation of needs and demands of the potential users on the one hand and of the opportunities and promises of new technological discoveries on the other. Critical comparison of the two trends leads to the choice of particularly interesting technological developments among which the most promising one can be distinguished as the pivotal objective of the analysis."

(OECD, 1978:25)

This approach suggests that an investigation of the impact of such a multifaceted and flexible technology like

the micro-computer must be iterative. The essential problem is to determine which group of farmers could possibly benefit most from the adoption of micro-computer technology and then determine optimal hardware and software combinations appropriate to that group or groups. There are as many configurations that computer technology can be packaged in as there are applications for their use. Furthermore, the technology must be available in both the physical and economic sense, i.e. within reasonable proximity and affordable.

3.3 Micro-computer Technology and Present Farm Applications

By definition, a computer is an electronic device capable of receiving and storing data, performing prescribed numeric or logical operations on the data, and reporting the results of those operations (Sonka, 1983). There are two parts of a computer system, hardware and software. Hardware consists of an input device, a central processing unit, video display, disk or other types of external memory, and a printer. Computers can be categorized according to their speed of performing calculations, capacity to store data and instructions, portability, and cost (Sonka, 1983). The characteristics that distinguish micro-computers from their larger cousins, main-frames, are size, cost, and limited internal memory. However, the internal memory and processing ability of micros are quickly catching up with many main-frame computers that have become standard on many

university campuses. Software can be considered the mind of the computer and the hardware its brain. The hardware provides potential, whereas the software provides applications. The key to usefulness of any system is appropriate software to handle the desired task. Would-be computer users are warned to first look at the software needed to solve their computer needs before deciding on hardware (McGrann, 1982).

In a Purdue University survey of on-farm computer users in Indiana, the most popular computer applications were in the financial areas: general ledger, accounting, record-keeping and financial statements. The most needed software development was in the areas of crop production, access to market data, market planning, and field records (Purdue 1982). The accounting software is probably more developed due to its similarity with non-farm business needs. General accounting packages can be adapted slightly to encompass the categories most appropriate to farm situations. However, the more farm oriented needs, like crop production software, investment, and market planning have had to wait for subject matter specialists to get involved with software development.

The Purdue University study tried to measure the benefits of micro-computers in a qualitative way when surveying on-farm computer users. It found that the majority of the farmers perceived the benefits to be improved control, time saving, cost reductions, education and entertainment.

However, the time saving element depends on the context in which time is measured and the quality of time considered. Henshaw has pointed out that it takes just as much time to input data into a computer as it takes to write it down in a ledger. Plus, time must be spent in learning the skills necessary to successfully use the technology. The farmer or farm manager must learn typing, accounting, ration formulation and other analytical skills to effectively use information generated by computer programs (Doster, 1982; McGrann, 1982). However, the time that a computer can save is realized in the analytical and computational aspects of data processing. Whereas, the time needed to collect and input data may be the same for a manual and computerized management information system, the computer can quickly facilitate the transformation of data to information. The immediacy of results is a primary feature of computers which make them most appealing in demonstrating the value of keeping records (Henshaw, conversation). An important question is whether people who are not good at or just dread mathematical calculations can find in the computer a welcomed relief.

3.4 Statement of Needs

The need to specify a measurement system stems from the observation that there is very little tangible evidence quantifying the benefits of planning tools including on-farm computers. To date studies have only exposed qualitative benefits derived from testimonials from present computer users. If we are to analyze the possible implications of

the technology on efficient utilization of inputs, distribution of income and structure of agriculture, we need to know more about which groups might benefit most from its adoption.

The lack of quantitative analysis of the value of on-farm computer use can be attributed to two causes. One is that the technology is in its infancy with a very short track record. The second is the nature of the technology itself. A computer is basically a management aid. The divergent opinions of those that study management as to whether it is an "art" or a "science" have made attempts at defining it, isolating it, and measuring it difficult.

Together with the problem of measuring the value of micro-computers as a planning tool to the farm manager are the problems of determining the economic value of information and measuring the management input to production. It seems that to solve any one of these problems is to substantially solve the other. Since one of the main functions of management is decision-making and the major input to decision-making is information - to determine the value of information requires a measure of both the changes in behavior and performance as a result of an improved information system. The problem then becomes what to measure as benefits and how to measure them.

Chapter 4

System Identification

System Identification forms a link between the statement of needs and a specific statement of the problem that the system is developed to solve. This phase leads to a detailed specification of the variables involved in the design and control phases and concludes with the determination of performance criteria which will assist in evaluating system alternatives. This section begins by defining management within the overall Farm System. The management system is further identified in terms of how computerized information systems are theorized to affect management. This chapter concludes by identifying the proposed Measurement System in terms of its relationship to the management system and criteria for evaluating a working system.

4.1 The Farm System

A "system" is a set of interconnected elements organized toward a goal or set of goals (Manetsch and Park, 1982). A basic systems model along with definitions of component parts are given in Figure 4. The systems approach forces a conscious recognition by the researcher of what is and is not under the manager's control and who are the relevant managers of that system.

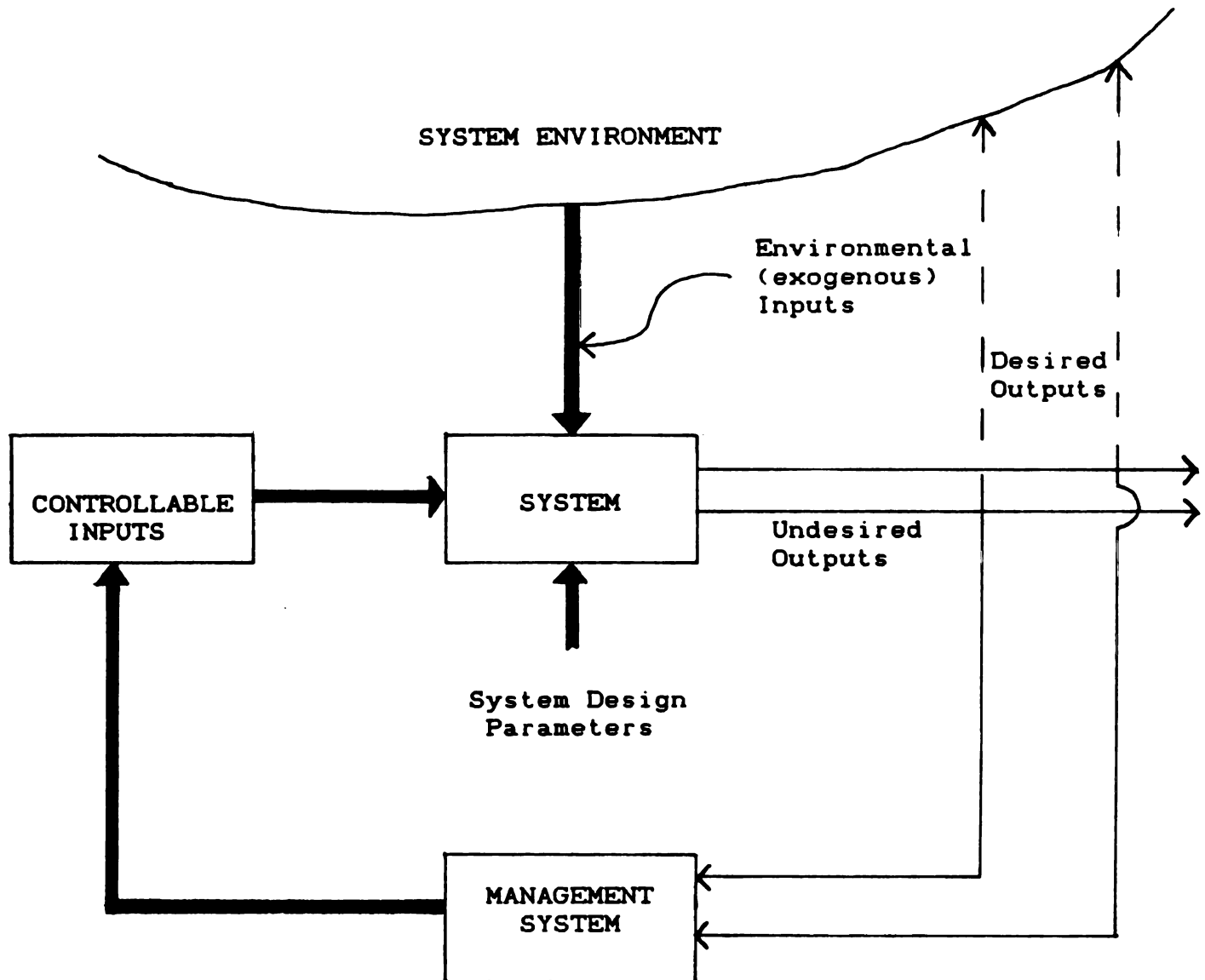


Figure 4: System Identification

The "Farm System" shown in Figure 5 includes the farm/family with its different production enterprises and consumption units which transform land, labor, and capital into outputs such as production, income, cash balance, consumption, education, net worth and debt. The transformation process is determined by the design parameters of the system which consists of land area, soil productivity, labor availability, input availability, input/output coefficients, and per-capita consumption. The controllable inputs under the direct influence of the manager(s) are levels and types of production, marketing strategies, and investment policies. The "System Environment" includes those inputs which are exogenous to the system or outside of the direct influence of the manager including: weather, the biological process itself, output prices, input prices, government programs, wage rates, interest rates, and credit availability. Although the manager may not be able to directly influence these factors, a knowledge of them and their probable directions is needed to make adjustments in his farm system.

4.2 The Management Process

According to Johnson (1977), management is best regarded as a separate "enterprise" which:

"...uses resources (time, information, data processing equipment. etc.) to produce decisions about, among other things, the amounts of inputs to use in producing specific products, levels of production and consumption,

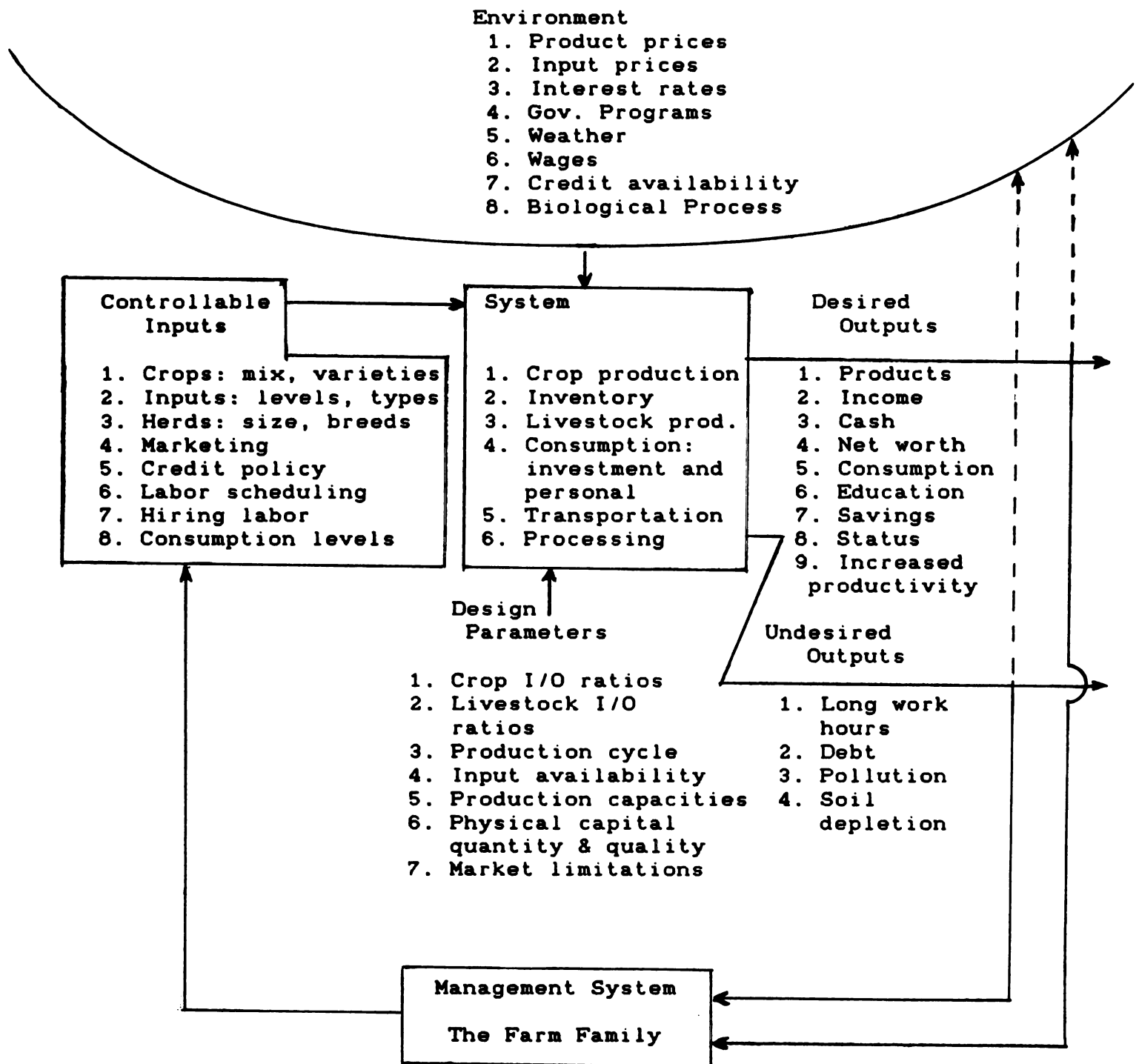


Figure 5. The Farm System

decision rules to use, actions to take in carrying out projects, projects to execute in administering programs, which programs fit under an overall policy, and what policies to adopt."

The management process produces decisions not products like corn or milk. Management can be further divided into: problem definition, observation, analysis, decision, execution and responsibility bearing (Johnson, 1977). Within the management system, normative and positive information is processed through decision rules to produce prescriptions. The manager's value system determines what is "good" or "bad" while the prescriptions or decisions made by the manager can be labeled "right" or "wrong" depending on how well these decisions are made or if they are appropriate for accomplishing the manager's intent.

Management: Art or Science

There are two divergent schools of thought as to whether management is a "science" or an "art". By "science" one means a verified, accumulated, and organized body of knowledge that has been objectively obtained and systematically checked (Richards and Greenlaw, 1972). The concept of "art" emphasizes the skills obtained through experience by the manager in solving problems. One school argues that management can never be a science due to the complexity of problems that managers face. Although the manager may use knowledge obtained from science, he must decide, even if such knowledge does not exist (Richards and Greenlaw, 1972).

Therefore, one cannot categorically assume that the utilization of scientific methodology will produce results better than those achieved by experience-based decision approaches.

In the past, economists by projecting the manager as the "rational" (scientific) man, emphasize the allocative role of management, but because of its Neoclassical underpinnings can be criticized for its reductionist and deterministic view of the managerial process. Johnson (1957) has pointed out that "... economics turns out to be a necessary but insufficient basis for management" and that "... static production economics assumes away much of both the process and problems of management" (1957: 444-445).

However, Teece and Winter (1984) have observed, an economist's view of management is disguised production economics. They further distinguish between economics and management in that economics concerns itself with problems that are very different from management problems (1984). The difference in focus can be summed up into three categories:

" 1. Economists have a certain brand of rationality based on a reductionist approach instead of seeing the problem as a whole.

2. Economists are not concerned with predicting the behavior of individual decision units, but with analyzing the pattern of behavior of whole populations of economic agents.

3. Economics deals primarily with a world of organized auction markets operating under high information constraints." (Teece and Winter, 1984)

The result has been the development of analytical tools by economists that (a) underemphasize dynamics, (b) have no embodied theory of innovation, (c) have an inadequate theory of the firm, (d) and have no role for entrepreneurship (Teece & Winter, 1984). Attempts of reforming the economist's static profit maximizing objective function approach as an approximation of how the manager behaves include the development of the expected utility hypothesis, dynamic programming, multivalued maximization techniques, and game theory.

Even these attempts at introducing dynamics into economic models have suffered from the economist's obsession with developing rigorous mathematical models which are cumbersome in arriving at solutions and whose underlying assumptions greatly restrict the generality of their conclusions. Some problems include empirical evidence of preference reversals which damages the generality of the expected utility hypothesis (Grethe & Plott, 1979). Even if the mathematical, expertise and data requirements problem necessary for arriving at solutions using these models is solved, these models de-emphasize the time consuming and expensive predecision stage that the manager must face where: 1) the alternatives must be selected, 2) the probabilities of occurrence of states of nature determined, and 3) the alternatives given utility weights based on estimating the utility of multi-variate outcomes (Toda, 1976). These models further give answers to only one problem, whereas any

particular decision will be nested with more grand problems within a "decision hierarchy" (Toda, 1976).

Such a restricted view of the manager's role by some economists has led others such as Johnson to view managers as essentially problem solvers. Now instead of the manager fullfilling the role as the economist's "rational man", he may use the tools of economics within certain of his functions. In particular within the analysis phase the manager can use the economic "...principle of matching added costs against added returns under certain second-order conditions, as a basis for defining an optimum" (Johnson, 1957: 447). Such a principle is of use both "... 1) in solving the breeding or engineering problem, which may be either static or dynamic, and 2) in ascertaining within the dynamic decision-making process, the optimum amount of information to acquire and the optimum amount of analyzing worth doing" (Op cit. 1957). The manager must set priorities when it comes to determining which problems to solve first and how much time to spend on each. The marginal returns from the appropriate allocation of time to decision-making could outweigh the benefits of a sophisticated method for solving any particular problem.

Further, not all of the information needed for the decision-maker is economic in nature and includes technical as well as human and institutional information. Different aggregates of information are needed for different sets of

problems. For instance, farmers use a different set of information sources when establishing a new enterprise than they do when managing an ongoing one (Johnson et al, 1961).

Mintzberg opposes the management sciences' classical view which suggests that the manager organizes, coordinates, plans and controls. Instead he emphasizes the "... interpersonal, informational, and decisional roles" that the manager plays (Mintzberg, 1975). The manager as resource allocator falls under his decisional role which also includes entrepreneurship, disturbance handler, and negotiator. Within his interpersonal role, the manager acts as a figurehead, leader, and liaison. His informational role requires him to be a monitor, disseminator and spokesman (Mintzberg, 1975).

While fulfilling these roles, the manager relies more on verbal methods of information gathering rather than on documents or outputs from sophisticated management information systems. The manager is more likely to make decisions based on "...programs remaining locked deep inside their heads" (Mintzberg, 1975 p53), instead of some systematic, analytically determined procedure which is external and open for evaluation. This internalization of the decision process is what may limit attempts at improvement by the management scientist, since only as these processes become externalized can they be scrutinized and analyzed. Mintzberg still accepts the usefulness of management scientists, since he sees their role as understanding and

educating the manager as to his different roles which includes, but is not limited to, systematic decision-making.

The issue as to whether management is an "art" or "science" raises questions regarding how the psychological makeup of the manager may affect the way they make decisions. The manager that sees himself as an "artist" may rely more on "seat of the pants" reasoning, while the "scientific" type may prefer more systematic management tools. Roberts and Lee used the Myers-Briggs Type Indicator (MBTI), which seeks to measure personality types, at Texas Tech University in 1977 to analyze personality types of both professors and students in the Agricultural Economics Department. Their result suggest that sensing and judging types prefer to learn in a systematic manner, while the intuitive and perceptive types prefer to learn in a flexible, unstructured manner. Students exhibiting contrasting personality types should not be taught or treated in the same manner (Roberts and Lee, 1977).

Henderson and Nutt, also using the MBTI, report that cognitive style seemed to influence executives' choices when choosing capital expansion projects under simulated conditions. Therefore, if cognitive style affects both how we learn, utilize information, and make decisions, then it would influence the farm manager to choose the information system most conducive to his decision-making process.

A related issue involves how much confidence a decision-maker places in information to be used for decision-making.

Fischhoff and Macgregor assert that forecasts "... have little value to decision makers unless it is known how much confidence to place in them" (Fischhoff and Macgregor, 1982). Therefore, a manager may choose not to use an "improved" information system, because his cognitive style may prejudice him against any "scientific" management tool.

Interaction Between Decision Making and Goals

The manager has to decide on what weights to give different outcomes based on his value/goal system which may change over time. The setting of goals and the evaluation of values is another function that the manager is burdened with, but is also prime areas for scientific analysis as an aid to understanding and process improvement (Johnson, 1957).

Goals are decisions that act as guide posts for the making of other nested decisions or represent constraints on what alternatives are looked at when making decisions. As such, no one or set of goals can be held to be constant over any wide range of managers nor constant over time with the same manager. Harman et al (1972) out of a list of eight goals discovered that four were picked first most often; 1)make more annual profits, 2)maintain or increase family living, 3) avoid years of low profits or losses, 4)avoid being forced out of business. The ranking of these goals however varied over manager characteristics of age and tenure of the operator, educational attainment, number of dependents, assets, net worth, debt-asset ratio, off-farm

income, total land and cropland in the operation, total acres owned, and the proportions of land and cropland owned (Harman et al, 1972). Such an extensive list of factors associated with the selection of primary goals makes the establishment of stable utility functions questionable.

Vogel (1981) argues that productivity and profitability are not the small farmer's top priorities. Woodworth et al (1978) and Orden (1977) independently found that small farmers did not take full advantage of credit opportunities, nor did they express strong desires to expand, indicating strong risk-averse behaviour.

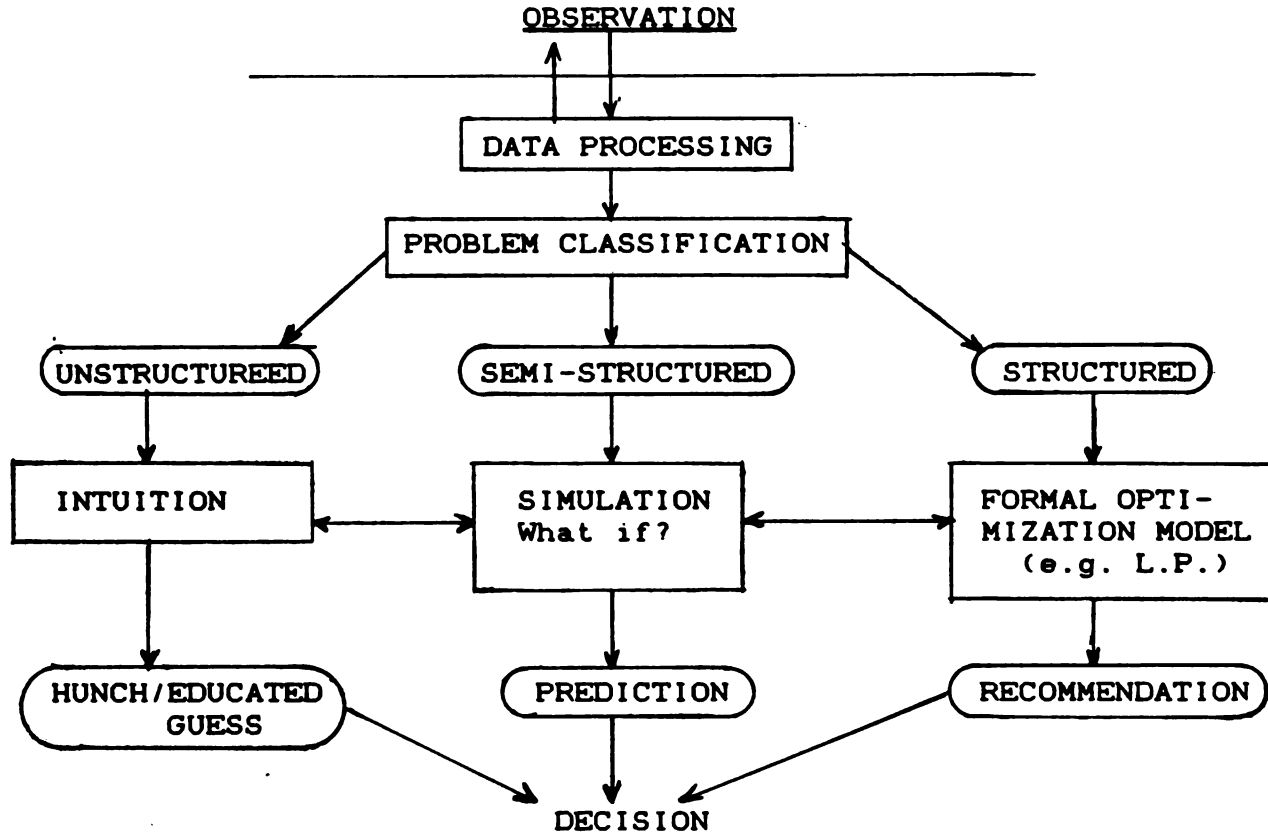
Unlike these findings, other researchers contend that small farmers do recognize economic as well as socio-cultural considerations (Hansen et al, 1981; Fiske, 1983; Schroeder, 1983). Hansen et al (1981), while using the Farming Systems Research method of investigation in one Florida county, discovered that to understand the small farm allocation problem one must look at the whole farm as a system. Goals of the family may include making a farm profitable, be self-sufficient and seek off-farm employment and all of these without the exclusion of the others. Efficiency, exorts Hansen et al (1981) must be measured according to the overall goals of the farm household and not just farm output efficiency. Schroeder (1983) also emphasized the blending and supportive nature of various goals towards the total family well-being in her study of Illinois small-scale farmers. Lifestyle goals and profit goals were

found not to conflict as the farm family attempts to maximize utility (Shcroeder, 1983). Profit motives were found to strengthen investment motives, and therefore indirectly strengthen the lifestyle motives. Lifestyle motives exerted a positive effect on investment and therefore profit (Shcroeder, 1983).

The profit maximizing motive which is hypothesized to be the prime mover behind economic decision-making, may not be the key factor for nonfarm as well as farm firms. Drucker (1977) argues that to understand business behaviour one must look at the business' overall objectives which more than not is survival, not short-term profit maximization. Profits are essential for survival but not to the sacrifice of other goals such as: perpetuity, harmonious relationship within the economy and society in which it must function, the ability to supply an economic good and service, and being a change agent within that society (Drucker, 1977).

4.3 Management Information Systems (MIS) vs Decision Support Systems (DSS)

Within the management process, it is the analysis phase in which the introduction of computers into the decision making process is theorized to have its greatest impact (Capouch, 1981; Doster, 1982; McGrann, 1982; King, 1985). Figure 6 represents this analysis phase with the emphasis on the level of structure of problems to be solved. In general, structured problems are those where there is very



DEFINITIONS:

STRUCTURED: These problems are of the recurring type which may be handled within some formal optimization model, solved through using heuristics (rules of thumb), or be so routine as to be almost an instantaneous response to stimuli - habit.

SEMI-STRUCTURED: Semi-structured problems while having part of its solution adaptable to systematic modelling, will usually not have a builtin optimization criteria. Results of different scenarios must be weighed by the manager against goals, values, and other decisions made or to be made.

UNSTRUCTURED: Unstructured problems arise which are completely novel to the manager, whose solution is not amenable to mathematical or other systematized modelling, and whose recurrence may be viewed as highly implausible.

Figure 6: Analysis Phase of Management System

little question as to the certainty of the information used to make the decision or the expected results. Here the manager is acting as though things are certain and can use such "rational" economic tools as formal optimization - techniques at arriving at prescriptions (King, 1985). However, a large number of problems facing the farm manager are of the semi-structured type, where there are probabilities of outcomes other than certainty.

In the case of structured and some semi-structured problems the concept of management information systems is relevant. King, using Davis and Olson definition, describes a management information system (MIS) as:

"...an integrated, user-machine system for providing information to support operations, management, and decision making functions in an organization. The system utilizes computer hardware and software; manual procedures; models for analysis, planning, control and decision making; and a database." (King, 1985)

Criticism of MIS concept has centered around the fact it only supports managerial work indirectly (Keen and Morton, 1978). MIS does not help managers integrate data from a number of sources into the context of particular decisions (King, 1985). Further, a MIS which may include optimization models, rules of thumb and systematic models (simulation) may not be useful in unstructured decisions which are unique and outcomes uncertain.

The concept of a decision support system (DSS) is a response to this problem. Sprague and Carlson (1982) define DSS as "interactive computer-based systems that help decision

makers use data and models to solve unstructured problems." The DSS concept emphasizes help or support for decision-makers and not a substitute for the decision-maker. Second, DSS are meant to be used directly by the decision-maker. Third, they integrate both data and models. Finally, DSS are designed for use in unstructured decision situations (King, 1985). However, the barriers dividing DSS and MIS seem to be both imprecise and movable.

