GAMING AS AN INSTRUMENT OF FARM MANAGEMENT EDUCATION - A DEVELOPMENT AND EVALUATION

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PREFACE

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CHAPTER I

INTRODUCTION

Prime objectives of farm management education are (a) fostering a greater understanding and appreciation of farm management activity and (b) developing a student's managerial capabilities. A lone, most effective method for attaining these objectives has not been decided. In fact, a high degree of uncertainty surrounds management education because managerial skills required for effective performance are extremely intangible and difficult to define. As a result, management education has taken, and is taking, many forms. The traditional lecture method has been supplemented by role playing, case studies, and more recently, management games.

Management games have a history tracing back several hundred years. They have their origin in war games which have a documented history of over three centuries. Management games designed for educational purposes have been used little more than a decade. The American Management Association Top Management Decision Simulation, possibly the earliest yet most widely used game, was introduced in 1957. The AMA game was a direct outgrowth of military games.

Management games have been enthusiastically received because they give insight into the recurring nature of management. This method gives educators the chance to show that management, including farm management, must function in a continuously evolving environment of technical and economic change. Other factors contributing to game acceptance were "impatience, dissatisfaction and, perhaps, distrust of purely static models."[1]

Most users of games feel that, properly designed and administered, management games are innovations with unmatched educational capabilities.[2] Because of the uniqueness of games, the number of colleges using them mushroomed in the last decade and management games became an integral part of the curricula of numerous business and management departments.[3] Likewise, they have been well received in agricultural economics.[4]

The number of games developed by agricultural economists has been rather small. One recent contribution to the catalogue of farm management games is the Oklahoma Farm Management Decision Exercise. This study endeavors to explain and evaluate the Oklahoma Farm Management Decision Exercise on the basis of (a) the problems and potentials for using it in teaching microeconomic principles and decisioning, (b) the manner in which it portrays the farm decision-making environment and (c) the opportunities it affords for exploiting basic pedagogical and psychological concepts.

Definition of A Management Game

A management game is a representation of a business situation, either real or hypothetical, and its activity.[5] It is a model designed to give verisimilitude to participants acting within the framework of the game situation. Gaming is the term applied to the act of "playing the game." A play usually refers to the decisions about actions which should be implemented for the period simulated and the associated computational activity.

Gaming is very much like the increasingly popular operations research technique, simulation. Gaming differs from simulation in that "The simulation is periodically interrupted for the purpose of reconsidering (and evaluating) the results of earlier decisions."[6] Walker and Halbrook make the distinction in this manner:

> In operational gaming, a player makes periodic decisions and responses through time within a simulated economic environment. Interaction of the human element, the player, with the problem components is emphasized. Simulation is a process of experimentation with a model to determine effects of different decisions by observing the distribution and level of results over time resulting from each initial decision.[7]

Hence, the human decision element which interferes during simulation is one distinguishing characteristic of gaming. Further, simulation requires that the same initial decision or modus operandi be pursued throughout all periods of activity. Gaming makes no assumptions about the strategies used, their consistency, nor their constancy from period to period.

Attributes of Games

Games may contain one or several combinations of the following attributes: (a) they may be static or dynamic; (b) they may be deterministic or probabilistic; and (c) they may be competitive or noncompetitive.

The essential difference between a static and dynamic situation is that the former relates specifically to one point in time in isolation. In the dynamic game a set of decisions at one point in time is influenced by what has happened before, and, in turn, influences subsequent sets of decisions. A static situation is typical of the case study approach. The time dynamic situation is generally associated with management games.

Deterministic rules give a single certain outcome for any particular set of player decisions, whereas a structure having probabilistic rules means a particular strategy may have any one of several alternative outcomes.

A noncompetitive game is constructed so the outcomes, be they deterministic or probabilistic, for a particular firm at any stage are determined as soon as the firm has chosen its strategy. If there is competitive interdependence, the outcomes for the firm may depend upon the strategies adopted by other firms.

Objectives

Educators in farm management are now past the "fad stage" in using management games. The present point of concern is "how can games best be fitted into the overall farm management teaching program?"

The specific objectives of this study are:

1. To explore and appraise ways the Oklahoma Farm Management Decision Exercise can be used in teaching farm management, especially as it relates to (a) the learning processes and principles and (b) the kinds of economic decisions required of farm managers;

2. To develop a computerized version of the Decision Exercise that allows the administrator the flexibility to exploit teaching opportunities through a formal educational cycle (e.g. a college course);

3. To develop a generalized computer game model which will accommodate any size farm and set of feasible crop and livestock activities;

4. To identify superior strategies for the "game farm" using computer simulation;

5. To describe uses of the Decision Exercise in education and relate participant reaction.

As implied by the objectives the analysis progresses in four basic stages: (1) explanation of the Decision Exercise model, (2) construction of the computer model, (3) demonstration of the kind of decisioning data which can be generated with the computer model, and (4) explanation of educational uses of the model.

The narrative follows these four stages, except for the first three chapters which provide the orientation, background and motivation for this study.

FOOTNOTES

[1]Odell L. Walker and W. A. Halbrook, "Operational Gaming and Simulation as Research and Educational Tools in the Great Plains," Proceedings of Farm Management Research Committee, Western Agricultural Economics Research Council, (Portland, Oregon, November, 1965), p. 105.

[2]Among those making this claim were: Burt Nanus, "Management Games: An Answer to Critics," Journal of Industrial Engineering, XII (1962), p. 467.

E. M. Babb and L. M. Eisguiber, Management Games for Teaching and Research, (Chicago, 1967), pp. 23-30.

Paul S. Greenlaw, Lowell W. Herron and Richard H. Rawdon, Business Simulation in Industrial and University Education, (Englewood Cliffs, 1962), pp. 2-7.

[3]Anthony D. Raia, "A Study of the Educational Value of Management Games," Journal of Business, XXXIX (1966), p. 339. Raia says 70 of 90 leading schools of business had integrated games into their curricula and 12 more were planning to add games as soon as resources were available.

[4]Babb and Eisgruber, p. 15: "Business games are clearly related to simulation. Simulation refers to models of real world situations. As models, simulations as well as games are attempts to duplicate essential characteristics of real world situations."

James L. McKenney, Simulation Gaming for Management Development, (Boston, Mass., 1967), p. 2: "Gaming is a competitive mental activity wherein opponents compete through the development and implementation of an economic strategy. The three basic components are an abstraction of an economic environment (or model), a series of rules for manipulating the model and a set of rules which govern the activity of participants."

Greenlaw, Herron and Rawdon, p. 5: "Gaming is a sequential decision making exercise structured around a model of a business operation in which participants assume the role of managing the simulated operation."

[6]Walker and Halbrook, p. 105.

[7]Ibid.

CHAPTER II

THE EVOLUTION OF FARM MANAGEMENT EDUCATION

Educational activity with the label of farm management did not begin until about the turn of the century. It developed as a result of a need; farmers in the late 1800's were experiencing very low rates of return. There were no disciplines of farm management or agricultural economics, hence, no trained economists to provide tutelage on means for ameliorating the low income problems. Early workers had to come from the technical fields of agriculture and the approach of these early "farm management" teachers was more technical than economic. Their educational effort centered on improved methods of doing particular jobs; but also included ways to reduce costs. Early writings were essentially of two types: (1) analysis of production practices for a given technical unit and (2) collection of data on "good" and "bad" practices.

Development by Decades

With one notable exception, economic theory received little educational attention in farm management prior to 1910. The notable exception was the work of Henry C. Taylor. His _An Introduction to the Study of Agricultural Economics_ allotted considerable space to material of a historical nature and to disproving the idea that farming was becoming too commercialized. However, Taylor emphasized "inter-enterprise competition," "diminishing returns" and "the selection of land and the management of a farm in such a manner as will enable the farmer, one year with another, to win the largest net profits."[1] Enterprise competition was discussed in terms of competition for labor.

1910's

There was some maturing of farm management teaching during the 1910-19 period. This maturation came in the form of a shift from analysis of particular enterprises or units to more consideration of the entire farming system. One of the earlier statements on whole farm planning came in the pioneering bulletin "Replanning a Farm for Profit." This bulletin was used by many in farm management teaching as a supplemental text throughout the 1910-19 decade. The particular statement on the whole farm approach said

> Not many care to attempt to coordinate all the manifold interests of the farm into a single comprehensive farm plan, and yet this is exactly what the farmer must do in everyday life if he would get the most out of his farm and make farming pay.[2]

The authors also refer to "a harmonic dovetailing together of the different parts"[3] of the farm, but no reference is made to using economic principles as a means of accomplishing the task.

Economic theory had a greater influence on farm management than during the previous period. Carver devoted sections in his book to "intensive and extensive margins" and to "management as a separate productive factor."[4] Nourse's book included a thorough discussion of diminishing returns and, according to Case and Williams, gave the best explanation to that time of the difference between diminishing returns and economies of scale.[5] Designation of the difference between gross returns and total outlay as the residual to interest on investment, wages of the family and entrepreneurship began to be used in the classroom in this period.[6]

Many farm management texts published during the 1910-19 decade continued to evidence the technical orientation of workers. Representative topics included (1) Types of Farms (2) The Farmstead, (3) Operations of Successful Crop Farms and (4) Important Factors for Success in General Farming and Dairy Farming. These latter "factors" included the soil, good hired labor, good management, and proper timing of planting and harvesting. In a chapter on "Planning the Farm" Andrew Boss talks about a farm plan in terms of the boundaries, ditches and distance from the farmstead to the field. On "transition plans" which might be necessary in changing the farm organization he says, "It is impossible, without loss, to change immediately from a given plan to the desired plan."[7]

Two approaches to more profitable farming taught during the 1910-19 decade were (1) the survey method and (2) the farm account method. The fundamental idea of the survey method was that the factors affecting success or failure of a farm could be discovered only by a study of a large number of farms in a homogeneous area. Evaluation of the practices of many farms was supposed to help the student delineate those activities which were most profitable.[8] The farm accounts proponents felt systematic accounting would give a basis for more intelligent direction of the farm by isolating those enterprises which were unprofitable. Seeds of partial budgeting were beginning to grow with the understanding that comparison of farm accounts between years required comparisons of only those costs which differ.

1920's

Major educational advances of the 1920's were (1) the publishing of

Knight's book Risk, Uncertainty and Profit[9] and its associated impact; (2) increased emphasis on enterprise combination rather than the single enterprise; (3) emphasis on the scientific method of analysis as opposed to the fact collection approach of the previous decade; (4) the development and refinement of budgeting; and (5) increased use of economic principles.

Most texts of the period dealt with "measures of efficiency" such as size of business, crop yield per acre, production per animal, and labor efficiency. Also emphasized was "balance of organization," the point being that the total combination of enterprises should be considered. The discussions of organizational balance included some of the early references to complementary and supplementary enterprises. Some texts included discussions of riskiness of enterprises. One notable book was Black's Production Economics.[10] This book included sections on "Specialization," "Comparative Advantage," "Least Cost," "Highest Profit Combination," and the "Marginal Approach to the Problem." One chapter was titled "Risk as a Factor in Production."

Farm accounting expanded rapidly during the 1920's. This expansion grew from the understanding that records were not an end in themselves but a means of isolating "imperfections" so "modifications can be made in the management of the business and a more profitable system can be evolved."[11]

1930's

The Depression Decade was a period of refining existing techniques and theories. Developments in the application of firm theory to the farm gained wide acceptance. A major text of the decade refers to "combining the enterprises...in such a manner that the marginal net return for each unit of resource shall be approximately equal, irrespective of the enterprise upon which the unit is expended."[12] Other texts were still following the Cornell approach and concentrating on such topics as "Types of Farming," "Amount of Livestock to Keep," and "How Large Should a Family Farm Be?".[13]

Another educational innovation was the first widespread use of demand, supply and mathematical models in teaching. With the models and because of the depression, there was emphasis beyond the individual farm firm, particularly to the aggregate effects of price changes and increases and decreases in production.[14]

1940's

Because of World War II the early years of the 1940's saw farm management education concentrating on (1) efficiency in allocating farm resources (2) economizing on the use of factors of production, particularly machinery and fertilizer, (3) ways to reduce weather risks and price uncertainty, and (4) alternative methods of integrating the production and marketing as a means of deriving greater profits for farmers.[15]

Firm theory was the body of theory in use in farm management education. Representative economic topics were diminishing returns, marginal analysis, cost analysis, and complementarity and supplementarity. Black's text, published in 1947, had sections on "diminishing returns," "determining the high profit point using marginal analysis," "factors determining relative and comparative advantage," and "complementarity and supplementarity of enterprises."[16] Other topics from firm theory were included but received lesser emphasis than the topics enumerated.

Generally received farm firm theory of the 1940's assumed a perfect market situation in which prices and technology were known with certainty. Analyses were carried out in a static framework. Management was assumed to make marginal adjustments in the production and marketing program until the maximum profit point was attained. Further, once a profit maximizing organization was attained, it stayed attained because the conditions making up the problem were static. Farm firm theory used in the 1940's rarely communicated the requirement that marginal conditions must hold simultaneously for profit maximization.

Black's discussion of management centered on organization, operation, buying and selling and financing. No space was allotted the decision process. The kinds of decisions farm managers must make (what to produce, what farm practice to employ, what to grow on each field, how much fertilizer to use) were listed and briefly discussed. Almost no consideration was given imperfect knowledge states and associated decisioning problems.

1950's

Farm management in the 1950's began to give greater attention to the role of the manager in the concept of the firm. The importance of factor and product prices and method of production continued to be emphasized. However, because of the realities of imperfect knowledge, farm management education in the 1950's put greater emphasis on knowledge states and procedures and strategies for decisioning in imperfect knowledge situations than it had in previous decades.

The text destined to have the most profound effect was Heady's Economics of Agricultural Production and Resource Use.[17] This book integrated theory and application better than any previous work. In the first half of his book Heady explained the factor-factor, factor-product and product-product relationships in great detail. The second section was devoted to "Planning Under Imperfect Knowledge." The discussion included explanations of risk and uncertainty and the role of managers in decisioning. Subjective probability and expected values were among decisioning models explained.

Another educational advance of the period was the Bradford and Johnson book Farm Management Analysis.[18] This text also had a thorough exposition on the economizing principles. A primary contribution of this work, however, was the separation of Knight's risk and uncertainty states into five knowledge states.[19] These incorporate statistical evidence and experience with subjective individual considerations. The first class, "subjective certainty," includes all situations of complete certainty but allows for those situations where the decision maker acts as though he had perfect knowledge. The second class, "risk action," assumes a known probability distribution for an event of interest. A third classification is the "learning" situation. Here the decision maker feels he has insufficient information for decision making and decides to wait until additional knowledge is accumulated. The "inaction" situation exists when a farm manager has inadequate information for action but declines to continue learning. The fifth case is "forced action." It is experienced when a decision must be made even though the manager feels he has insufficient knowledge to do so. This more complete treatment of knowledge states also served to provide a better basis upon which to build discussion of guides for decisioning under imperfect knowledge. Bradford and Johnson included two chapters on decisioning strategies.[20]

Bradford and Johnson describe subjective certainty and risk action as situations where the decision maker is aware of the relevant courses of action and knows the probabilities of each of the possible states of nature being the true state. Their recommendation for decisioning if either of these knowledge states is present is to choose the course of action which maximizes expected returns. The farm management techniques taught which would accomplish this objective were budgeting and marginal analysis. Linear programming, a technique that received little classroom attention until the 1960's, is also an analytical device for choosing a course of action in either the risk action or certainty knowledge states.

Strategies described by Heady and by Bradford and Johnson for dealing with the learning and forced action situations include diversification, discounting, flexibility, liquidity, insurance and contracting. Flexibility and liquidity are particularly relevant for the learning situation as they are employed to allow adjustment to an evolving or changing situation. Whenever information is becoming available through time, for example, it may pay to maintain liquidity and flexibility to allow postponing decisions until more information is available. Discounting, insurance, contracting, and liquidity are all strategies for hedging against unfavorable conditions which may arise from decisioning under insufficient knowledge.

Two additional strategies explained by Bradford and Johnson, (a) minimizing the maximum losses and (b) maximizing the minimum gain, had their origin outside the field of farm management and are associated with the body of knowledge known as decision theory. Decision theory, developed to aid in explaining decisioning under uncertainty, saw little classroom use in farm management during the 1950's.

The steps of management, traceable back to the scientific method of John Dewey, received renewed emphasis in this period. The Bradford and Johnson text and Farm Management by Heady and Jensen both discussed functional steps of management.[21] These steps were first listed in a Kentucky Experiment Station bulletin.[22] They are:

(a) recognition or definition of a problem
(b) observation of relevant facts
(c) analysis of alternatives
(d) decision making--choosing an alternative
(e) taking action
(f) bearing responsibility.

1960's

The early 1960's was a period of innovation in classroom application of new techniques of analysis, particularly programmed budgeting and simplified programming. The ability of these techniques to handle a greater number of activities than budgeting makes them a valuable supplement to budgeting.

Both programmed budgeting and simplified programming use a systematic procedure to select that combination of activities, from the set considered, that maximizes returns (in the static sense) to the specific combination of fixed resources. The budgeting technique has no means of assuring a profit maximizing plan short of considering all possible combinations of activities.

Teaching of decisioning and managerial processes has broadened to recognize that different decisioning processes may be necessary for different kinds of managers (e.g. the goals and strategies for attainment may be quite different for young and older farmers). Greater appreciation and use of findings in psychology and sociology; maturation of decision theory considerations developed during the 1950's in agricultural economics; and renewed interest in the farm firm cycle are all contributing to this new attitude of teaching management.

Publication of Hedges' book[23] served to expand the educational base of the discipline. This text is much like a book of case studies, but has the continuity not usually found in sets of case studies. Hedges demonstrates the use of economic principles and procedures in making optimum farm management decisions on topics that range from "Evaluating Climatic Influences on Farm Decisions and Profits" to "Planning Farm Structures and Improvements." Marginal analysis and budgeting are the primary techniques used. He includes no reference to programmed budgeting. A particular addition of this book is the evaluation of problems that management faces in adjusting the farm firm operation to outside forces. Hedges gives the most incisive treatment to date of restraints on traditional farm firm theory resulting from the need to coordinate farm plans with governmental programs and requirements and other institutional factors.

An Inventory of Progress and Needs

The objectives for farm management education suggested in the introduction provide guides for evaluating past, present, and future directions. To foster a greater understanding and appreciation of the demands of farm management activity, the educational content and technique should illustrate the environmental setting in which the activity occurs. Early developments in the discipline were oriented to the environment but afforded a meager conceptual base. Concepts for understanding decisions to be made and guides for making them are now a vital part of farm management training. Extensive coverage of economics and managerial theory in the body of knowledge reviewed in preceding pages prompt that conclusion.

Do the students assemble the parts into a whole with which they can deal with the decision environment? Does their training develop confidence and competence in meshing and applying separate concepts? It might be argued that affirmative answers to these questions are even more important in educational work than in research. In the latter, problems frequently can be considered individually through the well-known assumption--ceterus paribus mechanism of the researcher. The manager has no such escape.

Innovative classroom exercises in whole farm budgeting and linear programming are used by instructors to teach farm organization in a perfect knowledge or risk world. The formality of programmed budgeting and linear programming are especially helpful in expressing key components of economic decision problems to students. Development of constraints, production and input alternatives and objective functions provides an opportunity to demonstrate relationships between many decision requirements and farm management functions. Unfortunately, other managerial problems such as imperfect anticipation of environmental conditions, accumulative effects of decision-conditions interaction over time, time sequence of decisions, capital budgeting and management, disciplinary realities of cash flow, tax management, farm-household competition, interaction with other farmers, and firm growth are rarely integrated. The importance of consistency between short and long run aspects of these problems is difficult to explain and illustrate with traditional static methods.

The interest of the learner in the subject matter should not be overlooked in a consideration of managerial development. To be most effective, laboratory and lecture activity must be interesting, since motivation to learn is closely allied with interest. Some students, particularly non-majors, find farm management economics distasteful and uninteresting. There are several reasons. Students in the technical fields of agriculture are often more interested in things they can see or touch, e.g. crops and livestock. Some students have an aversion for mathematics. Others consider it unrealistic to use marginal analysis or linear programming to determine the most profitable input level, e.g. fertilization level, while assuming a large number of other variables remain constant. Other student critics say the economic principles and techniques taught in farm management are too complicated and laborious for application in the decisioning environment of the real world.

Summary

This chapter has recorded some of the major developments in the body of knowledge taught in farm management. The changes and additions through the decades have been substantial. However, as implied in the last section, there is yet much to teach; and in some cases, need for new ways of teaching. Also, new ways of making existing materials more interesting and meaningful could improve learning.

Farm management games have been suggested as a means for teaching some of the concepts involving time, interaction of decisions--conditions--restrictions, and imperfect knowledge. Management games have also been described as producing participant involvement and motivation.

The next chapter briefly describes some learning concepts and related educational claims for games. Later chapters relate the additions a farm management game can make to the teaching of concepts.

FOOTNOTES

[1]H. C. Taylor, An Introduction to the Study of Agricultural Economics, (New York, 1905), p. 40.

[2]"Replanning a Farm for Profit," 1908, quoted in H. C. M. Case and D. B. Williams, Fifty Years of Farm Management (Urbana, 1957), p. 19.

[3]Ibid., p. 20.

[4]T. N. Carver, Principles of Rural Economics, (Boston, 1911), p. 223.

[5]Case and Williams, pp. 205-206.

[6]This classification was first exposited in farm management by W. J. Spillman in Successful Hay and Seed-Corn Farms, USDA Farmers' Bulletin 272, 1906, pp. 14-15. Use of the term residual return did not come into use until the 1910-1919 decade. This terminology continues in use today.

[7]Andrew Boss, Farm Management, (Chicago, 1914), p. 81.

[8]This method was originally associated with Cornell and has come to be known as the Cornell Method. W. J. Spillman indicated the status of this approach in the 1917 publication Validity of the Survey Method of Research. He described the survey method as the application of the inductive method of reasoning to farm practice.

[9]Frank H. Knight, Risk, Uncertainty and Profit, (Boston, 1921).

[10]John D. Black, Introduction to Production Economics, (New York, 1926).

[11]L. A. Moorhouse, The Management of the Farm, (New York, 1925), p. viii.

[12]G. W. Forster, Farm Management, (New York, 1938), p. 74.

[13]L. H. Bailey, Farm Management, (New York, 1934).

[14]Case and Williams, pp. 263-71.

[15]Ibid., pp. 296-305.

[16]J. D. Black, et al., Farm Management, (New York, 1947).

[17]Earl O. Heady, Economics of Agricultural Production and Resource Use, (Englewood Cliffs, 1952).

[18]Lawrence A. Bradford and Glenn L. Johnson, Farm Management Analyses, (New York, 1953), pp. 109-190.

[19]Ibid., pp. 21-33.

[20]Ibid., pp. 343-50.

[21]Earl O. Heady and Harold R. Jensen, Farm Management Economics, (Englewood Cliffs, 1954).

[22]Glenn L. Johnson and C. B. Haver, Decision-Making Principles in Farm Management, Kentucky Experiment Station Bulletin 593, 1953, p. 8.

[23]T. R. Hedges, Farm Management Decisions, (Englewood Cliffs, 1963).

CHAPTER III

THE PSYCHOLOGY OF LEARNING AND POTENTIAL OF GAMES AS LEARNING DEVICES

The previous discussion enumerated some inadequacies of traditional farm management education. Gaming has been suggested as a technique for better communicating the subject matter of farm management.[1] It is informative and germane to consider how learning takes place and to assess the educational potential of games in that light. Knowledge of learning can also be valuable in isolating desirable and undesirable attributes of games and in planning the use of games. This chapter examines some generally accepted concepts held by psychologists and educators about learning and relates them to educational benefits claimed for management games already in use. Some of the learning concepts will be related specifically to the Oklahoma Farm Management Exercise in later chapters.

Principles of Learning

The learning principles explain the rate (velocity) and depth of a learning experience. The importance of each principle varies between learning experiences. For the most effective learning, several of the following conditions should be present.

Facilitation

The facilitation principle says "previously learned material will assist in the learning of new things if the previous learned responses are utilized."[2] This is the point of a leading economist who said, "If a student cannot see the use of principle or theory in the extremely favorable and simplified atmosphere of the classroom, can we realistically expect him to do so in the far more cluttered and complicated atmosphere of adult life?"[3]

The learning desired of the student must be within the range of possibility for the student involved, i.e., the experiences should be appropriate to the student's level of attainment.

Intensity

This principle focuses on stimulation of the senses; the thesis being "The greater the number of senses that can be stimulated, the more effective the learning."[4] Bringing up the same concept in various contexts, by different media and with considerable frequency increases the probability of retained knowledge.

Organization

The organization principle calls for continuity, sequence and integration of materials.[5] Continuity refers to vertical reiteration of materials. Sequence emphasizes the importance of having each experience build on preceding ones; but calls for broadening and deepening of successive experiences. Integration refers to unity among materials and experiences. Things learned which are consistent with each other, i.e., integrated and coherent, reinforce each other. Contrarily, inconsistencies and disorganization of materials can impede learning. Requiring new responses to the same stimuli, for example, can retard learning.

Exercise

The law of exercise[6] is recognized by psychologists as important to improving either manual or mental skills. This principle stresses practice and experience; active involvement by the student. If the objective of learning is problem solving, for example, the student must be given ample opportunity to solve problems. Further, one author says the most effective learning occurs when the problem to be solved is set up in the kind of environment in which such problems usually arise in life.[7] That is why economists set up model problems and why aspiring chemists do not just read chemistry books, but work with chemicals in a laboratory.

Effect

Transcendent of the learning principles is the law of effect. It says "learning will take place better, the more satisfying the result."[8] This law indicates that satisfaction in learning is the key to motivation. This implies the student must receive some reward for the effort expended. The reward (satisfaction) can come in a number of ways. Satisfaction from success such as a good grade on an exam may be sufficient recompense. Problems that are "real" to students tend to be satisfying and stimulating (e.g., practice under environmental conditions mentioned above). Enjoyment from a learning experience also may be sufficient motivation for learning.

Processes Affecting Learning

"Human learning takes place gradually, in extremely small steps, and behavior is modified by infinitesimal degrees rather than by leaps and jumps,"[9] according to one educator. He does not deny that flashes of insight do change a person's thinking; but suggests that behind every flash of insight is a history of preparatory learning of a fairly gradual nature.

Knowledge can be instilled through either specific or non-specific learning activity. Learning that is specific is designed to build up connections between specific stimuli and specific responses. Non-specific learning allows reorganization of knowledge in varied ways appropriate to the different kinds of situations in which the knowledge can be used. An example of specific learning might be memorization of multiplication tables, while corresponding non-specific learning involves the use of sets, subsets, unions, etc.

In economics the intent is usually non-specific learning. Concepts acquired in the classroom are to be transferred outside the classroom and applied in a variety of situations, rather than to a particular situation.

Specific learning is represented by the associative school in psychology.[10] The focus is on the response of the learner, its association with particular stimuli and the changes within the learner himself. This approach sees in any activity first a <u>situation</u> which influences or affects the individual, second a <u>response</u> which the individual makes to the situation, and third a <u>connection</u> (or association) between the situation and the response by means of which the former is enabled to produce the latter. Memorization and habitual behavior might be characterized as associative learning. Programmed learning is another method used to take advantage of this learning procedure. This associative view of learning says if the subject encounters the same situation, he will behave in the same manner as the previous time that situation was encountered. Nothing is said about how the subject will react to a new situation.

Cognitive (problem solving) learning is non-specific. It develops generalized modes of attack on problems. Katona[11] characterizes problem solving learning as (a) arousal of a problem or question (b) deliberation that involves reorganization and "direction," (c) understanding of requirements of the situation, (d) weighing of alternatives and taking their consequences into consideration, and (e) choosing among alternative courses of action. (Note the similarity to the functional steps of management.)

Problem-solving learning may occur through the discovery of consistencies in what appear at first to be unrelated events. The behavior, including decisions, resulting from non-specific learning may be such that the subject may never have acted that way before nor know of any others having behaved in the same way.

Effective Learning in Farm Management

How can an understanding of principles and processes help the instructor in farm management teach decision making? First, they suggest learning experiences must offer something the student feels is important; something in which he can get involved. Second, psychological concepts can help teachers isolate those methods and tools (e.g. visuals and models) which bring the greatest number of learning conditions into a learning situation. Third, an understanding of the learning process should aid in developing content (materials) which build on previous knowledge. Farm management education has long built on the assumption that students possess a thorough knowledge of technical agriculture.

Fourth, an appreciation of learning principles can give the teacher direction in selecting the needed information which is within the range of possibilities of the students. Fifth, an appreciation of the stimulus-response approach to learning can assist in understanding why some concepts in management are so difficult to grasp. In management, the same stimulus does not always elicit the same response. Sixth, since one objective of college farm management education is to affect the behavioral pattern of students after they have graduated, techniques that will give the student preparation (or experience) in thinking for themselves should be used. Seventh, an understanding of the learning process is basic to critical thinking on the educational benefits of management games. Such assessment can help in deciding what emphasis gaming should get in a total education program.

Educational Benefits Attributed to Games

Several benefits have been claimed for management games.[12] These claims are usually made concerning games as techniques for augmenting educational activity. Benefits claimed for management games are:

1. Games, even noncompetitive ones, usually result in a high degree of personal involvement.
2. Uncertainty can be convincingly illustrated in a management game.
3. Management games permit decision making over time. Games condense a large amount of decision making experience into a relatively short period of time.
4. Use of economic concepts can be demonstrated, once a grounding in the concepts has been accomplished.

5. The participant can gain proficiency through practice in using business control forms and analytical tools.
6. Computerized games make it feasible to work with more complete models than conventional tools.
7. Gaming gives the player opportunities for exploring the business environment of the model.
8. The process of creating a game is especailly fruitful in helping the designer(s) gain insights into the actual business situation the game is designed to simulate.
9. The social cost of training through use of games should be lower compared to on-the-job or "sink or swim" types of training.

Some justifications for these claimed benefits have been subjective. However, it is noteworthy to investigate what has been "learned" by users of games as it relates to principles and processes of learning discussed in the previous section.

That players can gain proficiency in using business control farms through gaming has been documented in a game used by the Westinghouse Company.[13] This game used business statements and accounting forms in the game situation which were identical to those used in actual business activity. After participation in the Westinghouse game, company employees exhibited much greater proficiency in using the same forms they had used prior to their game experience.

The administrators of the Carnegie Tech Game say, "it is clear that performance within the game improves during the semester of play... Students become much quicker and more sophisticated about abstracting, organizing and using information from a complex and diffuse environment."[14] Dill and Doppelt found indications of game participants experimenting with and learning from their game environment. They say that as the students play the Carnegie Tech Game "they (students) make more elaborate and subtle inferences about the relations of <u>past</u> results to <u>future</u> decisions."[15] "Superior" managers could also differentiate between valuable and trivial data. Wilkenson and Mills indicate using a management game in their course "undoubtedly made the teaching more effective than it otherwise would have been... Participation and interest (in the game) had the advantage that it enabled the application, by the player, of management tools already studied in formal lectures."[16]

The use of management tools by students of Wilkenson and Mills relates quite well to Neale's idea of students discovering principles and concepts while acting as economists.[17] An implication is that the place for experience and experimentation is in a classroom situation where the manager (student) can try tools and theories under the guidance and assistance of a professional. This should give the student an opportunity to explore the variants, exceptions and ramifications for which "air-tight" theory cannot give precise answers.

Summary

Education and psychology have provided basic principles by which learning experiences can be evaluated and understanding of the learning process improved. Nothing from this body of knowledge would discredit interesting, effective learning experiences no matter what the approach.

The newer technique of gaming can be viewed as an approach for augmenting other teaching methods. Games have been adjudged effective in bringing learning principles to bear on a learning situation. The use (and development) of games must give attention to building on the student's past knowledge and experience. Management games can provide an opportunity for using concepts from both firm and decision theory.

The responsibility of creating a situation in which learning can take place and past knowledge used still lies with the teacher and/or game designer. The following chapters refer to the learning concepts reviewed in this chapter as bases for evaluating possibilities and limitations of the Oklahoma Decision Exercise.

FOOTNOTES

[1] E. M. Babb and Ludwig Eisgruber, Management Games for Teaching and Research, (Chicago, 1967), p. 158.

[2] P. S. Greenlaw, L. W. Herron and R. H. Rawdon, Business Simulation in Industrial and University Education, (Englewood Cliffs, 1962), p. 34.

[3] H. S. Broudy, "Educational Theory and the Teaching of Economics," unpublished paper presented at Midwest Economic Association, St. Louis, 1959.

[4] Greenlaw, Herron and Rawdon, p. 34.

[5] Ralph W. Tyler, Basic Principles of Curriculum and Instruction, (Chicago, 1967), pp. 55-57.

[6] Allen M. Schmuller, The Mechanics of Learning, (Denton, 1959), p. 49.

[7] Tyler, p. 45.

[8] Greenlaw, Herron and Rawdon, p. 33.

[9] D. C. Neale, "Some Psychological Principles for Teachers," Proceedings; North Central Farm Management Workshops, 1946, p. 18.

[10] Schmuller, pp. 47-51.

[11] George Katona, "Rational Behavior and Economic Behavior," The Making of Decisions, ed. W. J. Gore and J. W. Dyson (London, 1964), p. 55.

[12] Drawn from: J. R. Green and D. L. Sission, Dynamic Decision Games, (New York, 1959), pp. 5-7.

W. R. Dill, "What Management Games Do Best," Business Horizons, III (1964), pp. 55-64.

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[13] K. J. Cohen and E. Rhenman, "The Role of Management Games in Education and Research," Management Science, VII (1961), p. 150.

[14] W. R. Dill and Neil Doppelt, "The Acquisition of Experience in a Complex Management Game," Management Science, X (1965), p. 34.

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[16] R. K. Wilkenson and G. Mills, "The Use of a Business Game in Management Training," Journal of Industrial Engineering, XVI (1965), p. 284.

[17] Neale, p. 22.

CHAPTER IV

THE DECISION EXERCISE

Gaming was initially introduced in farm management at Oklahoma State University to generate interest in a section on uncertainty in a senior level farm management course. Existing farm management games reviewed were rejected as not providing a model sufficiently elementary for the desired use. The result was the Oklahoma Game No. II, developed by Walker and Halbrook.[1] Game II required only two decisions: (1) the number of steers and (2) the number of hogs to have on a 200 acre corn farm. The objective was to maximize net worth at the end of a ten year gaming experience. This game was simple enough so game orientation and ten years of game play could be accomplished in two to three hours. The enthusiastic reaction of over two hundred students and faculty at Oklahoma State plus its use at North Dakota, Arkansas, Missouri and other states merit this elementary game a worthwhile contribution to the small catalogue of farm management games.

As a result of the success of Game II, Dr. Odell Walker was encouraged to develop a more complex game. He prevailed upon the author to assist him and the Oklahoma Farm Management Decision Exercise became a crude reality.[2]

The Model

It was originally decided that the Decision Exercise would be a non-competitive, probabilistic, hand-computed model. The hypothetical farm situation selected was based upon research which had just been completed in the Oklahoma Panhandle. This particular game farm situation was chosen because the Panhandle is a high risk area. A farm in that area and of the size chosen requires concentrated management effort. Also, the Panhandle region is rather unique and quite foreign to farming situations with which many potential game participants would be familiar. It was felt the "uniqueness" characteristic of the game was desirable as participants would be less likely to enter the game situation with preconceived bias. (The Panhandle farm was also chosen because of its uniqueness among other farm management games. No other game deals with this specific environment.)

No attempt was made to duplicate an existing or anticipated farm situation. A few salient features were attributed to the game farm to give the participant a feeling of realism as a means of inducing active involvement.[3] Throughout the construction of the game model an attempt was made to develop a model which would emphasize thinking and experimentation as opposed to a functional game which emphasizes training for a specific task. An explanation of the game farm and operating restrictions is given below.

Summarized in equation form the initial conditions are:

Cropland = 1600 acres
Pasture = 400 acres
Wheat allotment = 1/2 cropland
Beginning number of livestock = 0 head
Value of land and buildings = $140,000
Average value machinery = $10,000
Cash on hand = $2,000
Indebtedness = $50,000
Property tax = $.80 per acre

Restrictions within which the players must operate are:

Acres of broomcorn $\leq$ 100 acres
Native pasture required $\leq$ native pasture available
Average family living expense $\geq$ \$5,000; minimum annual family expense = \$3,000
Average machinery expense $\geq$ \$2,000; minimum annual machinery expense = \$0
Average land payment $\geq$ \$2500; one payment in three may be omitted
Average acreage fallowed $\geq$ 400 acres
Net worth ratio $\geq$ .35

The following is the description of the model and the explanation of restrictions furnished a participant in the gaming exercise.

OKLAHOMA FARM MANAGEMENT
Decision Exercise
Department of Agricultural Economics
Oklahoma State University

1. You are the owner-operator of a 2,000 acre farm. The value of land and buildings is \$140,000. You owe \$50,000 on a farm real estate mortgage carrying an interest rate of 5% on the unpaid balance. Interest must be paid each year. Principal is to be repaid in 20 equal installments. However, one principal payment can be deferred each three years and the term of the loan extended. Property taxes are \$1,600.

2. You have 1,600 acres of cropland and 400 acres of native pasture. The native pasture produces .6 AUM per acre (AUM equals animal unit month, which is the grazing required by one 1,000 pound cow for one month). Alternative crops, input requirements and returns are summarized in Table I. As indicated, returns from each enterprise vary with product prices and/or yield conditions. The wheat allotment is 800 acres. Land must be fallowed an average of once in four years. To assure that the fallow requirement essentially is met, you can never be more than 600 acres behind in your fallow program. Fallow costs \$4 per acre. A crop failure (i.e., conditions leading to the lowest return given for each crop in Table III) may be counted as 1/2 fallow. Capital for crop production will not be considered in capital and return computations.

3. There are currently no cows or steers on the farm. Livestock alternatives used in the area are cows on native, cows on native and wheat pasture, steers on native, and steers on wheat pasture and a small amount of native pasture (Table II). Steer numbers can be varied from year to year. Cows purchased must be held at least three years.

TABLE I

INPUTS FOR CROP ACTIVITIES IN THE DECISION EXERCISE

Item	Unit	Crop Alternatives[1]		
		Wheat	Sorghum	Broomcorn
Land	Acre	1	1	1
Allotment	Acre	1	0	0
Yield	Bu. or cwt.	Variable	Variable	Variable
Price	$/bu. or cwt.	1.60/bu.	1.55/cwt.	Variable
Grazing Produced	AUM/acre	Variable	.2	.2

[1]In addition to these alternatives, wheat pasture may be sold as described later.

TABLE II

INPUTS FOR LIVESTOCK ACTIVITIES IN THE DECISION EXERCISE

Item	Unit	Livestock Alternatives			
		Cow-Calf, Native	Cow-Calf, Native and Wheat	Steer, Native	Steer, Wheat Pasture
Native Pasture	AUM	13	10	6	.5
Wheat Pasture	AUM	0	3	0	2.5
Capital	$	200	200	120	120 (6 mo.)
Gain	Lb.	Variable	Variable	Variable	Variable
Buying and Selling Price	$	Variable	Variable	Variable	Variable

4. Native pasture and stubble production are considered constant from year to year. (Sorghum and broomcorn stubble are treated as perfect substitutes for native pasture.) Wheat pasture available for grazing varies as described in Table III. Therefore, the exact number of steers the wheat pasture will carry is unknown until after the steers are already purchased. Further, once steers for wheat pasture are purchased they must be kept and any deficit in wheat pasture made up by purchasing feed or renting wheat pasture. For example, if the zero wheat pasture event occurs and you had stocked anticipating the .2 AUM event, feed costs of $25 per steer ($10 per AUM) or $30 per cow would be incurred to replace the wheat pasture deficit. Or if .4 AUM is used for planning purposes and .2 AUM is obtained, $10 per AUM of wheat pasture shortage would be incurred. Alternatively, you may rent wheat pasture from a neighbor at a price you negotiate.

5. Wheat pasture can be sold only if: (1) no livestock using wheat pasture is kept on the farm and (2) all wheat pasture is sold to one renter.

6. Returns from livestock and crops vary with climatic and economic conditions. The probabilities of different levels of returns from each enterprise are indicated in Table III. Expected returns, E(R), (i.e., annual returns weighted by probabilities) also are given for each enterprise.

7. Custom harvesting is used and returns are net of these costs. Hired labor available for broomcorn harvest limits broomcorn to 100 acres. The labor cost has been deducted from broomcorn returns.

8. You have $2,000 the first year to invest in cows and/or steers. In addition, you may borrow on assets. You can expand or contract as desired subject to available cash and collateral. All livestock and machinery have a collateral value of 70% of their total value. Cow loans must be repaid in two years and steer loans must be repaid each year. The interest rate on short-term loans is 10% per annum.

9. Average machinery inventory is $10,000. You must spend an average of $2,000 per year to replace worn-out machinery and equipment. You may skip one year and spend $4,000 the next year, or spend $4,000 in a good income year rather than a bad year.

10. Your expenditure for family living must average $5,000 per year. A minimum of $3,000 must be spent in a given year. If this is done, $7,000 must be spent the next year to meet the $5,000 average requirement.

11. There are certain minimum operating restrictions which you cannot violate. The net worth ratio must exceed .35, the land equity ratio must exceed .4, and the creditor's risk ratio must not exceed 1.6. Should you violate any of these restrictions the banker will foreclose.

12. Objective: Maximize net worth at the end of N years.

TABLE III

RETURNS ABOVE CASH COSTS FOR CROP AND LIVESTOCK ACTIVITIES IN THE DECISION EXERCISE

	Crops[1]				Livestock			
					Cow-Calf[2]		Steers	
Probability	Wheat Grain	Wheat Pasture	Grain Sorghum	Broomcorn	Native	Wheat-Native	Native	Wheat
	$	AUM	$	$	$	$	$	$
1/3	5.00				35.00	40.00		
1/3	10.00				50.00	55.00		
1/3	20.00				65.00	70.00		
1/10		0					0	2.00
2/10		.1					5.00	5.00
4/10		.2					20.00	15.00
2/10		.3					30.00	20.00
1/10		.4					40.00	40.00
1/4			3.00					
1/2			11.00					
1/4			22.00					
1/2				0				
1/2				25.00				
E(R)	11.67	.2	11.75	12.50	50.00	55.00	19.00	15.20

[1]Returns from crops are net of cash costs.