Further classification of decisions according to the type of problems and information needs, while it may be theoretically useful, may not be practically possible. For instance, Johnson (1977) in reviewing lessons from the Interstate Managerial Survey, indicated that although information can be classified into categories of prices, production, new technology, institutional, and human, the solving of any specific problem requires information on all five subjects for their solution. This state of affairs again emphasizes the need for flexibility in a system designed to aid the decision-maker so that all relevant information can be processed properly. Adherence to set decision rules based on limited data could lead to myopic decision patterns adversely affecting the managerial process.

4.4 Computer Functions As They Relate to Measuring Value

Computer can be useful in three major areas: 1) Electronic Data Processing (EDP), 2) Management Information Systems (MIS) and 3) Decision Support Systems (DSS).

Electronic Data Processing (EDP) consists of observa-

tion, classification, and storage of data usually producing standardized reports, i.e. balance sheets, herd status, etc. The criteria for evaluating such a system consist of comparing the new system with the previous system in the areas of: 1) average processing time, 2) labor loading and 3) equipment cost (Keen and Morton, 1978).

Management Information System is classified in the area of Operations Research/Management Science, where the emphasis on structured problems where the objective, data, and constraints can be perceived (Keen and Morton, 1978).

Measurement criteria include:

- 1) profitability
- 2) application to major problems
- 3) quality of decisions
- 4) user satisfaction
- 5) widespread use (Ein-Dor and Segev, 1981)

Type of software included in Management Information

Systems include:

- 1) Linear Programming
- 2) ration balancing
- 3) lease/buy decision

With Decision Support Systems, the impact is on semi-structured problems where the computer can be used as an analytical aid, but where management judgement is essential (Keen and Morton, 1978)

Measurement criteria center on extending the range and capability of managers' decision processes to help improve their effectiveness in terms of:

- 1) Decision outputs
- 2) Changes in the decision process
- 3) Changes in managers' concepts of the decision

- situation
- 4) Procedural changes
- 5) Classical cost/benefit analysis
- 6) Service measures
- 7) Managers' assessment of the system's value
- 8) Anecdotal evidence (Kleen and Morton, 1978)

Type of software commonly classified as DSS include:

- 1) simulation modelling
- 2) electronic spread sheets
- 3) market forecasting (charting)
- 4) statistical analysis
- 5) management games
- 6) teaching modules

As can be observed the measurement criteria for EDP and MIS are more easily quantified than DSS. These differences will be explored more and are essential for isolating proper measurement criteria and emphasize the need for behavioral analysis especially in the case of DSS.

4.5 System Definition

In this section, a more specific model of both the management system and management evaluation system is presented. The general systems model was presented earlier where the "Management System" was identified in terms of its role as controller of the "Farm System" through the manipulation of inputs. The function of a "Measurement System" would be to determine how the firm's system may be affected by improvements in the manager's decision-making system.

The structure in which the Measurement System must operate is described in Figure 7. The System that we must develop is designed to measure the impact of improved information and planning tools on the behavior and effectiveness

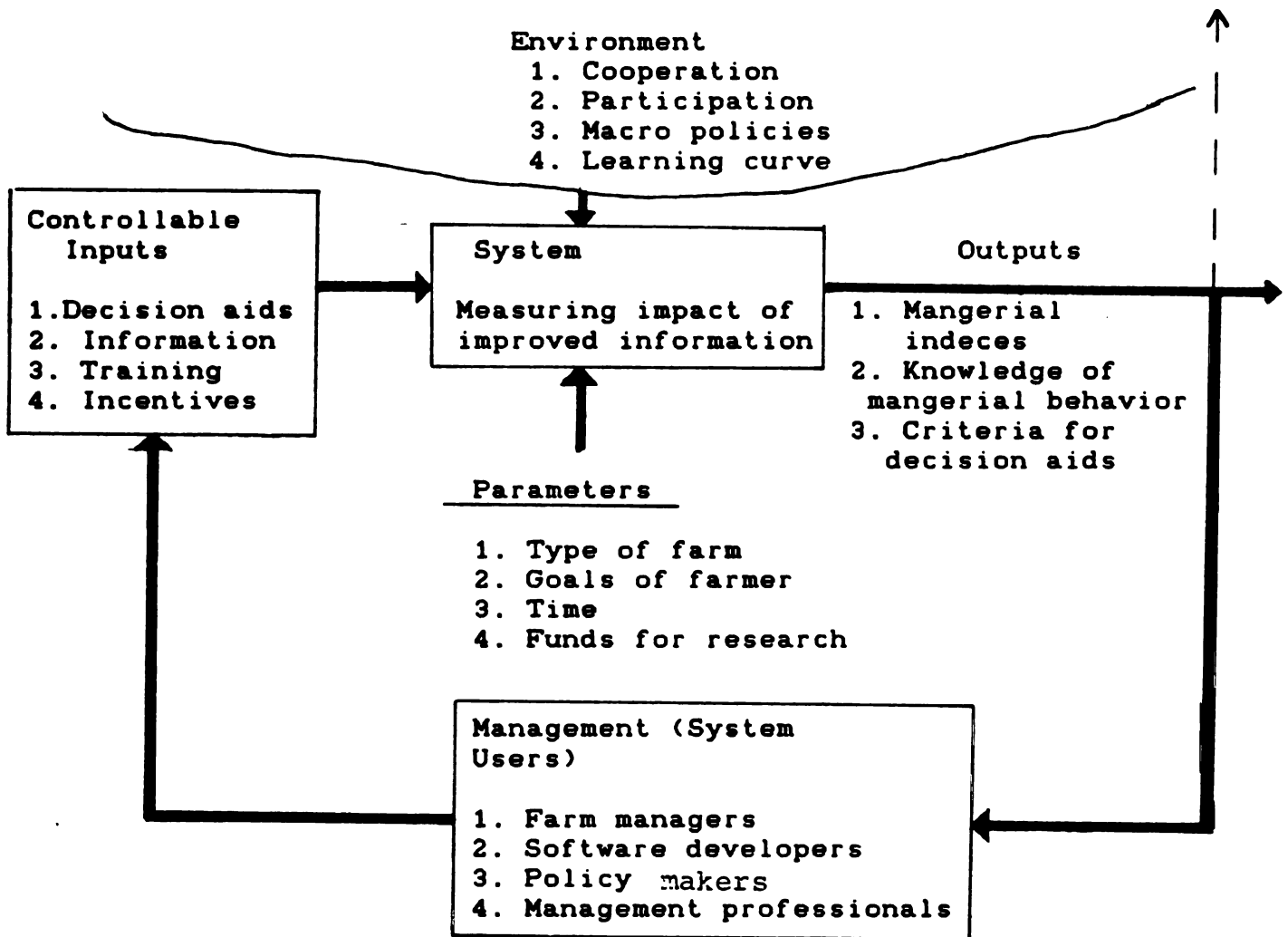


Figure 7: Measurement System

of the farm manager. The "managers" or primary users of the results of the measurement system would include computer users, software developers, policy makers, and managerial professionals. These individuals would supply the decision aids, information, training, and incentives necessary for the system to function.

Beneficiaries of such a procedure will be farmers who may make the decision to purchase a computer and who may be interested in furthering their understanding of management. Software developers would be interested in knowing the extent of possible adoption of the technology and may obtain ideas regarding software needs of potential adopters. Management professionals would be interested in both decision-making behavior and the relationship between behavior and performance. The management teacher could find the approach useful in focusing in on the most crucial areas for managerial success. Policy makers would be interested in the possible implications of the adoption or non-adoption of the technology and the role of government in such adoption.

However, the success of the system in producing tangible results of measured changes in effectiveness measures, information on how decisions are made, managerial indices, and criteria for further decision aid development is limited by outside factors such as cooperation between institutions and personnel dealing directly with the farmers, participation by the farmers, macro-policies and the learning curve.

Other parameters that will cause modifications in the system include: the type of farming system analyzed, the goals of the farmers, time and funding sources. Therefore, these factors must be considered while developing a useful tool.

Chapter 5

Problem Formulation:

Purpose of Measurement System

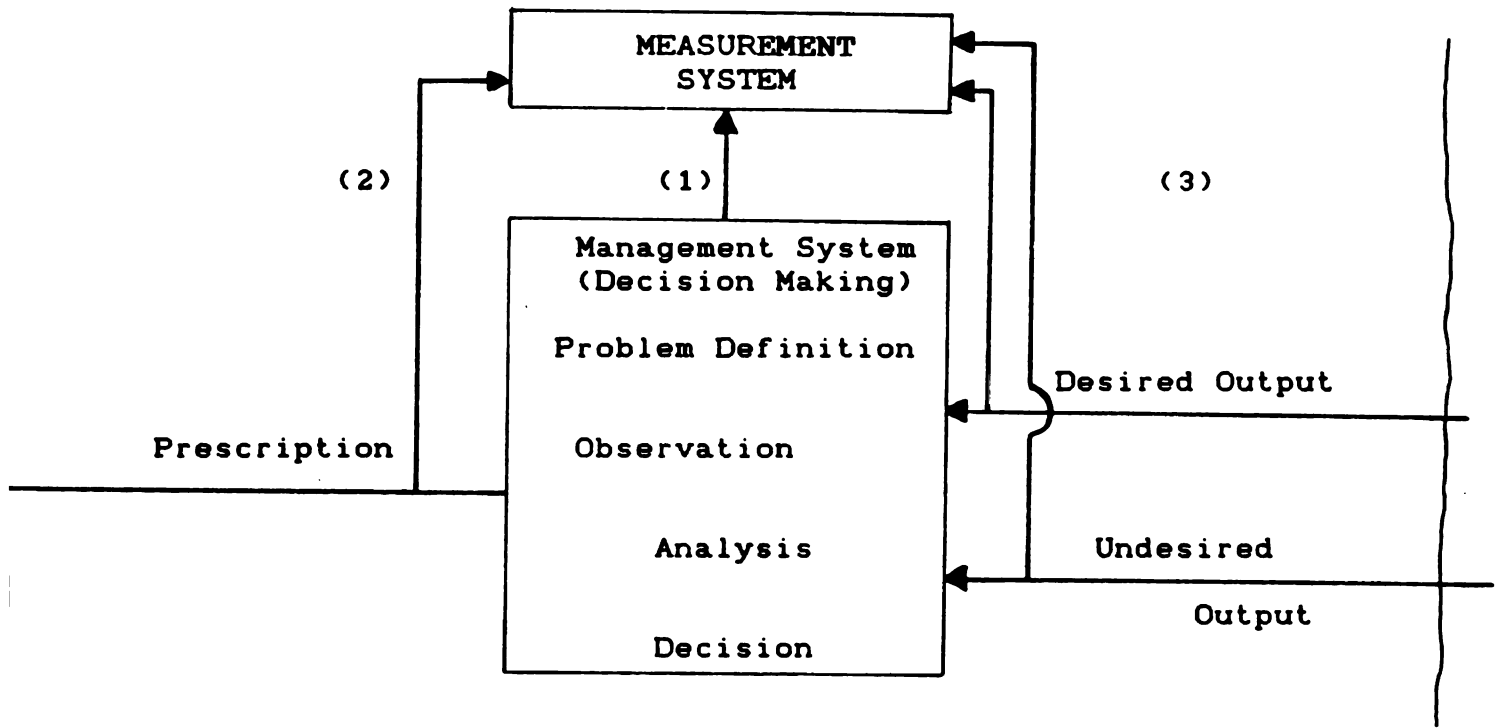
Problem Formulation involves defining the specifications for models which would address the real problem. A workable problem statement would indicate how the results of the model are to be interpreted and implemented.

In an attempt to aid decision-makers we first need a better understanding of the behavior of decision-makers along with the constraints to their decision resources in order to develop decision aides and educational programs. Although research has shown that "good" decision makers are "rational", the question still remains as to how many of tools developed and advocated by agricultural economists and other management professionals are being used by decision-makers and if being used, how effective are these tools. This research is an attempt to define the constraints to the use of such tools with implications to their potential value or needed modifications.

The purpose of developing a measurement system is for purposes of comparisons. Measurement requires definition, isolation and scaling. In defining the role of a business or organizational entity Campbell, Dunnette, Lawler, and Welch (1970) have distinguished among the concepts of

behavior, performance, and effectiveness. Behavior is simply what people do in the course of work. Performance is behavior that has been evaluated (i.e. measured) in terms of its contribution to the goals of the organization. Effectiveness refers to some summary index of organizational outcomes for which an individual is at least partially responsible such as profits, debt ratios and productivity. Most of the performance measures used by finance or business analyst are considered effectiveness measures by these definitions, while the behavioral aspects of performance are not generally considered. In other words performance deals with how a manager gets the firm to a position that can be evaluated in terms of effectiveness measures.

For our purposes an even clearer distinction between behavior, performance and effectiveness can be made. Figure 8 demonstrates how the isolation and measurement of the management system is dependent on where one monitors in relation to the throughput of information. The manager uses positive information from the outputs of his farm system along with his values and goals to formulate a prescription for further action. Management behavior or decision-making includes problem definition, observation, analysis and decision. To determine the effects of an improved decision-making system one can measure changes in the behavior of the manager which consists of measuring at point 1. One could compare differences in decisions made or prescriptions produced by the management system (performance), point 2.



- (1) Decision Making (Managerial Behavior)
- (2) Prescriptions (Managerial Performance)
- (3) System Outputs (Managerial Effectiveness)

Figure 8: Isolation And Measurement Of Managment System

One could also measure changes in actual conditions of the farm system (effectiveness), point 3.

The distinction between behavior, performance and effectiveness is important for our investigation since in the short run a manager's behavior may change without immediate results being measured by performance or effectiveness of the organization. That is, many factors outside of the manager's immediate decisions and actions may substantially effect the outcomes of his farm system.

Therefore, to thoroughly evaluate the benefits of an improved decision-making system we should attempt to measure both how the decision-making behavior and performance of the manager is changed as well as measure relevant system performance criteria (effectiveness measures). While previous studies have somewhat standardized the performance measures used to evaluate the physical and financial status of a farm, less attention has focused on the difference between "right" and "wrong" decision-making behavior. Furthermore, the long time lag between action and result in agriculture makes it difficult to determine improvements in effectiveness measures unless considerable time has elapsed. However, if a combination behavioral/performance oriented measurement system could be developed that would give some indication of possible future effectiveness, such a measurement system or test could help in evaluating decision support tools and educational programs designed to aid the manager.

Any measure of changes in management due to information must satisfy the criteria for scientific objectivity.

Therefore, any measurement concept must be evaluated with respect to internal and external consistency, clarity and workability (Johnson and Zerby, 1973). Internal consistency (coherence) is a logical or analytical matter where a set of concepts must bear logical relationship to each other. The external test of consistency (correspondence) is the test of experience. In order to apply the test of correspondence an existing concept is compared with concepts based upon new experience. A concept passes the test of clarity when it can be communicated between people without ambiguity and vagueness. The test of workability is a pragmatic test of usefulness (Johnson and Zerby, 1973).

The major thrust of this research is to clarify and measure the concept of management as it relates to farm decision-making, to identify the areas of managerial effectiveness that can be measured, and to identify areas of managerial ability that can be tested.

While performing the primary tasks involved with the development of the measurement system, other products will be produced which may be equally important. Subject matter information will be generated such as:

1. Validated managerial effectiveness measure(s),
2. Common behavioral attributes of "successful" (effective) farm managers,

3. Levels of use of economic tools by farm managers,
4. Information on the relationship between behavior, performance, and effectiveness,
5. Criteria for decision aid selection for cash grain farmers.

Chapter 6

Generation of System Alternatives

This phase of the analysis outlines alternative ways of solving the measurement problem focusing on how other researchers have attempted to measure the value of information. The chapter begins by developing a structure under which these studies can be categorized and then reviews the literature in the context of this classification scheme.

6.1 Measuring Behavior, Performance or Effectiveness

The value of information is related directly to how management is defined and measured, since information is an input to the decision-making phase of the management process. Information can be regarded as data in a form that is of real or perceived value for making current or prospective decisions (Davis, 1974). According to Goldman (1953: 2), "...the amount of information in a message should be measured by the extent of the change in probability produced by the message." Fuller (1982) asserts that information is valued only as it affects behaviour. Forster (1978) claims that the value of information increases with the riskiness of the decision to be made, and the value of the expected gain or loss from that decision. These different schools of thought stem from the issue as to whether management is a direct input to production, a factor that must be measured

only as a residual entity, or measured as a separate function.

Going back to Figure 8, we can classify past attempts at measuring the value of information into categories of 1) Measuring Improvements in Managerial Behavior, 2) Measuring Improvements in Managerial Performance and 3) Measuring Improvements in Managerial Effectiveness. How one defines the management function, and where one decides to measure changes in that function, opens the concept to criticism by one or more of the tests for objectivity.

6.2 Measuring Improvements in Managerial Behavior

Revisiting Figure 8, one may decide to measure management within the "Management System ", where one would compare managers' traits, levels of managerial knowledge, or management practices. Such an analysis was done by Vogel (1981) where he compared management practices of small and large farmers in southern Illinois. He found that on a percentage basis large farmers used more professionally accepted management practices than small farmers in respect to cultural practices, financial management, and marketing tools used. There are problems with using an index of a farmer's knowledge as a measure of management based on threats to coherence in that: 1) one may not be able to distinguish between knowledge and entrepreneurial logic, 2) it is difficult to distinguish between management ability and management input, and 3) the inclination for the re-

searcher to incorporate subjective elements in the index (Heady and Dillon, 1961). The underlying implications to the value of information is that the "more information used the better" or the "more certain practices used the better". The "better" being the subjective evaluation of the researcher as to what is the "right" or "wrong" way to behave.

Willingness to Pay

Another method of determining the value of information in decision-making would be to investigate farmers' willingness to pay for information services. One could keep track of how much farmers pay for information and processing equipment, along with assigning an opportunity cost for the value of time spent in collecting and processing data for decision-making purposes. Of course it could be argued that farmers do not allocate the optimal amount of resources to decision-making, and much of the information may be redundant. However, redundant information may hold value in that it may increase the confidence of the decisions made. This improvement in confidence could be of great value to decision-makers faced with a number of uncertainties.

Although the author has not found studies which measured the amount paid for information, this method could give some indication on the value of their present information resources as compared to the value of other productive inputs. However, the willingness to pay would be an hindsight measure determined after adoption of the technology. The value obtained in this manner can not be

extrapolated to represent how farmers would value an improved decision-making system with substantially different attributes.

6.3 Measuring Improvements in Managerial Performance

One can also compare managers in terms of the prescriptions or decisions which they produce. In practice it may be very difficult to actually see a prescription since this decision may only exist in the manager's head. What is observed is activity based on that decision and the final result of such activity demonstrated in the farm system outputs.

Within the teaching or training arena we use tests or questions which we have already determined the "right" answers to in order to test the student's ability. However, these questions must necessarily be abstractions from reality. It is hoped that scores on these tests can be a good indication of future managerial performance since prospective employers of these managerial students look at the grades from such tests in the selection process. Unfortunately not many real world problems are as structured as the problems presented in such tests.

Rohrbach (1983) conducted an experiment comparing the performance of graduate students in agricultural education on a standardized test. The object was to evaluate the effectiveness of computer aided instruction (CAI) in comparison to conventional instruction. Rohrbach's study indi-

cated "...that the lecture-discussion method of teaching was superior to the microcomputer-assisted technique in teaching the types of principles and concepts under the conditions described." The areas taught under the two methods were principles and methods in cost recovery and investment credit. Rohrbach admitted that his findings were not in line with other evaluations of computer aided instruction, however his findings would indicate that CAI may not be appropriate in all cases.

Simulation or Gaming

Kleijnen suggests the simulation or gaming approach as another method of measuring managerial ability. According to Kleijnen (1980) "...simulation can be characterized in the terminology of information economics as: dynamic (including feedbacks and feedforwards), non-linear, nonzero-sum game,...complex management processes, and multicriteria satisficing behavior based on imperfect knowledge."

Debertin et al. (1975; 1976) used the simulation gaming approach to assess the value of information and feedback to experimental managers of laboratory corn and soybean farms. The studies used both college senior undergraduates and farmers as subjects. Although the authors found a significant return to information to both groups, the returns as measured using students was higher than when using farmers (Debertin et al., 1976). This prompted the authors to point out areas of difficulty with the simulation gaming approach

to valuing information including: 1) the higher response to information by students might reflect marginal returns to education, 2) the differences in student and farmer behavior with the simulation model could mean that students were not better managers but better "players" of the game, 3) the information used in the experiment and the simulation model itself might not be representative of the real world, and 4) students might be willing to accept the information given at face value, whereas farmers may rely more on their own real world experience.

Performance Scale Building

The Smith and Kendall (1963) approach to performance scale development consists of getting a group of managers to name and define the major components of performance for the job in question. Using these definitions as guides, the participants then are asked to describe specific behavioral episodes that illustrate both effective and ineffective performance (i.e. critical incidents) within each of the a priori factors.

The advantage of this approach is that the researcher does not use his own normative judgement as to how the manager should behave, but depends on the managers themselves to determine what is "right" or "wrong".

6.4 Measuring Improvements in Managerial Effectiveness

This school of thought assumes that the value of information should be evaluated based on performance (effectiveness), where changes in system performance is the value

added by the managerial input once other production inputs are accounted for.

The Bayesian Approach

The Bayesian approach to measuring the value of information assumes that managers are "Bayesian" decision-makers maximizing expected utility or expected returns. Perrin (1976) paraphrases Schlaifer to say that

"...the value of a bit of information is the difference between the decision maker's current expectations of (a) the payoff value that will result if he chooses his act as well as he can without obtaining the information, and (b) the payoff value that will result if he were to obtain the information and then choose his act as well as he can. In other words, the value of the information is the increment in expected payoff that can be realized by utilizing the information in making the decision." (Perrin, 1976)

Perrin uses this method to obtain the value of soil test information in corn response in Brazil. He concluded that soil test information was quite valuable. However, he notes that the "... value measured is compared with the alternative of knowing nothing about the piece of land." (Perrin, 1976) Since farmers know a great deal about their land, one would expect the net value of soil tests to be smaller than measured.

Kleijnen (1980) goes further to critique the usefulness of the Bayesian or information economics approach. He states that much "...information is needed as input to decision calculus: one should know all the possible actions, all possible states of nature, and the corresponding payoffs...The decision maker is supposed to be purely

rational, and maximize expected profit or, more generally, maximize expected utility...Even in static models, the computations may become tedious, and pose difficult mathematical problems...In dynamic models the mathematical problems become tremendous...The models remain highly simplified...it ignores behavioral attributes of information."(Kleijnen, 1980)

Production Function

Kline (1963) argued that management is indeed a separate input to production and can be measured like other inputs to production. Some scientists like Welch and Pudasaini have argued that increases in management ability through education can be measured as changes in the marginal value product of management in a Cobb-Douglas production function (Pudasaini, 1983). Johnson (1963) argued that management does not produce products other than decisions. Heady (1963) argued that management and capital are almost perfect complements, and therefore can not be separated within the production function.

Residual Analysis

Advocates of farm budget analysis and cost/benefit analysis use the residual or net return approach to measuring managerial ability. Nielson and Crosswhite (1959) used increases in net farm earnings as a measure of project benefits when comparing Michigan farmers that were and were not involved with an intensive township extension

program. However, there can be substantial threats to the validity of such a measure. Other forces outside of the manager's control could effect net returns. Further, if a program or project is designed to help one aspect of the farm condition, other activities of the farm manager not influenced by the project could bias such an overall measure. The constraints of the manager must also be taken into account before he can be judged as to levels of success.

Experimental Approach

Rosenberg and Grey (1962) took the experimental approach in assessing the value of market information on the variation in prices received by alfalfa hay producers. Henderson (1979) points out that although the controlled experimental approach may be a reliable and useful technique, the political consequences of depriving a set of decision-makers with respect to information would generally preclude the use of this approach. Further, even under experimental conditions one has not solved the problem of differentiating between decisions and their consequences. In other words, by measuring consequences one measures the desired and undesired outputs of the system which is a function of both the management system and constraints imposed by the specific parameters of each farmer's system, along with the influences of exogenous environmental factors which may alter the intended outcomes of decisions.

Hypothetical Decision Approach

A hybrid method of determining the potential value of an

information system was attempted by the authour in an unpublished study in which he compared what a farmer would have done over a five year period using his present decision strategy and information system verses what he would have done given an "improved" decision system. Although the method used actual past data and attempted to simulate actual response, this approach can be critisized based on the assumption of static decision strategies. Shackle (1961) argues that as "...soon as we permit time to elapse we must permit knowledge to change, and knowledge cannot be regarded as anything else" (p. 41). He further asserts that there "...is no assurance that anyone can in advance say what set of hypotheses a decision maker will entertain concerning any specific act available to him. Decision is thought and not merely determinate response" (Shackle, 1961: 6).

PART III

MODELLING AND IMPLEMENTATION DESIGN

This part of the analysis will include the modelling and implementation design phases of the systems approach methodology. Modelling has as its input the feasible alternatives of Feasibility Evaluation and has as its output the broad specifications for the "Measurement System" to be implemented in the real world. The modelling process includes the selection of the specific concept to be modelled and the modelling itself. In this case the model will be procedures or steps to take in evaluating the value of planning tools in farm decision-making.

Implementation design takes the general model developed in the modelling phase and completely specifies the details of the system. "Completely specify" means developing a complete set of instructions that will lead to operationalization of the system. This would include specifying the necessary preparations for implementation including data and budgetary needs, along with the procedures for accomplishing specific functions.

Chapter 7

Concept Selection

This chapter will define the theoretical concept selected that will govern what will be measured in the "Measurement System". The concept selected will be tentative -- awaiting finalization upon the forthcoming implementation and feedback.

7.1 Concepts of Management and Information that Guide the Present Study

Management consists of planning the activities for a system, monitoring and controlling those activities, and finally evaluating system performance and learning from those results. In this case, the system is the farm which consists of production equipment and facilities, land, labor and capital. The planning function includes deciding on activities that affect both the short- and long-run performance of the system. Monitoring and control are on-going processes of decision-making as the manager tries to keep his plans on track facing disequilibria created by the environment and his own misconceptions of that environment. How the system is evaluated depends on the goals and values of the farm manager, his family and the surrounding community in which he must interact. The learning process

happens over time which forces adjustments in even the way decisions are made.

Although monitoring and control are important activities that the manager must perform, it would take extensive monitoring of the manager's behavior over the course of the planning horizon to determine how well he/she was doing. In other words, the monitoring and control activities deal more with the ability of the manager to carry through plans made and may be considered more of an "art" where quick judgement may be more appropriate than analytical processing. However, the relative importance of planning in comparison to control could vary according to farming systems. For instance, the success of a dairy farm may be more dependent on day-to-day recordkeeping and control than a cash grain operation. These possible differences emphasize the need for interaction with the farm managers themselves to get a feel for what is important before developing programs to improve management and instruments to evaluate management success.

The ability to learn is an important attribute that a manager must have. However, learning takes time and requires feedback from the operating farm system. Since farming is a biological process, the time required for feedback on decisions made would make an evaluation of the manager's increase in knowledge difficult to quantify except in a structured learning environment. However, the different psychological traits of managers should influence

how fast they learn, which techniques they choose to learn and which methods may be most appropriate in introducing a new technique such as using a computer to help make decisions.

7.2 Elements of The Decision Function

Since the major goal of this study is to develop a model of procedures to determine the potential value of planning tools in farm management, the management system or decision-making system of the farmer must be analyzed. The outputs of this system are decisions. Decisions can be grouped into categories of production, marketing and finance. In turn, decisions made in these areas can be expected to affect the performance of the farm business. However, due to factors outside of the immediate control of the manager, there is not a one-to-one relationship between decisions made and results. Complicating the matter is the fact that the objective function of the farmer may not be known, making evaluation of performance by an outsider difficult. However, we may state that:

Effectiveness = $s(\text{production, marketing, and financial decisions; ability to follow through; quality of resources; environment; and random factors})$

Here "s" represents the system's function of transforming these inputs into outputs which can be used to evaluate the effectiveness of the farm manager. Basically,

system performance is dependent on the decisions the manager makes, his ability to carry out those decisions and factors that affect that system which are beyond the control of the manager. The ability to follow through is related to both motivation and skill. This skill factor can be considered a component of the "art" of management discussed earlier.

As stated earlier, decisions are prescriptions which in turn are products of the management system. A convenient way of representing the relationship between decisions and resources used by the decision-maker is:

$$\text{Decisions} = r(\text{Information, Processing, Analysis, Time: Constraints})$$

Information can be considered as categorized pieces of data organized as factors or inputs to making decisions. Processing is the storing and transforming of these factors in a form appropriate to the particular decision. Analysis involves applying different techniques to the information. Each decision requires a certain amount of time between realization of the need to make the decision and the final derivation of an answer. The decision-maker is constrained by the availability and quality of the different inputs to the decision function. The decision-maker is governed by his own decision rule, "r", which specifies the amounts of each input to use toward the production of a prescription for action. Of course, the adequacy of the decision rule depends on the ability of the decision-maker to determine the possible alternatives and their respective probabilities

and outcomes.

It is hoped that although each farmer may use a different methodology to solve his particular problems, there might be common elements that may distinguish the more successful farmers from the rest. Of course, the more interesting question may not be what the decision rules are, but how the farmer arrives at that rule. Therefore, the decision rule itself is a function of even more primary elements represented by:

Decision rules = g(Goals, Values, Personality, Philosophy:
subject to Training, Experience,
Motivations)

Here the decision rule chosen is a function of how the farm manager views the world and his place in it.

7.3 Differences in Farming Systems as They Affect Management

As stated earlier, the "Farm System" transforms inputs into both desirable and undesirable outputs with the manager evaluating the "goodness" or "badness" of those outputs and formulating new prescriptions. However, farms are not homogeneous in their outputs, inputs or means of accomplishing the desired goals. The USDA has classified farms under broad categories of cash grain, field crop, vegetable and melon, fruit and tree nut, nursery and greenhouse, dairy, poultry and egg, and cattle/hog/sheep. Each of these broad farm types requires a different set of physical, human and capital resources. The human resources would differ as to skill levels and managerial responsibilities since each type

would be faced with a different set of problems.

Since a decision support system is designed to aid decision-making, it would require substantially different systems to satisfy the decision-making needs of farmers faced with such a wide variation in farming systems. For instance, a dairy farmer would need a day-to-day evaluation of herd performance to ensure maximum returns, while a cash grain farmer may have considerable stretches of time in which no physical measure of crop performance can be evaluated. Therefore, determining the potential value of computers in farm decision-making requires a system-by-system analysis if not a farm-by-farm one. How narrow or broad such systems are chosen will determine the reliability of measures developed while evaluating the decision-making system.

Chapter 8

Modelling of Concept

This phase of the process will involve developing a methodology which combines the essential parts of other attempts to evaluate the value of information into a structure which satisfies the perceived demands on such a measurement system. The general parts based on function will be developed here leaving the specifics of how to implement such a strategy given in the Implementation Design phase.

8.1 Measuring the Management System

In the previous chapter the System was defined in terms of measuring the impact of improved information (Figure 7). This Measurement System could include procedures to measure changes in managerial behavior, managerial performance, and/or managerial effectiveness (Figure 8). In terms of elements of the decision function, comparing changes in managerial behavior would include eliciting and comparing decision rules or how decisions are made. Determining improvements in managerial performance would include comparing the decisions made by managers. Using changes in effectiveness as a measure of improved management would include measuring the results of decisions on an operating farm

system.

The element of time plays an important part in determining the results of decisions and how the decisions are to be classified. Decisions can be categorized as short, medium and long run, or in the language of the systems approach, decisions can affect the controllable inputs, or decisions can determine and change the design parameters of the system. The agricultural production process will determine the time frame that is relevant in terms of what can be manipulated in the short run, such as the amount of fertilizer to apply. However, when one makes investment decisions, the effect covers the long run and sets the design parameters or basic input/output relationships for that system. Therefore, in evaluating the results of a decision, proper attention to the time frame over which that decision is effective is important for relevant measurement of system performance.

In an earlier section, previous attempts at measuring the value of information were categorized in the three areas: behavior, performance and effectiveness. Each methodology had its advantages; however, it may be that no one method is the best for all types of farming systems or decision environments. One type of decision environment could best be aided by changing behavior that might not be immediately measurable in terms of effectiveness, while the results of another type of decision may be easily traced by effectiveness measures. Therefore, what is suggested here

is the development of measurement system that is flexible across a broad spectrum of farming systems but in its use allows the managers (researchers, software developers, etc.) to develop concrete sets of evaluation criteria depending on the uses for the measure(s) of value.

Measuring the value of planning tools and information through comparative analysis can be accomplished by cross-sectional analysis or comparisons over time. Most of the behavioral and performance based methods of evaluation are based on a cross-sectional comparisons while the element of time is included when using the residual, experimental and hypothetical decision methodologies. Cross-sectional comparisons have the advantage of perhaps being quicker while increasing the potential for specification errors since some level of homogeneity is assumed across the measurement frontier. On the other hand observing the improvement of the same farmer over time eliminates the question of non-comparability, but the element of time makes the data collection and observation process more lengthy. Also, over time, other elements besides the experimental treatment have time to creep in reducing the ability to isolate the effect of the treatment.

Therefore, an approach combining both cross-sectional analysis along with observations over time could help isolate the real effects of information. In particular, if an instrument could be developed that measures behavior and performance and is a good predictor of effectiveness, we

could then use the instrument for measuring probable changes in effectiveness based on changes in behavior and then follow these same managers whose decision-making behavior have been altered over time to test their actual performance. In essence, we would then have two separate measures of the same entity which would allow us to make more conclusive evaluations of the resulting measures.

If the values obtained using the management index are similar to the values obtained in following the managers over time, the value of decision aids obtained using the managerial index approach could then be used as a quick estimate. However, due to changes in the importance of problems facing the farmer, no index can be expected to retain its appropriateness over a long period of time. Therefore, the adjusting of the index and its ability to predict would have to be done periodically requiring the time consuming process of observing another set of managers over time.

Furthermore, no attempt will be made to measure the value of an individual piece of information because decision-makers use a package of information for making any decision and no decision is made in a vacuum separate from other decisions. Since it is an information system that a farmer uses while managing his operations, it will be an information system that is evaluated.

8.2 Model

Figure 9 is a representation of the general framework of the model or procedures involved in determining the value of an information system or set of decision aids. This model is labelled Management Systems Research (MSR). The Management Systems Research model is defined by the author as a methodology for measuring improvements in the decision-making system, where managerial behavior is the subject and increased effectiveness the object. The decision-making system includes the decision rules, decision aids, data processing equipment, and both internal and external data used to make decisions.

The first step involves the selection of the farm type to be considered since decisions and therefore aids to such decisions would be radically different across farming systems. The process splits into two phases that can be carried on simultaneously. One phase deals with the identification of common behavioral incidents of successful farmers and from their responses, a behavioral instrument designed to predict effectiveness is developed. On the other branch, effectiveness measures are selected and tested for scientific objectivity, i.e. coherence, workability, internal and external validity and reliability.

Subsequently, the behavioral instrument is tested to see if it represents a good index in terms of its predictive ability of system performance (effectiveness). Once the managerial index is validated it can then be used as the

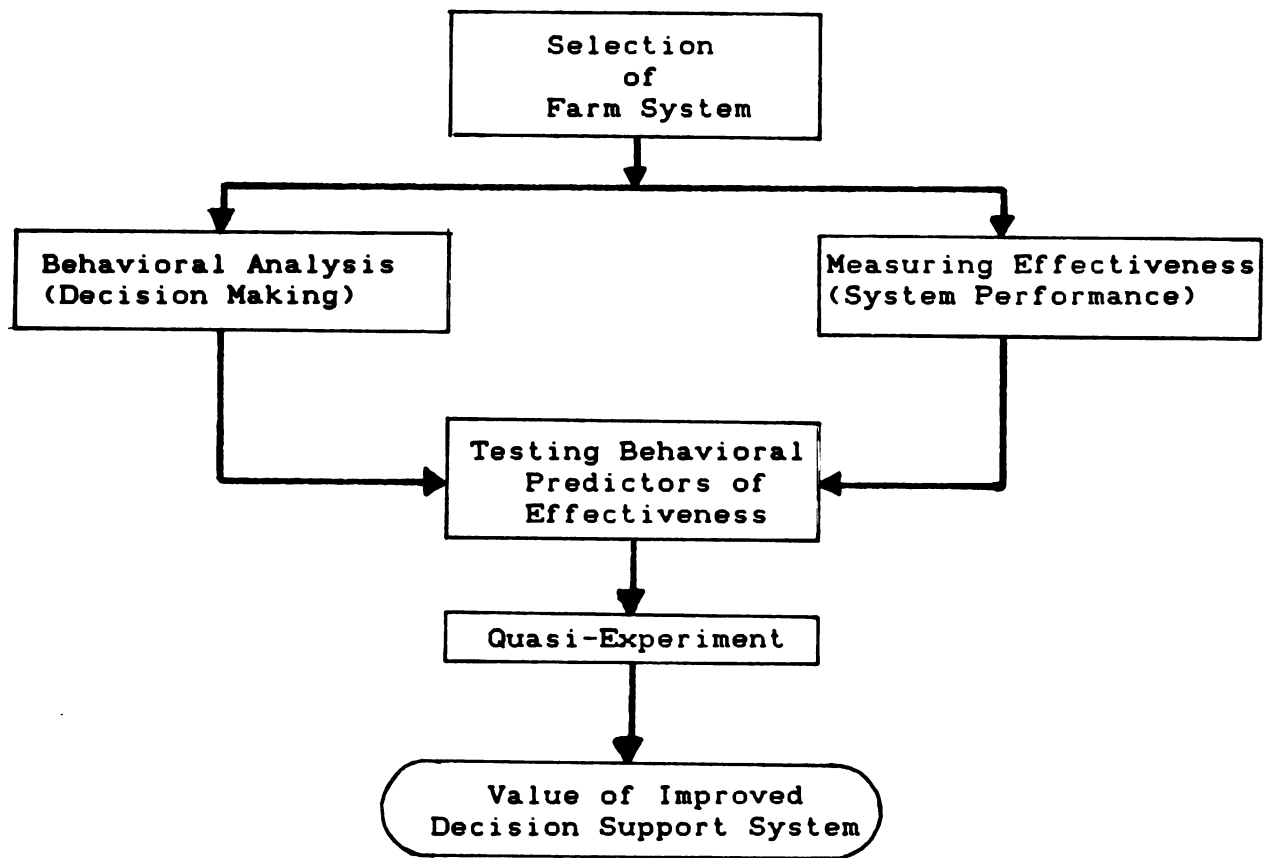


Figure 9 : General Framework For Measuring the Value of an Improved Information System

basis for testing farmers in a quasi-experiment designed to measure changes in managerial behavior, performance and effectiveness before and after the introduction of computerized decision aids. Finally, the result of the actual experiment will be a measure of the value of the set of decision aids chosen for analysis.

Chapter 9

Model Specification or Implementation Design

The Management Systems Research framework serves as the general model of the procedures. Now each component will be broken down to reveal the specific steps to be followed in measuring the value of decision aids. "Selection of Farm System" is depicted in Figure 10, "Behavioral Analysis" in Figure 11, "Measuring Effectiveness" in Figure 12, "Testing Behavioral Predictors of Effectiveness" in Figure 13, and "Quasi-Experiment" in Figure 14.

9.1 Selection of Farm Type

Selecting the specific type of farming system to be analyzed (Figure 10) begins with identifying the universe under consideration. How we categorize farm types may depend on whether we are interested in a national or state sample. The important enterprises and combination of enterprises may vary substantially across states. A combination of tobacco and vegetable production may be common in North Carolina, but rare in Michigan.

As mentioned earlier, the USDA categories of cash grain, field crop, vegetable and melon, fruit and tree nut, nursery and greenhouse, dairy, poultry and egg, and cattle-/hog/sheep may be a good starting point for classification.

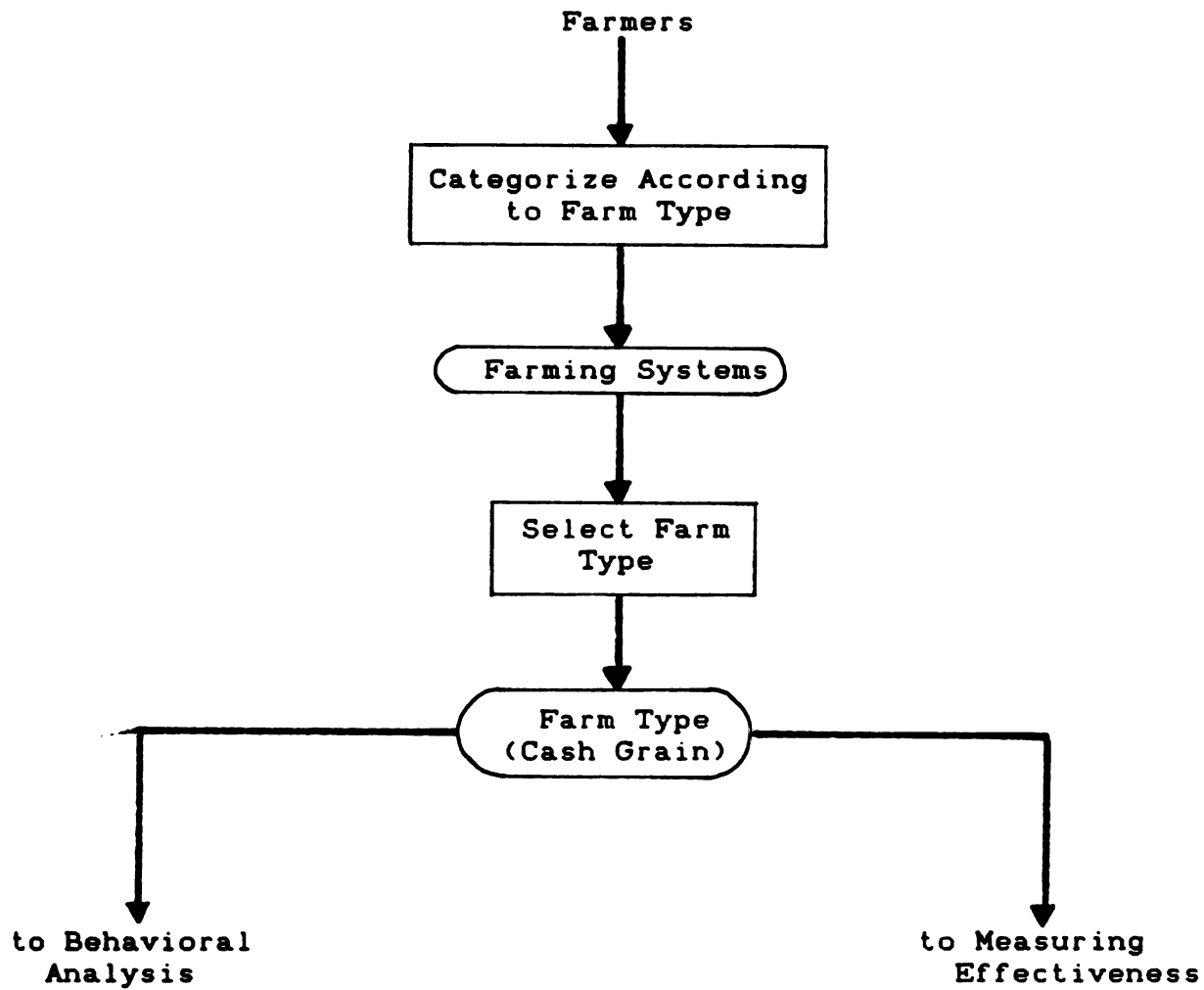


Figure 10 : Selection of Farm Type

However, these categories may need modifications depending on the scope of the research. In general, the broader the categories the less precise will be the measure of value due to the non-homogeneity of the decision environment.

However, with very narrow categories the measure may have limited usefulness. The tradeoffs involved would depend on the purpose and use of the measure.

After the farming systems or types have been identified, then a type for research can be chosen based on either the need, familiarity with that farming system, the importance of that farm type to the economy, or just arbitrarily selected as the first to be investigated. Both research and extension should be involved in determining relevant categories and selecting the specific type of farm for further analysis. Once the specific farm type is selected that information is then used in two simultaneous processes - Behavioral Analysis and Measuring Effectiveness.

9.2 Behavioral Analysis

The output of the behavioral analysis phase is an instrument or test that can be used to predict managerial effectiveness. By observing the decision-making behavior of the successful farmers, critical incidents of common behavior can be detected that can be used as indicators of success.

Once the farm type has been selected (Figure 11), means

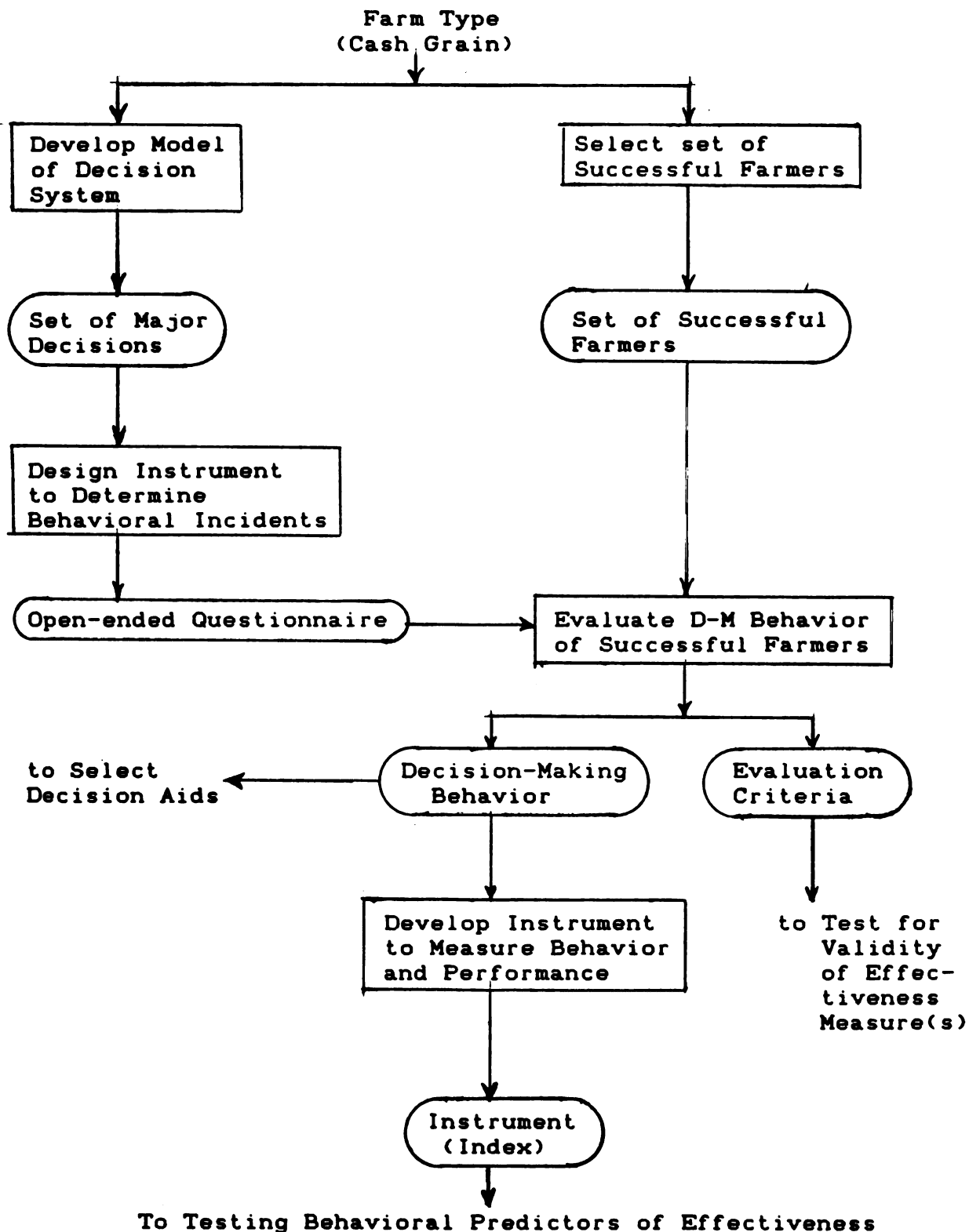


Figure 11 : Behavioral Analysis

for evaluating the decision-making behavior of successful farmers are prepared. This involves both developing an instrument to question farmers and identifying "successful" farmers.

The term "successful" farmer can be ambiguous depending on the criteria selected and who is doing the selection. There may be a set of farmers identified as "successful" based on more or less objective measures of effectiveness such as net income. The Extension Service in each county may have an available list of "successful" farmers. Farmers Home Administration, ASCS, Farm Bureau and individual commodity groups may each have separate lists of what they consider the more "successful" farmers. Without having access to extensive yearly records and an agreed upon criteria, any selection process may be biased since the sample is based on participation in programs sponsored by a particular agency. If a cross sample of lists from different agencies within the same county was developed, the names chosen in common could be an acceptable list of the better farmers. However, since tendencies and not statistical accuracy is demanded in this phase, selection by the Extension Service may be sufficient.

To develop an appropriate open-ended questionnaire for soliciting behavior, a set of the major decisions made by the farm type must be developed. Information for such a set could come from previous studies on decision-making, extension personnel, or by observing a set of farmers. The

questionnaire is then developed around these key decisions to obtain information on how the farm managers solve these problems. The questionnaire is open-ended to allow for as much farmer input as possible without leading them into preconceived ideas about how they should make decisions.

This evaluation process can produce a clearer understanding of the decision-making behavior of farmers along with getting a feel for what they use as criteria for evaluating effective management. Information on decision-making behavior can then be used to develop a more structured instrument to act as a test or managerial index designed to differentiate between "good" and "poor" managerial behavior and performance. Since the function of decision aids is to change managerial behavior, information on decision-making behavior is then necessary for selection of proper aids.

Knowing the evaluation criteria of farmers for defining a successful manager is essential for testing the validity of an effectiveness measure. Therefore, one output of this system goes directly into the next phase designed to develop valid and reliable measures of managerial effectiveness.

9.3 Measuring Effectiveness

This phase is designed to select and validate measures of managerial effectiveness. The major input in this phase is the farm type selected for analysis (Figure 12) and the output would be an effectiveness measure or set of measures

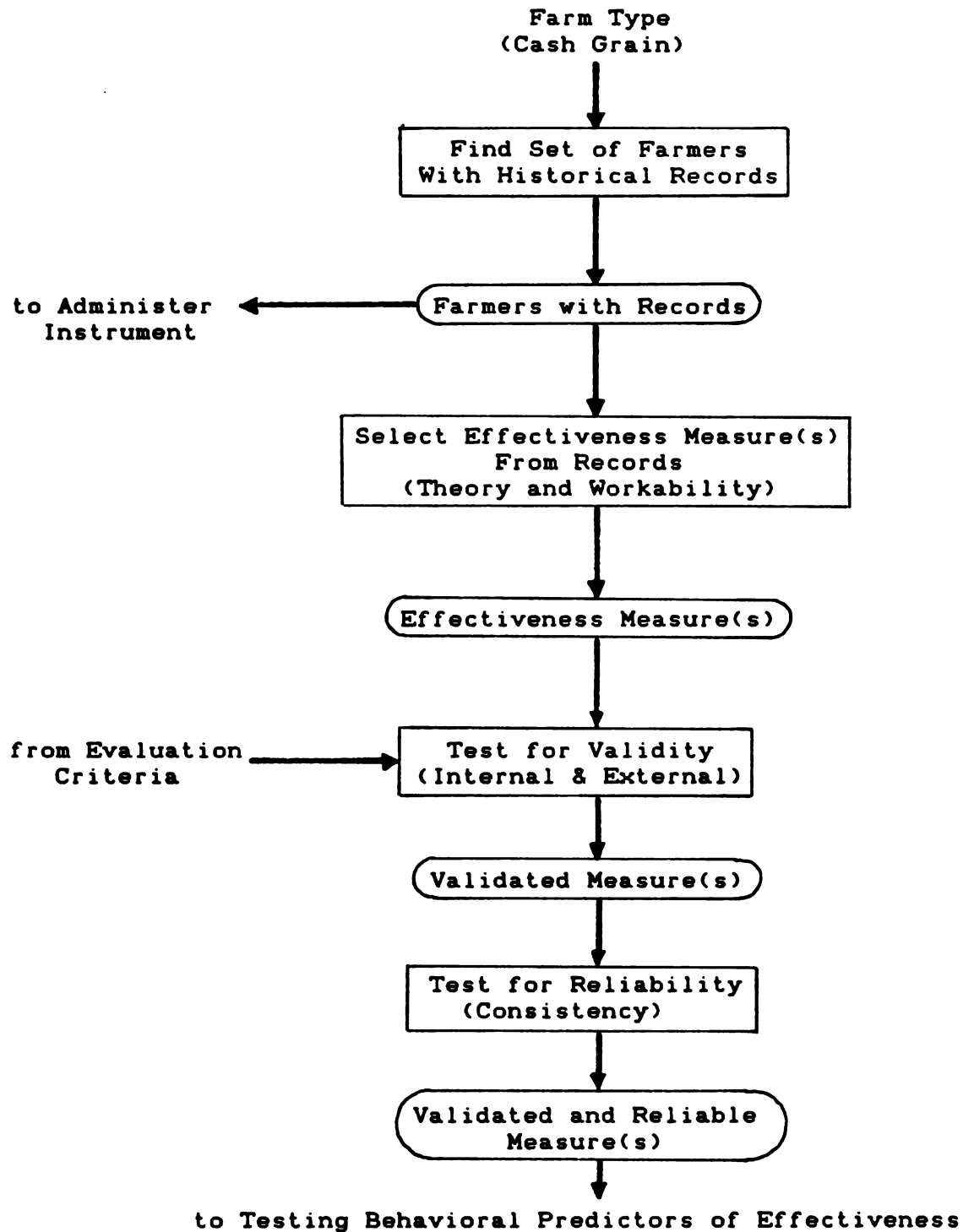


Figure 12 : Measuring Effectiveness

that had been tested for coherence, workability, validity and reliability.

A major problem with selecting an effective measure is identifying a set of farmers with historical records that are both compatible and complete enough for further analysis. The selection of an effectiveness measure is dependent on the theory that identifies the measure as valid and the practical problem of measurement. Of course, the measure chosen will depend on the type of farm analyzed and on whether the analysis is to be a cross-sectional comparison or a comparison over time.

Once a measure is chosen it must be further evaluated in terms of validity and reliability. Since one set of possible benefactors of the end product of measuring the value of decision aids is the farmers themselves, it is important that the measure be relevant to their value system. Therefore, information obtained from the open-ended questionnaire to the successful farmers on how they would evaluate the effectiveness of another manager would be important in the screening process of measurement selection.

Other tests for validity could be statistical tests that would check if the measure was actually measuring what it is posited to measure. In other words, a measure of managerial effectiveness should not be dependent on factors outside of the manager's control such as soil type, closeness to markets or some other advantage or disadvantage beyond his control.

The measure should be reliable in that one should be able to replicate the measure and arrive with basically the same conclusions. Statistically, the test for reliability could be accomplished by seeing if the measure can classify managers into levels of effectiveness over an extended time, since one would expect the relative position of management abilities to be somewhat constant over time, unless severely disturbed by concentrated programs to change the level of management. Once a measure has been tested for scientific objectivity, it can be used to test the relationship between managerial behavior and effectiveness.

9.4 Testing Behavioral Predictors of Effectiveness

This phase is designed to test the relationship between behavior, performance and effectiveness. If a management index can be developed that can be used as a predictor of effectiveness, the stage is set for cross-sectional evaluation of programs or systems designed to increase the level of managerial effectiveness.