[2]Returns from cow-calf enterprises are net of cash costs other than interest. These return figures include the sale of cull cows.

Definitions

A few terms used in this and later chapters are capable of being misunderstood because of the variety of meanings they can have. This section will give the intended meaning of these terms in this study.

Activity refers to a particular technique of production used with an enterprise. It embodies a unique set of inputs and ways of handling them. An enterprise refers to a crop or class of livestock. Cows are an enterprise in the Decision Exercise. Cows on native is an activity because it is a unique way of handling cows. The method of satisfying the pasture requirement differentiates the cows on native activity from cows on native and wheat pasture.

There is a set of revenue values associated with each activity in the Decision Exercise. These values have definite probabilities of occurrence (see Table III). Event is the term used to identify a particular value which the stochastic revenue (also grazing for wheat) variable takes on. The possible revenue events for wheat are \$5, \$10, and \$20. Favorable and unfavorable are the terms used to identify the highest and lowest event values for an activity. The favorable event for wheat would be \$20 and \$5 would be the unfavorable event.

The arithmetic mean of the probability distribution for an activity is its expected value. The expected value of wheat revenue is \$11.67 (i.e. 1/3 x \$5 + 1/3 x \$10 + 1/3 x \$20). Expected value is comparable to "normal" value used in farm management. Prices and yields used in linear programming and whole farm budgeting are usually normal values.

Organizational Alternatives

The player of the Decision Exercise can make organizational selections from three crop and four livestock activities. The crop activities are wheat, grain sorghum and broomcorn (see Table I). Table I provides no information on yields or prices. The crop plan can be varied from production period to production period, within restrictions given in the previous section. The livestock activities are cows on native pasture, cows on native and wheat pasture, steers on native pasture, and steers on wheat and native pasture. The grazing and capital requirements of each are given in Table II.

Unintentional Fallow

Unintentional (free) fallow is the term assigned the acreage a player (player and participant are used interchangeably) can count as fallow, at no extra cost, when he experiences a crop failure from any of the three crops. A crop failure occurs when the net revenue from a particular crop is the lowest of its possible outcomes. For example, if a player had 100 acres broomcorn and the net revenue value was $0 per acre, he could count one-half (50 acres) as free fallow.

Activity Return Figures

The Decision Exercise was developed for hand computation and an attempt made to eliminate as many computations as possible. As a result, the revenue figures are given as net above operating costs per unit of activity.

The possible net revenue figures for each activity are given in Table III. The frequency distributions associated with each set of outcomes are given in the left-hand column. The expected value, E(R), for each activity is given in the last row of the table. This value is determined by multiplying the probability values by the outcome values for each activity.

Since the net revenue per unit concept is one of the more important simplifications in the Decision Exercise, it is important that the consequences be evaluated. Among the possible undesirable consequences are the following:

1. the player does not see the separate effects of production or price variability;
2. the player does not get an accurate picture of total operating costs, hence, the total dollars which are managed; and
3. there is no opportunity for the player to try different points along an isoproduct curve.

Summarily, the three points may imply too little realism. This may cause the student to loose interest.

The rationalization on the part of the designers of the Decision Exercise for using net revenue per unit was as follows:

1. a primary objective of the game is improved decisioning, thus, greater emphasis was put on decisioning as opposed to the realism associated with total revenue and total expenses;
2. operating and fixed expenses are included (e.g., capital for livestock and fallow costs) where the designers desire to reinforce learning made in other courses in economics or agricultural economics; and

3. time is a very limited commodity in most situations where the game will likely be used, hence the desire to reduce routine time consuming computations.

A table of price-yield combinations could be used to help students understand and accept the use of net revenue per unit. Table IV gives an example for wheat. A single combination of inputs with an annual cost of $11.80 is assumed. Yield variability would be explained by weather and timing of operations; price variability by economic conditions.

TABLE IV

PRICE-YIELD COMBINATIONS FOR DETERMINING NET REVENUE FROM WHEAT

	Wheat Yield		
Wheat Prices	for $5 return[1]	for $10 return	for $20 return
$1.70	9.9	12.8	18.7
1.60	10.5	13.6	19.9
1.50	11.2	14.5	21.2
1.40	12.0	15.6	22.7
1.30	12.9	16.8	24.5

[1]e.g., $5 = 9.9 ($1.70) − $11.80

The Wheat Pasture Event

Wheat pasture grazing is also a stochastic variable. Possible yields vary from 0 to .4 AUM's per acre (see column 3, Table III). The grazing distribution is conditional upon the net revenue event obtained for wheat. For example, if the wheat revenue event is $5 the possible wheat grazing events are 0, .1 and .2 with the probabilities .25, .50 and .25 (see row 1 of Table V). Given a .33 probability for each of the three wheat revenue events the joint probability of wheat revenue and grazing events is given in the last row of Table V. The joint probability of a $5 wheat revenue event and a 0 pasture grazing event would be .083 (.33 x .25 = .083). The joint probabilities are rounded to the nearest tenth in Table III.

TABLE V

DETERMINING THE JOINT PROBABILITIES OF WHEAT PASTURE GRAZING AND WHEAT REVENUE EVENTS

Wheat Return Events	Wheat Pasture Grazing Events 0	.1	.2	.3	.4
		-Conditional Probabilities-			
$5	.25	.5	.25		
$10		.12	.76	.12	
$20			.25	.5	.25
Joint Probability	.083	.205	.414	.205	.083

Cost Figures Used

Both operating and fixed costs are included in the Decision Exercise. Fixed costs are used sparingly and aggregated as much as possible. For example, the player is told he must maintain an average machinery inventory of $10,000 on which the annual depreciation is $2,000. There is no attempt to separate the depreciation on the tractor from that on the plow, etc. The other primary asset against which there is a major fixed cost is land and buildings. This cost has two components. There is an annual principal payment of $2,500 and an interest payment of 5 percent of the unpaid balance.

Operating expenses, too, are included only for conceptual emphasis or when they cannot be broken down to a per unit basis. The purchase cost of steers, for example, is included to emphasize the magnitude of capital necessary for a buy-sell steer activity. The possible variability in the interest rate paid for different term capital and the flexibility of one activity as opposed to another are other reasons for including cow and steer capital. Fallow costs are included to make the player explicitly recognize there is an associated tillage cost; that a piece of land does not lie idle for a year at no cost. Another operating expense, wheat pasture purchase, is included because it requires bargaining between individuals and adds realism to the game.

Game Play - Administrator's View

W. R. Dill has said, "the measure of a good game is not the number of decisions that must be made but the number of kinds of decisions that must be made."[4] This study would amplify this statement to include, "and the number of economic concepts that must be used." The following are some economic and organizational decisions, with suggestive concepts and skills, emphasized in the game.

Decisions and Concepts

1. Isolating Relevant Data
    a. restrictions
    b. probability of outcomes
    c. expected returns
2. Evaluation of Potential Returns
    a. relating expected value to "normal" returns
    b. range of returns
    c. relating knowledge in game to knowledge states in theory of decision making
3. Evaluating Economic Variables and Selecting Plan
    a. competition between activities
    b. complementarity or supplementarity between activities
    c. operating and fixed costs
    d. opportunity cost
    e. interest computation and debt repayment
    f. intermediate products
    g. long run and short run
4. Analysis of Outcomes
    a. budgeting
    b. profit and loss evaluation
    c. items of comparative analysis
    d. considering long-run goals

5. Choosing Strategies for Living With Uncertainty

    a. diversification

    b. flexibility

    c. liquidity

    d. discounting

    e. game theoretic models

The decisions and related concepts listed above could be called the content aspects of the Decision Exercise. The game was designed to give participants the opportunity to make the decisions listed, and make them in time dynamic, uncertain environment. There is no method incorporated for making sure the participants use all the concepts listed. One of the responsibilities of a game administrator is to bring important concepts to the fore if they are overlooked by participants.[5] The administrator may help the participant <u>discover</u> consistencies in what may appear to the participant to be unrelated events.

The game designers believe the experience and practice in decisioning under uncertainty can achieve several behavioral objectives. These objectives are:

1. To improve participant competence in recognizing and evaluating new situations.

2. To improve the ability of participants to interpret economic and technical data.

3. To foster a clearer understanding of the importance of facts and principles.

4. To improve participants' ability to apply principles and analytical tools.

5. To encourage an appreciation for assessing and classifying experiences (re-evaluation).
6. To make more vivid the concept of economic irrationalities.
7. To give participants experience in setting goals and seeking ways of attaining them.

Game Play - Student's View

The long-run, transcendent goal of net worth maximization was established by the game designers. The participant has the responsibility for all decisions affecting the means to attaining that goal. Such decisions are affected by both economic and subjective criteria plus the participant's interpretation of the situation. This section gives a partial coverage of analyses students could make when participating in the Decision Exercise. As mentioned, there is no assurance a particular student will make these considerations. They are presented to give examples of analysis and decisioning which have taken place during uses of the game.

Evaluating Enterprises and Choosing a Farm Plan

Major decisions in the Decision Exercise relate to the selection of a farm plan. A starting point for analysis could be the level of returns expected per unit from each activity, i.e., E(R). The E(R) values might be weighed against the range and distribution (variability) of possible outcomes in deciding on the desirability of alternative activities. The revenue evaluation could be supplemented with a comparison of grazing provided by each of the crop activities. This would involve comparing broomcorn and grain sorghum (crops with less stable revenues, but sure grazing available) with wheat (less variable revenues but variable grazing yield). Better students should recognize that an expected return per AUM can be determined for each type of grazing. For example, if a player was comparing steers on wheat pasture vs. steers on sorghum and broomcorn aftermath he would find the expected value for one AUM of each type of grazing. The student might discount the expected value of wheat pasture grazing for uncertainty. Adding together E(R) and the expected revenue per acre from grazing should give a more satisfactory decision variable than looking at only E(R).

Following an analysis of the characteristics of returns from each enterprise, the player must decide upon the mix of enterprises to include. Among the considerations are diversification vs. specialization and liquidity - flexibility vs. inflexibility. If the events are not correlated, the diversification decision centers on (1) fewer enterprises with a high E(R) and (2) more enterprises with less likelihood of very wide fluctuations in total returns.

The choice between cows and steers is a flexibility decision. The purchase of cows requires their maintenance in the plan for three decision periods; steer numbers may be changed each period. By choosing cows a participant would forego the flexibility of changing plans the next period should an unprofitable plan be selected. Implicit in the three year restriction is the importance of long-run considerations when selecting a plan that includes cows.

Steers are also a more liquid asset than cows as money invested is paid back each period. The decision to select steers over cows might, thus, include a discount factor because money invested in cows is not retrievable for three decision periods.

The level of total returns might be another decision variable. The player who must get some minimum income might choose a maximin strategy. He might exclude broomcorn, for example, because the other two crop activities have a higher minimum return and probability distributions which are less likely to give the lowest return per acre.

Meeting the Fallow Restriction

The decision of how many acres to intentionally fallow to meet the fallow restriction is closely allied to crop decisions. One strategy would be to increase the crop acreage by the amount of expected free fallow. This could be done by deciding on a basic crop plan which uses all 1,200 acres of the 1,600 cropland acres (400 acres left for fallow). The expected free fallow is computed and this amount planted to one of the cash bearing crops. The computation of free fallow for an organization of 800 acres wheat and 400 acres grain sorghum is given in Table VI.

TABLE VI

DETERMINING FREE FALLOW FOR A HYPOTHETICAL FARM PLAN FOR THE DECISION EXERCISE

Item	Probability of Getting Lowest Return	Acres	Percent of Crop Acreage Qualifying As Free Fallow	Expected Free Fallow
Wheat	.33	800	.50	133
Grain Sorghum	.25	400	.50	50
Expected Free Fallow				183

The player might elect to put all 183 acres in grain sorghum, increase its acreage to 583 and reduce actual fallow to 217 acres. The above is only one of several alternatives open to the player. Another strategy would be to fallow 400 acres each year. A third strategy would be to start out fallowing nothing and fall behind by the maximum 600 acres allowed in the early years.

Disposition of the Intermediate Product Wheat Pasture

The player who has some wheat in his plan has the alternatives of (1) not using wheat pasture, (2) not including steers on wheat pasture and bargaining with other players to sell as much pasture as he can at whatever price he can get or (3) putting steers or cows on wheat pasture. (The alternative of having some livestock and selling excess wheat pasture is not allowed. Hence, the decisions to graze wheat or raise wheat pasture for sale are "all or none" situations.) Players learn rather fast it is unprofitable to either let wheat pasture go unused or to be overly optimistic concerning the generated wheat pasture event.

Comparing Two Uses of Wheat Pasture

A partial budget could be very useful to the player deciding between the raise wheat pasture for sale and put livestock on wheat pasture alternatives. Probabilities on wheat pasture grazing events (Table III) indicate the chances are one in ten no wheat pasture will be available. The chances are two in ten the .1 AUM event will be generated.

The player considering raising wheat pasture for sale would have no pasture available when the demand is the greatest (the zero event). Thus, if he raised the 800 acres of wheat allowed by the allotment restriction, he could expect to have 80 AUM's of wheat pasture for sale two years in ten. The maximum price he would receive would be $10 per AUM, thus, the expected receipts for a ten year period are $1,600. There would be no added expense for the wheat pasture sale alternative.

As a comparison to selling wheat pasture, a player with 800 acres wheat could have 60 steers on wheat pasture (using the .2 AUM expected wheat pasture event to determine steer numbers). The expected returns from 60 steers for 10 years would be $9,120. Because of the possible occurrence of events less than .2 AUM's, the player could determine wheat pasture purchases during a ten year period would have a maximum expected cost of $2,800. Another expense item would be interest on steer capital. If interest were paid in half the ten years the interest expense would be $1,100.

A partial budget comparing the sell wheat pasture and graze steers alternatives could, thus, have the following entries:

	Sell Wheat Pasture	Graze Wheat With Steers
1. Receipts that change	$1,600	$9,120
2. Expenses that change	--	3,900
3. Difference	1,600	5,220
4. Gain		+$3,620

These computations show a player electing to have 60 steers on wheat pasture could expect an average of $362 per year greater returns than he could expect when raising wheat pasture for sale. The $362 return might be discounted by the player to allow for the lower capital requirements and lower chance of experiencing actual losses with the sell wheat pasture alternative.

The Cost of Overstocking

The participant who elects to have cows or steers on wheat pasture may encounter a problem of overstocking. Overstocking means there is a deficit of wheat pasture. It occurs when the generated (actual) wheat pasture event is less than the expected event used in deciding the number of head of livestock to include in the plan for a particular period. For the player who overstocks, the alternatives are (1) bargain with other players who raise wheat pasture for sale or (2) pay $10 per AUM for needed pasture. (The Decision Exercise assumes unlimited substitute pasture is available at $10 per AUM.)

In determining the amount to offer for wheat pasture, the participant could first determine the expected value of an AUM of wheat pasture. The considerations of a participant with steers on wheat pasture could be as follows:

1. Determine the value of the native pasture used by each steer. (This could be accomplished by using an opportunity cost for native.)
2. Subtract the charge for native from expected return per animal to ascertain the share going to wheat pasture.
3. Divide the expected return by the number of AUM's of wheat used to get expected return per AUM of wheat pasture.

If the opportunity cost of native is subtracted out, the expected value of an AUM of wheat pasture is $5.41. If no opportunity cost is charged for native pasture (the relevant case when steers are already purchased before the grazing event is known) the value of an AUM of wheat pasture would be $6.08.

The player who is overstocked can use these two values as a starting place for bargaining with the player who has raised wheat pasture for sale. The upper limit on the price paid for wheat pasture will be $10. The lower limit will be determined by the demand for and supply of wheat pasture.

Computational Forms

The hand-computation model is designed around five basic planning and analysis forms. These are (1) the Projected Profit and Loss Statement, (2) a Pasture Balance Sheet, (3) a Credit Planning Form, (4) an Actual Profit and Loss Statement, and (5) a Comparative Analysis Sheet--including a Net Worth Statement. Each form has a specific purpose as will be indicated below. The overall purpose of the forms is to give participants experience in using business forms commonly used by good managers.

Projected Profit and Loss Statement

The game participant is provided a projected profit and loss statement for use in estimating income from a particular plan (see Figure 1). In farm management terms, this statement is much like a short-term budget. (Short term expectations rather than normal income and expense items are included.) The title, Projected Profit and Loss, was used in the Decision Exercise since this is a general term used in accounting and in non-agriculture business forms. It was hoped the familiarity with budgeting held by students participating in the game would reinforce understanding of the projected profit and loss statement, and vice versa. The projected profit and loss statement is an abbreviated form

PROJECTED PROFIT AND LOSS STATEMENT--19__

Receipts

Item	Decision	Expected Net Sales
Wheat		
Grain sorghum		
Broomcorn		
Fallow		xxx
Cows, native 1/		
Cows, native & wht. past. 1/		
Steers, native 1/		
Steers, wht. past. 1/		
Wheat past. sales		
1. Total net sales	xxx	
Capital sales e.g., cows	xxx	
Steer capital	xxx	
2. Total net sales & L.S. capital	xxx	

Expenses

Item	Expected Expenses
Property tax	
Fallow	
Land interest	
Interest on short-term loans 2/	
Other	
3. Total expenses	
4. Net cash available for debt repayment, family living & investment (2 - 3)	

ANTICIPATED CASH FLOWS

Anticipated available cash (4 above)		______
Other anticipated cash outlays		
Steer loan	______	
Loan to cover last years losses	______	
Cow loan carryover from previous year	______	
New cow loan 3/	______	
Machinery purchases	______	
Est. income taxes (10% of 1 minus 3)	______	
Land payment	______	
Family living	______	
Total other anticipated cash outlays		______
Anticipated cash balance (anticipated available cash less total other anticipated cash outlays)		______

1/ Complete parts 5 and 6 of pasture balance sheet.

2/ Complete credit planning form to get total loans and loan interest.

3/ Include only that portion which is to be paid this year.

Figure 1. The Projected Profit and Loss Statement Used in the Decision Exercise

of the actual profit and loss. Thus, a completed projected profit and loss statement can expedite the completion of the actual profit and loss statement.

Pasture Balance Sheet

The pasture balance sheet (Figure 2), while not particularly sophisticated, was developed to help a participant visualize aids which can be useful in planning. In the Decision Exercise its purpose is to force the student to overtly examine influencing factors which might otherwise be overlooked.

Credit Planning Form

The credit sheet (Figure 3) has both planning and analysis objectives. In terms of planning it requires the determination of the amount of capital which will be needed and the asset(s) which will be used as collateral for obtaining credit should there be insufficient cash on hand. Analytical uses focus on the possible length of time money will be tied up, the payback requirements, and the rate of interest paid on the various items.

Actual Profit and Loss Statement

The actual profit and loss statement contains a summary of the actual costs and returns experienced by the business during the accounting period (see Figure 4). The included values are _ex post_ rather than _ex ante_ as in the projected profit and loss statement.

The game participant can use this statement for planning and analysis. By building a set of these statements he builds a "data bank" of information about the game farm. Year to year comparisons then can be

PASTURE BALANCE SHEET

5. Expected Pasture
   a. Native: ______ acres x .6 AUM [1/] per acre ____________
   b. G. Sorghum: ______ acres x .2 AUM per acre ____________
   c. Broomcorn: ______ acres x .2 AUM per acre ____________
   d. Total ____________
   e. Wheat pasture: ______ acres x ______ AUM per acre = ____________

6. Pasture Requirements for Livestock Plan

		Wheat (AUM)		Native (AUM)
a. Cows, native			13x___hd. =	________
b. Cows, native and wheat pasture	3x___hd. =	________	10x___hd. =	________
c. Steers, native			6x___hd. =	________
d. Steers, wheat pasture	2.5x___hd. =	________	.5x___hd. =	________
e. Total[2/]		________		________

7. Actual Pasture Available ______ (acres) x ______ (event) = ________

8. Deficit in Wheat Pasture (7 minus 6e) ________

9. Cost of purchasing feed or renting in wheat pasture (Feed @$10/AUM, wheat pasture @$______/AUM) ________ [3/]

10. Wheat Pasture Sales ________ [4/]

[1/]Pasture is measured in animal unit months throughout this exercise. One AUM is the amount of pasture required to carry one 1,000# cow and her calf (one AU) for one month.

[2/]Must not exceed expected pasture. Compare with 5d and 5e.

[3/] & [4/]Carry forward to P. & L. Statement (Form E).