The first step in this phase (Figure 13) consists of administering our prototype, or first attempt at an instrument to measure managerial behavior, to the set of farmers identified as having historical records. Once the instruments have been completed then they must be scored according to some standard. One method of scoring would be to use management professionals as the experts and accepting their

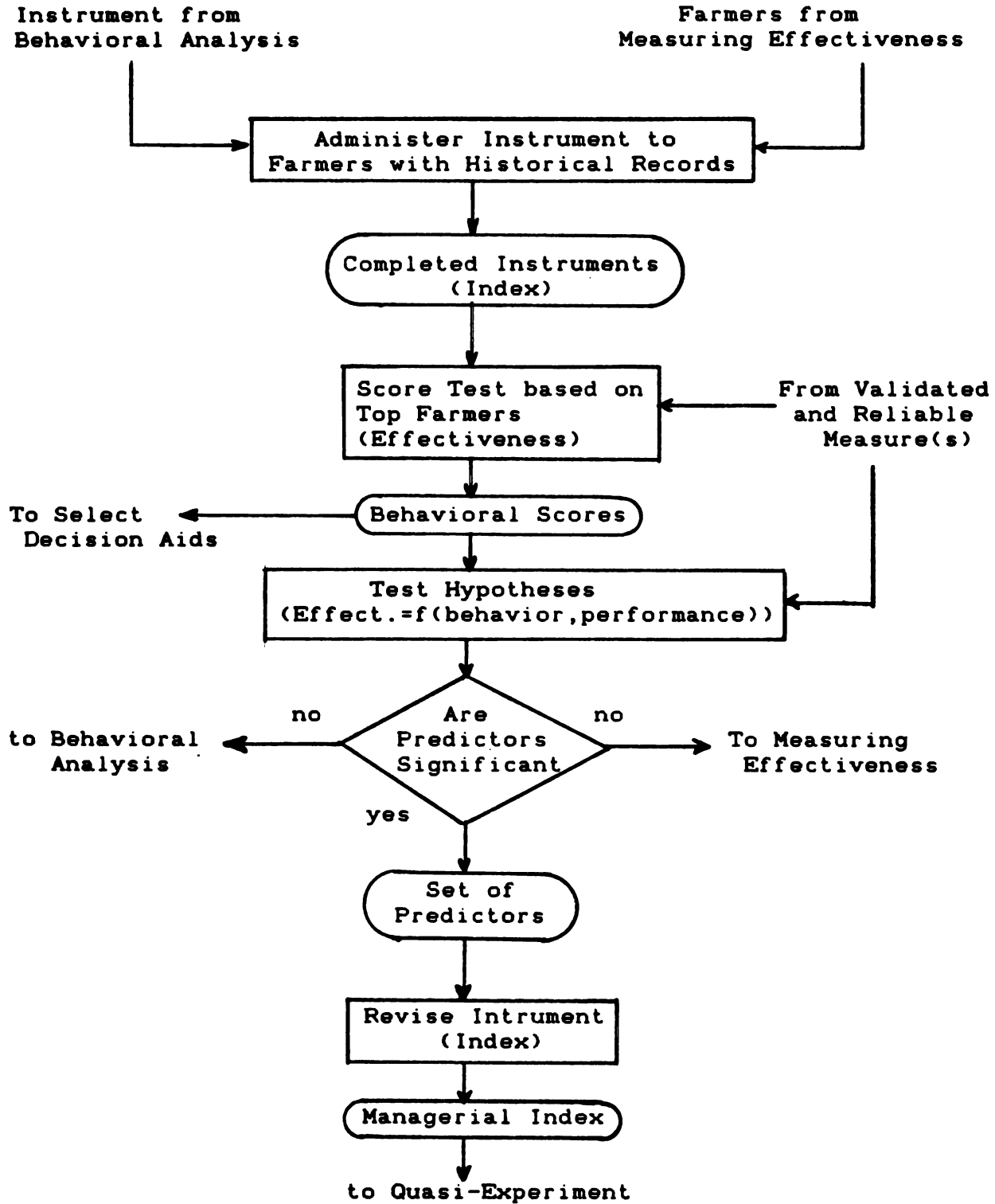


Figure 13 : Testing Behavioral Predictors of Effectiveness

answers as the norm. Another method would be to go back to the first set of successful farmers, give them the test, and use their responses as the norm. However, a quicker method would be to use the effectiveness measure chosen to divide the farmers into management groups according to prior levels of farm success. The answers of those farmers in the highest group based on the effectiveness measure can then be used as the norm for scoring the instrument.

The behavioral scores would be aggregated according to production, marketing, and financial decision-making. To reiterate, behavior refers to how the decision-maker makes the decision or the process involved in making the decision. This would include the type of information used, the place from which the information is obtained, how the information is obtained, stored, processed and analyzed.

There is a gray area between behavior and performance. Performance evaluation would require comparing answers to specific problems. For instance, the farmer could be given a problem situation and supplied with relevant information that could be used in its solution. This form of evaluation is similar to tests given in an academic setting where one assumes that there is a "right" solution to the problem. These performance scores can be aggregated in the same areas of production, marketing and finance. These scores can be another set of possible indicators of managerial effectiveness.

As mentioned earlier, behavior and performance are

based on decision rules which are functions of the value system, training, personality and experience. Part of the evaluation process would include questions on these aspects of the makeup of the individual managers. We can test hypotheses that posit a relationship between the behavioral and performance variables with the psychological, sociological and demographic variables.

Statistical tests for significance that are performed in testing these relationships will indicate the degree of reliability of the managerial index as an indicator of effectiveness. The parts of the index that passed the test can then be used to establish a revised instrument based on the set of predictors that are found significant. If no relationship is found between the items on the managerial instrument and the measure of effectiveness, one can conclude that the behavioral and performance criteria were not appropriate and go back to steps within the Behavioral Analysis phase. One can also conclude that the effectiveness measure may not be appropriate and therefore go back to steps within the Measuring Effectiveness stage.

However, one could also conclude that for this type of farm the decision environment is too diverse and the paths to success may be so varied that a simple managerial evaluation index is not feasible. Even if this is the case, much information on the decision-making behavior of farmers would have been compiled. Much of this information is directly used in trying to produce a reliable index, however much

anecdotal information may not have been used since only one or two farmers may have made these comments. However, these comments can be extremely valuable in terms of getting a feel for the general decision-making environment. In particular the attitude of the farmers toward certain institutions and programs can help shape future directions for those interested in aiding farm decision-makers.

9.5 Quasi-Experiment

The previous phases set the stage for actual measurement of the value of decision aids. The mode of evaluation is direct measurement via a quasi-experiment. As stated earlier, measuring the value of information through comparative analysis can be accomplished by cross-sectional analysis or comparisons over time. An approach combining both cross-sectional analysis between farmers along with observing the same farmers over time could help isolate the real effects of information.

In particular, if we could develop an instrument that measures behavior and performance and is also a good predictor of effectiveness, then we could use the instrument for measuring probable changes in effectiveness based on changes in behavior and then follow these same managers whose decision-making behavior have been altered over time to test their actual performance. In essence, we would then have two separate measures of the same entity which would allow us to make more conclusive evaluations of the

resulting measures. If the values obtained using the management index are similar to the values obtained in following the managers over time, then the value of decision aids obtained using the managerial index approach could be used as a quick but reliable estimate.

The basic design for such a quasi-experiment is based on the "Nonequivalent Control Group Design" as described by Campbell and Stanley (1963). In this design, both the experimental group and the control group are both given a pretest and post-test, however, the experimental group and control group do not have pre-experimental sampling equivalents as required for a pure experimental design. As described later the experimental group will be composed of some type of previously assembled collective or self-selective grouping. The control group is then selected to best match the experimental group on relevant characteristics. Assuming that the control group is properly selected one can regard this design as controlling for the main effects of history, maturation, testing, and instrumentation (Campbell and Stanley, 1963).

The first step in this phase (Figure 14) is the selection of participants. The type of farmer selected must meet certain criteria which make random selection, especially of the experimental group, almost impossible. The selection of farmers and the appropriate decision aids and mode of delivery must be iterative to ensure the proper fit. To a great extent the farmers must be self-selective since parti-

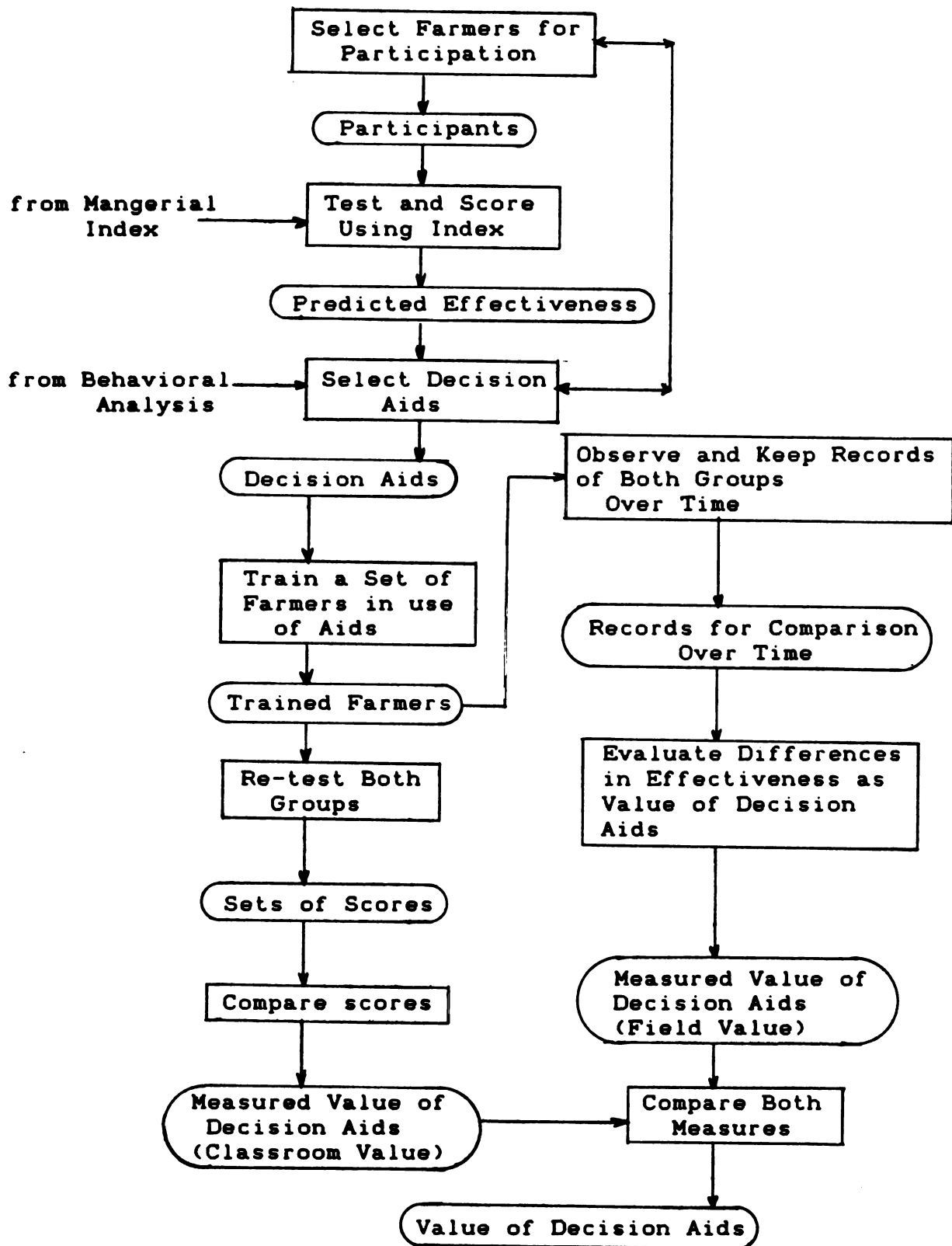


Figure 14 : Quasi-Experiment

cipation is both optional and will require a lot of time and effort.

The mode of delivery of the technology will also play a role. Computers are expensive in both physical and human capital terms. Therefore, one would expect that there are few farmers of any given type that have access to computers. One may find a few larger farms with computers, but very few smaller sized operations would be expected to have them. Therefore, to get a sample of larger farmers, a search procedure would be necessary. To obtain a sample of smaller farmers a delivery system would have to be installed. Such a delivery system could be through current Extension facilities and programs. For instance, North Carolina Extension has placed computers in all of their offices. Also, there is in place a program to provide management assistance to smaller farmers through what is called the Farm Opportunities Program in which paraprofessionals are used to work intensively with a small group of farmers over a three to four year period. If Extension and/or paraprofessionals are used then the selection process would have to focus on the enthusiasm and the abilities of people within these institutions to facilitate the incorporation of the managers of smaller farms into the experiment.

Although the self-selection process removes the randomness, it does get around the moral issue of providing information to one group while excluding others. Of course the problem still remains of both attrition and the filtering of

information between the control group and experimental groups. Also, the problem arises as to improvements in the technology over time with the introduction of new decision aids. For control purposes one would want to stick with one set of aids; however, this must be tempered with the moral obligation of giving to enthusiastic managers the best tools possible.

After the experimental group is selected a control group must be chosen to match the basic characteristics of the experimental group as to farming systems, location and demographic characteristics. Once the experimental and control groups are selected the managerial index is given to all participants. The Myer's-Briggs' Type Indicator (MBTI) is also administered to determine the effect of cognitive types on the decision rules chosen. Then farmers from the experimental group would be trained in the use of computerized decision aids chosen for evaluation. Afterwards, both groups are retested with the experimental group allowed to use computers to help answer and solve the problems on the index. A new set of scores are then available for cross-sectional and longitudinal evaluation.

Since the managerial scores are used to predict effectiveness, the difference in effectiveness measures can be used as the expected value of the improved system. There are several ways of evaluating these scores. One is to look at the difference between groups at the second testing. Another would be to look at the increase between testing of

the experimental group. Still another would be to take the difference between means of the effectiveness measure before and after training the experimental group and subtract from that the observed difference of means of the control group for the two tests. This method would control for the learning process outside of computer training. This measure would constitute the "Classroom" value of the decision aids.

These same farmers in both the control and experimental group can then be observed over time and comparisons made after a number of years. The selection of the time frame must take certain things into consideration. Too short of a period could make the measure biased due to the environmental effects of drastic weather or policy conditions that may prevail in a given year. Too long of a period could result in both high attrition rates and technology obsolescence. Since the Farm Opportunities Program requires participation from three to four years, four years may be a feasible, if arbitrary, time frame.

The effectiveness measure chosen would then be compared between the groups following the same basic procedure outlined above so that the learning process that would have occurred without the computer can be statistically eliminated. The difference between means of the experimental and control groups can then act as the "Field" value of the decision aids. However, one would expect that the longer one uses the system the more proficient one would become. Therefore, it may be worth looking at the difference between

the first year and last year of participation as an indicator of increased managerial ability over time. However, due to environmental conditions the two years chosen could be crucial. Although such a comparison could be informative, there may be too many threats to the reliability of such a measure since its ability to be replicated would be nil.

The final step in the process would be to compare the "Classroom" value with the "Field" value to see if they support or contradict each other. Of course, how well they support or contradict would be a subjective matter on which the users of the measure must decide. However, if the values do support each other then the "Classroom" value and approach could be used for further evaluation of decision aids for these farm types.

PART IV

IMPLEMENTATION AND RESULTS

Implementation is to give physical existence to the desired system. In the case of this research the system is the set of procedures for establishing and using a measurement system for evaluating computer benefits to farm decision-making.

To determine the workability of the system, Michigan will be chosen to test the methodology. Since the total procedure is quite lengthy and cumbersome, the phases of the system will be looked at separately. The phases include Selection of Farm Type, Behavioral Analysis, Measuring Effectiveness, Testing Behavioral Predictors of Effectiveness, and Quasi-Experiment. Each phase except Quasi-Experiment will be designed and implemented in this analysis. Suggestions on how the Quasi-Experiment can be accomplished will be developed and discussed, but actual implementation will not be a part of this analysis.

Therefore, each chapter will consist of implementing the separate phases of the procedure and presenting their results. The outputs resulting from implementation emphasized here will be those that are directly used in the next phases. Secondary outputs or subject matter information not specifically used in following phases will be

discussed in subsequent chapters.

Although there may be many questions on the validity, usefulness and workability of this system of procedures, it is hoped that the implementation of major parts of the system will act as a preliminary test of the system. An estimate of the time and effort necessary for carrying out the procedures can be weighed against perceived usefulness of the information obtained through system implementation. The systems approach requires iteration. By reviewing the results of this trial run one should be able to modify the procedures used to accommodate other situations.

Chapter 10

Selection of Farm Type

As mentioned earlier the type of farm may greatly alter the set of decision aids useful for farm managers, as well as change the evaluation procedures and criteria for such aids. In general, the broader the categories, the less precise will be recommendations for decision aid selection, and the less useful will be the measure of value for those aids, due to the non-homogeneity of the decision environment. However, with very narrow categories the measure may be generalizable to a limited number of farm situations.

10.1 Implementation

As mentioned earlier the USDA classifies farms into categories of cash grain, field crop, vegetable and melon, fruit and tree nut, nursery and greenhouse, dairy, poultry and egg, and cattle/hog/sheep. The Michigan Department of Agriculture classifies farm production into slightly different categories combining cash grain and field crops under one heading of field crops. Included under field crops are corn, soybean, wheat, oats, barley, rye, hay, dry beans, potatoes, sugarbeets and spearmint. The other Michigan agricultural categories include: fruit, vegetables, floriculture, livestock and poultry, and dairy. The Michigan

State University computerized record keeping system (TelFarm) has labeled the Michigan Department of Agriculture's field crop category as cash grain or cash grain and sugar beet. For our purposes field crop and cash grain will be used synonymously.

Selection of a category for analysis should be based on importance of that farming system to the state, the availability of information on historical farm performance and the availability or accessibility to analysis of the important decisions made by that farm type. The availability of information on historical system performance is essential for the successful accomplishment of the Measuring Effectiveness phase of the overall methodology. For the successful completion of the Behavioral Analysis phase, one must make an assessment of whether the major decisions made within the farming system can be isolated and evaluated.

10.2 Results/Outputs

According to the 1985 Michigan Agricultural Statistics, field crops accounted for 7.724 million harvested acres of the 7.939 million total crop acreage in 1984. In dollar terms field crops represented \$1.5 billion out of the total \$1.79 billion in crop receipts for the same year. Therefore, field crops ranked first by far in importance of the crops grown in Michigan. Cash receipts from cattle and calves were \$248 million in 1984 while receipts from hogs, sheep and lamb, poultry, and milk were \$203 million, \$4.6 million, \$29.4 million, \$724 million respectively.

Therefore, as a category field crop production ranked first in Michigan in terms of gross receipts.

Historical records on the farm system performance is essential for selecting the proper effectiveness measure by which a farm manager is evaluated. Some farmers keep accurate records of their past performance; however, relying on records kept by farmers can pose some problems in terms of reliability and comparability. Fortunately, Michigan State University has an on-going farm recordkeeping system called TelFarm in which a number of cash grain or field crop farmers have participated in over the years. The records kept by TelFarm are based on standard recordkeeping procedures which allow for comparability across farms and over time. There are 84 cash grain or field crop farms which have continuously participated in the recordkeeping system from 1981 to 1984. The information available on these farms include: production performance such as yields, labor use and efficiency, and financial information such as net income, returns to assets and debt ratios. Therefore, the availability of this information makes the selection and analysis of effectiveness measures possible for farms primarily engaged in field crop production.

The third criterion for selection is that the major decisions for the specific farm type can be isolated and analyzed. Fortunately, Hepp and Olson (1980) have investigated what were the important decisions made by Michigan field crop farmers. This information can act as a basis for

determining the decision- making system of field crop operators to be used in the Behavioral Analysis phase of the methodology. However, the ability to isolate and analyze these decisions can only be determined through the actual implementation of that phase.

Therefore, field crop (cash grain) farms are selected for implementation of the following phases of the analysis. The farm type selected is now used in both the Behavioral Analysis and the Measuring Effectiveness phases which follow.

Chapter 11

Behavioral Analysis

Now that cash grain or field crop farms have been selected for analysis the process of developing an instrument to serve as a predictor of managerial success can be initiated. From Figure 11 one can see that the major functions involved in this process include designing and administering an open-ended questionnaire to determine behavioral incidents of successful field crop farmers. The informational outputs of these functions allow us to develop the test instrument, and add to information necessary for the selection of decision aids for the quasi-experiment, along with providing evaluation criteria for evaluating the validity of effectiveness measures.

Implementation and results will be discussed in the following sections. The following sections will include: 1) select set of successful farmers, 2) develop model of the decision system, 3) design instrument to determine behavioral incidents, 4) evaluate decision-making behavior of successful farmers, and 5) develop instrument to measure behavior and performance.

11.1 Selecting Set of Successful Farmers

Implementation

Although the term "successful" farmer may be both ambi-

guous and subject to differing interpretations, one must start somewhere. The first step in the selection process begins with a tentative definition of what is a "successful" farm manager. In this case "successful" manager can be defined as one whose farm seems to stand a better chance of survival while accomplishing both individual and family goals.

Michigan cash grain or field crop farmers are divided into two main categories based on topography and crop mix. Saginaw valley farmers have the opportunity to grow sugar beets, which is a high returns per acre crop, while other parts of Michigan due to less favorable conditions cannot economically do so. The majority of Michigan's cash grain operators are found in the lower half of the state. For these reasons it was decided to concentrate in two major areas - south central Michigan and the Saginaw Valley (see Figure 15). Ingham County in central Michigan and Tuscola County representing the Saginaw Valley were selected based on location, accessibility, and possible willingness of Extension personnel and the subsequent farmers selected to participate.

It was decided by Dr. Hepp and the author to use the Extension service for help in locating willing participants for this phase of the analysis. Farm management personnel, familiar with the managerial behavior and a feel for the willingness of their more successful farm managers to participate, were asked to supply us with a list of candidates.

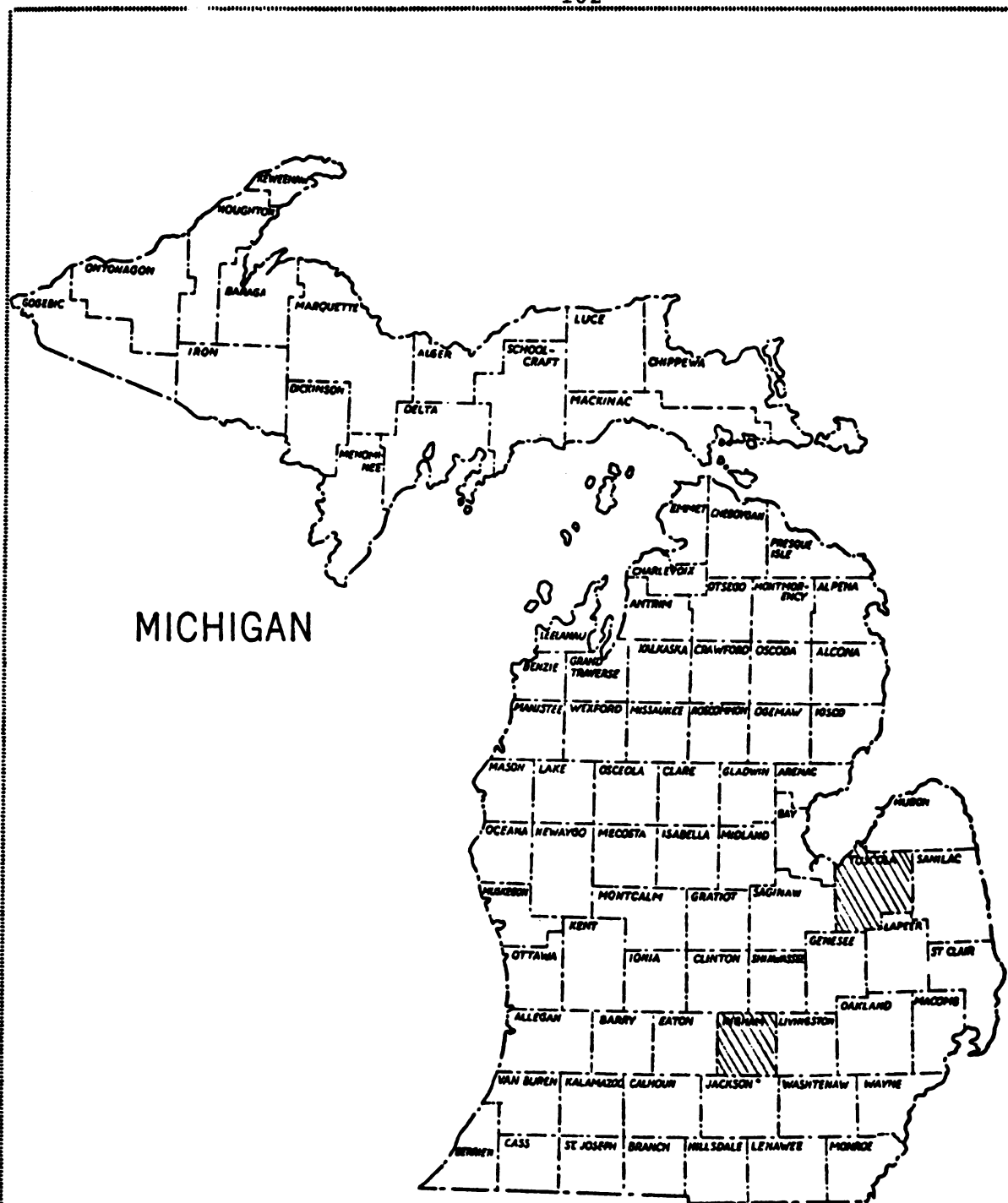


Figure 15: Map of Michigan

Results

There were seventeen farmers actually interviewed. All but one were cash grain operators with the other being a hybrid seed producer. Nine were chosen from central Michigan and eight chosen from the Saginaw Valley. The size of crop operations ranged from 400 to 4,600 acres for the 1985 crop season.

11.2 Develop Model of Decision System

Implementation

Research has indicated a number of important and often made decisions that the farm manager must make. Important decisions as determined by Hepp and Olson (1980) include:

1. Purchase or rental of machinery and equipment
2. Repairing or building new buildings
3. What to plant
4. Livestock mix
5. Whether to purchase land
6. Whether or not to rent out land
7. Sale land
8. Whether or not to expand
9. Whether or not to quit farming
10. Remodel or build new home
11. Insulating home
12. Prices and Marketing

As was mentioned in an earlier section (Measuring the Management System), the element of time is important in classifying decisions and determining the effect of such decisions. The above decisions can be classified according to their short and long run effects and the frequency that they are made. Determining what to plant, whether or not to rent out land, determining prices and marketing can be

classified as short-run and requiring attention by the manager. The sale of land, expansion, and staying in farming are decisions which can definitely be classified as having long term consequences. Other decisions such as the livestock mix, remodeling or building new home, purchase or rental of machinery and equipment, and insulating the home would take an intermediate position on a short-long run continuum.

Since the goal of this analysis is to measure possible benefits of computer aided decisions, the question of comparability is important. It is more difficult to measure the effects of long run decisions because of both the non-recurring nature of such decisions, and the possibility of environmental or exogenous effects distorting such comparability. Therefore, the short and medium range decisions will be the focus for developing the measurement system.

With this in mind the areas of decisions explored by this study include:

1. Determining the portion of crops to produce
2. Adding a new crop or substantially changing the crop mix
3. Determining corn variety
4. Determining when to purchase inputs
5. Determining when to sell corn
6. Determining the adequacy of on-farm storage capacity
7. Estimating the price you expect to receive for corn
8. Determining whether to participate in government corn programs
9. Determining whether to purchase a piece of land
10. Determining how much to pay for rental land
11. Determining the need to replace equipment

11.3 Design Instrument to Determine Behavioral Incidents

In the developmental stage of scale evaluation, analysis of the decision function was done by asking a set of questions for each of the decisions analyzed. This phase of the research can be considered a "fishing expedition", in that we are putting out a big net of questions to possibly retrieve only a few areas that may distinguish the better farmers from the rest of the pack. These questions included:

- A. What factors would a "good" decision maker in comparison to a "poor" decision maker consider in making this decision?
- B. What calculations would be appropriate for solving this problem?
- C. Do you spend a lot of time collecting and analyzing information for this decision? C1. How much?
- D. How constraining are the following factors on making a good decision:

- | | Small | | | Large | |
|--|-------|---|---|-------|---|
| | 1 | 2 | 3 | 4 | 5 |
| 1. Knowledge of how to make decision | | | | | |
| 2. Internal data from farm | | | | | |
| 3. External data (prices, quality etc.) | | | | | |
| 4. Government (policy, taxes etc.) | | | | | |
| 5. Data Processing capabilities | | | | | |
| 6. Time to make decision | | | | | |
| 7. Uncertainty from results of prior decisions | | | | | |
| 8. Uncertainty from outside sources | | | | | |
| 9. Other - specify | | | | | |

- E. What are your major sources for external data?
- F. How would you or what would you need to help you improve the way you make this decision?