Figure 2. The Pasture Balance Sheet Used in the Decision Exercise

CREDIT PLANNING FORM--19__

11. Cash balance from previous year	
12. Losses from previous year	

13. Livestock loans	Cows	Steers
a. Additional capital for L.S. purchases		
b. Cash used for purchases		
c. Net capital needed (a minus b)		
d. Collateral value of all livestock (70% of owned plus new purchases)		
e. Loans currently outstanding on L.S.		xxx
f. Net collateral value of L.S. (d minus e)		
g. Loan using L.S. as collateral		
h. Other loans (c minus g) (Using ___________ as collateral)		

14. Loan Summary	Loan	i rate	Interest
a. Cow loans (13, g plus h)		10%	
b. Steer loans (13, g plus h)		1/	
c. Cow loan carryover from previous year		10%	
d. Loans to cover previous losses (12 above)		10%	
Total short-term loans		xxx	xxx
Total interest	xxx	xxx	

15. Cash not used to cover L.S. purchases	

1/ Use a 5% interest rate for steers held only six months, i.e., steers on wheat pasture. Use 10% for steers on native.

Figure 3. The Credit Planning Form Used in the Decision Exercise

PROFIT AND LOSS STATEMENT--19__

Receipts

Item	Decision	Event (Return)	Actual Net Sales
Wheat			
Grain sorghum			
Broomcorn			
Cows, native			
Cows, native & wheat			
Steers, native			
Steers, wheat past.			
Wheat pasture sales			
16. Total			
Capital sales			
Steer capital			
17. Total net sales & L.S. capital			

Expenses

Item	
Property tax	
Fallow cost	
Land interest	
Interest on short-term loans	
Winter feed costs	
Winter pasture rent	
Land rent[1/]	
18. Total expenses	

19. Net cash available for debt repayment, family living and invest. (17 - 18) ______

Inventory Changes

	Mach.	Cows
20. Beginning inventory	$	
(-) Depreciation		xxx
(+) Purchases		
(-) Sales	xxx	
21. Ending inventory		
Net change in inv. (21 - 20)		
Investment credit (7% of purchases)		xxx
22. Net adjustments for inventory		

Taxes

Farm income (16 - 18)		
(-) Personal deduction[2/] (1/10 of farm income)		
(-) Exemptions	1800	
(-) Depr. on mach.		
Total deductions		
(=) Taxable income		
Income tax = taxable income x rate		
23. Actual income tax paid (Income tax-I. credit)		

CASH FLOWS

Unused cash (from 15)		
Net cash available from 19)		
24. Total cash		
26. Cash balance or deficit (24 - 25)		
27. New loan needed to cover losses (if 26 is negative)		

Other cash outlays:

Steer loans		
Loans to cover previous years losses		
Cow loan carryover		
New cow loan		
Machinery purchases		
Income tax		
Land payment		
Family living expenses		
25. Total other cash outlay		

[1/]To be used if the size of the operation is expanded through renting in additional land.

[2/]Cannot exceed $1,000.

Figure 4. The Actual Profit and Loss Statement Used in the Decision Exercise

made and the effects of "good" and "bad" years analyzed. Activities or expenses which have the most significant effect on net income in a given year or over a span of years can be isolated on this form. Such analysis might influence the strategy of the participant in playing the game in future periods.

Comparative Analysis Statement

This statement was designed to enable the participant to study essential information as reflected by operations (see Figure 5). The statement was patterned after a form recommended for general use by the American Bankers Association.[6] Data are included on financial items, profit and loss and management analysis ratios. The participant can observe farm operating results and their fluctuations with favorable and unfavorable sets of events. The results of a few periods should indicate the likelihood of the farm's success.

Net Worth Statement. This section of the comparative analysis statement is included to let the player take stock of his position at the end of each simulated year. From this statement the player can determine the value of assets and liabilities; make comparisons with previous years to see if net worth is growing or shrinking; and determine the degree of solvency of the business.

Financial Ratios. To draw conclusions concerning the adequacy of capital and the level of solvency, various statement items are related to each other in ratio form. The ratios included are those commonly used in credit analysis. Such ratios are helpful in following the financial trend of the business and in comparing one farm with another.

Fallow Summary. The fallow summary provides space for a participant to maintain a record of his fallow program. Including both intentional and

COMPARATIVE ANALYSIS STATEMENT

Net Worth Statement

	Mar. 31, 19__	Mar. 31, 19__	Mar. 31, 19__	Mar. 31, 19__
Assets:				
Cash	______	______	______	______
Cows	______	______	______	______
Machinery	______	______	______	______
Land & bldgs.	______	______	______	______
Total	______	______	______	______
Liabilities:				
Cow loans outstanding	______	______	______	______
Other short-term loans	______	______	______	______
Land mortgage	______	______	______	______
Total	______	______	______	______
Net worth:	______	______	______	______

Comparative Income and Expense Statement

Receipts				
Crops[1/]	______	______	______	______
Livestock	______	______	______	______
Capital sales (cows)	______	______	______	______
Steer capital	______	______	______	______
Total	______	______	______	______
Expenses				
Total	______	______	______	______
Net cash available (19)	______	______	______	______
Total other cash outlay	______	______	______	______
Cash balance of deficit (26)	______	______	______	______

Comparative Ratios

Net Worth Ratio: Net Worth/Total Assets	______	______	______	______
Land Equity Ratio: Land Equity/Land Assets	______	______	______	______
Creditor's Risk Ratio: Total Debt/Net Worth	______	______	______	______

Fallow Summary

Intentional fallow	______	______	______	______
Unintentional fallow	______	______	______	______

[1/]Includes wheat pasture sales, if any.

Figure 5. The Comparative Analysis Statement Used in the Decision Exercise

unintentional fallow allows the player to evaluate his position at any point in time and make projections about future needs. This summary also provides a game administrator easy access to fallow information so he can make sure the restrictions are being met.

Plug-In Elements

Since the number of decision variables remains constant throughout the Decision Exercise, two "once only" decisions were included (a) to facilitate learning related to but not included in the model and (b) to maintain participant interest. The introduction of new variables is called the "plug-in" effect. One plug-in effect was designed to have long-run implications, the other to have short-run effects. Both were developed with the intent they be used as surprise occurrences.

Acreage Expansion Opportunity

The acreage expansion plug-in element was developed to give participants experience in determining a price to pay for purchased or rented land. The decision experience can be administered in several ways. The following sequence has been used.

1. Players are told that the $10,000 average machinery investment is adequate to farm an additional 400 acres of land with identical capabilities and proportions of cropland and pasture as the 2,000 acres they already manage. (The discretion of the game administrator can be used in determining the maximum number of acres a player can add.)
2. The total number of acres available is made known. (The number of acres to make available is arbitrary. Making

enough acres available so about one-third of participants can add land works relatively well.)

3. Teams are asked to submit bids on the available land, and to indicate how many acres they will purchase at that price.
4. The land is distributed with the highest bid getting all the land desired (up to the maximum); the next highest bid gets second priority, etc., until all land is given out.

The net worth and land equity ratios should establish opportunities to bid. The concept of capitalizing expected returns to determine an economically justifiable price to pay for land acquisition is taught concurrently with the exercise. Discussion of prices bid and economically rational means of arriving at a price to bid provides an excellent experience for some game participants.

Using Marginal Analysis

As previously mentioned, the Decision Exercise provides participants no opportunity to choose among input levels. The participant cannot influence net revenue. Because of this game characteristic, the game designers developed a plug-in decision experience to give participants the opportunity to make an economic decision on level of input use.

The plug-in decision involves only the wheat activity. Participants are informed the weather and price conditions for the wheat activity are known for certain. Data on wheat production response to fertilization amenable to marginal analysis is supplied. Participants are given the opportunity to fertilize (top-dress) if they desire. No assistance is given the participants in selecting the level to use. It is assumed they will draw on previous economic training in making a decision. After all decisions are made the game administrator explains the concept being demonstrated in an attempt to make it more meaningful to those who might not have understood.

Summary

This chapter described the current version of the Decision Exercise. A discussion of earlier versions, evolutions and revisions which have taken place was not included. Nor was it intended that this should be a final version. It is hoped the findings of this study will point out deficiencies in the model and suggest improvements that could be made.

This chapter has shown how farm management economics can be illustrated using the Oklahoma Farm Management Decision Exercise. The next chapter describes the computer model and describes the computational steps required by both the computer and hand models.

FOOTNOTES

[1]Odell L. Walker and W. A. Halbrook, "Operational Gaming and Simulation as Research and Educational Tools in the Great Plains," _Proceedings of Farm Management Research Committee_, Western Agricultural Economics Research Council, (Portland, Oregon, November, 1965), pp. 105-111.

[2]The trials and revisions which produced the current version will not be discussed. The present version was pretested on state and area extension farm management specialists prior to its use.

[3]Discussion of important features to consider when constructing games can be found in:

E. M. Babb and Ludwig Eisgruber, _Management Games for Teaching and Research_, (Chicago, 1967), chapter 4.

Paul S. Greenlaw, Lowell W. Herron and R. H. Rawdon, _Business Simulation in Industrial and University Education_, (Englewood Cliffs, 1962), chapter 3.

J. M. Kibbee, C. J. Craft and Burt Nanus, _Management Games_, New York, 1961), pp. 93-144.

[4]W. R. Dill, "What Management Games Do Best," _Management: A Book of Readings_, ed. H. Koontz and C. O'Donnell (New York, 1964), pp. 296.

[5]The role and importance of the game administrator in gaming experiences has been discussed by:

Babb and Eisgruber, pp. 33-46.

Greenlaw, Herron and Rawdon, pp. 194-203.

Kibbee, Craft, and Nanus, pp. 63-92.

[6]_Farm Credit Analysis Handbook_, (New York, 1965), pp. II-1 to II-4.

CHAPTER V

THE COMPUTERIZED DECISION EXERCISE AND A GENERALIZED GAME MODEL

The description of the Decision Exercise in the previous chapter centered on economic considerations. This chapter focuses on the kinds of computations required; presents a computer model developed to make those computations; and introduces a generalized computer model which can be used with almost any set of technical-economic conditions.

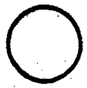
Objectives for computerizing the Decision Exercise were (1) to reduce routine calculations required of participants and (2) to develop a model which could be used in simulation. The first objective resulted from the limited time available for classroom problem-solving activities. By reducing the time spent on arithmetic, more time is left for participants to analyze, evaluate and make decisions. Results from simulation were needed to provide the game designers improved knowledge about the Decision Exercise.

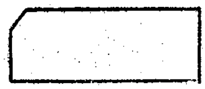
The Decision Exercise computer program was developed for an IBM 7040/7044. It can be used with an IBM 7090/7094 by altering a few format and read statements. FORTRAN IV was the computer language used.[1]

Operational Subsections

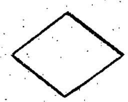
The explanation of important subsections of the computer model is given in flow chart form (Figure 6) and explained in words. The following symbols will aid in reading the flow chart.

 (a) Program terminals

 (b) Connectives to other parts of the program.

 Input devices: cards.

 Output devices: cards, paper.

 Decision and control statements.

A complete print-out of the computer program is provided in Appendix A.

There are eight basic operational subsections in the computer program. These are:

1. Event generation
2. Pasture availability and requirement determination
3. Activity revenue determination
4. Debt and interest determination
5. Receipts and expenses summarization
6. Tax computation and non-deferrable cash flows
7. Feasible deferrable cash flow payment
8. Critical ratio determination

Event Generation

The random variables and their associated distributions were described in Chapter III. The computerized Decision Exercise model uses the same discrete probability distributions as the hand computed model. There are two reasons. First, the game designers assumed users of the Decision Exercise would substitute the computer model for the hand-computed model after a few plays. Using the same events in the computer

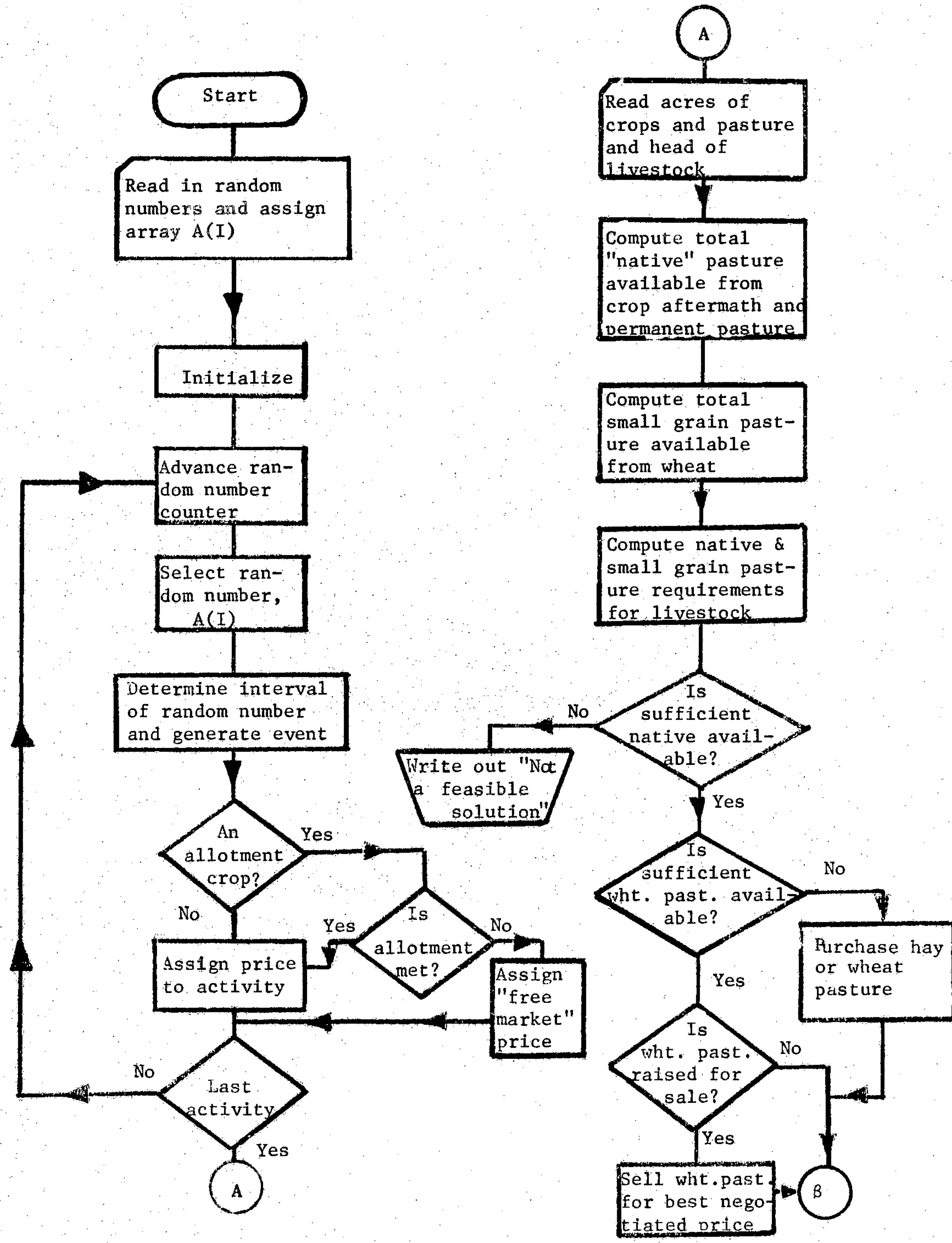


Figure 6. Flow Chart; Computer Model of the Decision Exercise

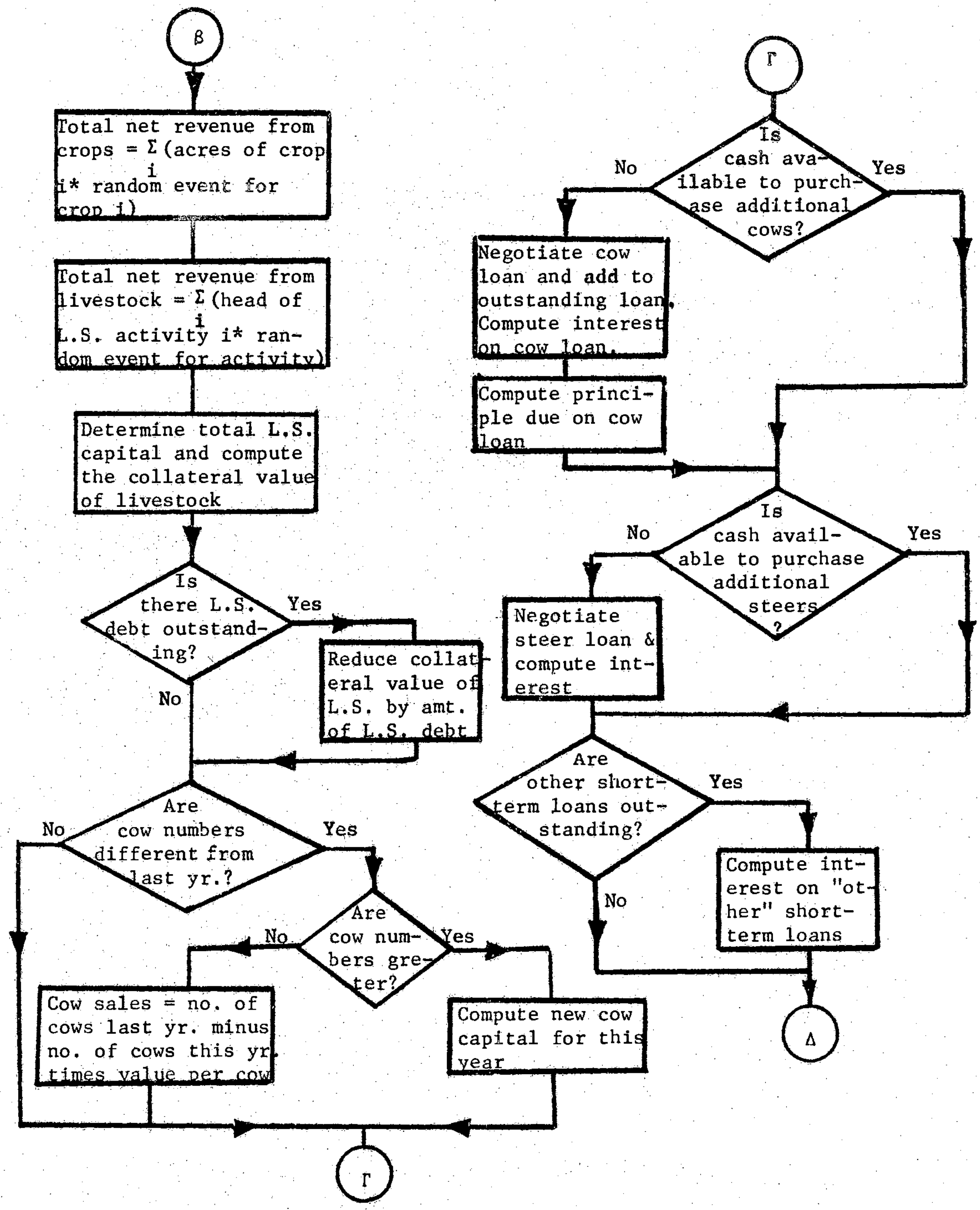


Figure 6 (Continued)

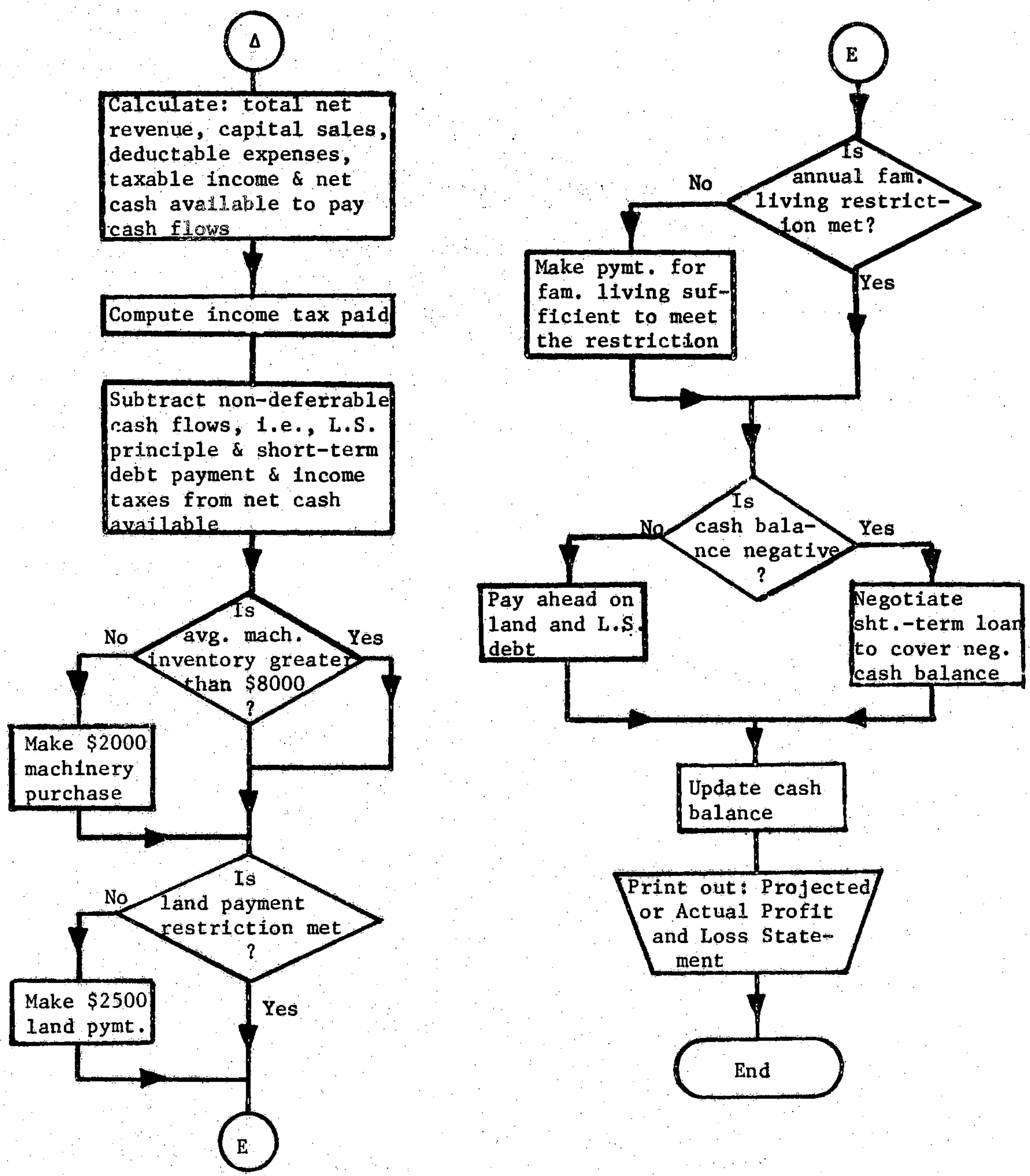


Figure 6 (Continued)

model that were used in the hand-computed model should facilitate continuity of gaming experiences. Secondly, a simulation analysis of possible growth paths was planned for the game farm. By using the same distribution in gaming and simulation, specific information on possible outcomes from gaming could be generated.

The procedure of random event generation is explained in Figure 6, column 1. The following is the set of computer statements for determining the wheat revenue event.

```
      IF(A(I).LE.33.)  GO TO 202
      IF(A(I).LE.66.)  GO TO 203
      IF(A(I).LE.99.)  GO TO 204
  202 PWHT = 5.
  203 PWHT = 10.
  204 PWHT = 20.,
```

where A(I) is a random number and PWHT is the return value for wheat. The random numbers were drawn from a random number table and fed into the array A(I). A different random number from the array is selected for each activity each play of the game. If the random number falls between zero and 33 in the above example, the revenue event for wheat used in the given play will be $5. Similarly, it will be $10 if the random number is between 33 and 66 and $20 if the number is between 66 and 100. Net revenue events for all other activities are obtained in a similar manner. Revenue events for cows are perfectly correlated in the computer model.

As mentioned previously, wheat pasture events are conditional upon the wheat revenue event. Thus, the first step in generating this event requires a check to see which wheat revenue event was obtained. This determination indicates from which distribution the grazing event is to be drawn. Except for this additional step, the grazing event is generated exactly as are revenue events.

A continuous probability distribution could have been used rather than the discrete distribution. This would require adding a random number subroutine, but would have made the program more realistic. Difficulty associated with keeping track of generated events was the deterrent to using a continuous distribution in the original Decision Exercise computer model. The generalized computer game model explained later in this chapter utilizes a continuous distribution. The subroutine used will be described in that section.

Pasture Availability and Requirements

Available small grain and aftermath grazing are determined by multiplying acres of each crop by the expected grazing per acre. The computations are made in equations (5-1)[2] and (5-2).

$$ANA = A_i * G_i \tag{5-1}$$

where ANA_i = available aftermath (native) pasture from crops; A_i = acres; and G_i = grazing expected (may be a randomly generated event).

$$SGG = A_i * SG_i \tag{5-2}$$

where SGG = small grain grazing and SG_i = small grain grazing event generated.

Total available AUM's of native pasture grazing ANATPA, is determined by summing ANA for all i including native pasture. SGG is the total small grain grazing available since wheat is the only crop furnishing small grain grazing.

The amount of pasture required is computed by multiplying the number of head of each class of livestock (given by the player's decision) by the grazing requirements per head and summing over all classes. Total native and wheat pasture required, REQNAT and REQWHT, are then compared with the amount of each type pasture available. If more native pasture is required than is available, the computer terminates the run for an actual profit and loss statement and prints the participant a message telling him his organization is not feasible. (Runs which are intended to give a projected profit and loss are not terminated.) A deficiency in wheat pasture is met by either purchasing (1) additional winter feed or (2) additional wheat pasture from another participant. The cost of the additional winter feed is $10 per AUM. To be used in the computer model, the negotiated wheat pasture alternative requires _a priori_ knowledge of the event by the game administrator.

Debt and Interest Determination

Both short-term and long-term debt items are included in the Decision Exercise. Land debt is the only allowed long-term debt. The long-term interest rate is five percent. Short-term debt may be incurred for livestock loans or to cover losses. Livestock and machinery inventories and owned land are used as collateral for short-term debt. The interest rate on short-term debt is 10 percent, even when land is used as collateral. Debt may be incurred as long as the net worth ratio exceeds .35.

The sequence of computations in this section is as follows:

1. Determine if there is any change in cow numbers. If so, is new loan required?

2. If steers are included, is a loan needed?
3. Determine total new livestock loan.
4. Is there collateral available? What is it?
5. Is there cow loan outstanding?
6. Total all livestock loan and compute interest.
7. Compute interest on balance of real estate loan.
8. Compute interest on other short-term loan outstanding (e.g., loans to cover losses in previous periods).

Activity Revenue Determination

Total net revenue from activity i is obtained by multiplying the generated revenue event for activity i by number of units of activity i. The equation would read:

$$ENS_i = P_i * U_i \tag{5-3}$$

where ENS_i = expected net sales from activity i; P_i = generated revenue event for activity i; and U_i = units of activity i (e.g., acres, head).

Summary of Total Receipts and Expenses

Total net revenue from all enterprises, TOTNET, includes all livestock and crop net revenues plus the return from sale of small grain pasture, WPS.

$$TOTNET = \sum_i ENS_i + WPS \tag{5-4}$$

Total revenue for paying deductible expenses and cash flows, SALES, includes cow and steer capital sales.

$$SALES = TOTNET + CSALES + STRCAP \tag{5-5}$$

This equation is used to add money to cash flow which was removed earlier for steer or cow purchases. Steer capital, STRCAP, is added and subtracted each year. The net effect is zero but it does permit computation of interest if a loan is needed. This technique for handling steer capital is a reasonable approximation of reality. Most buy-sell steers are purchased and sold within a single decision period. Cow sales, CSALES, will have a positive value in periods when the cow herd numbers are reduced.

Deductible cash expense, EXP, refers to expenses which would reduce taxable income, but which have not been subtracted out when determining net revenue. For the Decision Exercise these expenses are property tax, fallow expense, land interest, interest paid on short-term debt, and other expenses such as land rental and small grain pasture rental.

Tax Computation and Non-Deferrable Cash Flows

Non-deferrable cash flows is the term applied to obligations that must be paid whether or not cash is available. They differ from deductible expense because they do not reduce the amount of taxes paid. Principal payments on steer loan, cow loan and other short-term loan are items in this category. In the Decision Exercise taxes paid are also classified with non-deferrable expenses.

The tax computation made by the computer are based upon the 1967 Farmer's Tax Guide. Taxable income, TAX, is determined by equation (5-6).

$$\text{TAX} = \text{TONET} + \text{CSALES} * .5 - \text{EXP} - \text{Standard deduction} - \text{Exemptions} \quad (5\text{-}6)$$

Tax equals total net revenue plus capital gains (cow sales) minus deductible expenses (EXP), an allowance for standard deduction (not to exceed $1000), and an $1800 allowance for exemptions. (Altering the model to reflect changing tax laws requires changing only one statement.) Taxable income is then multiplied by the mean rate from the tax bracket into which the income value falls to determine tax paid.

Actual tax paid could be made more accurate by including 20% additional first year depreciation when appropriate. This decision is an alternative currently left to the participant. If there is insufficient cash for payment of non-deferrable cash flows, a short-term loan must be made for the succeeding year.

Deferrable Cash Flows

As explained in the previous chapter, machinery purchases, land debt repayment and family living expenditures can be varied in accordance with certain minimum restrictions. The decision diagram for evaluating the possibilities for paying these deferrable expenses is given in the last section of Figure 6.

The model first makes sure the minimum requirements on machinery inventory is met. It next checks to see if land payments have been made the previous two years. If land payments have not been made in the two previous periods a $2500 payment is made; if it has, then no payment is made at this point. The computer next checks to see if the $4000 average family living level has been maintained in the past. If not, it brings the average up to $4000.

After all restrictions have been met the computer checks to see if the cash balance is positive or negative. If negative, a short-term loan must be obtained. If there is cash on hand the program will use the cash to reduce livestock and land debt as cash on hand earns no interest, but future interest payments can be reduced by paying ahead.

Payments are first made on livestock loan principle as a higher interest rate is paid on livestock than on land.

Equity Position and Critical Ratios

The computer model has the capability to update and compute assets, liabilities, net worth, and all critical ratios. To print out a complete net worth form would require additional statements. The auxiliary information printed out with the actual profit and loss statement gives all information necessary to construct a net worth statement. The participant is required to prepare and maintain the net worth statement.

Input

Only three cards are required to input participant decision information. Figure 7 shows the decision form the player fills out for each decision period. The first number of the two digit number preceding each statement on the decision form refers to the card number (i.e., 1, 2, or 3) and the number after the decimal refers to the field in which the particular item falls. The blanks on the righthand side of the decision form correspond to specific columns on the data cards.

The only input required of the game administrator is a set of random numbers for the array A(I). Ten years of play requires 70 numbers. At 40 numbers per card this is less than 2 IBM cards for the array A(I). The administrator also must make sure the three cards furnished by participants are in the order required by the computer for accurate output generation.

OKLAHOMA FARM MANAGEMENT DECISION EXERCISE

Decision Form

for

Period ______

Decision Information		Team No. ___ ___ ___._
1.1.	Acres Cropland	___ ___ ___ ___ ___ ___._
1.2.	Acres Pasture	___ ___ ___ ___ ___._
1.3.	Acres Wheat	___ ___ ___ ___ ___._
1.4.	Acres Grain Sorghum	___ ___ ___ ___ ___._
1.5.	Acres Broomcorn	___ ___ ___ ___ ___._
1.6.	Acres Fallow	___ ___ ___ ___ ___._
1.7.	No. of Cows on Native	___ ___ ___ ___ ___._
1.8.	No. of Cows on Native and Wheat	___ ___ ___ ___ ___._
1.9.	No. of Steers on Native	___ ___ ___ ___ ___._
1.10.	No. of Steers on Wheat	___ ___ ___ ___ ___._
2.1.	Value of Cow Capital at End of Last Year	___ ___ ___ ___ ___ ___ ___._
2.2.	Losses Last Year, If Any	___ ___ ___ ___ ___ ___ ___._
2.3.	Carryover Cow Loan From Last Year	___ ___ ___ ___ ___ ___ ___._
2.4.	Land Debt Unpaid	___ ___ ___ ___ ___ ___ ___._
2.5.	Cash Balance, If Any	___ ___ ___ ___ ___ ___ ___._
3.1.	Amount Spent on Machinery Last Year	___ ___ ___ ___ ___ ___._
3.2.	Land Payment Last Year	___ ___ ___ ___ ___ ___._
3.3.	Land Payment Year Before Last	___ ___ ___ ___ ___ ___._
3.4.	Family Living Last Year	___ ___ ___ ___ ___ ___._
3.5.	Land Rental Payment	___ ___ ___ ___ ___ ___._
3.6.	Year	___ ___

Figure 7. Computer Input Form; Computer Model of the Decision Exercise

Output

The computer model prints two kinds of forms: (a) the Projected Profit and Loss Statement, and (b) the Actual Profit and Loss Statement. The data on cropland uses, livestock enterprises, cash on hand, outstanding debts, and other data used in constructing a net worth statement are processed and updated before being printed out.

Projected Profit and Loss Statement

The output in the projected profit and loss statement is deterministic since the player furnishes the net revenue and small grain grazing events. The event generator section of the computer model is not used.

A sample projected profit and loss statement is shown in Figure 8. The number of units of each activity (i.e. acres, head) and total net revenue from each activity are shown in the receipts section. Capital sales are also shown under receipts. Only tax deductable expenses are listed in the expense section.

The list of non-deferrable cash flows is a direct function of the plan specified by the participant. This list, coupled with deferrable cash flows, gives the participant an estimate of the minimum income necessary to cover cash flows for the specific plan.

Auxiliary information deals with the utilization of expected pasture and the composition of short term assets and debts. The pasture information indicates the pasture surplus or deficit the player could expect with a given organization. Current asset and debt data could be used for computing a current ratio or determining if new debt should be incurred in the current decision period.

PROJECTED PROFIT AND LOSS STATEMENT TEAM 5.

ITEM	DECISION	EXPECTED NET SALES	ITEM	EXPECTED EXPENSES
WHEAT	600.00	6000.00	PROPERTY TAX	1600.00
GRAIN SORGHUM	200.00	2200.00	FALLOW	800.00
BROOMCORN	100.00	2500.00	LAND INTEREST	2375.00
FALLOW	200.00		INT ON SHT-TERM LOAN	912.00
COWS-NATIVE	40.00	2000.00	OTHER	0.00
COWS-N AND WHT PASTURE	0.00	0.00		
STEERS-NATIVE	0.00	0.00	TOTAL EXPENSES	5687.00
STEERS-WHEAT PASTURE	40.00	800.00		
WHT PASTURE SALES		0.00		
TOTAL NET SALES		13500.00		
COW CAPITAL SALES		0.00		
STEER CAPITAL SALES		4800.00		
TOTAL NET SALES AND L.S. SALES		18300.00	NET CASH AVAILABLE FOR DEBT REPAYMENT FAMILY LIVING AND INVSTMT	12613.00

ANTICIPATED CASH FLOWS

NONDEFFERRABLE		DEFERRABLE	
STEER LOAN	3360.00	MACHINERY	2500.00
LOANS TO COVER LAST YEARS LOSSES	0.00	LAND PAYMENT	4000.00
COW LOAN CARRYOVER FROM LAST YR	0.00	FAMILY LIVING	0.00
NEW COW LOAN	2800.00		
INCOME TAX PAID	941.71		
MISC.SHT-TERM LOANS	1840.00		

AUXILIARY INFORMATION

NATIVE PASTURE USED	540.00	CASH ON HAND	0.00
NATIVE PASTURE AVAILABLE	540.00	VALUE OF COW CAPITAL	8000.00
WHEAT PASTURE USED	100.00	OUTSTANDING COW LOAN,	2800.00
WHEAT PASTURE AVAILABLE	120.00	OTHER SHORT TERM LOANS	2828.71

Figure 8. Sample Projected Profit and Loss Statement; Computer Model of the Decision Exercise

Actual Profit and Loss Statement

The actual profit and loss computer print-out (see Figure 9) is much like that of the projected profit and loss statement. The net revenue events generated by the program are included in the receipts section. A feasible cash flow solution is furnished the participant. Items in feasible cash flow solution includes both non-deferrable and deferrable cash flows and meets the restrictions of the Decision Exercise. The participant has the flexibility of choosing the feasible cash flow solution generated or developing an alternative which more nearly fits his strategy or preferences.

Auxiliary information is sufficiently complete to allow the participant to prepare a net worth statement and other items on a comparative analysis statement.

The Generalized Computer Game Model

The computerized model of the Decision Exercise serves its purpose as a time saver. With minor adjustments the model could be altered to allow generation of revenue and grazing events from a continuous normal distribution. However, the Decision Exercise model is limited to a specific, pre-determined farming situation and set of activities.

The generalized game model was developed to allow use of entirely new activities and farm situations. This model can be used with almost any set of crop and livestock activities. As written the model will handle ten crop and eight livestock activities. With minor adjustments the computer program could be expanded to handle 40 activities and not exceed storage capacity of the IBM 7040 computer. The computer program for the generalized game is given in Appendix B.

ACTUAL PROFIT AND LOSS STATEMENT TEAM 5.

ITEM	DECISION	PRICE	NET SALES	ITEM	EXPENSES
WHEAT	600.00	10.00	6000.00	PROPERTY TAX	1600.00
GRAIN SORGHUM	300.00	11.00	3300.00	FALLOW	800.00
BROOMCORN	100.00	0.00	0.00	LAND INTEREST	2500.00
FALLOW	200.00			INT ON SHT-TERM LOAN	912.00
COWS-NATIVE	40.00	65.00	2488.00	OTHER	0.00
COWS-N AND WHT PASTURE	0.00	70.00	0.00		
STEERS-NATIVE	0.00	30.00	0.00	TOTAL EXPENSES	5812.00
STEERS-WP	40.00	15.00	600.00		
WHT PASTURE SALES			0.00		
TOTAL NET SALES			12388.00		
COW CAPITAL SALES			0.00		
STEER CAPITAL SALES			4800.00		
TOTAL NET SALES AND L.S. SALES			17188.00	NET CASH AVAILABLE FOR DEBT PAYMENT FAMILY LIVING AND INVSTMT	11376.00

FEASIBLE CASH FLOW SOLUTION		AUXILIARY INFORMATION	
CARRYOVER COW LOAN PAID	0.00	CASH ON HAND	0.00
PAID LOAN ON LAST YRS LOSSES	0.00	VALUE OF COW CAPITAL	8000.00
STEER LOAN PAID	3360.00	VALUE OF LAND AND BLDGS	140000.00
PRINCIPLE ON NEW COW LOAN	2800.00	OUTSTANDING COW LOAN	2800.00
INCOME TAX PAID	741.31	DEBT TO COVER LOSSES	11865.31
MACHINERY PURCHASED	4000.00	LAND DEBT BALANCE	47500.00
LAND PAYMENT	2500.00		
FAMILY LIVING	8000.00	NET WORTH RATIO	0.58
MISC.SHT-TERM LOANS	1840.00	LAND EQUITY RATIO	0.63

Figure 9. Sample Actual Profit and Loss Statement; Computer Model of the Decision Exercise

No specific farming situation is developed for the generalized computer model, hence, resource restrictions such as acres, head, allotments, etc. must be made explicit outside the computer model. Because the computer model does not check for restrictions, greater responsibility is placed upon the game administrator to insure participants do not exceed the set limits.

One way to handle an allotment problem would be to have two wheat activities which were identical except one would have greater receipts due to government payments. Players who did not wish to stay within the allotment restriction would select the wheat activity without the government payment; whereas, the participant who chose to comply with allotments would choose the activity which included government payments in the receipts.

Inputs by Game Administrator

The basic data on crops and livestock must be supplied the computer model by the game administrator. The following list of crop information is supplied on one IBM data card per crop activity:

1. Name of activity
2. Normal yield per acre
3. Standard deviation on normal yield
4. Price per unit of crop
5. Standard deviation on price
6. Price floor below which price cannot fall, if any.
7. Small grain grazing mean
8. Standard deviation on small grain grazing
9. Aftermath grazing mean

10. Standard deviation for aftermath grazing
11. Total capital on annual equivalent basis
12. Expenses per acre
13. Production trend, if any
14. Interest rate which must be paid on any loan required to cover expenses.

The livestock data which must be furnished are:

1. Name of activity
2. Normal production per head
3. Standard deviation on production
4. Normal price received
5. Standard deviation on price
6. Annual capital requirement
7. Expenses per unit
8. Native pasture required per unit
9. Small grain grazing required per unit
10. Price floor, if any
11. Production trend, if any
12. Interest rate which must be paid on any loan for the particular activity.

The data are stored in two and three dimensional arrays to allow easy retrieval within the program.

Inputs Furnished by Game Participants

As written, the generalized model does not provide storage of basic asset and debt information. The player provides this information each period in the Financial Information section of the decision form (see Figure 10).

The participant also furnishes decisions on capital flows, i.e., payment on debt and purchases and sales of assets. These data are supplied in the Investments and Disbursements and Inventory Adjustments sections of the decision form. Thus, the participant is committed to investment and debt payment decisions before the events of the year are known.

The decisions on crop and livestock activities are given in the Farm Plan section of the decision form. Given a knowledge of the list of possible crop and livestock activities, the player can choose any combination of those activities. The example decision form has no specific crop activity names. In actual use an activity identification such as wheat with 0-45-0 fertilizer or sorghum with government payment would be substituted for activity name of crop i.

If 10 crop and eight livestock activities are used, the generalized model would require only three input cards per participant.

Assumptions of the Model

There are three very crucial assumptions of the generalized model. First, all income is assumed received at the end of the year, thus all expenses must be paid out of cash on hand from the previous year. If insufficient cash is available to cover expenses, money must be borrowed to cover them and interest on short-term borrowed capital paid at the prescribed rate for each activity. The second assumption requires all production to be sold at the going price in the year in which it was produced. No storage opportunities are included. The third assumption

Oklahoma Farm Management Game No. IV
Decision Form

Team I. D. ______________________ Year ______________________

Financial Information:

Value of long-term assets ______________ Long-term debt ______________
Value of intermediate-term assets ______________ Intermediate-term debt ______________
Cash on hand ______________ Short-term debt ______________

Investments and Disbursements:

Value of long-term assets purchased this period ______________
Payment on short-term loan ______________
Payment on intermediate term loan ______________
Payment on long-term loan ______________

Inventory Adjustments:

Value of beginning cow inventory ______________
Value of beginning machinery inventory ______________
Value of cows to be purchased this period ______________
Value of machinery to be purchased this period ______________
Value of cows sold this period ______________

Farm Plan:

Activity name for crop i ______________
. . . .
. . . .
. . . .
Activity name for crop j ______________

Activity name for livestock i ______________
. . . .
. . . .
. . . .
Activity name for livestock j ______________

Acres of pasture

Figure 10. Computer Input Form; Generalized Computer Model

requires deficiencies in grazing to be made up by hay purchases. Minor adjustments could be made in the model to allow buying and selling of pasture as was explained for the previous model.