The above decisions can be categorized as predominantly affecting production, marketing and financing; as stated, these decisions can be considered short to medium run. Not being sure that one can capture the essence of what makes the more successful farmers by focusing on particular

decisions, effort was put forth to evaluate possible philosophical and procedural differences, that may cut across individual decisions within the areas of production, marketing and financing. The set of questions designed to get at possible behavioral incidents include:

A. Production

1. What do you consider the keys to getting good yields in corn/ wheat/ soybeans?
- 2 . How do you ensure that you will have enough time to get your planting and harvesting done ?

B. Marketing - Crops

1. What is your general philosophy about crop marketing?
2. Would you consider either production or marketing as more or less important for the overall success of the farm business?
3. What marketing alternatives do you feel most confident with, i.e. forward contracting, cash, hedging etc.?

C. Financing and Capital Investment

1. What is your general investment strategy for land?
2. What is your general credit policy?

These questions may only scratch the surface as to how farmers make decisions. However, if from this group we can find some decisions which in the manner in which managers behave in trying to solve them, significantly differentiate between managerial success, then a more intensive evaluation of those decisions are warranted. In fact the more interesting questions may deal with how the manager decides on a decision rule rather than comparing the decision rules themselves which this research analyzes.

Also, this research only emphasizes one of the facets

of management and planning, excluding the other aspects of monitoring, control, evaluation and learning. Of course, there are some managers that may be very good at planning but not so good at follow through. The results of such behavior can affect returns in similar manners.

11.4 Evaluate Decision-Making Behavior of Successful Farmers and Develop Instrument to Measure Behavior and Performance

This section presents the results of administering the open-ended questionnaire to the successful farmers. These responses are then utilized in developing the instrument to measure managerial behavior and performance. The format of this section is to first present the responses grouped according to areas of general philosophy, production, marketing, finance and information processing, then the questions designed from these responses will be presented.

11.41 General Philosophy

Keys to Successful Farming

As a general observation most of these farmers were reluctant to consider themselves successful and even more reluctant to judge other farmers. However, the farmers did give forty-two different keys to successful farming. These statements can be grouped into eight categories and ranked according to the number of mentions of items within that category (see Appendix A). The categories include: financial management(19), production(10), timeliness(9), reacting to changes (decision-making)(9), attitude(8), communica-

tions(7), marketing(4) and general(4). It seems that financial management has become the most important key to successful farming and this is in accord with current financial conditions in agriculture (Append. A, Table I).

Although marketing was viewed as important by farmers, they felt that they could not do very much about it and therefore to be successful they have to do a good job at the other aspects of farming. Also, none of the farmers mentioned the importance of doing their own repair work on machinery. However, from subsequent questions it was found that all the farmers could and did do most of their repairs outside of major overhauls on engines and transmissions with two even doing those. Therefore, this item just may be taken for granted by farmers. From this analysis, it seems that a test for measuring managerial success should emphasize financial management, production and timeliness.

Criteria for Manager Evaluation

Related to the keys to success question was the idea of setting criteria on which to evaluate a manager. The responses to this question were categorized objective, subjective and behavioral (Append. A, Table II). The objective factors included profitability, production costs, assets and liabilities, yields, and financial returns on assets. Of these objective measures, profitability was chosen most by these farmers as a criteria for evaluation.

Among the subjective factors, appearance seemed to be

an important evaluation criteria, which would indicate that these farmers felt that looking prosperous was a good sign of being successful. The fact that the more successful farmers also felt that one could evaluate a farm manager by observing his managerial behavior, encourages the development of a managerial index.

What Farmers Like and Dislike About Farming

From the farmers' responses it seems that independence, the challenge or feeling of accomplishment that farming offers, along with the love for the outdoors and closeness with the family seem to be their major motivating factors (Append. A, Table III). However, uncertainty and unpredictability generated by the market and weather along with the high asset requirements tend to reduce the level of enjoyment of their profession.

The model presented earlier would present the hypothesis that these motivating factors should effect the decision rules chosen and the amount of time spent in collecting and analyzing information for decision-making. The responses to a set of questions on goals and perspectives could be tested as to their discriminating ability in relation to decision rules used or factors analyzed.

Questions Developed

The questions developed from these responses are presented in Appendix C under "Decision-Making Analysis Questionnaire" and include questions 8,9,10,11,34,37 and 39. The options presented to the farmers in questions 10, 37 and

39 were based on the categories established by grouping the responses to similar questions asked in the open ended-questionnaire.

8. How many farm organizations are you a member of?_____

9. How many community organizations do you participate in?__

10. How did you acquire the majority of your owned land?
(Check one)

- ___a) Inherited
- ___b) Bought from family member(s)
- ___c) Bought from non-relatives
- ___d) Other (specify)_____

11. How many years have you been farming independently?_____

34. How much repair work do you do on your equipment on your farm?

_____%

37. What are the most important keys to being successful in farming? (Rank 3)

- ___a) Attitude: motivation, dealing with people etc.
- ___b) Timeliness: getting things done on time
- ___c) Managing money and finances: controlling costs, managing credit etc.
- ___d) Productivity: solid production practices, stewardship of land, adequate buildings and machinery etc.
- ___e) Decision-making: ability to react to change, planning, pin pointing problems etc.
- ___f) Communications and public relations: keep contact with outside world, be able to get expert help etc.

39. Which of these statements best describes why you stay in farming? (Rank 3)

- ___a) Family tradition
- ___b) Feeling of accomplishment
- ___c) Like to control assets
- ___d) Attachment to land
- ___e) I'm a "Workaholic"
- ___f) Locked in by assets
- ___g) Don't have other skills
- ___h) Offers high standard of living
- ___i) Like working with family

11.42 Production

Good Yields in Corn

The fourteen farmers that responded to this question indicated that the most important keys to getting good yields in corn were fertilization, variety selection, timing of planting, improved soil productivity and pest control (Append. A, Table V).

Having Enough Time for Planting and Harvesting

Timeliness was earlier depicted by these farmers as being most essential for success, therefore they seem most sensitive to unanticipated delays during planting and harvesting. To ensure against such delays they indicated that having adequate and reliable equipment, along with preseason preparations, diversity in crops and maturing dates, the willingness to 'run until done', experience, and two way communications equipment were essential (Append. A, Table VI). Of course there may be a thin line between having adequate equipment and being over-equipped which ties this strategy to the overall investment strategy.

Proportion of Crops to Produce

The factors which are predominant for determining crop mix are rotation, government programs, returns per dollar, and in the case of the sugar beet producers, controlling the ground for sugar beet production (Append. A, Table X). The rotational considerations are most important because these farmers felt that a good rotation could help in controlling

pests, increasing overall soil productivity and reducing erosion. In other words, they felt that long term benefits outweighed the benefits of trying to receive maximum profits per year by changing crop mix in response to yearly price changes. Government policy and programs along with their prior participation in these programs set constraints on their acreage allotments to corn and wheat. In fact it seemed that farmers spend a lot of time trying to guess what the government was going to do since they felt that government programs set the market price. Government policy was stated to be the biggest constraint to making the crop mix decision. In particular, a delay in the releasing of quota, loan price and set-aside information delayed the crop mix decision which added uncertainty to other phases of the planning procedure (Append. A, Table XXIII).

Substantially Changing Crop Mix

The farmers in general expressed great reluctance in substantially changing their crop mix in response to short term fluctuations in prices received for commodities. They would consider such changes only if they could be guaranteed an extremely high contract price, plus government programs would have to be considered along with the effects that such changes would have on available labor and equipment, the riskiness of the changes and the erosion or weed problems it might introduce (Append. A, Table XI).

Determining Corn Variety

In determining corn variety, maturity dates as well as performance and quality were important factors to consider. As sources of information, MSU yield trial results were the most frequently mentioned followed by on-farm test plots, experience and dealer recommendations (Append. A, Table XII).

When to Purchase Inputs

Cash discounts along with income tax considerations seem to be the most predominant factors which effect the timing of input purchase. Other factors considered are the interest rates for borrowed funds, the availability of the input along with expected price changes, the effects on cash flow and the desire to have the inputs far enough in advance as not to pose problems at time of use (Append. A, Table XIII).

Questions Developed: 12 - 22

12. If you had to grow corn in another part of the state what would be your primary source of information on the best varieties of corn to plant? (Rank 3)

- a) Seed dealers
- b) Farmers near your new farm
- c) Extension
- d) Past experience on old farm
- f) Local elevators
- g) Farm journals

13. How many varieties would you plant?_____

14. If you found that you were consistently falling behind on getting your planting done on time, what would be the

first thing you would try to eliminate the problem? (Select one)

- ___ a) Start planting earlier
- ___ b) Get larger equipment
- ___ c) Reduce acreage
- ___ d) Diversify crops and/or varieties grown
- ___ e) Hire more help
- ___ f) Put in more hours

15. In which crop is downtime the least expensive during harvest? (Rank 3 least)

- ___ a) soybeans ___ b) wheat ___ c) corn ___ d) navy beans
- ___ e) sugar beets ___ f) barley ___ g) seed corn

16. Assuming that other crop prices remain the same, how high would corn prices have to be projected for the coming year before you would double your acreage of corn?

Give high price ____.

17. How low would corn prices have to be projected as falling in the next year to get you to cut your acreage in half?

Give low price ____.

18. If you were interested in adding a crop to your present crop mix, what factors would most influence that decision? (Rank 3)

- ___ a) Projected average price for next 5 years
- ___ b) Equipment requirements
- ___ c) Production practices and costs
- ___ d) Compatibility with present rotation
- ___ e) Labor requirements
- ___ f) Lowest price over last 5 years
- ___ g) Government programs

19. Assume that interest rates are 12%, and your fertilizer dealer is offering a 10% discount in December for fertilizer that you would use on corn in the spring. Would you? (Select

one)

- ___a) Borrow money to take advantage of discount
- ___b) Wait to purchase until spring

20. Soil tests calls for 100 lbs of nitrogen on corn for your type of soil and variety of corn. Would you? (Choose one)

- ___a) Use a bit more
- ___b) Use as recommended
- ___c) Use a bit less

21. Do you know your cost of production for each of your major crop?_____

22. If yes, what was your cost of producing for corn in 1985?

Cash Expenses: per acre		Fixed expenses or overhead: Per acre	
Labor (Hired)	-----	Land Rental Charge	-----
Labor (Own & family)	-----	Depreciation	-----
Repairs	-----	Interest on debt	-----
Seed	-----	Insurance	-----
Fertilizer and lime	-----	Taxes	-----
Pesticides	-----	Utilities	-----
Drying costs	-----	Other	-----
Fuel	-----		
Other	-----		
Total-----	-----	Total	-----
Total cash and overhead			-----
Yeild per acre			-----
Cost per bushel			-----

11.43 Marketing

Crop Marketing Strategy

The basic strategy for crop marketing can be summarized as first and foremost knowing your cost of production for each crop, evaluating the advantage of entering the government programs with this cost of production figure in mind, then trying to stagger sales during the year so as not

to get stuck with corn for more than nine months and not being forced to sell at harvest (Append. A, Table IX).

"Trigger selling" summarizes their strategies most adequately in that they sell when prices reach that trigger and do not wait in hope of getting a better price.

When to Sell Corn

The farmers emphasized the necessity of knowing cost of production before being able to make the sell decision (Append. A, Table XIV). After knowing cost of production, including storage and government interest charges, strategies ranged from trigger selling to selling when needed to pay off creditors or scheduled sales spread out over the year. Again the emphasis was put on getting rid of the commodity and not carrying it over into another season.

On Farm Storage

For most of the farmers on farm storage was looked at as a method to ease harvest bottlenecks more than as a marketing tool (Append. A, Table XVI). However, farmers did mention that on-farm storage could provide some bonuses in prices received by holding until elevators were short. Some felt that it was cheaper to store on the farm, and on-farm storage gave them the option of selling either on the market or to the government. Another interesting strategy was to have enough storage to cover only owned acreage production while selling the excess from rented acreage at harvest. This allows for matching fixed asset capacities to assured

volumes, allowing the rented acreages to fluctuate without adversely affecting fixed asset utilization.

Price of Corn

It seems to be the very strong opinion of these farmers that it is a waste of time trying to guess corn prices. The best one can do is to use the government loan rate as the bottom floor for corn prices and use that figure when forecasting expected returns (Append. A, Table XVII).

Participation in Government Programs

The majority of these farmers always participated in the government corn program and would not grow corn without such programs (Append. A, Table XVIII). Some of them would at least pencil in the anticipated income comparing "in" versus "out" of the program, but they stated that they seldom came up with figures that would indicate not to participate. However, they indicated that they put their marginal land in the conservation program in order to qualify. In determining how much they would pay in rent for a piece of land the ASCS corn basis was often considered.

Questions Developed: 23-25

23. What are your reasons for entering the government loan program? (Rank 3)

- ___a) Sets price floor
- ___b) Cheap source of operating capital
- ___c) Is an assured market
- ___d) Can utilize marginal land as set aside
- ___e) Never entered

24. If the government got out of the corn market, the best strategy for selling corn would be: (Rank 3)

- ___a) Use market information to pick highest price
- ___b) See what neighbors are doing
- ___c) Sell at harvest
- ___d) Sell some corn every month
- ___e) Set trigger above cost of production and began to sell when price reaches that point
- ___f) Sell when market is going up
- ___g) Sell just after market starts going down
- ___h) Store on farm until elevators offer premium
- ___i) Sell as cash is needed to pay bills

25. The advantage of on-farm storage is: (Rank 3)

- ___a) Can participate in government loan program
- ___b) Saves time during harvest
- ___c) Can get better price by holding
- ___d) Can store cheaper than at elevator
- ___e) Utilizes labor in off season

11.44 Financing: Investment and Money Management

Land Investment Strategy

The farmers indicated that the land investment decision was more of a response than a plan in that they could only purchase land as it became available with the further pressure of expanding to allow family members to get into farming (Append. A, Table VII). The expansion process usually started with renting more land and then purchasing that land when it came up for sale. Some farmers more than others would evaluate the land price against the expected returns for that land, while others would look at their present income generating potential and asset position to see if they could subsidize the purchase of that land.

Credit Policy

From the seven farmers that responded to this question the only predominant incident was a policy to use one lender to ensure against becoming over extended and loosing track of one's debt load (Append. A, Table VIII). The most striking observation about their responses was the diversity of opinions about the use of credit and rules of thumb used to deal with the credit issue. Opinions ranged from "...never use credit to purchase inputs" to "...borrow to maintain cash flow." This area seems ripe for further evaluation of both the positive and normative aspects behind the selection of such diverse methods of handling debt.

Buying Land

Although most land purchase decisions were not considered until a particular piece of land became available, the farmers indicated that they would match expected returns against the monthly costs of that property (Append. A, Table XIX). They would test the quality of the land by getting soil tests or from prior experience from renting the property.

Pay for Rental Land

The most important factors for determining how much to pay for rental land were rental terms, the quality of land and expected yields (Append. A, Table XX). Reasons for renting land included the desire to lease first in order to test the productivity of the land before purchase, and taking a longer lease in order to build up the productivity

of a piece of land.

Equipment Replacement

The major considerations in determining whether to replace a piece of equipment were the perceived productivity differences between the old versus a new piece of equipment, the ability to afford the replacement, and the dependability of the machinery during prime utilization periods (Append. A, Table XXII). Indications of productivity problems included the size of repair bills and constantly being behind on job completions. Other rules of thumb for equipment management included running machinery until it dies, buy only used equipment, buy back up equipment for parts, take good care, purchase for expected growth in acreage, size for the job and knowing your capabilities for doing repair work.

Fifteen out of seventeen farmers interviewed could and did do all of their repair work except major overhauls to engines and transmissions, while the other two even did the major overhauls. Therefore it seems that the ability to do your own repair work is an essential ingredient in farming success.

Questions Developed: 26-33,35

26. How often do you prepare a projected cash flow? (Select one)

- ___a) Yearly
- ___b) Monthly
- ___c) Quarterly
- ___d) None

27. A good reason for renting more land would be: (Rank 3)

- ___a) Spread fixed costs
- ___b) Increase labor utilization
- ___c) The rental land is close to own land
- ___d) To test productivity before deciding to purchase
- ___e) Act as buffer while making equipment systems change

28. In deciding to purchase a piece of land up for sale

which of these statements best describes how you would go about making the decision? (Select one)

- ___a) I have been renting it for a while and if I don't buy it someone else will and get the benefits.
- ___b) I would compare the expected net returns over the life of the mortgage compared to monthly payments and purchase only if it pays for itself.
- ___c) I would determine if the equity base in my present operation could subsidize the purchase of the land.
- ___d) If the expected net returns per acre are greater than my average cost of land, I would purchase.

29. If at the end of tax year you had \$20,000 more taxable income than expected, would you? (Choose one)

- ___a) Purchase machinery or equipment to get tax credit
- ___b) Pay taxes on the income and put the rest on the mortgage
- ___c) Invest in more land
- ___d) Spend more on consumption
- ___e) Buy more inputs for next year to reduce this year's taxes

30. Indicate how many years you would finance the following items: (If less than one year indicate with a fraction)

	Years
a) Production Equipment	-----
b) Land	-----
c) Production inputs used up in one year	-----
d) Machinery shed	-----
e) Personal car	-----

31. Assume you have the option of renting land from someone

on fixed cash rent or shares. Choose the alternative you would prefer under the following conditions. (Indicate "F" for fixed cash rent and "S" for shares.)

- ___ Prices are volatile
- ___ Prices are stable and high
- ___ Prices are stable but low
- ___ The land is not well drained
- ___ The land does not have a ASCS corn basis
- ___ They want a long term lease on good land
- ___ Don't know productivity of land

32. Assume that you have enough equipment and labor to work an extra 40 acres of land and you currently grow a combination of corn, wheat and soybeans. Also assume that a piece land comes up for sale that historically produces 100 bushels of corn. If the finance terms are at 10% fixed interest for 15 years, how much would you be willing to pay per acre?_____

33. In choosing the following types of equipment pick 3 attributes from the list which are most important when making the decision to purchase. (Place letter of attribute next to number)

Equipment	Attributes
Planter __1 __2 __3	A. Price
Tractor __1 __2 __3	B. Age
Harvest	C. Condition
Truck __1 __2 __3	D. Financing arrangements
Combine __1 __2 __3	E. Depreciation
	F. Investment tax credit
	G. Resale value
	H. Size
	I. Dealer service
	J. Availability of spare parts
	K. Availability of back up equipment
	L. Performance qualities
	M. Dependability

- N. "State of the art"
- O. Flexibility of uses
- P. Own ability to repair
- Q. Horsepower
- R. Lease options
- S. Compatability with other equipment

35. How many different lenders do you do business with?_____

11.45 Information Processing

Of the twelve specific decisions analyzed some more than others seem to require more calculations than others and some require more internally generated historical data than others. Theoretically, computerized data storage and processing equipment should be most useful where the decision requires either/or extensive and accurate calculations and/or extensive records.

The decision on when to sell corn was mentioned most by the farmers as one where calculations are very important (Append. A, Table XXII). In particular, figuring the cost of production for each crop is both crucial and difficult. Only after costs of productions are known can the manager set price thresholds for the sell decision. However, a number of managers expressed their skepticism towards sophisticated charting or forecasting models for corn and felt that the combination of the government loan rate and futures market prices were sufficient for estimating future prices within the growing season.

Next on the list is the land investment decision where

forecasting future cash flows and the effects of that purchase on other fixed asset capacities are so important. When to purchase inputs along with the decision to change crop mixes follow in line as to the necessity of calculations. Calculations seemed to play the smallest role in the storage decision, determining expected corn prices, determining corn variety, and whether to rent verses buy a piece of land.

Determining the proportion of each crop to grow was a decision that farmers felt would be most aided by extensive internal historical records including acreages grown and performances on each portion of land along with optimal input requirements for each parcel. Historical records from the farm could aid the corn variety determination decision along with helping determine the level of participation in government programs.

The equipment replacement decision was most dependent on the performance and reliability of the machinery. Therefore, records on break downs, repair expenses and field performance information such as time per job and fuel consumption would aid greatly in determining whether a newer or larger piece of equipment was warranted.

Constraints on Making Good Decisions

Due to the length of the questionnaire all of the specific decisions were not analyzed to determine constraints to making those decisions. However, of the ones analyzed, proportion of crops, changing crop mix, corn

variety, input purchase and when to sell corn seem to be most affected by both the availability of external information on prices or qualities along with what the government programs for the next year was to be and tax policy considerations. It seems that the timing of government programs is a major determinant of management strategy in these key decisions.

Questions Developed: 36,38

36. Rank the usefulness of doing extensive and accurate numerical calculations when making decisions in the following categories. (Circle 1,2,3,4 or 5 where 1 means not useful and 5 means very useful)

	Not useful			Very useful	
a) Determining crop mix	1	2	3	4	5
b) Adding a new crop	1	2	3	4	5
c) Determining crop varieties	1	2	3	4	5
d) When to purchase inputs	1	2	3	4	5
e) Cost of production for individual crops	1	2	3	4	5
f) Estimating the future price of corn	1	2	3	4	5
g) Determining the economic level of fertilizer to use	1	2	3	4	5
h) Determining whether to enter a government program	1	2	3	4	5
i) How much to pay for land	1	2	3	4	5
j) Choosing between financial options	1	2	3	4	5
k) Making an equipment purchase	1	2	3	4	5
l) Estate planning	1	2	3	4	5

38. How many years of historical records on the following items do you have that are readily available?

No. of years	Item
----	a) Crop performance by fields
----	b) Variety performance
----	c) Soil test data by fields
----	d) Fertilizer utilization for each crop

- e) Chemical utilization for each crop
- f) Land cost per acre
- g) Fuel utilization per acre
- h) Yearly equipment repair cost for each peice
of major machinery
- i) Hours of planter use

Chapter 12

Measuring Effectiveness (System Performance)

Now that field crop farms have been selected for analysis, an appropriate measure of effectiveness must be selected and tested for validity and reliability. This phase commences by locating a set of farmers with historical records of farm performance. Then an effectiveness measure is chosen based on theory and workability. The measure is tested for internal and external validity, which incorporates the views of the farmers themselves on an appropriate measure, along with statistical tests. Then the measure is tested for reliability by comparing the consistency of the measure over time. Once a measure has been tested for both validity and reliability it is then used in the next phase where the behavioral predictors of effectiveness are used to predict the effectiveness measure chosen.

12.1 Implementation

Selection of Effectiveness Measure

As stated earlier there are 84 field crop farmers that have been involved in the Michigan State TelFarm record-keeping system for at least four years. Among the information collected and stored on these farms are yields, net income, acreage planted to specific crops, production costs, assets and liabilities, and financial returns to assets.

Information from the Behavioral Analysis phase indicated that if farmers interviewed were given the opportunity to evaluate how effective another farm manager was, they would choose profitability, production costs, assets and liabilities, yields, financial returns on assets, and compare these measures over time as criteria for evaluation. Profitability was chosen most by these farmers as a physical and comprehensive measure of performance.

However, there are different interpretations and consequently measures of profitability. There is the income tax definition; there is the cash verses accrual method of determining net income; and there is the economic definition of profits based on the opportunity cost principal. The definition chosen here will be based on economic theory and is the definition used in evaluating profitability by the TelFarm system.

In TelFarm net farm income is determined using the accrual method of accounting where this year's costs are matched against this year's value of production. The income calculated may be different from actual cash expenses subtracted from this years sales because of inventory changes for both inputs and outputs. After net farm income is calculated, assumed charges for unpaid family labor, assumed returns to operator labor, and assumed return on operator's average capital (equity) are subtracted to arrive at a residual which is assumed to measure the value of the management input. Since each farm would have different

total acres, dividing by crop acres brings us to a measure comparable accross farms of similar types. This we will call "Management Income per Acre".

Test for Reliability

As stated earlier, any measure must stand up to the test of scientific objectivity. In particular management income per acre can be said to be a workable definition within the limited confines of those farmers that keep good records. The question of clarity is dependent on the user's understanding and the ability to relate the concept. An important issue arises as to the validity and consistency of the measure, or reliability. Does it measure what it portends to measure and is that measure a consistent indicator of that attribute over time?

One way of testing the consistency of management income per acre is to first assume that managerial ability does not change very much over a short period of time, since agricultural production is faced with long lags. Therefore, even though the level of management income may change on a yearly basis due to influences outside of the control of the manager, for a set of managers facing similar circumstances, the relative position of these managers as measured by a managerial variable should show signs of consistency. In particular, if we measure a farmer's relative position to the average or mean, then his position should not change drastically over a relatively short period of time - say

four years.

Analysis of variance will be the statistical technique used to determine the consistency over time of management income per acre as a measure of managerial performance. Analysis of variance (ANOVA) compares the variance of a group from the mean to determine whether the differences of means of the groups can be attributed to differences between the groups or just a factor of random occurrences (noise).

Another question arises as to whether we are measuring managerial effectiveness, noise or some other phenomena. In particular, going back to our farm system, there are factors which contribute to the performance of the farm system that are not under the immediate control of the farm operator. One can argue that the differences in management income per acre is just a function of location, soil type or the availability of specialized markets which allow a higher return.

We know that soil types vary extensively in Michigan. They vary across counties and even within counties. It stands to reason that if a farmer were in a county that had corn yields consistently higher than another county, his returns per acre might be greater. Also, in Michigan some counties, due to their soil type and climatic conditions, can economically grow sugar beets, which is a high value crop. Therefore, before one can say that the management income variable is a residual attributable to the managerial input, the effects of location should be investigated.

Earlier it was noted that Heady and others question the validity of most measures of management because of the alleged association between capital and management. According to this argument one can not adequately distinguish between the two. Therefore, if a statistical relationship does exist between levels of capital on the farm and our chosen measure of effectiveness, serious questions of validity do exist.

Along with the capital issue is the question of economies of size, there are some that question whether larger farms have an economic efficiency advantage due to size. Therefore, it would be advised to see if our measure of effectiveness is statistically associated with a measure of farm size.

Linear multiple regression is the technique chosen to test the spuriousness of management income per acre (MI/A). The hypothesis tested will be whether average county yields in corn, being in the Saginaw Valley, the amount of capital per acre and farm size as measured by acreage are significantly associated with MI/A.

12.2 Results

Test for Consistency Over Time

The first step in preparing the data for using analysis of variance is to divide the farmers for whom we can calculate their management income for the four years between 1981 and 1984 into three equal groups. The farmers are then sorted in descending order in terms of their respective

differences from the mean of management income per acre (DFMGT). The first third of these farmers are considered in the high management group, the next third in the middle management group and the bottom third in the low management group. Now one must determine if the variance in their respective effectiveness be best attributed to the management groups or a random effect of time. In other words, do members in the mangament groups stay within these groups over time or just shift around aimlessly?

The results of ANOVA (Table 1) indicate that the variance attributable to management group membership was significant to at least the 0.001 level of probability; whereas, the variance attributable to time was not significant. In other words, it is very unlikely that the variance observed as being attributable to differences between the three management groups happened by chance. Furthermore, management grouping accounted for 36.7 percent ($R^2=.367$) of the variance in management income per acre, while grouping by year accounted for only 0.16 percent of the variance.

Therefore, although we cannot say categorically that management income per acre is a perfect indicator of managerial performance, at least it seems to be able to consistently group farmers over time. Of course differences in the levels of this variable can be attributable to other factors beside managerial ability such as differences in primary resource qualities, in particular, land

Table 1: ANOVA-2 MANAGEMENT BY GROUP AND YEAR

A. One way ANOVA: DFMGT grouped over variable 1 (GROUP)
with values from 1 to 3

A N A L Y S I S O F V A R I A N C E T A B L E

	Degrees of Freedom	Sum of Squares	Error Mean Square	F-value	Prob.
Between	2	749512.8111	374756.41	71.10	.000
Within	245	1291435.4056	5271.16		
Total	247	2040948.2167			

$$R^2 = \text{Sum of Squares Between} / \text{Sum of Squares Total} = .367$$

=====

B. One way ANOVA: DFMGT grouped over variable 2 (YEAR)
with values from 1 to 4

A N A L Y S I S O F V A R I A N C E T A B L E

	Degrees of Freedom	Sum of Squares	Error Mean Square	F-value	Prob.
Between	3	3329.1226	1109.71	0.13	
Within	244	2037619.0941	8350.90		
Total	247	2040948.2167			

$$R^2 = \text{Sum of Squares Between} / \text{Sum of Squares Total} = .0016$$

and climate. The extent of some of these other factors which question the validity of this measure will be addressed later.

Association of MI/A with Yield and Location

Since by grouping the farmers by their average management income per acre figure over a four year period seemed to account for a substantial part of the variance, the next step is to test the relationship of average MI/A over the period to related environmental factors and the capital endowment of the farm. The environmental factors investigated are the average county yields and whether the farm is in the Saginaw Valley or not. Since Heady (1963) hypothesised that management ability was associated with capital structure, it might be interesting to see if the amount of investment per acre is related to management income.

Hypothesis: The null hypothesis is that there is no relationship between MI/A and Average county corn yeilds, whether the farm is in the Saginaw Valley or not, the dollar amount of investment per acre, or the number of acres farmed.

Model:

$$Y = b_1 + b_2 * X_2 + b_3 * X_3 + b_4 * X_4 + b_5 * X_5 + e$$

Where:

Y = MI/A : average management income per acre (1981-1984);
dollars,

b_1 = constant,

b_2 = YCORN :Average county corn yields (1981-1984);
measured in bu/acre,

b_3 = CTY :Location (1=Saginaw Valley, 0=Not in Saginaw Valley),

b_4 = CAPAC :Average dollar value of total capital per
acre (1981-1984),

b_5 = ACRE :Average acres farmed per manager (1981-1984),

e = Error term.

Of course, the price received by the farmer affects his income. The individual farmer may be able to get higher than the average prices due to his/her marketing strategy, but this is part of the managerial input and should be a part of MI/A. If the farmer is getting a higher price due to a locational advantage then this should be accounted for by the locational variable (CTY).

Results

The results of multiple regression (Table 2) reveal that the combination of the four variables (YCORN, CTY, CAPAC, ACRE) is a poor predictor of management income per acre (MI/A). Using the 5 percent confidence level for evaluating the F-statistic, for the equation, we can accept the null hypothesis that there is no relationship between the set of independent variables and MI/A. However, one of the independent variables, ACRE, may show some influence on MI/A. At the 10 percent level of significance on the T-statistic we can reject the null hypothesis that the coefficient is zero. However, an R^2 of 0.041 would indicate that

Table 2: ENVIROMENTAL VARIABLES AFFECTING MIA

Function: MULTIREG

Data case no. 1 to 71

Without selection

2-YCORN

3-CTY

4-CAPAC

5-ACRE

1-MIA

Var. No.	Regression Coefficient	Standard Error	Student T value	Prob
2	1.7039E+00	1.3663E+00	1.247	.21
3	-1.6261E+01	2.2620E+01	-0.719	.47
4	-6.0627E-03	1.3108E-02	-0.463	.64
5	6.8738E-02	2.9414E-02	2.337	.02

Intercept = -248.7215

Coefficient of Determination (R-Square) = 0.096
 Adjusted R-Square = 0.041
 Multiple R = 0.309
 Standard Err of Est. = 68.024

ANALYSIS OF VARIANCE TABLE

	Sum of Squares	df	Mean Square	F	Signif
Regression	32263.760000	4	8065.94000	1.74	.151
Residual	305399.400000	66	4627.26400		
Total	337663.200000	70			

these variables account for only 4.1 percent of the variance in MI/A.

Therefore, it would seem that management income per acre can not be adequately explained as the result of location, county corn yields, size of farm or amount of investment per acre. But size of the farm may have some effect once the other variables are taken into consideration. The positive sign on ACRE indicates that larger farms may have an advantage at attaining high management income. However, one cannot be sure of the direction of causality. It could be that the ability to manage well may influence the size of operation attempted, or farming a larger operation could increase the manager's abilities, or simply that management income per acre is affected by economies of scale having nothing to do with ability.

Since the relationships between MI/A and the independent variables are small and statistically insignificant except for ACRE, one can argue that MI/A is measuring something other than environmental or structural variables outside the immediate influence of management. Therefore, it would seem that MI/A has passed this test for validity in that the measure was not substantially influenced by this set of non-managerial variables.

Chapter 13

Testing Behavioral Predictors of Effectiveness

The first step in this phase consists of administering to a set of farmers with historical farm records the instrument or test designed in a previous chapter to measure managerial behavior and performance. Once the managerial test has been completed by the farmers, they must be scored based on some criteria.

Once the behavioral scores are compiled, statistical tests for significance can be performed to indicate the degree of reliability of the managerial index as an indicator of effectiveness. A revised managerial test can then be formulated based on the results of the statistical analysis, where the best set of predictors can be used as the basis for the new instrument. The new instrument can then serve as the managerial index to be used in the quasi-experiment, where comparisons can be made between the index in measuring the value of decision aids and the value obtained by observing sets of farmers over time as they use different decision systems.

The chapter will be divided into four main areas: 1) Administering the Instrument to Farmers, 2) Scoring the Test, 3) Testing the Hypothesis and 4) Revising the Instrument.

13.1 Administering the Instrument to Farmers

The farmers chosen to participate in this phase of the analysis are the same set used for validating management income per acre as an effectiveness measure. These were 84 cash grain or field crop farmers that participated in the TelFarm record keeping system from 1981-1984.

Out of these 84 farmers there were 47 usable questionnaires returned for a response rate of 56 percent. "Usable" means completely filled out.

13.2 Scoring the Test

The method of scoring the test is based on the principle adhered to throughout this analysis, and that is, that the behavior of the more successful farmers is the key to their success as measured by effectiveness. The first step in the scoring process is to select a set of farmers whose answers are to serve as the criteria for scoring the responses of the other farmers. Since management income per acre (MIA) was chosen as the effectiveness measure, the criteria for selection of the top management group is that they must have had a management income per acre value that placed them in the top one third of all the managers for at least three of the four years, and in the top one third as determined by the four year average of management income per acre.

Based on the above criteria six farmers were selected

from the 47 farmers completing the questionnaires. Their responses were used as the standard by which the other questionnaires were scored.

The questionnaire itself - found in Appendix C - was divided into five parts including: 1) Background Information, 2) Production Decisions, 3) Marketing, 4) Investment and Money Management and 5) General Management. The area soliciting background information was not scored as such, in that no score was given them other than a numerical code representing the raw responses given.

However, the questions in the other areas were scored according to the following criteria. Questions 12, 15, 18, 23-25, 27, 33, 37 and 39, where the respondents were asked to rank 3 of the alternatives given, were scored by giving scores of 5, 3 and 1 based on responses of 1, 2 and 3 respectively. Then the scores for each alternative were added together; now this value was used as the score given to the respondents for selecting the respective alternative.

However, although the respondents were asked to rank three alternatives, they were scored based on the first two alternatives they selected regardless of whether that alternative was selected first or second. A demonstration is in order.

Let us take question 23 as an example of this type of scoring.

23. What are your reasons for entering the government loan program? (Rank 3)

- a) Sets price floor
- b) Cheap source of operating capital

- c) Is an assured market
- d) Can utilize marginal land as set aside
- e) Never entered

Alternative "a" was chosen first three times, twice once, and third once giving it a score of 19 $((3 \times 5) + (1 \times 3) + (1 \times 1))$. Alternative "b" was chosen second four times, and third once, giving it a score of 13 $((4 \times 3) + (1 \times 1))$. The other three alternatives were scored likewise with the result being alternative a=19, b=13, c=10, d=3, and e=5. For the next phase of the scoring, only the top three responses (a, b and c) were left with their scores, while the other responses were given a zero score. Now if a respondent chose "a", "b" or "c" for his first or second choice then he was scored accordingly. For instance if the respondent chose "a" first and "b" second, then he was given a total score of 19+13, or 32. However, if he chose "a" second and "d" or "e" first, then he received only 19 points.

There were other questions such as 19, 20, 26, 28 and 29, where the respondent was asked to select only one. In these cases if the set of farmers chosen as the standard selected a given alternative, that alternative was given a score of 5. When all six of the respondents' selections had been noted and tabulated, the sum of the values within each alternative became the score given to subsequent respondents that chose that alternative.

There were a set of questions - 13, 30a, b, c, d, e, 32, 34, 35, and 38 - where a specific number was asked for. In these cases the correct answer was assumed to be one within

one standard deviation of the mean of the responses given by the six more successful farmers. For instance, question 13 asked how many varieties would one plant. The mean was four and the standard deviation was about one. Therefore, each respondent was subsequently given a score of 30 if their response fell between 3 and 5. Each one of these questions was given a different value or score for answering correctly. The selection of the level was based on giving that question a weight in proportion to the possible scores obtainable on the other questions, and the relative smallness of its standard deviation. If the standard deviation was small, one could assume that the issue was quite settled. Whereas, if the standard deviation was large for these six respondents, then either the question did not bring out a behavioral incident, it was too vague, or there may be more than one right solution to the problem under real world conditions. A smaller standard deviation would warrant giving that question a proportionally higher potential value.

There were a few questions - 21 and 31 - where only a yes/no or s/f (share/fixed) response was asked for. In these cases the majority response was selected as the correct response and scored as to give questions 21 and 31 comparable weights with the other questions.

Question 36, which asked respondents to rank the usefulness of doing extensive and accurate numerical calculations when making decisions over certain categories of

problems, was scored by giving five points to each alternative level of usefulness chosen by the six more successful farmers. Subsequent respondents were then given the sum of each level of usefulness when they chose the appropriate response. For instance, the problem of adding a new crop was given a level of 3 on the usefulness scale by 3 respondents and 5 by the other 3. Therefore, if a subsequent respondent chose either 3 or 5 they would receive 15 points, but they would not receive any points for choosing 1, 2 or 4.

Question 22, where respondents were asked to figure out their cost of production for corn, yield per acre and cost per bushel were used as the criterion variables. They were scored by first determining the mean and standard deviation, then for yield per acre the subsequent respondents were given a score of 20 if their yield was no less than one standard deviation below the mean, and given 20 points if their cost per bushel was at most one standard deviation above the mean. Of course, if they did not respond, they were given a score of zero. This question may cause problems in subsequent interpretation since more than one thing is being measured at once. Here both the ability to do the computations (behavior and performance) and the actual system response (yields or cost per bushel) which are effectiveness measures are both being treated together.

Finally, questions which included multiple parts were given a total score based on the sum of scores obtained from

answering the parts.

13.3 Testing the Hypotheses

Hypotheses Development

Now there are 47 completed and scored questionnaires, or managerial tests that can now be used to test the relationship between effectiveness and behavior/performance. The questionnaire is comprised of many questions which can be categorized according to production, marketing, finance, and information processing as well as further divided into whether the questions measure behavior or performance. Therefore, there are a number of hypotheses that can be tested based on how one categorizes the questions. Each of the hypotheses are then tested by using linear multiple regression.

Hypotheses to be Tested:

Hypothesis I: There is no relationship between effectiveness and the total score of answers to the questionnaire.

Hypothesis II: There is no relationship between effectiveness and behavior or performance.

Hypothesis III: There is no relationship between effectiveness and scores on production, marketing, finance, and information processing.

Hypothesis IV: There is no relationship between effectiveness and any set of questions on the managerial test.

Testing

Hypothesis I: There is no relationship between effectiveness and the total score of answers to the questionnaire.

This hypothesis is based on adding the individual scores from questions 11 through 39 into a composite score (TSCORE) which reflects the overall behavior and performance aggregated across the entire managerial test. The formal model can be represented as: $MIA = C + b * TSCORE + e$

Results

As shown in Table 3, TSCORE accounts for only 2 percent of the variance in MIA and is not significant at the .10 level. Therefore, one can argue that the null hypothesis of no relationship between management income per acre, and the total score received on the managerial test instrument, holds.

Hypothesis II: There is no relationship between effectiveness and behavior or performance.

The model to be tested based on this hypothesis becomes:

$$MIA = C + b_1 * BEHAVIOR + b_2 * PERFORMANCE + e$$

BEHAVIOR is the variable that represents a summation of all the scores on the questionnaire that relate how a manager behaves while making decisions. PERFORMANCE represents the

Table 3 : Testing Hypothesis: $MIA = C + b \cdot TScore$

Data case no. 1 to 47
Without selection

TSCORE
MIA

47 cases read 0 missing cases discarded

Variable	Regression Coefficient	Standard Error	Std. Partial Regr. Coeff.	Student T value	Prob
TSCORE	1.1022E-01	7.8505E-02	0.2049E+00	1.404	.16

Intercept = -133.763

Coefficient of Determination (R-Square)=	0.042
Adjusted R-Square	= 0.021
Multiple R	= 0.205
Standard Err of Est.	= 71.172

A N A L Y S I S O F V A R I A N C E T A B L E

	Sum of Squares	df	Mean Square	F	Signif
Regression	9985.090000	1	9985.09000	1.97	.167
Residual	227944.000000	45	5065.43000		
Total	237929.000000	46			

summation of scores of each question where the farm manager is asked to solve a problem, or state how he solved a problem. An example may be helpful in making the distinction between a behavioral question and a performance question. An example of a behavioral question is question 18:

18. If you were interested in adding a crop to your present crop mix, what factors would most influence that decision? The farmer is given alternative possible pieces of information that he might use in making the decision. An example of a performance question would be question 19:

19. Assume that interest rates are 12%, and your fertilizer dealer is offering a 10% discount in December for fertilizer that you would use on corn in the spring.

From here the farmer is given two possible courses of action from which to choose. The distinction is that question 18 is trying to solicit how the manager makes the decision, while question 19 asked the farmer to solve the problem and give a prescription.

Results

The results of linear multiple regression analysis (Table 4) indicates that the null hypothesis is not rejected at the .10 confidence interval as measured by the probability of the F-statistic for the relationship $MIA = f(\text{BEHAVIOR}, \text{PERFORMANCE})$. However, it is interesting to

note that the performance variable is much closer to being significant than the behavioral variable, which may indicate that subsequent questionnaires should attempt to include more questions asking the farmers to solve problems or asking them past prescriptions followed.

It is comforting to note at this point that there is a high degree of correlation between BEHAVIOR and PERFORMANCE as seen in the correlation table presented in Table 4. This indicates that at least the questionnaire backs up the hypothesis that there is a relationship between how farmers make the decisions and the actual decisions they make.

Hypothesis III: There is no relationship between effectiveness and scores on production, marketing, finance, and information processing.

The model to be tested here is:

$$MIA = C + b_1 * PROD + b_2 * MARK + b_3 * FIN + b_4 * INFO + e$$

PROD is the summation of the scores on questions relating to production decisions, MARK is the total score on the marketing questions, FIN is the total score on the financing and money management questions, and INFO is the total score on questions relating to information.

Table 4: Testing Hypothesis II: $MIA = f(\text{BEHAVIOR}, \text{PERFORMANCE})$

Function: MULTIREG

Data case no. 1 to 47

Without selection

BEHAVIOR

PERFORMANCE

MIA

47 cases read

0 missing cases discarded

Correlation Matrix

	BEHAVIOR	PERFORMANCE	MIA
BEHAVIOR	1.000		
PERFORMANCE	0.600	1.000	
MIA	0.139	0.254	1.000

Variable	Regression Coefficient	Standard Error	Std. Partial Regr. Coeff.	Student T value	Prob
BEHAVIOR	-1.6695E-02	1.4506E-01	-.2096E-01	-0.115	.90
PERFORMANCE	3.2930E-01	2.2477E-01	0.2669E+00	1.465	.14

Intercept = -123.714

Coefficient of Determination (R-Square) = 0.065
 Adjusted R-Square = 0.022
 Multiple R = 0.255
 Standard Err of Est. = 71.107

ANALYSIS OF VARIANCE TABLE

	Sum of Squares	df	Mean Square	F	Signif
Regression	15454.300000	2	7727.17000	1.53	.228
Residual	222475.000000	44	5056.25000		
Total	237929.000000	46			

Results

The results of multiple regression (Table 5) for this configuration of variables were similar to the preceeding one, in that the null hypothesis of no relationship between MIA and now the questions aggregated according to their reference to production, marketing, finance, and information processing, still held. Non of the individual variables were significant at the .10 probability of the t-statistic. However, there were strong correlations between some of the independent variables themselves which is to be expected if the questions are measuring aspects of the same attribute.

The strong multi-collinearity between MARK, FIN and INFO may point one in the direction of a different combination of scores, that may lead to a set of variables that may indeed be related to the dependent variable. This information is used in establishing such a set in the next hypothesis to be tested.

Hypothesis IV: There is no relationship between effectiveness and any set of questions on the managerial test.

As stated above the previous regressions on MIA indicate that there may be another combination of scores that may indeed be considered indicators of effectiveness. The previous analyses also indicate that a number of the questions may be discarded leaving a core of questions that may

Table 5: Testing Hypothesis III: $MIA = f(PROD, MARK, FIN, INFO)$

Function: MULTIREG

Data case no. 1 to 47

Without selection : 47 cases read, 0 missing cases discarded

PROD

MARK

FIN

INFO

MIA

Correlation Matrix

	PROD	MARK	FIN	INFO	MIA
PROD	1.000				
MARK	0.227	1.000			
FIN	0.455	0.527	1.000		
INFO	0.240	0.572	0.481	1.000	
MIA	0.087	0.192	0.248	0.092	1.000

Determinant of matrix is= .359372

Variable	Regression Coefficient	Standard Error	Std. Partial Regr. Coeff.	Student T value	Prob
PROD	-8.2089E-02	4.8356E-01	-.2836E-01	-0.170	.86
MARK	1.9779E-01	3.1278E-01	0.1224E+00	0.632	.53
FIN	3.7118E-01	3.0707E-01	0.2372E+00	1.209	.23
INFO	-1.0673E-01	2.3466E-01	-.8534E-01	-0.455	.65

Intercept = -139.924

Coefficient of Determination (R-Square)= 0.072

Adjusted R-Square = -.016

Multiple R = 0.268

Standard Err of Est. = 72.506

ANALYSIS OF VARIANCE TABLE

	Sum of Squares	df	Mean Square	F	Signif
Regression	17127.900000	4	4281.97000	0.81	.523
Residual	220801.000000	42	5257.18000		
Total	237929.000000	46			

be the basis for a test that has a better chance at predicting success.

The approach here is to fish through the variables one at a time, and select the questions that show a strong correlation with MIA, and then aggregate these scores into variables according to decision type, i.e. production, finance, etc. After the searching, testing and reaggregation, another model can be posited and statistically tested.

Results

After looking at individual questions and their statistical association with the dependent variable, these questions stand out as possible raw material for aggregation and testing: 6, 10, 16, 19, 22, 27, 29, 30 and 31. Questions 6 and 10 are background variables which stand alone and are not appropriate for aggregation. Questions 16 and 19 are related to both marketing and production, but much more related to knowing and controlling one's cost of production. Therefore, these two questions are aggregated; summing their individual scores to form a new variable COSTPR, which is an indicator of the farmer knowing his cost of production.

Questions 19, 27, 29, 30 and 31 are all related to financial or money matters. All of these questions are performance type questions except 27, where behavior is solicited. Therefore, a new variable FINBP was calculated by aggregating scores to questions 19, 27, 29, 30 and 31.

Now a new model can be posited:

$$MIA = C + b_1 * ORGAN + b_2 * ACQUIRE + b_3 * COSTPR + b_4 * FINBP + e$$

Where ORGAN is the organizational structure of the farm, ACQUIRE is how the farm was acquired, COSTPR is the aggregated variable measuring the performance of the farmer in measuring and using his cost of production information, and FINBP is the aggregated variable measuring both behavior and performance of the manager when faced with financial and money matter type decisions.

Results

Table 6 presents the results of multiple regression analysis. Immediately, one can reject the null hypothesis of no relationship between MIA and our independent variables, since the F statistic was 6.48, which represented a probability smaller than .001 for type I error. The equation itself according to the coefficient of determination accounted for over 38 percent in the variance of management income per acre. The variable showing the greatest association with MIA was FINBP or the variable representing the farmers score on the questions categorized as pertaining to finance and money management.

Therefore, this analysis would indicate that this subset of variables from the original management test instrument may indeed be predictors of managerial effectiveness as measured by management income per acre. In particular, higher scores on the questions pertaining to determining

Table 6 : Testing Hypothesis IV: $MIA = f(ORGAN, ACQUIRE, COSTPR, FINBP)$

Function: MULTIREG

47 cases read: 0 missing cases discarded

ORGAN
ACQUIRE
COSTPR
FINBP
MIA

	Minimum	Maximum	Mean
ORGAN	1.00	5.00	1.702
ACQUIRE	1.00	4.00	2.681
COSTPR	0.00	70.00	20.213
FINBP	30.00	157.00	112.851
MIA	-305.50	81.00	-67.114

Correlation Matrix

	ORGAN	ACQUIRE	COSTPR	FINBP	MIA
ORGAN	1.000				
ACQUIRE	0.329	1.000			
COSTPR	0.002	0.198	1.000		
FINBP	0.194	0.321	0.425	1.000	
MIA	0.288	0.360	0.384	0.543	1.000

Determinant of matrix is= .637405

Variable	Regression Coefficient	Standard Error	Std. Partial Regr. Coeff.	Student T value	Prob
ORGAN	9.5282E+00	7.4813E+00	0.1656E+00	1.274	.20
ACQUIRE	1.5695E+01	1.4586E+01	0.1447E+00	1.076	.28
COSTPR	6.2669E-01	4.3996E-01	0.1927E+00	1.424	.16
FINBP	1.0823E+00	3.9695E-01	0.3828E+00	2.727	.00

Intercept = -260.212

Coefficient of Determination (R-Square)= 0.382
Adjusted R-Square = 0.323
Multiple R = 0.618
Standard Err of Est. = 59.188

ANALYSIS OF VARIANCE TABLE

	Sum of Squares	df	Mean Square	F	Signif
Regression	90793.400000	4	22698.30000	6.48	.000
Residual	147136.000000	42	3503.24000		
Total	237929.000000	46			

cost of production and on making financial, investment and money management decisions are positive indicators of increased management income per acre. Further, that the organizational structure of the farm, and how that farm was acquired influence the ability of the behavioral and performance variables to predict management income per acre.

Further analysis showed that one could drop either ORGAN or ACQUIRE without either significantly reducing the coefficient of determination, increasing the standard errors of COSTPR and FINBP, or substantially changing the magnitude of the coefficients on COSTPR and FINBP. Table 7 presents these results which indicate that the best estimate of the coefficients on COSTPR and FINBP are obtained by including ORGAN and dropping ACQUIRE.

If we accept the hypothesis that MIA is a function of ORGAN, COSTPR and FINBP, questions may still arise as to the validity of the scoring method and subsequent analysis. In particular, since the six farmers selected for establishing how the questions were to be scored were included in the 47 cases used for testing the model and developing the coefficients, one can then argue that the deck is stacked in favor of accepting such an hypothesis of subsequent association. Therefore, as a check, MIA was regressed against ORGAN, COSTPR and FINBP without the six farmers used as the stan-

Table 7: Comparing Hypothesis IV without ACQUIRE or without ORGAN

47 cases read

0 missing cases discarded

A. Without ACQUIRE

Variable	Regression Coefficient	Standard Error	Std. Partial Regr. Coeff.	Student T value	Prob
ORGAN	1.1907E+01	7.1602E+00	0.2069E+00	1.663	.10
COSTPR	6.7494E-01	4.3847E-01	0.2075E+00	1.539	.13
FINBP	1.1731E+00	3.8859E-01	0.4149E+00	3.019	.00

Intercept = -233.404

Coefficient of Determination (R-Square)= 0.365
 Adjusted R-Square = 0.320
 Multiple R = 0.604
 Standard Err of Est. = 59.297

ANALYSIS OF VARIANCE TABLE

	Sum of Squares	df	Mean Square	F	Signif
Regression	86737.700000	3	28912.60000	8.22	.000
Residual	151192.000000	43	3516.09000		
Total	237929.000000	46			

B. Without ORGAN

Variable	Regression Coefficient	Standard Error	Std. Partial Regr. Coeff.	Student T value	Prob
ACQUIRE	2.1184E+01	1.4035E+01	0.1953E+00	1.509	.13
COSTPR	5.6192E-01	4.4016E-01	0.1728E+00	1.277	.20
FINBP	1.1509E+00	3.9611E-01	0.4070E+00	2.906	.00

Intercept = -265.146

Coefficient of Determination (R-Square)= 0.358
 Adjusted R-Square = 0.313
 Multiple R = 0.598
 Standard Err of Est. = 59.615

ANALYSIS OF VARIANCE TABLE

	Sum of Squares	df	Mean Square	F	Signif
Regression	85110.800000	3	28370.30000	7.98	.000
Residual	152819.000000	43	3553.92000		
Total	237929.000000	46			

dard for scoring the instrument. Table 8 shows the results of that analysis and although the coefficients are less significant, and the overall measure of significance of the equation is reduced, the elimination of the six farmers does not change the basic structure of the relationship. The null hypothesis of no relationship is rejected at the 0.01 level of probability.

Earlier, when evaluating the validity of MIA, the question arose as to whether the size of the farm influenced management income per acre or did the ability to manage affect the size of the farm. Table 9 reveals that the addition of the two environmental variables, CTY and ACRES, does not add to the predictive ability of the other variables. The low t values also indicate that they are not significant indicators of management income per acre, and the sign of ACRE is even negative. Such results would indicate that the addition of FINBP greatly reduces the ability of the size of the farm to predict MIA. Therefore, not only is MIA further validated, but financial managerial ability seems to be essential for effectiveness.

Table 8: Tsting Hypothesis IV without Six Top Farmers

case no. 7 to 47
 41 cases read: 0 missing cases discarded

Variable	Regression Coefficient	Standard Error	Std. Partial Regr. Coeff.	Student T value	Prob
ORGAN	1.1028E+01	8.0767E+00	0.1932E+00	1.365	.17
COSTPR	4.7478E-01	5.0429E-01	0.1401E+00	0.941	.35
FINBP	1.1405E+00	4.2957E-01	0.4069E+00	2.655	.01

Intercept = -229.277

Coefficient of Determination (R-Square) = 0.306
 Adjusted R-Square = 0.250
 Multiple R = 0.553
 Standard Err of Est. = 62.006

A N A L Y S I S O F V A R I A N C E T A B L E

	Sum of Squares	df	Mean Square	F	Signif
Regression	62722.100000	3	20907.40000	5.44	.003
Residual	142254.000000	37	3844.69000		
Total	204976.000000	40			

Table 9: MIA=f(ORGAN, COSTPR and FINBP:CTY and ACRE)

Function: MULTIREG

Data case no. 1 to 47

Variable Number	Regression Coefficient	Standard Error	Std. Partial Regr. Coeff.	Student T value	Prob
ORGAN	1.2130E+01	7.5648E+00	0.2108E+00	1.604	.11
COSTPR	6.1464E-01	4.5857E-01	0.1890E+00	1.340	.18
FINBP	1.2098E+00	4.2690E-01	0.4278E+00	2.834	.00
CTY	-1.2887E+01	2.2398E+01	-.7413E-01	-0.575	.56
ACRE	-1.1140E-02	5.1980E-02	-.3077E-01	-0.214	.83

Intercept =-230.007

Coefficient of Determination (R-Square)= 0.371
 Adjusted R-Square = 0.294
 Multiple R = 0.609
 Standard Err of Est. = 60.421

A N A L Y S I S O F V A R I A N C E T A B L E

	Sum of Squares	df	Mean Square	F	Signif
Regression	88250.900000	5	17650.20000	4.83	.001
Residual	149678.000000	41	3650.69000		
Total	237929.000000	46			

In conclusion the null hypotheses I, II and III were accepted and hypothesis IV was rejected. In analyzing hypothesis IV, it was discovered that sets of questions on the managerial test were found to be significant indicators of MIA. In particular, questions dealing with the farmer's ability to calculate and use his cost of production information, along with his ability to solve financial, or money decisions, were found to be significant predictors of management effectiveness. A qualifying demographic characteristic, organizational structure or how the farm was acquired, added to the predictive ability of the two managerial characteristics.

13.4 Revising the Instrument

The results of testing the relationship between management income per acre and the managerial test indicates that the attempt to establish a managerial index may be fruitful. However, such a test should be slanted highly towards questions on financing, money management, investment and knowing one's cost of production for individual commodities.