Computational Subsections of the Model

The operations performed by the model may be grouped into subsections. The distinction is not always clearly recognizable in the source program because of certain programming procedures used. A flow chart is presented to illustrate the general sequence of operations (see Figure 11). The computational subsections are as follows:

Event Generation

Generation of price and production events for each activity requires the use of a random normal number generator subroutine,[3] plus the means and standard deviations supplied by the game administrator. The subroutine produces a random number, X, such that $-\infty < X < \infty$. The distribution of the X's has mean zero and variance of one. Any particular random event, $RAND_{ij}$ is obtained by equation (5-7).

$$RAND_{ij} = S_{ij} * X + M_{ij} \tag{5-7}$$

where S_{ij} is the jth standard deviation for the ith activity and M_{ij} is the jth mean for the ith activity. (j refers to the event of interest e.g., yield, price, etc.). The model checks generated price and yield events to make sure they are not lower than the "floor" values set by the game administrator. If the generated values are lower than the "floor" value, the "floor" value is automatically assigned the event. Hence, even though the values are drawn from a normal distribution,

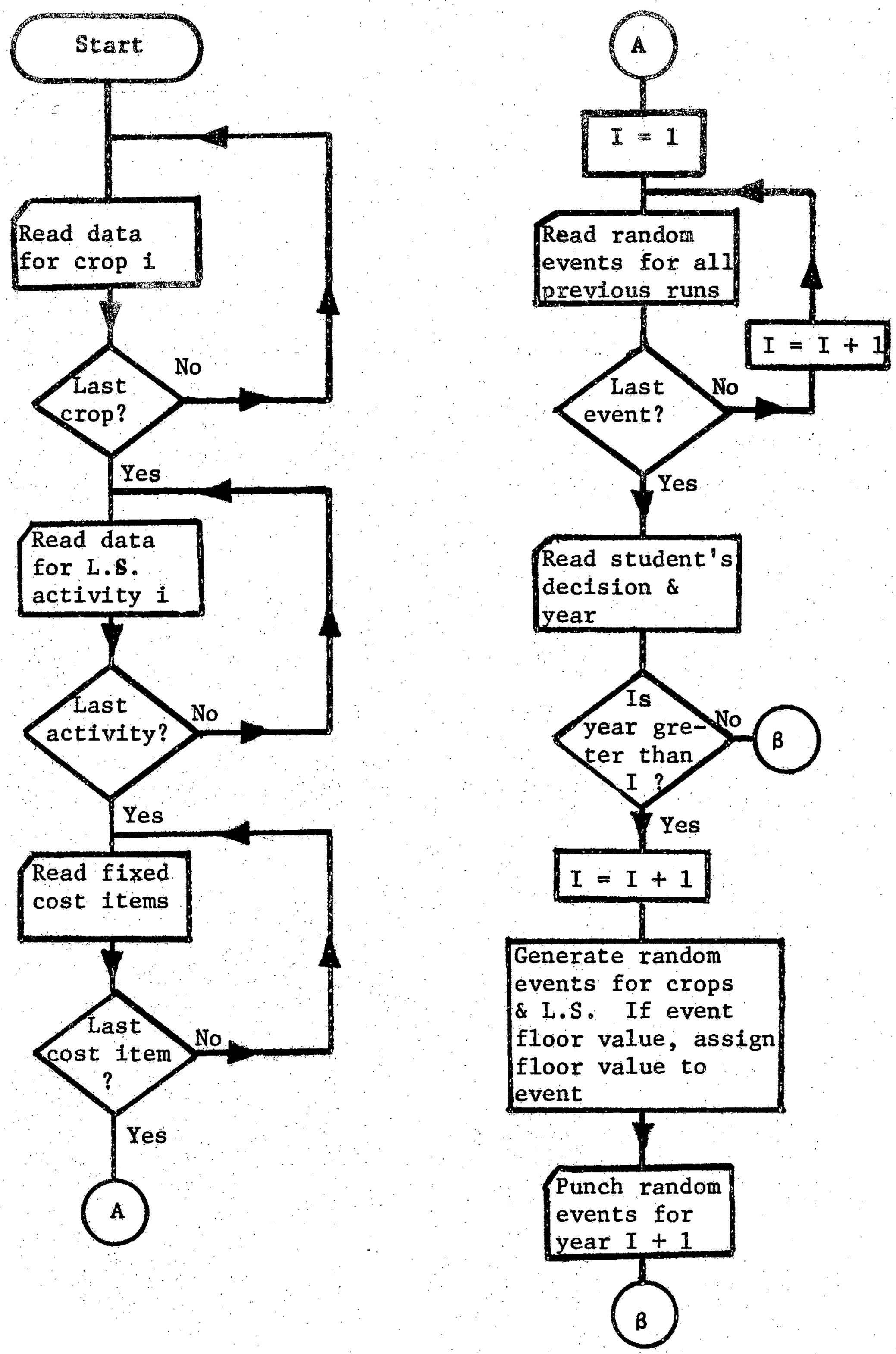


Figure 11. Flow Chart; Generalized Computer Model

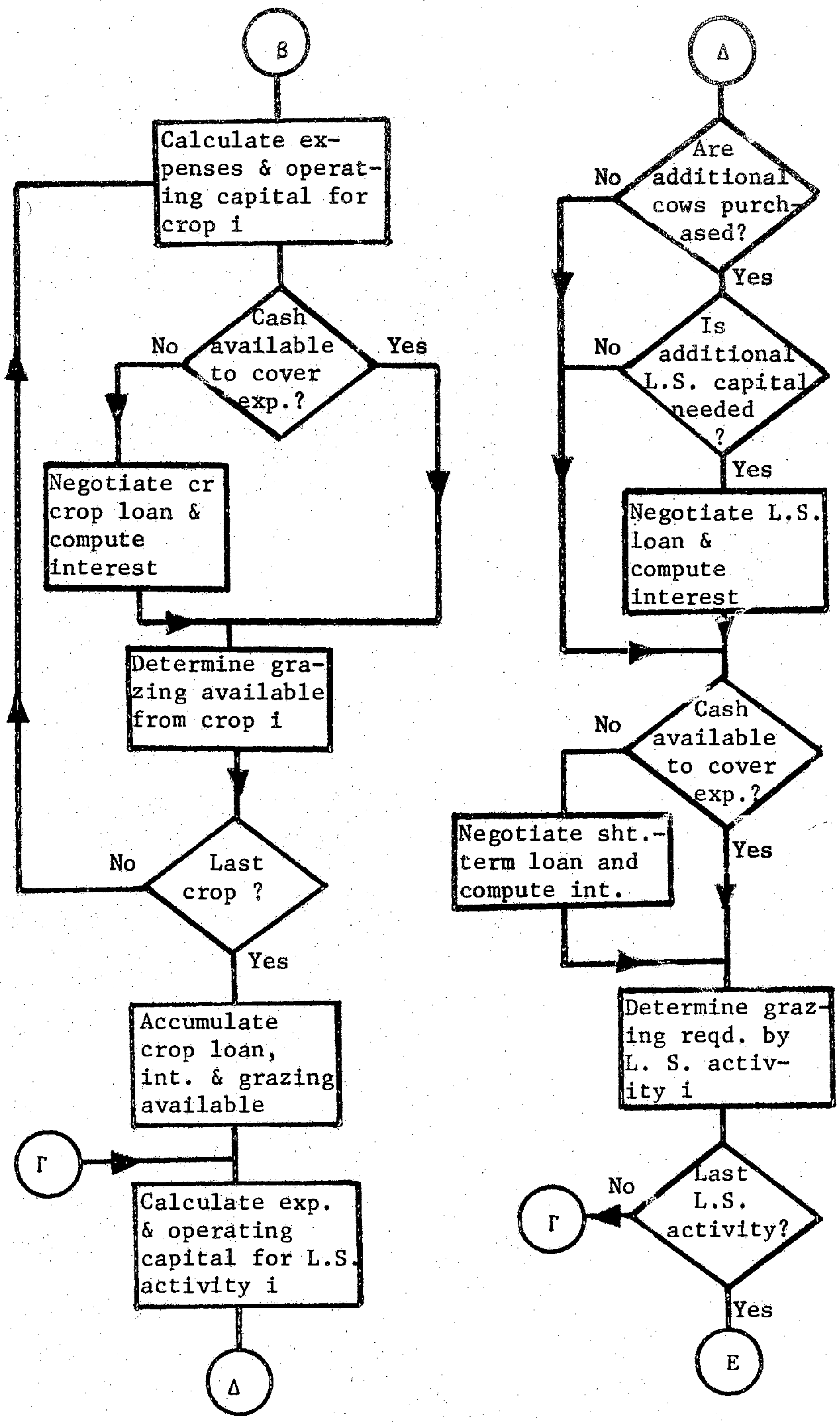


Figure 11 (Continued)

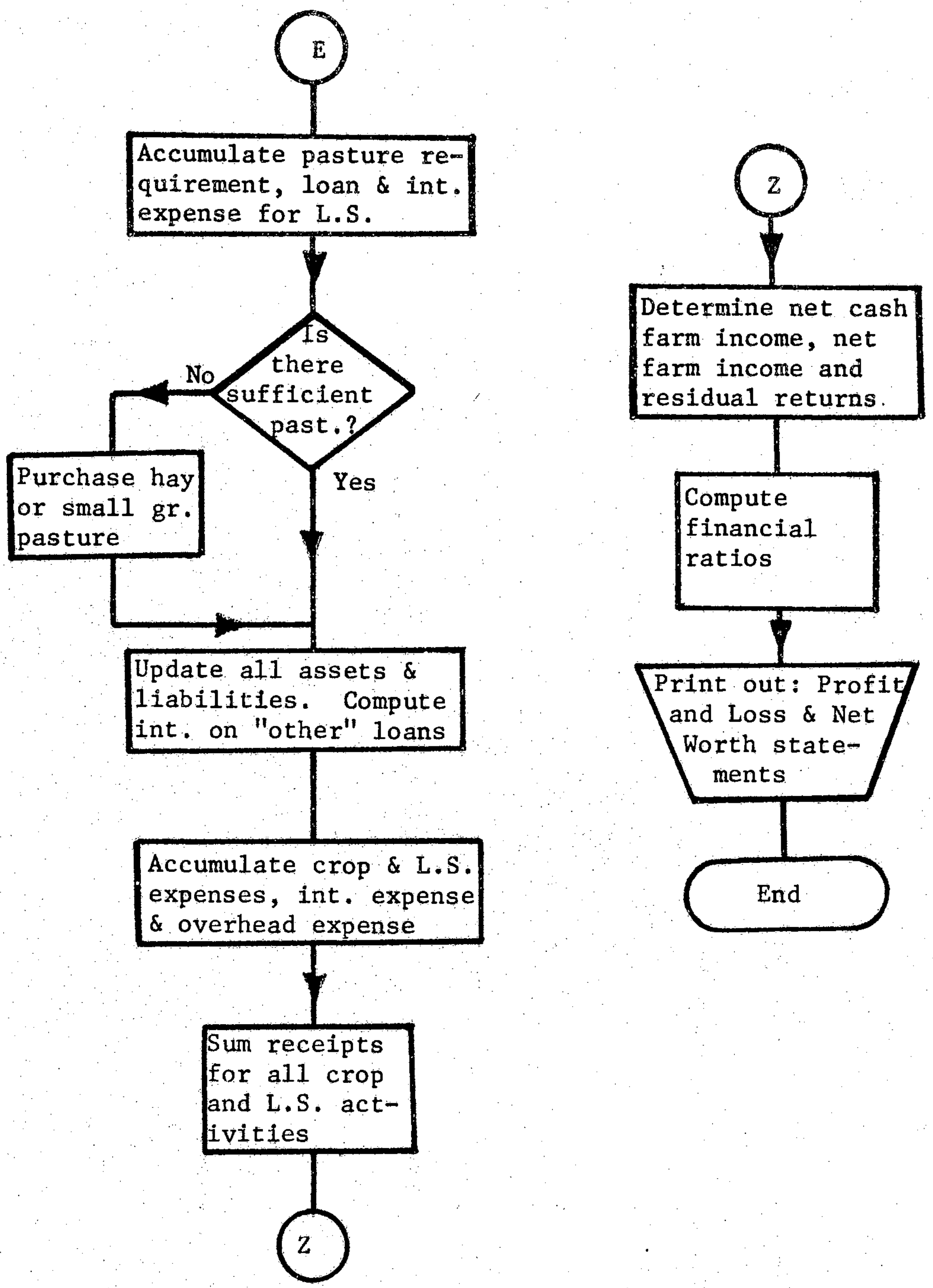


Figure 11 (Continued)

because of the floor values the resulting distribution is non-normal.

Crop Expense and Capital Determination

Expenses for each crop activity are determined by

$$E_i = Cr_i * A_i \tag{5-8}$$

where E_i = total expenses, less interest expense, for crop i and Cr_i = expense per acre for crop i. Crop expenses are sequentially computed. As the expense for each crop i, i = 1...10, is computed, a check is made to see if sufficient cash is available to cover the expense of that crop. If there is insufficient cash, a short-term loan is negotiated and interest computed on the loan[4] at the specified rate. Total crop expenses are determined by summing all E_i and all crop interest expenses.

Grazing From Crops and Pasture

Permanent pasture is assumed to produce a fixed amount of grazing per acre. Aftermath grazing can be either a fixed or stochastic variable. It is assumed to be substitutable for permanent pasture. Equation (5-9) determines the total native pasture available.

$$N = \sum_i (RAND_{ij} * A_i) + P_a * AUM; \tag{5-9}$$

where N = total "native" pasture; $\Sigma(RAND_{ij} * A_i)$ = total aftermath grazing from all crops; P_a = acres of permanent pasture; and AUM = grazing available from each acre of permanent pasture.

Small grain grazing is determined by

$$SG = \sum_i (RAND_{ij} * A_i); \tag{5-10}$$

where SG = total small grain grazing available and $RAND_{ij}$ = small grain grazing from each acre of crop i.

Livestock Expenses and Capital Determination

Expenses for each livestock activity are determined by:

$$Ex_i = Ls_i * H_i \tag{5-11}$$

where Ex_i = total expenses, less interest expense, for livestock activity i; Ls_i = livestock expenses per head, less interest expense; and H_i = number of head of activity i.

Livestock expenses are paid out of cash on hand at the beginning of the period as is done with crops. A short-term loan must be negotiated to cover any expenses not covered by beginning year cash balance. Additional breeding stock are purchased out of cash if there is a positive balance. If insufficient cash is available a loan is made.

Interest on livestock loan is not included in expenses and must be computed if there are livestock loans. Total livestock interest, $\Sigma (Int_i)$, is added to livestock expenses to get total livestock expenses, TOT.

$$TOT = \sum_i (Ex_i) + \sum_i (Int_i) \tag{5-12}$$

Pasture Balance

Native pasture and small grain grazing required by livestock are determined by equations (5-13) and (5-14).

$$R_N = \Sigma(Pn_i * H_i) \tag{5-13}$$

where R_N = total native required by livestock and Pn_i = native required per head.

$$R_{SG} = \Sigma\,(Sg_i * H_i) \tag{5-14}$$

where R_{SG} = total small grain grazing required by livestock and Sg_i = small grain grazing required per head.

A test is made to see if sufficient grazing is available. If grazing is not available, the model branches to the appropriate equations and makes up the deficit native and/or small grain pasture by purchasing hay. The equation for deficit pasture is:

$$H_p = \begin{cases} 0; & \text{if } R_N \leq N \text{ and } R_{SG} \leq SG \\ D * Hay_p; & \text{if } R_N > N \text{ and/or } R_{SG} > SG \end{cases} \tag{5-15}$$

where H_p = cost of purchased hay; D = deficit pasture; and Hay_p = price of hay per AUM.

Expense and Debt Summarization

Interest on all carryover land, livestock and short-term debt not previously computed is determined in this subsection. This interest is then added to total crop and livestock expense, total overhead (fixed) and deductible expenses. Debt and asset balances are also updated in this subsection by making the payments and purchases prescribed on the decision form.

Crop and Livestock Sales

Total sales is a sum of gross receipts from all crop and livestock activities. The equation is

$$\text{Sales} = \Sigma(Y_i * P_i * A_i) + \Sigma(Pr_i * Pl_i * H_i) \qquad (5\text{-}16)$$

where Y_i = yield event for crop i; P_i = price event for crop i; Pr_i = production event for livestock i; and Pl_i = price event for livestock i. All four random events have the name RAND plus identifying subscripts in the computer program.

Measures of Income and Financial Balance

Net cash from operations is the difference between gross sales and total expenses assignable to the activities in the farm plan. Subtracting deductible, also called non-allocatable, expenses from net cash from operations gives net cash farm income. Non-allocatable expenses are property tax, interest on mortgage, interest on crop loans, other interest, and hay purchases and pasture purchases. Net cash farm income is adjusted for short and intermediate term capital changes to get residual return to land, labor, management and risk.

Intermediate term asset ending value is determined by adjusting beginning value. Purchases are added and sales and/or depreciation are subtracted.

Output

Figure 12 gives a sample output for the generalized computer model. Five crop and four livestock activities were included for the example. The output includes both a profit and loss statement and a current net worth statement. The participant's name and the decision period simulated are also printed out to facilitate ease of administration.

PROFIT AND LOSS STATEMENT JUST AND MORRIS YEAR 1

ACTIVITY	DECISION	PRICE	SALES	EXPENSES
WHEAT	250	1.41	7928.97	5372.50
GRAIN SORGHUM	50	1.22	1189.65	1277.00
BROOMCORN	50	13.95	749.68	662.00
OATS	100	0.63	3147.65	2094.00
FALLOW	100	0.00	0.00	400.00
COWS,NATIVE	10	24.28	573.87	2000.00
COWS,NAT-WHT	10	26.54	2122.77	2000.00
STEERS,NATIVE	10	22.04	2932.68	1118.40
STEERS,WHEAT	10	22.20	4015.80	630.70
TOTAL SALES			22261.06	
TOTAL EXPENSES				15154.60
NET CASH FROM OPERATIONS			7106.46	

NON-ALLOCATABLE EXPENSES

PROPERTY TAX	1600.00
INT ON MORTGAGE	2500.00
INT ON SHORT TERM CAPITAL	465.10

FARM INCOME 2541.36

ADJUSTMENTS FOR CAPITAL CHANGE

	LIVESTOCK	MACHINERY	
BEGINNING INVENTORY	6000.00	10000.00	
PURCHASES	400.00	2000.00	
SALES	800.00		
DEPRECIATION		2000.00	
NET CHANGE	-400.00	-0.00	-400.00

RESIDUAL RETURN TO LAND, LABOR,
MANAGEMENT, AND RISK 2141.36

****

NET WORTH

ASSETS		LIABILITIES	
SHORT TERM	2541.36	SHORT TERM	0.00
INTERMEDIATE TERM	15600.00	INTERMEDIATE TERM	2000.00
LONG TERM	150000.00	LONG TERM	49000.00
		TOTAL LIABILITIES	51000.00
		NET WORTH	117141.36
TOTAL ASSETS	168141.36	N.W.+LIABILITIES	168141.36

NET WORTH RATIO	0.70
LAND EQUITY RATIO	0.67

****

Figure 12. Sample Output; Generalized Computer Model

All numbers in the receipts and expenses section of the profit and loss statement are generated by the computer model except numbers in the decision column. The decision values were furnished on the decision form by the participant. Prices are randomly generated events. (Prices for livestock are given per hundredweight.) Sales per activity are price times production per unit times number of productive units. Production per unit was purposely excluded to allow interested students to compute this value. As explained earlier, net cash from operations is the difference between total sales and total expenses.

The computer prints only those non-allocatable expenses which have non-zero values. Hay purchase cost and interest on other loans were suppressed as they would add no useful decision information. Non-allocatable expenses are subtracted from net cash from operations to get farm income.

Adjustments for the capital change subsection of the profit and loss statement include adjustments specified by game participants on the decision farm. When these inventory adjustments, plus depreciation, are added to farm income a net farm income value is obtained. This is called residual return in the statement since this is an often used, but less often understood, farm management term.

The net worth statement includes the usual balance sheet items. The terms used are general to allow their application to a large number of situations. As in the previous model, net worth ratio and land equity ratio are included as indicators of financial safety.