The production and marketing sections of the managerial test did not serve as good predictors of management income per acre. Four separate hypotheses can be given for the inability of these sections to serve as predictors. First, these farmers may be very similar in their decision-making behavior in production and marketing, therefore these areas do not account for differences in effectiveness of the

managers. Second, the questions developed for these sections may not have been adequate to find such distinctions. Third, the measure of effectiveness may be slanted away from discovering differences that may in fact occur between farmers in their decision-making behavior and performance in production and marketing. Fourth, the managerial test was slanted toward the planning phase of the manager's task, leaving the control and follow through areas untouched. Therefore, farmers may be similar in their planning decision-making in the area of production and marketing, but their abilities to carry out such decisions may differ.

Although the acceptance of any of the above hypotheses would warrant further attempts to find better measures of production, and marketing behavior/performance, there is clear evidence that financial, investment and money matter type decisions are indicators of management income per acre. It would follow that one could use the questions from this first attempt as the core for the establishment of future managerial tests. Such tests should lean heavily towards asking questions in the areas of finance, investment, money matters and cost of production, that require the manager to solve a problem or state how he has solved such a problem before. It seems that focussing on the behavioral aspects such as sources of information and decision rules used are not as effective as comparing the actual decisions made when trying to measure management decision-making. This brings

back in mind the role of simulation as a possible method of putting the decision-maker in as close to a real problematic environment as possible.

Therefore, at least two courses of action should be followed. More investment, financial and money matter problem situations should be developed for managers to solve on a managerial test. Further work should be done to develop simulated real world environments in which the decision-maker must plan a course of action that requires the ability to determine and use one's cost of production information, along with the ability to make financial and money matter decisions.

13.5 Implications for Quasi-Experiment

The above analysis indicates that a revised questionnaire should be developed which emphasizes performance on money and investment type decisions. However, since investment decisions take a longer time to measure their effects, this could pose problems with conducting a comparative study. Although, it was hoped that three to four years may have been sufficient to analyze differences in effectiveness, a long time frame such as five to seven years may be warranted because of the nature of the issues that make a difference in farm success.

Another implication focuses on the problem of testing. Problem-solving and particularly under realistic simulated conditions takes time. Although, the questionnaire used in

this analysis probably took only one hour at the most, a test involving many problems under simulated conditions could take hours. Whether one could get a sufficiently large enough set of farmers to go through with such an extensive ordeal is problematic. Therefore, it becomes a question of weighing the advantages of accuracy obtained by a more rigorous test versus participation levels necessary for statistical comparisons.

Chapter 14

Evaluation of Secondary Outputs

As stated earlier the open-ended questionnaire was used in the development phase of the managerial test to establish behavioral incidents of the farmers selected by extension personnel as being the more successful farmers in their respective counties. The method of filtering such information derived from administering the questionnaire was a simple numbers game, in that responses were categorized into similar groups and the groups which had the most responses were selected as incidents of similar behavior. However, there were many responses or even side comments by individual or only a few farmers that hold interest when one is trying to investigate the decision environment of farm managers.

14.1 Decision-Making Behavior of Successful Farmers

This section is dedicated to presenting information that was not used directly into establishing the managerial test, but hold interest in the light that it sheds on the general structure of the problems facing farm managers. The comments will be divided into four major categories: 1) time management, 2) structure of decision-making, 3) discipline and 4) institutional problems.

14.11 Time Management

The limitations that time presents is an important element within the problem environment of the farmer. In general economic theory, the object maximized is profit with biases towards profits or returns to a fixed asset other than the manager's time. The managers interviewed in the developmental stage of the managerial test point to the importance of time management with such statements as:

1. "Know how long to spend on a problem."
2. "Know which times are most critical and allow room for the unexpected."
3. "Decisions are made quickly but with a lot of thought; must have feel of situation."
4. "Gathering information takes time, not making decisions."
5. "Computers could bring problems of information overload. Good managers will know what information is important and how much time to spend on a particular decision."
6. "Use tape recorder to remember details of problems while working."
7. "Labor is most constraining factor. Maximize labor productivity!"
8. "Make preparations. Plan ahead."

These statements emphasize the need for the manager to conserve his precious time. However, a conflicting element arises between saving time and keeping control as evidenced by the following quotes:

1. "If you run your own equipment, you can use older equipment."

2. "If you do the work yourself you can spot problems more easily."
3. "It's hard to get and watch help, therefore it is better to do as much work yourself as possible."
4. "Some farmers allow their wives to keep the books, but if you do that you won't know your day-to-day financial situation."

Instead of the manager allocating jobs to others, allowing him to concentrate on decision-making, these statements suggest that to make the right decisions requires the manager to do most of the work. Therefore, there is some optimal trade off-region between doing the work yourself to keep control, and allocating jobs to others to save time. It is the farmers that have established the right combinations, that are successful.

14.12 Structure of Decision-Making

Establishing the right combinations of human resources and responsibilities requires an understanding of the decision environment facing the manager along with understanding the human element.

1. "Personality combinations are important."
2. "When making joint decisions in a partnership, try to eliminate as many subjective factors as possible. Education helps to remove emotionalism from decision-making."
3. "A lot of decisions are made for you, it's a matter of how you adjust."
4. "Profits come from higher yields and reduced costs, not expected higher prices."
5. "Invest in items that reduce the risk in farming."

6. "Could have learned about farming by working, but could learn more being a finance or management major."
7. "Changes in environment shifts emphasis from production and marketing to finance."

The implication here is that more emphasis needs to be put on dealing with the human problems associated with joint decision-making, and understanding more about finance and money along with production agriculture in our teaching and extension programs.

The importance of establishing and sticking to the right rotation is an issue expressed by most of the farmers. This brings into serious doubt the usefulness of marginality and short term profit maximizing decision models.

1. "Long-run returns over short run expectations..."
2. "Government programs limit ability to make adjustments."
3. "A field is a system, it is hard to identify isolated variables."

14.13 Discipline

Self discipline along with communicating the need for sacrifice to family members are areas pointed out by the following comments:

1. "... ability to follow through on plans. How often does one miss a schedule?"
2. "Must be able to sacrifice personal wants for long term stability."
3. "Family stress management is needed."
4. "One expands to bring in a family member, but this can cause a strain on the firm and the family."

Here the rigours of being in a business which requires participation by the whole family makes farming somewhat

different from other businesses. The farm is also the home. The development of the farm depends on the life cycle and aspirations of the family. The kind and direction of expansion can also be separate problems as evidenced by these statements:

1. "Looking at verticle instead of horizontal expansion. Try to provide more services."
2. "Do not expand to carry equipment."

The expansion problem may lead one to delve in uncharted regions such as providing a further stage in processing, or the requirements of discipline again forces one not to get attached to the idea of expansion.

14.14 Institutional Problems

Along with the limitations on crop acreage adjustments due to government programs, other institutional issues are of concern to these farmers such as:

1. "Tax policy dictates many investment decisions."
2. "Must pay taxes. Saving on taxes should not influence equipment investment."
3. "Inexperienced loan officers have caused problem in PCA's. Their bad advice may have caused over-capitalization."
4. "Loan officers are over reacting and causing land values to decrease even more, causing another whole rung of foreclosures."
5. "Loan officers are jumping to fast from equity financing to cashflow criteria."

As mentioned in an earlier chapter it was government policy which seemed to add the most to the unpredictability

of returns in the minds of many of the farmers. Here tax policies and the behavior of the banking industry are felt to influence the financial health of farms. It would seem that not only do farmers need to be educated in financial matters, but more experienced and educated loan officers need to be employed in the federal banking system. The ability of the loan officer to give advice on, and evaluate financial matters should be in line with the tremendous risks facing the farmers using the financing. In other words, to put a "greenhorn" in a position to determine the financial future of a farm with substantial assets is showing a lack of respect of the risk that such a farm manager is taking. Further, long-term implications of tax policy to the over capitalization problem in agricultural production should be investigated, along with how the requirements of income disclosure may require information in a form not compatible for decision-making.

14.2 Implications of Observed Decision-Making Behavior to Farm Management/Agricultural Economics

There are implications for farm management training and agricultural economics research that stem from this investigation on managerial behavior. The emphasis on marginality and understanding production function analysis may be premature to teaching basic concepts of cost accounting and understanding how to make lumpy investment decisions. More emphasis should be placed on understanding interper-

sonal relationships and developing communication skills instead of production agriculture. Further, emphasis should be placed on expanding the managers' concept of the world so as to plan for potential problems that begin outside of his immediate production environment. In other words, less emphasis should be placed on micro-economic theory and more on macro-economic and policy environments that affect the long term survival of the farm business.

14.3 Performance (Effectiveness) Measures Revisited

In our analysis on determining appropriate effectiveness measures, other aspects such as workability had to be considered as well as accuracy, validity, and reliability. The extensive information needed and adherence to a set definition is a hindrance to using management income per acre as a criteria. An information system designed to measure and record information necessary for the formulation of the economist's definition of income may not be one appropriate for determining taxable income. Since, many farmers may only keep necessary information for filing taxes, lack of conformity in the computing of profits could cause problems in making comparisons between farmers. This is a particularly acute problem when trying to develop a quasi-experiment in which recording necessary data for comparisons on the control groups could pose such non-comformity problems.

Another issue arises as to why the management test was

able to predict management income per acre without the use of the production or marketing questions. Maybe if another criteria besides management income per acre were chosen, then evidence of production and marketing decision-making differences that affect that effectiveness measure could be observed. In particular, one may want to investigate whether the respondents differed in yields per acre on their major crops and if these differences were associated with farm success, and if these differences could be predicted by the production section of the managerial test. One could also compare prices received on their major commodities and do a similar two stage analysis.

It may be difficult to get farmers to give us enough information to measure management income accurately and consistently across a large enough sample for statistical examination. Therefore, there may be a need to develop or choose a proxy to this measure which is more workable. However, such a proxy will have to include a measure of the assets committed or some other factor which describes the asset risk that the manager is facing. Management income per acre, by giving a charge to the use of capital and a charge for the use of operator and family labor, does allow one to compare farms not only between their respective levels of income but also on the efficient use of assets and labor committed.

However, management income per acre may not take into account the level of exposure to the risk of foreclosure due

to the level of debt carried by the farm. A suggested modification would be to discount MIA by a factor related to the debt to equity ratio. A farm with more debt is exposed to the possibility of foreclosure and should be making relatively more income than a similar farm with less leverage, if we are to compare farm managers on the basis of ensuring long term viability.

14.4 Criteria for Development and Selection of Decision Aids

There are certain implications of the above analysis which point to areas of most probable usefulness of computerized decision aids. Cost of production, lumpy investment analysis, determining how much land to rent and the appropriate price, and long term implications of a certain rotational scheme under different assumptions of the future could be prime candidates for computer aided support. Also, control of labor utilization could be a major concern when developing recordkeeping systems. Farms may not need day-to-day recordkeeping systems, but one providing maximum utilization for decision-making with minimal updating.

The computer aid must solve the trade-off problem between accuracy and ease of use to show benefits. Farmers are doers, not armchair managers. They do not want to be bogged down in paperwork, but understand the need of putting a pencil to paper on major decisions.

The computer system should be designed to aid decision-making, not replace the tax accountant. The farmer will

still have to use the accountant for IRS purposes, but the farmer needs more details on certain areas than required by the government such as monitoring his and his family's labor along with the ability to allocate costs across different enterprises. The computer system should provide the flexibility for changes according to the user's specific production system, managerial structure and aptitude. In particular, spreadsheet analysis is preferred over basic or pascal languages because of the ease of learning and the potential for the farmer to make adjustments to packaged templates and to use the spreadsheet to formulate new tools.

A specific suggestion is that a complete planning, control and evaluation system for farms be done in an integrated electronic spreadsheet format. Such a system is now being developed by the author.

PART V

CONCLUSIONS AND RECOMMENDATIONS

The Management Systems Research model developed and tested in the above analysis is an attempt to structure a research process that starts with managerial behavior as the subject and improving effectiveness as the object. The ability of this methodology to accomplish its overall objectives is the purpose of the following discussions along with determining how such a methodology can be profitably used in the future.

Chapter 15

Summary of Major Findings

As stated in the objectives the major purpose of this research was to develop and test a model which would measure the potential value of planning tools to farm decision-making. The systems approach was used to develop the Management Systems Research model as a methodology for measuring such potential. In accomplishing the primary goals other products were produced including a validated managerial effectiveness measure, common behavioral attributes of effective farm managers, use of economic tools by farm managers, information on the relationship between behavior, performance, and effectiveness, and information on the criteria for decision aid selection.

The Management Systems Research model developed included five major activities: 1. Selection of Farm System, 2. Behavioral Analysis, 3. Measuring Effectiveness, 4. Testing Behavioral Predictors of Effectiveness, and 5. Quasi-Experiment. The first step of selection of a farm system begins with categorizing farms into types. The USDA classification scheme was chosen as a first cut which consists of cash grain, field crop, vegetable and melon, fruit and tree nut, nursery and greenhouse, dairy, poultry and egg, and cattle/hog/sheep. Since the Michigan State

TelFarm program combined the cash grain and field crop categories, and this classification seemed to produce adequate homogeneity across the farms considered, field crop and cash grain were considered one category.

Once a farm system or type was selected, an open-ended questionnaire was developed and administered to a group of successful cash grain farmers as identified by extension personnel in Ingham and Tuscola counties. Information from the interviews was used to develop a managerial index questionnaire, and helped in determining the appropriate effectiveness measure for the farm manager.

The farmers selected profitability as the most important criteria for evaluating a farm manager. Therefore, management income per acre was chosen as a measure of effectiveness, and this measure was tested for workability, reliability, and validity. The reliability test consisted of testing for consistency of the measure over time in identifying the TelFarm cash grain farmers in terms of managerial groups. The results of ANOVA showed that the management grouping accounted for 36.7 percent of the variance in management income per acre over the four year period between 1981 and 1984, while grouping according to the year accounted for only 0.16 percent of the variance.

Management income per acre was checked for validity by testing the relationship between the average management income per acre for each of the farmers against locational and farm size variables. The results of multiple regression

demonstrated that the average county corn yield, location, capital invested per acre, and average acres farmed per manager were poor predictors of the average management income per acre over the four years tested.

With a validated managerial effectiveness measure and a managerial index developed, the next step was to administer the test to the TelFarm cash grain farmers and test the relationship between behavior, performance and effectiveness. The results of the analysis demonstrated that managerial effectiveness could be predicted by a subset of the managerial questions focusing on cost realization and financial decision-making. The specific financial questions included in the financial management index (FINBP) were 19, 27, 29, 30, and 31.

Question 19:

19. Assume that interest rates are 12%, and your fertilizer dealer is offering a 10% discount in December for fertilizer that you would use on corn in the spring. Would you? (Select one)

- ☒_1_a) Borrow money to take advantage of discount
- ☐___b) Wait to purchase until spring

The more successful farmers chose "a" which showed their ability to use credit wisely to take advantage of discounts. Therefore, they expressed an understanding of the present value concept in evaluating short-term purchasing decisions.

Question 27:

27. A good reason for renting more land would be: (Rank 3)

- ☒_2_a) Spread fixed costs
- ☒_1_b) Increase labor utilization
- ☐___c) The rental land is close to own land

- ___d) To test productivity before deciding to purchase
- ___e) Act as buffer while making equipment systems change

The more successful farmers chose "b" and "a" in that order. Therefore, these farmers expressed the need to maximize labor utilization and to use rental land for a flexible way to expand in order to better utilize equipment. They also showed a preference for expansion through renting instead of buying and minimized the use of rental land as a way to control a piece of property for future purchasing. The decision rule then filters down to using rental land as a flexible way of expanding to better utilize intermediate assets and labor.

Question 29:

29. If at the end of tax year you had \$20,000 more taxable income than expected, would you? (Choose one)

- ___a) Purchase machinery or equipment to get tax credit
- _2_b) Pay taxes on the income and put the rest on the mortgage
- ___c) Invest in more land
- ___d) Spend more on consumption
- _1_e) Buy more inputs for next year to reduce this year's taxes

The more successful farmers chose "e" - to buy more inputs for next year, and "b" - put the rest on the mortgage. These farmers would not allow the desire to reduce taxes to force them into increasing their long term debt load. In fact, the more successful farmers would use such unexpected profits to reduce their debt and increase only short-term assets. Therefore, the decision rule seems to be not to make long-term investment decisions based on the desire to reduce short-term taxable income.

Question 30:

30. Indicate how many years you would finance the following items: (If less than one year indicate with a fraction)

	Years
a) Production Equipment	___3.5___
b) Land	___22___
c) Production inputs used up in one year	___0.5___
d) Machinery shed	___5___
e) Personal car	___0.5___

The conservative use of credit by the more successful farmers is expressed through the short length of time they would be willing to finance long-term assets. This conservative nature conflicts with the economic or financial management suggested policy of matching long-term financing to long-term assets. The unwillingness of the more successful farmers to use such a principle reflects their understanding of another finance principle of matching risk with returns. These farmers understand the variable nature of the returns to agriculture, and are not willing to over-extend themselves facing such variability. The benefits of financial leverage are discounted by the more successful farmers with their knowledge of the riskiness of that leverage. Investment discipline as a managerial quality is highlighted by their response to this question. As a decision rule, these farmers seem to be saying to finance a long-term asset for a considerably shorter length than the expected life of that asset.

Question 31:

31. Assume you have the option of renting land from someone on fixed cash rent or shares. Choose the alternative you would prefer under the following conditions. (Indicate "F"

for fixed cash rent and "S" for shares.)

- _S__ Prices are volatile
- _F__ Prices are stable and high
- _S__ Prices are stable but low
- _S__ The land is not well drained
- _S__ The land does not have a ASCS corn basis
- _S__ Don't know productivity of land

The more successful farmers chose fixed rental arrangements only with a high degree of confidence in expected favorable returns. Therefore as a decision rule, the lack of knowledge of the productivity of the rental land and/or volatility in prices is a cue to seek crop sharing type of arrangements which would allow them to share that risk with the landlord.

The farm organizational and historical development variables also played significant roles in predicting MIA. In particular, the farms that were purchased instead of inherited and the incorporated or jointly owned seemed to have higher management incomes per acre. This could have some serious implications toward the viability of sole proprietor farms in comparison to their more organized counterparts. It may be that the inclusion of other people into the decision-making process increases the managerial resource pool which in turn increases the viability of the farm. It also seems that the farm managers that purchased their farms instead of inheriting them do a better job at managing

Now that it seems possible to make apriori predictions of managerial success using an index, the stage is set for using such an index for measuring the possible benefits of

improved decision aids. The remaining test is to compare the measure obtained from the management index against observed differences between a set of farmers over time: one set using the computerized system and the other without such aids. One such quasi-experiment is set to be conducted in North Carolina with the farmers involved in the North Carolina A&T Farmer Opportunities Program.

Chapter 16

Evaluation

The objective of the process started in this study is to evaluate the role of planning tools in farm decision-making. The present study presents the conceptual framework and carries through such a methodology up to the quasi-experimental phase of implementation. The total process can be considered to have three phases: 1. Conceptual framework, 2. Implementation, and 3. Evaluation of the two methods for measuring value of information.

16.1 Conceptual Framework Evaluation

The conceptual framework for Management Systems Research consisted of five parts: 1) Selection of Farm System, 2) Behavioral Analysis, 3) Measuring Effectiveness, 4) Testing Behavioral Predictors of Effectiveness and 5) Quasi-Experiment. At the end of the quasi-experiment the measure of the value of information or decision aids is compared using the "classroom" or index measure against the "field" or experimental method.

The systems framework seemed to work well in structuring the problem and controlling the flow of events. Therefore, in general, the general systems framework seems to work as a methodology to develop and control this type of

model development. The Management Systems Research model developed consisted of five parts of which the last four are separate research topics in themselves. The present study attempted to test the first four parts of the model while laying the groundwork for the last - Quasi-Experiment.

In this iteration of the model the selection of the farming system was helped by the pre-existence of a set of farms with available historical effectiveness measures. The selection of future farms for such an analysis must weigh the problem of accessibility of information to the loss of randomness and the ability to extrapolate findings to a wider universe that such data requirements produce.

No distinctions were made between large and small farms. In the case of cash grain farms in Michigan this may not cause a problem in the homogeneity of the decision environment. However, in other areas and with a different set of major commodities the question of size or scale may pose homogeneity problems.

The behavioral analysis section can prove to be the most informative in producing subject matter information on how the more successful farmers make decisions. However, this portion of the model presents a different set of problems for future replications. The development of the open-ended questionnaire requires background information on the nature of the important decisions made by that farm type. Such background information on what are the major decisions may not be readily available. In the present implementation

the results of a previous thesis were available that provided the needed information. Therefore, the time involved in establishing the open-ended questionnaire may have to be expanded on future replications.

Although, only one measure was tested for validity and reliability in the measuring effectiveness section of the model, other measures could be evaluated. Since the workability of different measures may vary across farm types, it is advisable to test more than one in case there is need for a proxy to take the place of the more preferred measure.

Validity and reliability were tested statistically using linear multiple regression analysis and analysis of variance. However, other methods not presented here could be tested against the present ones chosen for answering the questions of the appropriateness and objectivity of an effectiveness measure.

Testing the behavioral predictors of effectiveness is by far the most frustrating portion of the analysis since the possible combinations of questions can be substantial. A more efficient form of factor analysis could be employed to simplify such a task. However, doing the factor development by hand does have some merit due to the ill-defined boundaries between what is a production, marketing and financial question along with the fine distinction between behavior and performance. Going over the data more closely allows one to get a feel for the decision environment and the nuances of that environment facing the

farm manager.

Since the quasi-experimental part of the model was only developed and not yet tested, it is difficult to evaluate it based on the experience of the present study. However, some possible problems with implementation are discussed in the following section.

16.2 Implementation Evaluation

It was thought that the testing of the model on cash grain farmers in Michigan would act as a model for replication of the total methodology in North Carolina. However, the results derived from testing the management index against the effectiveness measure indicated that much of the first steps in the process need not be duplicated for North Carolina. In particular, administering the open-ended questionnaire was done to develop an appropriate test for that type of farm operation. The production and marketing problems facing farmers may be more varied across locations and farming systems than are financial type problems. However, since only the financial managerial type questions showed any relationship to success, and these questions are general enough to apply across a wide diversity of farm types and locations, it is felt that the managerial index developed in this research can act as the nucleus for one to be used in North Carolina.

Therefore, instead of repeating Selection of Farm System, Behavioral Analysis, Measuring Effectiveness, and

Testing Behavioral Predictors of Effectiveness, one can start with the managerial index and proceed to the Quasi-Experiment. Of course, the more appropriate way would be to replicate these first steps and see how the index developed from the replication compares with the present version. However, this would take another full year if the necessary information was available. This is not the case in North Carolina. North Carolina does not have enough field crop or cash grain farmers that have participated in a mail-in recordkeeping system for a long enough period to carry out the complete analysis.

Not only is the implementation of the complete model a problem in North Carolina, but the question of workability arises in other states since there are a limited number of states that have programs such as Michigan's TelFarm program. Another procedure could be to ask the farmers for financial information on the same managerial test sent to them. To determine management income per acre requires information from both the balance sheet and income statement, along with estimates of family and operator labor actually used on the farm during the analysis period. However, experience has shown that farmers are either reluctant to divulge such information in mailed survey or do not have such information readily available.

The question of workability of the methodology also is important for implementation of the quasi-experiment even in North Carolina where at least a possible set of participants

may already be identified. A quasi-experiment is time consuming. One would need at least three to four years of continuous observation to be able to draw any real conclusions. This of course takes money on the part of the research institution and cooperation between research, extension personnel and the farmers themselves. Due to the financial crisis and high degree of attrition among farmers, one can expect a significant number of the participants to drop out before the end of the experimental period making problems of comparability between experimental and control groups and statistical significance of the results very important.

Finding and keeping willing participants is made more difficult because of the time involved in learning new managerial techniques and keeping good records. The decision aids chosen must require the minimal amount of time and effort for use until their benefits can be proven to participants. Although it was hoped that one could administer the managerial questionnaire a total of three times to the experimental group, this may not be practical since this may overburden the participants with tests. Also, it should take at least one year before the user of the decision aid is both comfortable with using it and appreciative of its value. Therefore, the managerial test should probably be administered only twice to each group: once at the initiation of the experiment and at the end.

Fortunately, the majority of the North Carolina farmers

in the Farm Opportunities program are field crop farms and some with a few cattle or swine. Although, the replication of the total methodology may not be necessary for carrying out the quasi-experiment and subsequent determination of the potential value of information for these type farms, the procedures would need to be completely replicated for more specialized farms such as dairy, feedlot, horticultural crops, and orchards. In these systems production and marketing could be either more essential for success and/or more diverse within the categories.

The model can be evaluated between its potential payoff and its recognized costs. The model was able to identify incidences of behavioral incidents and develop an instrument that showed promise in predicting managerial effectiveness. The purpose of such a test was to eliminate the necessity in measuring the value of a decision aid by using a quasi-experiment. Hopefully, the results of the quasi-experiment justify the substitution of such an expensive and time-consuming method with such a managerial test.

From beginning to end the methodology tested here on Michigan cash grain farmers took one year to implement. However, since the results of testing the relationship between effectiveness and managerial index indicated that specific production and marketing decisions, which would limit applicability of the results to cash grain farmers, did not play a major role with this set of farmers in predicting effectiveness, a more generalized grouping of

farms across production-defined boundaries could limit the need for the number of replications. It would seem that many of the financial and money management type questions could be applicable to a wide variety of farm types. And such questions that deal with cost of production could be set up differently for each farm type. In other words, instead of asking a feedlot operator to figure the cost of production for corn, a similar question could be posed on cost of weight gain per animal.

In fulfilling the model's primary objective in setting up the structure for determining the value of computerized farm management aids, the secondary outputs may prove to be more important for long range planning for research, extension and teaching. The subject matter information developed from such a methodology presents a current picture of the managerial environment and means of coping with such environment by farm managers. The understanding of the decision-making behavior of farmers can point to whether the major problems facing them are of a production, marketing, financial or some other as yet unclassified nature.

Chapter 17

Recommmendations

This research has produced information that may have significant bearings on how the Land Grant system conducts extension, research and teaching especially in the management or economic areas. In general the focus of our efforts should be on profitability rather than increasing output. The farmers analyzed in this research seemed to be somewhat homogeneous in the production and marketing decision-making. Their effectiveness could only be predicted by their measured ability to answer financial management and cost of production type questions. However, since all of these farmers were on a particular record-keeping system, one might suspect that this group was biased toward the more sophisticated set of farmers. In other words, a more random group of farmers may show more variance in their production and marketing decision-making. On the other hand, since these farmers were on a recordkeeping system one could argue that the sample was biased in a direction that would minimize the difference in financial decision-making or any other type of decision-making that required financial data.

Therefore, although we can not be sure that this group is representative of all cash grain operators, the evidence

points to certain adjustments in the emphasis placed by the Land Grant system on production agriculture. Replication of this methodology over a broader area or in different parts of the country should add to the reliability and applicability of the findings and suggestions to a wider audience.

17.1 Extension

The findings of this research point to the extension service providing more training to farmers on financial decision-making. Particularly, emphasis needs to be placed on investment analysis, credit policy, organizational structure, and determining cost of production. This would probably mean an increase in the number of trained extension personnel in these areas.

The question remains as to the level of involvement of extension personnel in the role of consulting. The accepted role of extension has been to educate, not advise, particularly when it comes to financial matters. Extension can walk that thin line between education and consulting by providing the tools and helping in their application without giving specific advice. In making decisions, the successful farmers exhibit similar rules of thumb or decision rules which extension personnel could suggest as useful tools for managers with similar problems. The computer could be a useful tool in storing such decision rules, i.e. expert systems, and applying such rules through appropriate software. This is not to suggest that extension should not

continue to be involved in educating farmers on new production technology, but such education should include how to measure the profitability of such technology.

17.2 Research

Research on decision-making behavior takes time, money and "people skills". Although micro-economics deals with relationships between firms, it does not go into the depths necessary for predicting individual behavior. Therefore, the tools developed using the micro-economic approach should not be oversold to the individual decision-maker until they have been evaluated for workability and usefulness. A major component of workability for these tools is the availability of relevant and reliable internal data from the firm. More behavioral research should be undertaken to understand why many farm managers do not keep adequate records.

When the emphasis is on increasing output on a national basis, the knowledge of individual decision-making may be minimized. However, if emphasis is placed on making agriculture more profitable, then research on behavior and individual response to macro level policy and environment is warranted as well.

In the past not much research has been done on the level of adoption of management tools, nor on the realized benefits of such tools. The present study points out that studying the managerial tools as a technology towards

increasing profitability is needed and can be handled within a manageable framework. Further, along with more research on the managerial tools themselves, it would seem that the Land Grant institutions should do more research on the implications of their production-oriented research toward profitability. For instance, economic analysis of the field trial results of a new production technology should be implemented and presented along with the physical results of such trials. If that is not practical, then at least information and analysis tools should be presented that would allow the farmer to make such evaluation.

There are some other specific topics for research which this present study suggests. Along with the replication of the testing of behavior and performance against effectiveness in other states, other questions arise within the scope of the present data set. For instance, although the production and marketing sections did not predict managerial effectiveness as measured by management income per acre, it would be interesting to know if this portion of the index could predict some other effectiveness measure. In particular, the production questions may predict yields per acre of corn on the individual farms, and the marketing questions may predict variances in the price of corn received. A corollary of this question is the issue of the association of yield per acre and price received per bushel with management income per acre. These further analyses could help determine both the reliability of the total index

and help in understanding the importance of production efficiency and marketing as related to financial success.

The present research has pointed out the general conservative nature of successful farmers towards credit. Agriculture in the past has exhibited both low returns to assets and high levels of variability in returns. More research is needed in the area of understanding the relationship between risk and returns in agricultural production in order to develop tools that would give farmers assistance in analyzing the riskiness of potential investments.

17.3 Teaching

The general findings of this research along with some specific statements by some of the farmers interviewed indicate that farmers are realizing the importance of a business oriented education instead of one emphasizing how to maximize production. In particular, if the schools of agriculture do not provide financial management training as a part of their programs, it is likely that farmers, serious about farming as a money-making business, may gravitate to the business schools.

Although micro-economics is a useful tool in evaluating sector response, more courses on individual decision-making behavior must be made available to help the real world manager. Even within micro-economics, the tools and theories should be given substance by relating them to problems faced by the decision-maker and not just the

curiosity of the academician. Of course, the level of relevant teaching and research will depend on the career incentives faced by the economic and management professionals.

The economic tools which should be stressed more include investment models - such as the present value concept, money and banking, optimization models - such as linear programming, opportunity cost, cost/benefit analysis and decision theory within a value of information framework. Linear programming and the concept of opportunity cost are most helpful for major transitional type questions such as adding a new enterprise, expansion and determining the level of off-farm employment to pursue.

With the present distress in agriculture and the chronic low returns to assets facing the farm manager, the importance of financial management training cannot be over-emphasized since it seems that success is not just a function of productivity but also the ability to control assets. The possibility of high productivity with low financial returns is a fact of life in agriculture and a threat to the survival of the individual farm firm. Therefore, a well rounded program for the farm manager should include cost accounting, recordkeeping, and simple systems analysis.

17.4 Farm Policy

One of the findings of the present study indicates that the farm managers who purchased their farms instead of inheriting them do a better job at managing. This could have policy implications to how the present financial crisis in agriculture is handled. It may be an economically beneficial strategy for the government to buy the mis-managed farms and sell them to other farmers or the same farmers once they have completed training in financial management and can pass some type of managerial test. Success in agricultural production may now be a factor of knowlege - managerial and scientific, and less a function of hard physical work. The new manager must be sound in his "scientific" ability to manage as well as skillful in the "art" of management.

The "art" of management as it relates to farming may be difficult to teach in a classroom setting. This type of human capital may best be developed through the experience of working on the farm. However, financial managerial ability may be augmented through an intensive classroom type program centered around computerized decision aids. The value of such training and tools will be the output of the intended quasi-experiment.

17.5 Recommendation for Model Application

Along with the use of the Management Systems Research model for its primary intended use, i.e. establishing a

measurment system to determine the value of improved planning tools or decision aids, the model serves an added purpose in focusing attention on the problem areas facing managers and the areas where extension, research and teaching should focus efforts. Since the environment of the farmer changes, such a methodology used on a recurring basis could help pinpoint future problem areas. For instance, some conditions may warrant emphasis on production agriculture, while other conditions such as the present financial crisis warrant emphasis on cost reductions and wise investment decisions. Such an iterative methodology can serve as a barometer of these changes.

Another issue that is highlighted by this form of analysis is that farm management advisors and teachers can learn from the successful farmers what is needed by the less successful farmers to improve the effectiveness of this set of farmers. It may be more realistic to bring the less successful farmers to the level of their more successful peers than it would be to transform these farmers into the "economic man" or any other type of ideal manager posited by our given professions as the ideal. There must be a compromise between bringing the manager up to the level of using our sophisticated economic tools and developing managerial tools that are both useful and useable. The model or methodology presented in this study could prove useful in developing and refining such tools. The model at present was able to produce a few general non-quantified

decision rules, but a more detailed iteration of the model could be used to help develop expert systems for farm management.

17.6 Preliminary Assessment of The Role of Microcomputers in Farm Decision-Making

The final output of the implementation of the total measurement system or model is to measure the potential value of computers to farm managers. Although the present analysis was only the first step in the total process, information obtained does reflect on the overall issue of the role of computers in farm decision-making.

Computers are efficient at manipulating, storing and presenting numerical data. Many aspects of production require experience and a tactile awareness of the physical production environment for efficient manipulation of the controllable inputs. Marketing requires a system and discipline with a major part of that system being a knowledge of one's cost of production. Financial management requires a firm knowledge of the dollar and cents aspects of the farm system. From the present analysis it was discovered that the factors that could predict effectiveness were those which required a firm grasp of the numbers - dollars and cents - of the farm system. Therefore, computers could play a major role in helping the farm manager with the very areas that may determine the farm's economic survival, i.e. keeping up with the cost of production and the financial aspects of the

firm. Although the quantified benefits of computers has not yet been established, it is in the areas of financial management and enterprise cost control that one can expect to find the greatest monetary payoffs for the role of micro-computers in farm decision-making for cash grain or field crop farms.

The fact that all the farmers used in the present analysis were on a monthly mail-in recordkeeping system - TelFarm - presents other implications. Having good records is not enough to ensure sound management. The ability to use such information and develop the "right" prescriptions is essential. Therefore, future computer applications should not be confined to recordkeeping but should include planning and monitoring. This would mean the development of planning tools such as simulation that allows for the flexibility in use accompanied by training in financial analysis, cost control and organizational planning.

APPENDICES

APPENDIX A : OUTPUT OF OPEN-ENDED QUESTIONNAIRE

Table I
Keys to Success
N=17

Categories	Dimensions	Mentions
1. Financial management:	9	19
	A. Managing money	6
	B. Know and control costs	4
	C. Good source of financing	3
	D. Profitability	1
	E. Deal with one lender	1
	F. Cash flow	1
	G. Don't buy high priced land	1
	H. Only own land that can be brought up to standards	1
	J. No debt load	1
2. Production:	7	10
	A. Stewardship of land	2
	B. Keep up with new technology	2
	C. Blend of labor, capital and crops	2
	D. Solid production practices	1
	E. Adequate machinery	1
	F. Necessary functional buildings	1
	G. Adequate size of operations	1
3. Timeliness:	4	9
	A. Do it when necessary	6
	B. Good health	1
	C. Be able to work	1
	D. Plan ahead	1
4. Decision Making:	7	9
	A. React to higher interest rates & lower prices	2
	B. Flexibility	2
	C. Be able to handle unpredictability	1
	D. Set up plan and track expenses	1
	E. Analyze what was done	1
	F. Do things yourself to know problem areas	1
	G. Pin point problems	1
5. Attitude:	6	8
	A. Managing people	2
	B. Have to enjoy it	2
	C. Attitude	1
	D. Sort needs out from wants	1
	E. Willing to do office work	1
	F. Ambitious	1

6. Communications:	4	7
A. Keep contact with outside		3
B. Promotions of farming		2
C. Involvement in organizations		1
D. Listen to consumers		1
6. Good Marketing:	1	4
7. General:	4	4
A. Be good in prod., mktg. and finance		1
B. Off-farm income		1
C. Asset valuation		1
D. Participation in government programs		1

Table II
Criteria For Measuring Management
N=17

Type	Category	Dimension	Mentions
A. Objective: 6			19
	1. Profitability	1	5
	2. Production costs	1	3
	3. Assets and liabilities	1	3
	4. Yields	1	3
	5. Fin. returns on assets	1	3
	6. Time	2	2
	a. How got started		1
	b. Comparison over years		1
B. Subjective: 4			27
	1. Appearance	5	11
	a. Physical view of crops		4
	b. Appearance of farmstead		3
	c. Machinery appearance		2
	d. Tile lines and drainage ditch appearance		1
	e. Errosion		1
	2. Production	4	9
	a. Timing		4
	b. Production Practices		3
	c. Time efficiency		1
	d. Machinery use efficiency		1
	3. Financing	3	5
	a. Lines of credit		2
	b. Pays bills on time		2
	c. Have handle on finances		1
	4. Community status	1	2
C. Behavior: 2			19
	1. Managerial ability	5	12
	a. Extensive & good records		4
	b. Marketing ability		3
	c. Knowing financial status		2
	d. Planning ability		2
	e. Preventive measures		1
	2. Attitude	5	7
	a. Dedication		2
	b. Accurate and honest		2
	c. Willingness to change		1
	d. Ability to listen		1
	e. Good attitude		1

Table III
Like and Dislike About Farming
N=17

Like	Mentions	Dislike	Mentions
1. Own boss	15	Unpredictable long hrs.	4
2. Feeling of accomplishment	10	Returns not commensurate with risk	4
3. Being outdoors	6	Uncertainty	3
4. Closeness with family	4	Market risks	3
5. Trying new technology	2	Need too much money to operate bus.	2
6. Flexibility of jobs	2	Financial pressures	2
7. Honest work	1	Lack of security	2
8. Feels knowledgeable in this	1	Tied to physical process	1
9. Like people in agr.	1	Government control	1
10. Close to basic elements	1	Reduced no. of suppliers	1
11. Habit	1	Cold weather	1
12. Attachment to land	1	Mental stress	1

Table IV
Information Processing
N=17

How often done	Farm Computer	Processing Method Computer Service	Hand Records	Total
Yearly	6	6	5	17
Quarterly	0	3	1	4
Monthly	5	1	1	6

Table V
Good Yields in Corn
N=14

Factors	Mentions
Fertilization	12
Variety	9
Timing of Planting	7
Improved Soil Productivity	6
Pest Control	5
Tiling/drainage	3
Other	6

Table VI
Time for Harvesting and Planting
N=15

Factors	Mentions
Adequate and Reliable Equipment	10
Preseason Preparations	9
Diversity of crops & maturity dates	8
Run until done	6
Experience	5
Two way communications	5
Make sure you have 1 month to do 15 days work	3
Switch between crops while planting depending on weather	3
Reduce slack only if planning to change equipment capacity	3
Other	9

Table VII
Land Investment Strategy
N=8

Item	Mentions
Stand alone returns vs. price for land	4
Only when available	3
Forced to bring others in	3
Size of equipment	2
Ground must be real cheap	2
Disinvest in high valued property	2
Low down payment, low risk	2
Security in ownership	2
Other	9

Table VIII
Credit Policy
N=7

Item	Mentions
Use only one lender	4
Use accelerated payments plan	2
Don't borrow money for inputs	2
Borrow to maintain cash flow, operating capital	2
Other	12

Table IX
Crop Marketing Philosophy

Factors	Mentions
Cost Plus	7
Corn/wheat in government program	4
Staggered Sells	3
Other	22

Table X
Proportion of Crops to Produce
N=16

Item	Mentions
Rotation to control pests, conservation, and for overall soil productivity	12
Government programs	11
Returns per dollar	9
Control ground for sugar beets	5
Spreading work load	5
Spreading price and weather risks	5
Equipment	2
Soil types and productivity	2
Other	5

Table XI
Substantially Changing Crop Mix
N=12

Item	Mentions
Extremely high contract offer	9
Good government program incentives	6
Spread labor and equipment - time allocation	4
To help an erosion or weed problem	3
Riskiness of crop	3
Cost of production	2
Other	5

Table XII
Determining Corn Variety
N=14

Item	Mentions
Use different varieties to stagger maturing dates	9
Use MSU yield trials	8
On-farm test plot results	5
Own experience	4
Take advice from dealer	4
Use 3 year comparisons	2
Phase in new variety over 3 years	2
Fertility requirements of each variety	2
Spread risk	2
Experience with chemical & prod. practices	2
Other	3

 Table XIII
 When to Purchase Inputs
 N=11

Item	Mentions
Taxes	10
Cash discounts	10
Buy early to get lower prices and insure availability	6
Interest rates	6
Cash flow effects	4
Trends in prices	4
Have well ahead of needs	4
Volume discounts	3
Adequacy of on-farm storage	2
Other	5

Table XIV
 When to Sell Corn
 N=10

Item	Mentions
Cost of production	10
Trigger selling	5
Price must pay storage and interest or let government have it	4
Sell to keep good line of credit	3
Scheduled or spread out sells	3
Don't guess the market	2
Other	8

Table XVI
On-Farm Storage
N=11

Item	Mentions
Ease harvesting bottleneck	9
Keep on farm waiting for elevator shortage	4
Allows choice between government and market	4
Cheaper to store on farm	4
Prices lowest at havest	2
Always store at elevator	2
Other	2

Table XVII
Price of Corn
N=6

Item	Mentions
Government loan program sets price	5
Useless to guess price	3
Other	4

Table XVIII
Participation in Government Programs
N=10

Item	Mentions
Always in corn program, if not then plant something else	8
Anticipated income in vs. out of program	5
Put set aside on low yielding land	2
Own basis - past participation	2
Other	5

Table XIX
Buying Land
N=13

Item	Mentions
Cost per month vs. expected returns	11
Quality of land	3
Compare monthly cost to total land cost/acre	2
Interest rates	2
Transportation - proximity	2
Terms	2
Other	5

Table XX
Pay for Rental Land
N=17

Item	Mentions
Rental terms - fixed price vs share, risk, management and landlord requirments	5
Lease first to test productivity before buy	4
Longer lease to build of productivity	4
Quality of land	3
People seek me out	3
Expected yields	3
Expected prices	3
Cost	3
Past ownership practices	2
Proximity	2
Spread fixed costs	2
Other	10

Table XXI
Equipment Replacement
N=17

Item	Mentions
Productivity evaluation	12
Ability to afford	10
Dependability - esp. at prime time	7
Repair bills	5
Buy used equipment only	4
Constantly not getting job done on time	4
Backup equipment for spare parts	3
Run until it dies	3
Purchase for expected growth in acreage	3
Take good care	3
Size for job	3
Keep older equipment only if you have the ability to repair them yourself	3
Must have better equipment when using hired labor	2
Retire equipment before loosing all resale value	2
New technologies force acquire new equipment	2
Depreciation used up	2
Compatability between equipment and land	2
Other	12

Table XXI
Information Processing

Decision	Extensive Calculations	Extensive Historical Records
Prop. of crops	6	8
Add crop	8	1
Corn variety	3	6
Purcase inputs	8	4
Sell corn	14	0
Storage	0	0
Price of corn	0	0
Govern. programs	7	5
Land investment	11	0
Pay for rental land	7	1
Replace equipment	6	8

Table XXIII
Constraints on Making Decisions

Decision	Constraints				
	Internal Data	External Data	Government Policy	Time	Wheather
Prop. crops	2	5	8	4	2
Add crop	4	7	3	4	-
Corn variety	1	2	1	1	-
Input purchase	2	4	3	-	2
Sell corn	-	3	2	-	-

APPENDIX B: OPEN-ENDED QUESTIONNAIRE

I. Description of Farm and organization

1. Type and size of enterprise, # people involved in D-M.
2. How long have you been farming?
3. How did you get started in farming?
4. Do you have off-farm employment? How many hours/week?

A. General Philosophy

5. What do you consider the major keys to successful farming?
6. What do you like and dislike about farming?
7. What criteria would you use to evaluate whether a farm manager is successful or not?

II. Management Information System

8. Reports; type, purpose, schedules
9. Processing: equipment, responsibilities

III. Decision Making

A. Production - 10. What is your major crop?

i. General

11. What do you consider the keys to getting good yields in corn/ wheat/ soybeans?
12. How do you ensure that you will have enough time to get your planting and harvesting done ?

ii. Specific Problems or decisions

13. Determining proportion of crops to produce.
14. Determining whether to substantially increase or decrease the acreage of your major crop?
15. Determining corn variety.
16. Determining when to purchase inputs.

B. Marketing - Crops

i. General

17. What is your general philosophy about crop marketing?
18. Would you consider either production or marketing as more or less important for the overall success of the farm business?
19. What marketing alternatives do you feel most confident with, i.e. forward contracting, cash, hedging etc.? End

ii. Specific Decisions

20. Determining when to sell your corn/soybeans.
21. Determining the adequacy of on-farm storage capacity?
22. Estimating the price you expect to receive for corn?
23. Determining whether to participate in the relevant government corn program?

C. Financing and Capital Investment

i. General

- 24. What is your general investment strategy for land?
- 25. What is your general credit policy?

2. Specific Problems

- 26. Determining whether to expand or reduce overall operations?
- 27. If you have decided to expand how do you decide on either rental or purchase of land?
- 28. Determining how much to pay for rental land.
- 29. Determining the need to replace equipment.
- 30. Determining whether to do self repair on equipment and buildings vs paying outsiders.

IV. Specific information or questions for each specific problem

1. Planning - Identification, observation, analysis, decision.

- A. What factors would a "good" decision maker in deference to a "poor" decision maker consider in making this decision?
- B. What calculations would be appropriate for solving this problem?
- C. Do you spend a lot of time collecting and analysing information for this decision? C1. How much?
- D. How constraining are the following factors on making a good decision:

- | | Small | | | Large | |
|---|-------|---|---|-------|---|
| | 1 | 2 | 3 | 4 | 5 |
| 1. Knowledge of how to make decision | | | | | |
| 2. Internal data from farm | | | | | |
| 3. External data (prices, quality etc.) | | | | | |
| 4. Government (policy, taxes etc.) | | | | | |
| 5. Data Processing capabilities | | | | | |
| 6. Time to make decision | | | | | |
| 7. Uncertainty from results of prior Dec. | | | | | |
| 8. Uncertainty from outside sources | | | | | |
| 9. Other - specify | | | | | |

- E. What are your major sources for external data?
- F. How would you or what would you need to help you improve the way you make this decision?

2. Monitoring-Control: implementation, observation, problem id., analysis, decision

- G. What signals do you look for that might require substantial alterations of your plans?
- H. How do you monitor or keep up with these signals?

3. Evaluation-Learning:

- I. What criteria do you use to evaluate whether this was a good or bad decision? How often do you evaluate?

APPENDIX C: DECISION-MAKING ANALYSIS QUESTIONNAIRE

I. Background Information

1. Name_____
2. How many hours per week do you work off the farm?_____
3. Do you have two-way communication equipment to communicate between the house and field?_____
4. Number of different farms under your control:_____
5. Distance to furthest farm_____
6. Type of organization (circle): a) sole proprietorship,
b) partnership with brother(s), c) partnership with children,
d) corporation, e) other (specify)_____.
7. Are you planning to expand your operations to bring a family member into the farm business within the next 5 years?_____
8. How many farm organizations are you a member of?_____
9. How many community organizations do you participate in?_____
10. How did you acquire the majority of your owned land? (Check one)
___a) Inherited
___b) Bought from family member(s)
___c) Bought from non-relatives
___d) Other (specify)_____
11. How many years have you been farming independently?_____

II. Production Decisions

(Note: Many of the questions in this and following sections will ask you to rank the alternatives given. Please rank the top three most appropriate by numbering them 1, 2 or 3.)

12. If you had to grow corn in another part of the state what would be your primary source of information on the best varieties of corn to plant? (Rank 3)
___a) Seed dealers
___b) Farmers near your new farm
___c) Extension
___d) Past experience on old farm
___f) Local elevators
___g) Farm journals
13. How many varieties would you plant?_____

14. If you found that you were consistently falling behind on getting your planting done on time, what would be the first thing you would try to eliminate the problem? (Select one)

- ___ a) Start planting earlier
- ___ b) Get larger equipment
- ___ c) reduce acreage
- ___ d) diversify crops and/or varieties grown
- ___ e) Hire more help
- ___ f) Put in more hours

15. In which crop is downtime the least expensive during harvest? (Rank 3 least)

- ___ a) soybeans ___ b) wheat ___ c) corn ___ d) navy beans
- ___ e) sugar beets ___ f) barley ___ g) seed corn

16. Assuming that other crop prices remain the same, how high would corn prices have to be projected for the coming year before you would double your acreage of corn?

Give high price ____.

17. How low would corn prices have to be projected as falling in the next year to get you to cut your acreage in half?

Give low price ____.

18. If you were interested in adding a crop to your present crop mix, what factors would most influence that decision? (Rank 3)

- ___ a) Projected average price for next 5 years
- ___ b) Equipment requirements
- ___ c) Production practices and costs
- ___ d) Compatibility with present rotation
- ___ e) Labor requirements
- ___ f) Lowest price over last 5 years
- ___ g) Government programs

19. Assume that interest rates are 12%, and your fertilizer dealer offering a 10% discount in December for fertilizer that you would use on corn in the spring. Would you? (Select one)

- ___ a) Borrow money to take advantage of discount
- ___ b) Wait to purchase until spring

20. Soil tests calls for 100 lbs of nitrogen on corn for your type of soil and variety of corn. Would you? (Choose one)

- ___ a) Use a bit more
- ___ b) Use as recommended
- ___ c) Use a bit less

21. Do you know your cost of production for each of your major crop? ____

22. If yes, what was your cost of producing for corn in 1985?

Cash Expenses: per acre		Fixed expenses or overhead: Per acre	
Labor (Hired)	-----	Land Rental Charge	----
Labor (Own & family)	-----	Depreciation	----
Repairs	-----	Interest on debt	----
Seed	-----	Insurance	----
Fertilizer and lime	-----	Taxes	----
Pesticides	-----	Utilities	----
Drying costs	-----	Other	----
Fuel	-----		
Other	-----		
Total-----	-----	Total	----
Total cash and overhead			----
Yeild per acre			----
Cost per bushel			----

III. Marketing

23. What are your reasons for entering the government loan program? (Rank 3)

- ___a) Sets price floor
- ___b) Cheap source of operating capital
- ___c) Is an assured market
- ___d) Can utilize marginal land as set aside
- ___e) Never entered

24. If the government got out of the corn market, the best strategy for selling corn would be: (Rank 3)

- ___a) Use market information to pick highest price
- ___b) See what neighbors are doing
- ___c) Sell at harvest
- ___d) Sell some corn every month
- ___e) Set trigger above cost of production and began to sell when price reaches that point
- ___f) Sell when market is going up
- ___g) Sell just after market starts going down
- ___h) Store on farm until elevators offer premium
- ___i) Sell as cash is needed to pay bills

25. The advantage of on-farm storage is: (Rank 3)

- ___a) Can participate in government loan program
- ___b) Saves time during harvest
- ___c) Can get better price by holding
- ___d) Can store cheaper than at elevator
- ___e) Utilizes labor in off season

IV. Investment and Money Management

26. How often do you prepare a projected cash flow? (Select one)

- ___a) Yearly
- ___b) Monthly
- ___c) Quarterly
- ___d) None

27. A good reason for renting more land would be: (Rank 3)

- ___a) Spread fixed costs
- ___b) Increase labor utilization
- ___c) The rental land is close to own land
- ___d) To test productivity before deciding to purchase
- ___e) Act as buffer while making equipment systems change

28. In deciding to purchase a piece of land up for sale which of these statements best describes how you would go about making the decision? (Select one)

- ___a) I have been renting it for a while and if I don't buy it someone else will and get the benefits.
- ___b) I would compare the expected net returns over the life of the mortgage compared to monthly payments and purchase only if it pays for itself.
- ___c) I would determine if the equity base in my present operation could subsidize the purchase of the land.
- ___d) If the expected net returns per acre are greater than my average cost of land, I would purchase.

29. If at the end of tax year you had \$20,000 more taxable income than expected, would you? (Choose one)

- ___a) Purchase machinery or equipment to get tax credit
- ___b) Pay taxes on the income and put the rest on the mortgage
- ___c) Invest in more land
- ___d) Spend more on consumption
- ___e) Buy more inputs for next year to reduce this year's taxes

30. Indicate how many years you would finance the following items: (If less than one year indicate with a fraction)

- | | Years |
|---|-------|
| a) Production Equipment | ----- |
| b) Land | ----- |
| c) Production inputs
used up in one year | ----- |

- d) Machinery shed
e) Personal car

31. Assume you have the option of renting land from someone on fixed cash rent or shares. Chose the alternative you would prefer under the following conditions. (Indicate "F" for fixed cash rent and "S" for shares.)

- ___ Prices are volatile
___ Prices are stable and high
___ Prices are stable but low
___ The land is not well drained
___ The land does not have a ASCS corn basis
___ They want a long term lease on good land
___ Don't know productivity of land

32. Assume that you have enough equipment and labor to work an extra 40 acres of land and you currently grow a combination of corn, wheat and soybeans. Also assume that a piece land comes up for sale that historically produces 100 bushels of corn. If the finance terms are at 10% fixed interest for 15 years, how much would you be willing to pay per acre? _____

33. In choosing the following types of equipment pick 3 attributes from the list which are most important when making the decision to purchase. (Place letter of attribute next to number)

Equipment	Attributes
Planter __1 __2 __3	A. Price
	B. Age
Tractor __1 __2 __3	C. Condition
	D. Financing arrangements
Harvest	E. Depreciation
Truck __1 __2 __3	F. Investment tax credit
	G. Resale value
Combine __1 __2 __3	H. Size
	I. Dealer service
	J. Availability of spare parts
	K. Availability of back up equipment
	L. Performance qualities
	M. Dependability
	N. "State of the art"
	O. Flexibility of uses
	P. Own ability to repair
	Q. Horsepower
	R. Lease options
	S. Compatability with other equipment

34. How much repair work do you do on your equipment on your farm? _____%

35. How many different lenders do you do business with?_____

V. General Management

36. Rank the usefullness of doing extensive and accurate numerical calculations when making decisions in the following categories. (Circle 1,2,3,4 or 5 where 1 means not useful and 5 means very useful)

	Not useful				Very useful
a) Determining crop mix	1	2	3	4	5
b) Adding a new crop	1	2	3	4	5
c) Determining crop varieties	1	2	3	4	5
d) When to purchase inputs	1	2	3	4	5
e) Cost of production for individual crops	1	2	3	4	5
f) Estimating the future price of corn	1	2	3	4	5
g) Determining the economic level of fertilizer to use	1	2	3	4	5
h) Determining whether to enter a government program	1	2	3	4	5
i) How much to pay for land	1	2	3	4	5
j) Choosing between financial options	1	2	3	4	5
k) Making an equipment purchase	1	2	3	4	5
l) Estate planning	1	2	3	4	5

37. What are the most important keys to being successful in farming? (Rank 3)

- ___a) Attitude: motivation, dealing with people etc.
- ___b) Timeliness: getting things done on time
- ___c) Managing money and finances: controlling costs, managing credit etc.
- ___d) Productivity: solid production practices, stewardship of land, adequate buildings and machinery etc.
- ___e) Decision-making: ability to react to change, planning, pin pointing problems etc.
- ___f) Communications and public relations: keep contact with outside world, be able to get expert help etc.

38. How many years of historical records on the following items do you have that are readily available?

No. of years	Item
----	a) Crop performance by fields
----	b) Variety performance
----	c) Soil test data by fields
----	d) Fertilizer utilization for each crop
----	e) Chemical utilization for each crop
----	f) Land cost per acre
----	g) Fuel utilization per acre

- h) Yearly equipment repair cost for each peice of
 major machinery
- i) Hours of planter use

39. Which of these statements best describes why you stay in farming? (Rank 3)

- ___a) Family tradition
- ___b) Feeling of accomplishment
- ___c) Like to control assets
- ___d) Attachment to land
- ___e) I'm a "Workaholic"
- ___f) Locked in by assets
- ___g) Don't have other skills
- ___h) Offers high standard of living
- ___i) Like working with family

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