Summary

This chapter has presented the Decision Exercise computer model and a generalized model which could be viewed as an extension of the Decision Exercise model. Both programs were designed to minimize participant time spent in routine calculation, and, hence, allow more time for planning, analysis and decisioning. As would be expected, the time savings feature is more significant in the general model since more activities and variables can be included in this model. In fact, one minute of computer time for the general model substitutes for 2 to 3 hours of hand computations. The general model also has greater appeal because it uses gross sales and expenses, production trends, variable interest rates and a continuous distribution for random events. Conversely, the value of simplicity associated with the Decision Exercise model should not be underestimated because of its administrative niceties.

A possible criticism of both computer models is the exclusion of production response equations. Choice among levels of inputs is a very basic economic consideration. A choice among levels of inputs could be most effectively incorporated in the generalized model. This would require the inclusion of several activities for the same crop. Each activity would have a different level or combination of inputs. The choice in the Decision Exercise between cows on native and cows on native and wheat is an example of choosing between different input combinations, hence, different points on a production surface.

A simpler means of incorporating input-output relationships would entail including production response equations for the various enterprises. This could be accomplished in the Decision Exercise model by using gross receipts and expenses and requiring participants to decide on level and combinations of inputs. Introduction of specific production functions into the generalized model would eliminate a major purpose for which the model was designed.

The current use of electronic data processing, least-cost ration formulation, and linear programming all point to increased use of computer technology in farm management. A good experience with the computer by game participants, who are also present and future farm managers and farm leaders, may set the stage for wider, more rapid acceptance (i.e., less distrust) of future computer uses which may be developed for agriculture. It is possible that improved computer technology and a model such as the generalized model presented here will soon provide decision information straight off the printer in a form similar to that shown in the next chapter.

FOOTNOTES

[1]D. D. McCracken, A Guide to Fortran IV Programming, (New York, 1965).

[2]The * sign is the multiplication sign in Fortran IV.

[3]The subroutine NORNUM was obtained from the library of subroutines in the Oklahoma State University Computer Center. The NORNUM subroutine is explained and evaluated in the article by Richard Kronmal, "Evaluation of a Pseudorandom Normal Number Generator," Journal of the Association for Computer Machinery, XI (1964), pp. 357-363.

[4]If the same interest rate was charged on all short-term crop loans this determination could be made after all crop expenses were totaled. The alteration in the computer program would be minor and some computer time would be saved.

CHAPTER VI

SIMULATION WITH THE DECISION EXERCISE

Simulation consists of constructing a model embodying relevant variables and relationships that characterize a real system. The model is then run repetitively to generate a set of outcomes that would be expected from the real system under similar conditions. In this study the model is the computerized Decision Exercise; the real system is the game farm; and the set of outcomes contains annual net worth and residual income values. The observable outcomes result from the interaction of predetermined farm plans and the stochastic variables.

If the computer model is an accurate representation of the real system and the specification of parameters and variables is correct, simulation gives the economist the closest thing to a controlled experiment yet embraced by the discipline.[1] As explained in the last chapter, knowledge of distributions of events and the structure of the game model allowed the Decision Exercise to be exactly duplicated for simulation.

Two sets of outcomes were generated by simulation in this study. One set, called the "set of annual possibilities," was developed to indicate what might happen if short run alterations were implemented on the game farm. The second, the "ten year growth set," contained more usual simulation results. In the latter, a given decision strategy, or plan, was specified; several runs of predetermined length were made and the implications, both short and long run, of various plans were analyzed. Both approaches provide valuable data about the real system.

In this study the intended uses of the simulation results are pedagogic. First, the generated information provides game designers insight of possible outcomes from Decision Exercise. Second, the summarized data show the responsiveness of the Decision Exercise to plans representing decision strategies. These data can be used in evaluating growth potential and riskiness of plans as a means of intensifying and facilitating student learning. Third, the data are useful to others using the Decision Exercise.

Strategies Used in Simulation

An appreciation of the fixed plans selected to be simulated is basic to understanding the results of the two types of simulation employed. The strategies guiding choice of plans selected to be simulated have a basis in economic and decision theory, but were also developed based upon observation of strategies students have used. Strategy I, for example, is classified as a minimax strategy because it (1) excludes the most volatile crop activity, broomcorn, (2) uses only the .1 AUM expected wheat pasture grazing event in deciding the number of steers to run on wheat pasture, and (3) includes wheat, the crop with the highest minimum return per acre, up to the maximum allowed by the allotment restriction.

Strategy II is a diversification strategy. "Some of each crop is included" in the words of an optimistic student, "to make sure you get in on the good revenue values that can occur for each activity." The entire wheat allotment is planted to illustrate the natural reaction to plant all the allotment. Livestock numbers are selected based upon expected pasture availability.

Strategy III is called a flexibility-liquidity strategy. It is so named because steers are included rather than cows. Steers are more flexible than cows because they are bought and sold each year. They may be included in one decision period and reduced or left out the next. Cows, once purchased, must be held at least three years. Because of their annual turnover, steers are also more liquid than cows. This strategy also assumes a natural response to the wheat allotment, and uses a .2 AUM per acre small grain grazing value as a basis for computing the number of steers to include in the plan.

Strategy IV is the optimum long-run economic organization generated with linear programming. It is the static long-run solution obtained when expected revenue and grazing values are used. The linear programming solution tells which organization should be selected to get maximum profit if revenues are those given by expected value and the restrictions are those given in the explanation of the Decision Exercise. Such an optimum organization is equivalent to that published in typical farm management publications, e.g., experiment station bulletins.

Strategies V, VI and VII are classed as gambler strategies. The emphasis is on specialization rather than diversification, particularly in strategy V. The plan representing strategy V includes only grain sorghum and steers on native pasture. Moving from plan V to VI to VII may be viewed as a stepwise procedure for evaluating the possible effects of modifying specialized plan V (Table VII).

The seven plans selected as representative of the seven strategies are given in Table VII. The ensuing discussion explains simulation results for each of the seven plans.

TABLE VII

SEVEN PLANS USED IN SIMULATION

Activity	Plans						
	I	II	III	IV	V	VI	VII
Wheat	800	800	800	642	-	-	-
Grain Sorghum	583	495	583	642	1350	1262	1262
Broomcorn	-	100	-	100	-	100	100
Fallow	217	205	217	216	250	238	238
Cows, Native	27	-	-	-	-	-	39
Cows, Native-Wheat	-	34	-	37	-	-	-
Steers, Native	-	-	54	-	85	87	-
Steers, Wheat	32	23	64	8	-	-	-

Preset Conditions for the Single Year Simulations

In addition to the farm plan, beginning year cash balance, deferrable cash flows, wheat pasture price and fallow acreage were other decision variables which had to be preset for single-year simulations. The beginning year cash balance was set at $2,000 for all simulations. The deferrable cash flow items (i.e., machinery purchase, land payment and family living) were charged at their average annual requirement, a constant of $8,500 each simulation run. The wheat pasture price was set at $10 per AUM, the maximum value a game player would be required to pay if he experienced a deficit in small grain pasture. Fallow was handled as follows: (1) a farm plan consistent with the decision strategy was selected and 400 acres assigned to fallow; (2) the expected amount of "free fallow" from the plan was determined using equation (6-1); and (3) the acres in crops increased by the amount of "free fallow."

The "free fallow" equation was

$$FF_i = A_i * P_i * 1/2 \tag{6-1}$$

where FF_i = the expected free fallow from crop i; A_i = the acres of crop i; P_i = the probability of getting the lowest revenue value for crop i; and 1/2 = the percent of acreage of a "crop failure" on crop i which counts as fallow. For 500 acres of wheat $FF_W = 500 \times 1/3 \times 1/2 =$ 133.

The Set of Annual Possibilities

Fifty one-year simulations were generated for each of the seven organizational strategies explained above. The outcome observed was annual residual returns. Annual residual = [(total net revenue + cash sales) - (non-allocated expenses + non-deferrable cash flows + deferrable cash flows - adjustment for change in net worth)] . Outcomes would have been different if a beginning cash balance other than $2000 had been assumed. An outcome value could be adjusted for any beginning cash balance by equation (6-2).

$$I_{ar} = i_s - i_x \tag{6-2}$$

where I_{ar} = change in annual residual return; i_s = interest charges on livestock and short-term debt assuming a $2,000 beginning year cash balance; and i_x = interest payment for livestock and short-term debt assuming $X beginning year cash balance.[2]

The same 50 sets of randomly generated events (net revenue and yield variables) were used in the single year simulations for each of the seven strategies. The mean value of the 50 events generated for each variable and the expected value of the variables are given in Table VIII.

TABLE VIII

AVERAGE RANDOM VARIABLE VALUES FOR 50 SETS OF RANDOMLY GENERATED EVENTS

	Random Variable						
	Wheat	Grain Sorghum	Broom-corn	Cows Native	Cows Native-Wheat	Steers Native	Steers Wheat Pasture
Mean value of 50 simulations	$11.50	$11.68	$ 9.50	$50.90	$55.90	$17.00	$16.32
Expected value	11.67	11.75	12.50	50.00	55.00	19.00	15.20

Except for steers on wheat pasture, all variables had a lower than expected mean value for the 50 runs. The broomcorn average is appreciably different from the expected value, hence, all distributions of annual residuals including broomcorn will have a slightly lower mean than would be expected. The distribution of annual residuals for plans with broomcorn will also be skewed slightly to the left of what would be expected.

Histograms showing the range and distribution of the 50 outcomes are presented for each of the seven plans simulated (Figures 13 and 14). Ten intervals, $3,000 in width, were chosen as a means of presenting the results. The mean of the ten intervals, $7,000, corresponds relatively well with the computed means of the annual residuals.

Means and standard deviations, the percentage of outcomes below $1,000, and the distributions of outcomes are criteria used in comparing single-year simulation outcomes for the seven plans. Comparison on the basis of these criteria gives some indication of the responsiveness of the Decision Exercise to different strategies and provides insight for game designers.

Strategy I

The average annual residual value for the 50 single year simulations of plan I is $6,533. One standard deviation of annual residuals is $5,798. Thus, two-thirds of annual residuals for plan I would be expected to be in the interval $1,735 to $12,331; or 83 percent of plan I outcomes should exceed $1,735. The actual occurrence of outcomes for the 50 simulations of plan I shows 78 percent between $1,000 and $13,000 (see plan I, Figure 13).

The distribution of annual residuals from single year simulations displays the minimax characteristic. Although a large percentage of outcomes are in the $1,000-4,000 interval, very few (only eight percent) fall below the $1,000 level. Inspection of the histograms for the other six plans shows no other plan has a smaller percentage of outcomes below $1,000.

In addition to showing game designers and users the possible outcomes and their frequencies from each plan, the information on distribution also furnishes valuable decisioning information for participants. Access to the distribution of outcomes from plan I, for example, would show the participant he could have a high degree of confidence an annual residual value would exceed $1,000.

If a game administrator desired to wait until after game play was completed to present the histograms of annual residuals, the material could be used in critiquing the game. Post-game educational uses of the plan I distribution could focus on reasons for the gaps in the distribution and the large percent of outcomes in the $1,000-4,000 interval.

Strategy II

This strategy shows some of the advantages, and limitations, of "not putting all your eggs in one basket." As compared to plan I, the histogram of annual residuals from plan II does not possess the gaps in returns but displays a smoother distribution (see plan II, Figure 13).

The standard deviation for plan II, $6,285, is larger than the $5,798 for plan I. As a result, the percentage of outcomes clustered in the $1,000 to $13,000 range for plan II, 64 percent, is lower than the corresponding 78 percent for plan I. Further, a larger percent of the residuals, 14 percent, falls below the $1,000 level than in plan I. Two factors contribute to the distributional differences between plans I and II; particularly to the percent in the lower intervals. First, the livestock activities were selected using the .2 AUM expected value

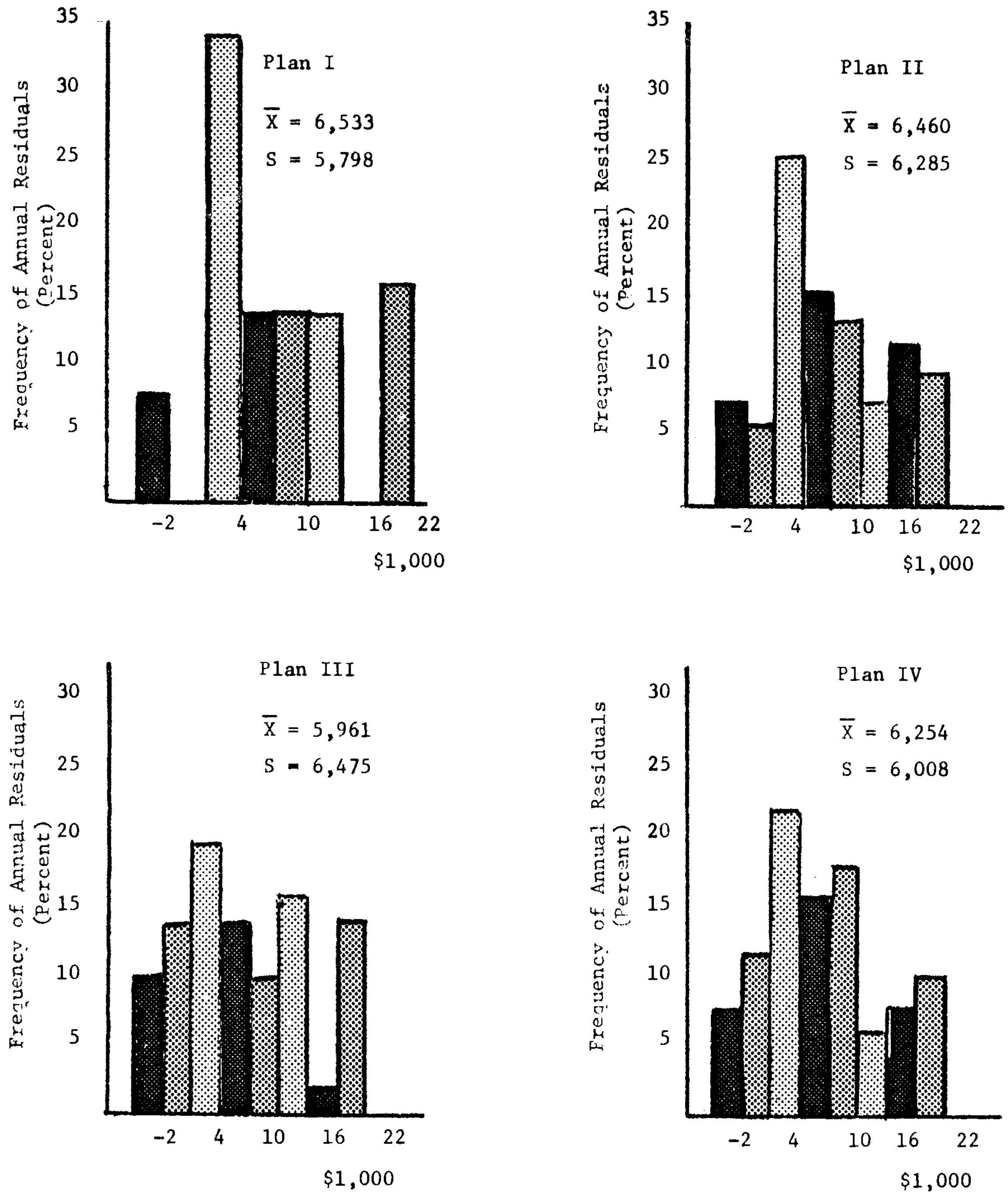


Figure 13. Distributions of Annual Residuals From Single Year Simulation of Four Decision Strategies

for wheat pasture. At a cost of $10 per deficit AUM of wheat pasture, this choice criterion causes a greater number of low outcomes than using a .1 AUM value as a basis for decisioning. Second, a crop with a less variable return, grain sorghum, was partially replaced by broomcorn, with a more volatile return.

Strategy III

The distribution of outcomes from plan III is heavily weighted with low annual residuals (see plan III, Figure 13). Ten percent of the outcomes are less than $2,000 and 24 percent are less than $1,000. This plan has the lowest mean, $5,961, and the greatest standard deviation, $6,457, of plans I through IV.

Since the crop organization for plans I and III are identical, the differences in the distributions of annual residuals can be attributed to the livestock activities. A game participant with knowledge of the distributions could compare the higher level and lower variability of annual residuals from plan I against the flexibility afforded by plan III. In the 50 simulations of plan III, steer numbers were held constant. In a game situation, steer numbers could be altered to provide flexibility; whereas, cow numbers could not be reduced if an unwise decision were made.

The liquidity characteristic attributed to plan III is a legitimate classification as steers tie up capital for less than a year. Cows tie up operating capital until they are sold (three years in the Decision Exercise).

If the results of plans I and III were used in teaching, at least three factors contributing to low returns could be isolated. First, steers have a lower return per AUM than cows. Second, the livestock system is penalized when unfavorable wheat events are obtained since steer numbers were determined using a .2 AUM value for wheat pasture. In periods when 0 or .1 AUM wheat grazing events are obtained the income contribution of steers on wheat pasture is small, and may be as little as -$1,476. Third, because of the higher capital requirements for steers, a greater interest expense must be paid for steers as compared to cows.

Strategy IV

As previously mentioned, plan IV is the optimal organization determined by linear programming when expected values are used for the C_j values. These results, as usually presented, are highly specific. They apply to one set of conditions, those expected under the average or normal conditions. Because of their specificity, linear programming results have their greatest usefulness in long-run planning. The set of annual residuals for the optimal organization are useful for short-run decisioning since they indicate the range and distribution of possible annual incomes from using the optimal organization. The distribution shows what could happen from conditions other than normal conditions.

The mean of annual residuals for the optimal plan, $6,254, is lower than that of three other plans. None of the other three is more than $300 greater. The standard deviation of outcomes is the second lowest of the seven plans; although, 20 percent of plan IV annual residuals do fall below $1,000, a greater percentage than for either plans I or II. On the basis of annual residuals, a player in the Decision Exercise would be hard pressed to attach any priority to plan IV over either plans I or II.

Strategy V

A trimodal distribution of outcomes results from specialized plan V (see Figure 14). Thirty percent of the annual residual values fall below $1,000, and even more critically, all 30 percent are less than -$2,000. Thirty percent of outcomes exceed $13,000; 28 of the 30 percent exceeding $16,000. The mean of this distribution is the lowest of the seven plans and the standard deviation is the largest.

The results of plan V simulation were enlightening to the game designers. They realized the outcomes would be variable; they had not anticipated the variation being as great as it was. Neither had they anticipated such a large percentage of the residuals being negative.

Strategy VI

The distribution of annual residuals from plan VI also displays a trimodal tendency (Figure 14). The inclusion of the broomcorn activity does reduce the percent of outcomes falling below -$2,000 (from 30 percent to 22 percent). The percentages falling in the -$5,000 to $1,000; $1,000 to $13,000; and $13,000 to $22,000 intervals remain at 30-40-30. The mean is slightly higher and the standard deviation lower in plan VI as compared to plan V. The mean would have been higher had the expected proportion of $25 broomcorn events been generated.

Strategy VII

Any difference in the outcome distributions from plans VI and VII can be attributed to the change from steers to cows. Of the seven plans, plan VII has the third largest mean of annual residuals. It also has the third smallest standard deviation. This indicates the player who could survive mild fluctuations in the short-run would expect to come

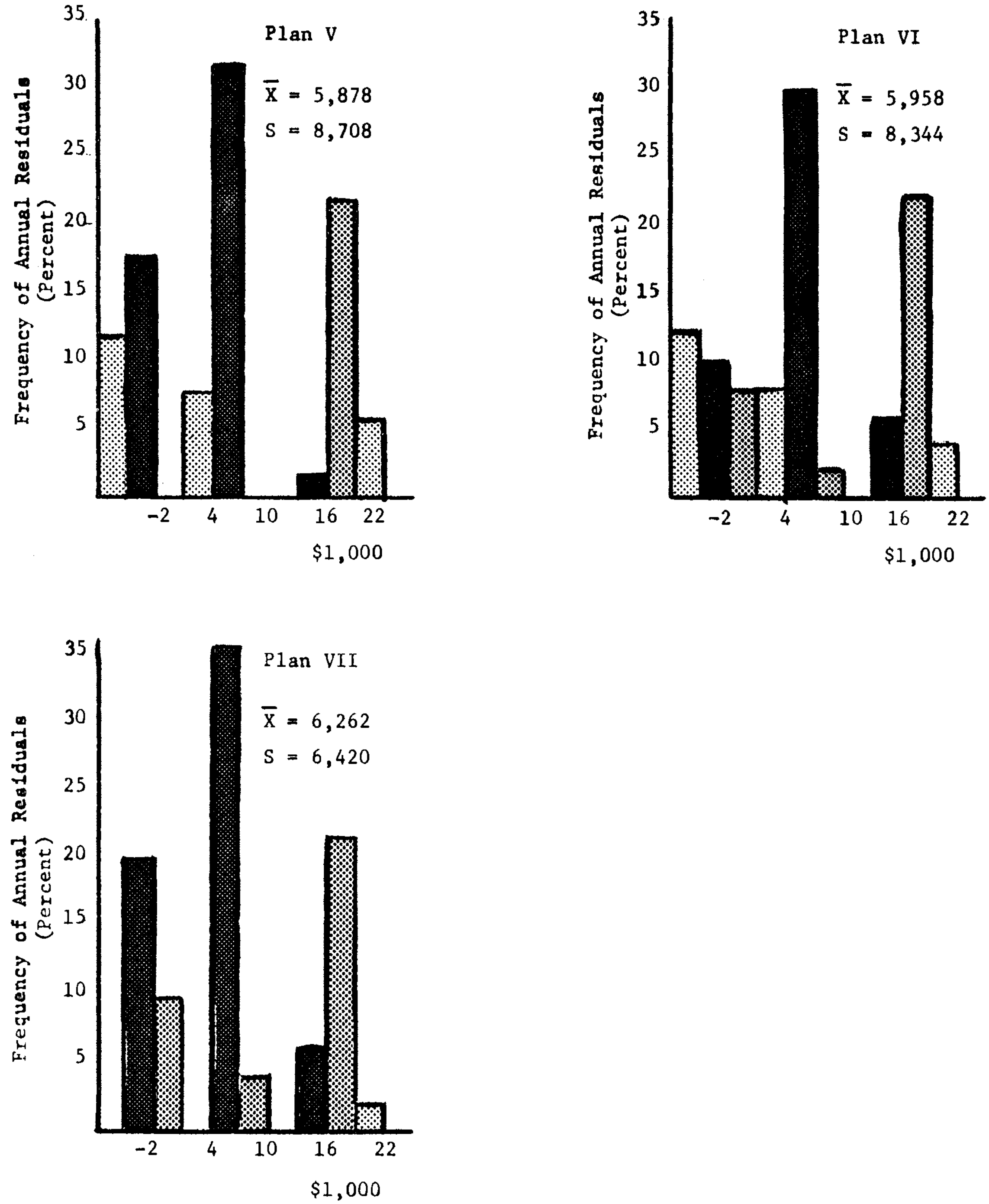


Figure 14. Distributions of Annual Residuals From Single Year Simulation of Three Gambler Strategies

out quite well in the long-run.

Educational uses of the set of annual residuals for plans V through VII could focus on the differences in distributions, the means and standard deviations of each, and the reasons for the differences. Inspection of the distributions show no annual residual values below the -$5,000 level for plan VII, for example. Plans V and VI both had 12 percent of outcomes below -$5,000. Further the annual residual values falling in the $1,000-$4,000 interval in plans V and VI fall in the $4,000-$7,000 interval in plan VII.

That plan V had the lowest mean and highest standard deviation would likely have been overlooked had the distribution of annual residuals not been plotted and the mean and the standard deviation computed. Investigation of the differences in plans V, VI and VII could focus on the effect of adding broomcorn (which allowed more acres in crops) and of adding the "sure" enterprise, cows.

As previously indicated, the information on distributions of outcomes can be used as a directly consumable input in decisioning. Comparison of results for plan V to VII with those from plans I through IV would provide sound bases for analyzing the effects of diversification or steers vs. cows.

Preset Conditions for Ten Year Simulation

The seven farm plans used in the single-year simulations were also used in the ten year simulations. The farm plans remain invariant throughout a ten-year simulation run. For the first period of each ten year run, parameters (e.g., cropland acres) and variables (e.g., cash balance and net worth) were assigned values identical to those given game participants during the first play of the Decision Exercise. After the first period, the results of any period t (e.g., asset and debt position) were used as inputs in period t + 1, etc. The deferrable cash flow decisions were handled in the manner described in Figure 6, page 69. (This decision flow chart explains the process by which the computer program assures the restrictions set for the Decision Exercise are met.) The variables, fallow and wheat pasture purchases, were handled exactly as they were for single-year simulations.

Knowledge of ranges and distributions of outcomes from various farm plans is less useful for long-run decisioning than for short-run planning. Information on income and growth paths over time are more likely to provide long-run decisioning information.

The ten year simulation period was chosen because this is the number of periods the game designers visualized the Exercise would be used. This proved to be a sufficient period to permit the accumulative effects of favorable and/or unfavorable sets of events to manifest themselves. Net worth was selected as the particular variable of interest since (1) it is a function of income, assets and liabilities and (2) its maximization is the stated objective for participants in the Decision Exercise.

Summarizing the Growth Paths

Outcomes from the ten year simulations allow five types of evaluation. First, the interaction in time between a given strategy and a particular set of random events can be observed. Second, since each strategy was replicated 20 times, different runs for the same strategy (plan) can be compared and the time paths analyzed. Third, outcomes from two different strategies under the same set of events can be compared. Fourth, the average outcomes for all strategies can be evaluated and compared. Fifth, the replication of each strategy allows determination of the interval into which selected percentages of the net worth values might fall. Discussion of the ten-year simulations relies primarily on points four and five.

Five curves were constructed to summarize growth results. In the figures they are labeled high, high standard deviation (S_H), average, low standard deviation (S_L), and low (see Figure 16 for an example). The high and low curves give only the largest and smallest net worth values per period obtained from all replications of a strategy. The individual decision period net worth values for all replications of a strategy are averaged, period by period, to get the average growth curve. High and low standard deviation curves are developed by computing the mean plus or minus one standard deviation in a particular period and plotting the values above and below the average curve. The standard deviation values obtained and plotted are used only as approximations and guides. It is realized the assumptions of independence, normality and common variance are not strictly met in sequential simulation. A helping, or reference, line is given on each figure to make it easier to read and compare the figures.

Strategy I

As mentioned previously, a single simulation run can be viewed as a single experiment on the model. The growth paths for five separate experiments of the Decision Exercise with plan I as the organizational strategy are given in Figure 15. The sets of events contributing to

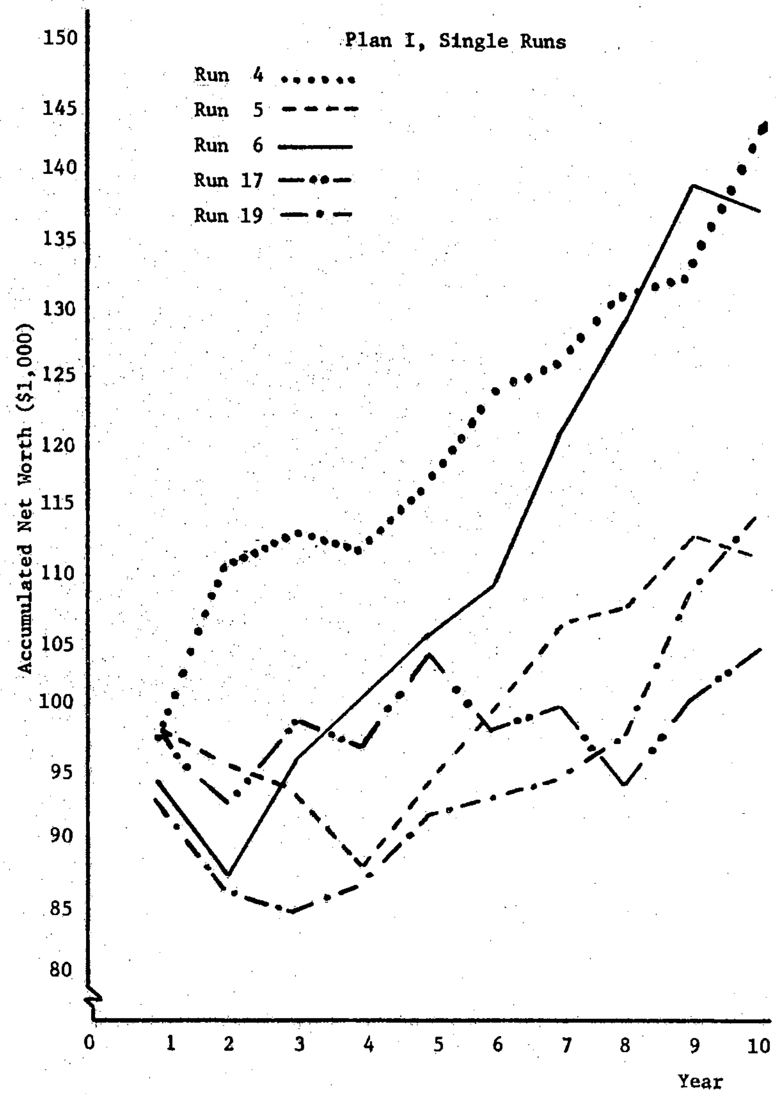


Figure 15. Growth Paths for Five Simulation Runs of Plan I

each growth path are given in Appendix C, Table XVIII. The events for run 19 are also given in Table IX. Comparison of the events for run 19 and the graph of run 19 in Figure 15 shows that both wheat and grain sorghum must have unfavorable events for net worth to fall below that of the previous period. Examination of the sets of events for the other runs plotted shows why net worth rises or falls. In most cases an unfavorable event for either wheat or grain sorghum must be offset by a favorable event for the other to give an increase in net worth over the previous period. Examination of growth paths also reveals a slight net worth increase can be realized if both wheat and grain sorghum realize the median events ($10 and $11).

TABLE IX

RANDOM EVENTS FOR RUN 19

	1	2	3	4	5	6	7	8	9	10	$\bar{X}$
Wheat	5	5	5	5	10	5	5	20	20	10	9.00
Grain Sorghum	11	3	3	22	11	22	11	3	11	22	11.90
Broomcorn	25	25	0	0	0	0	0	0	25	25	10.00

The five runs presented in Figure 15 are averaged with the other simulation outcomes for plan I to derive the points which make up the average growth path for plan I (see labeled curve in Plan I, Figure 16). The average increase in net worth over the 10 years from the $102,000 beginning period net worth is $35,100. This is comparable to a 3 percent return to beginning equity, risk and management, compounded annually, after an average of $4,000 is withdrawn annually to pay family labor.

The average growth path is instructive, but inadequate for evaluating desirable or undesirable effects of an organizational strategy. The levels attained by the high and low curves shows what might happen if several consecutive periods of favorable or unfavorable events occurred. Such accumulative effects are identified on the high and low curves by a sequence of points on the same curve identified with the same simulation run. In plan I, for example, nine of the ten high values are associated with run 3 (see plan I, Figure 16). This run had a high percentage of favorable crop events. The set of random crop events for run 3 is given in Table X. Crop events only are included since they have the greatest effect on income, hence, net worth.

TABLE X

RANDOM EVENTS FOR RUN 3

	1	2	3	4	5	6	7	8	9	10	$\bar{X}$
Wheat	10	20	5	20	10	20	20	20	20	5	15.00
Grain Sorghum	11	22	22	22	3	3	22	22	22	22	16.10
Broomcorn	25	25	25	25	0	25	25	0	0	25	17.50

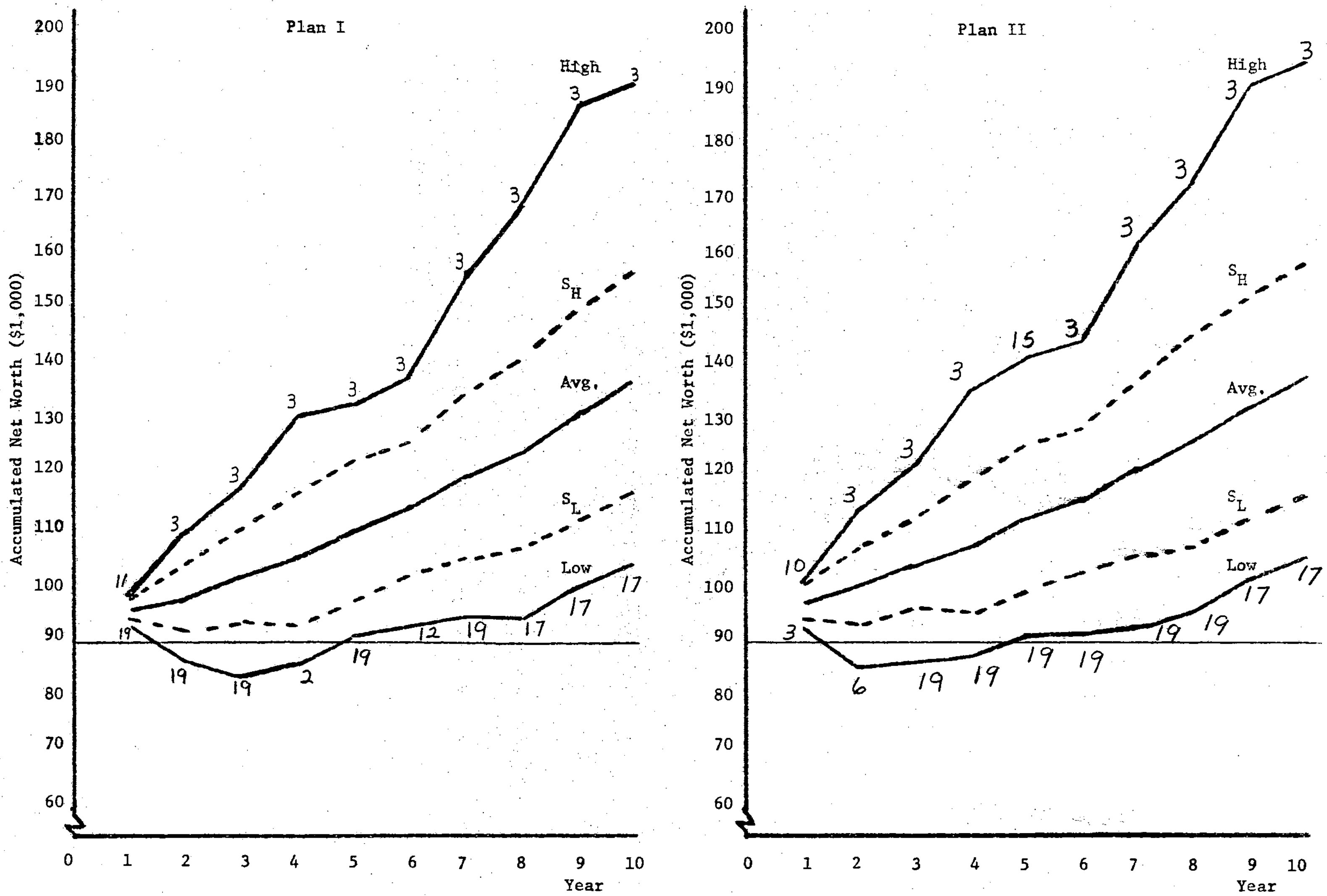


Figure 16. Growth Paths for the Minimax and Diversification Decision Strategies

The random events in period 5 are lower than in previous or succeeding periods (Table X). The effect of the unfavorable events in period 5 are manifested as a flat area on the high curve for the minimax strategy.

Graphing of mean plus or minus one standard deviation curves gives the range within which approximately two-thirds of the outcomes of other runs for plan I would be expected to fall, if the usual assumptions held. In the first period net worth values would be expected to fall within $\pm$\$2,097 of the mean. By period ten, one standard deviation is $\pm$\$20,007.

The mean minus one standard deviation might be used by game players as a decisioning guide. For example, eighty-three percent of outcomes for sample runs would be expected to lie above the S_L curve. Basing decisions upon S_L, a participant could be fairly confident no net worth value for plan I would fall below \$90,000 and that ending net worth would exceed \$117,300.

Examination of the low curve shows only three points below the \$90,000 line. Although the curves in Figure 16 do not show it, run 19 was the only run for plan I which had more than one net worth value below \$90,000.

Strategy II

The substitution of broomcorn for 100 acres of grain sorghum and alteration of the livestock plan from plan I to develop plan II does not give a wider range in high and low values for each period. The standard deviation values are only slightly larger for plan II as compared to plan I. However, that diversification can have an effect is observable in the high curves for the two plans. Run 3 is common to both curves, thus, the $3,000 greater ending value of plan II must be attributed to the substitution of broomcorn for 100 acres of grain sorghum and the altered livestock plan. There is little difference in average and low curves between plans I and II. In fact, using the graphs in Figure 16 to compare plan II with I is insufficient basis for concluding one plan is superior to the other. Minimax characteristics in the ten year simulation of plan I are less noticeable than in the single year simulations.

Strategy III

As explained earlier, strategy III has the same crop plan as strategy I. Steers only were selected for the livestock plan and a .2 AUM wheat pasture yield was used in determining the number of steers to include on wheat pasture. Thus, any difference in plans I and III must be attributed to steers and the selection of a livestock plan based upon mathematical expectations for pasture yields.

The high curve of most favorable outcomes for plan III is shaped much like the corresponding curve for plan I; however, all points for plan III are lower than the respective points for plan I. The highest net worth attained by plan III is lower than the corresponding high for plan I by more than $9,000.

It is in the average and low curves where plan III exhibits its most undesirable characteristics. The average net worth at the end of ten years is $122,295; more than $10,000 lower than the tenth period average net worths for plans I, II and IV. The consequences of unfavorable events is particularly observable in the low curve for plan III. The low curve drops to $78,867 in the brief span of four periods (plan III, Figure 17); a decline in net worth of $23,133. The

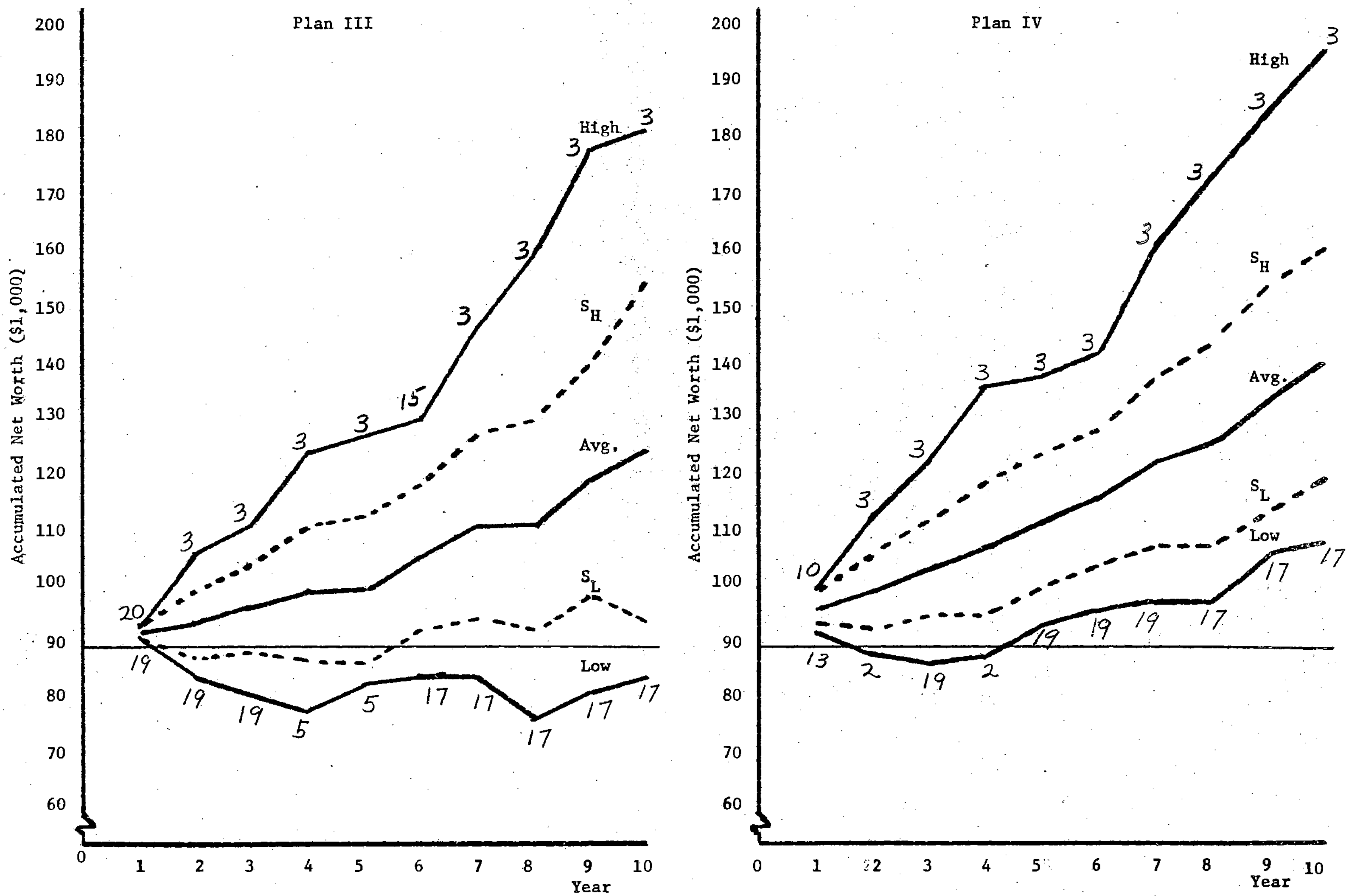


Figure 17. Growth Paths for the Flexibility and Optimal Decision Strategies

corresponding value for plan I was \$5560 greater. The period 4 low value is not sufficient to put the player out of business. The net worth ratio, .525, is still appreciably above the .35 minimum set for the participants in the Decision Exercise.

The distribution of outcomes in the single year simulations indicated steers were less profitable than cows in the Decision Exercise. The ten year simulations confirm this and show the possible opportunity cost of raising steers can be as great as \$10,000 in net worth after only ten years when plan III is used.[3] These results could be used in teaching to reinforce, or confirm, economic considerations on returns per AUM of grazing (discussed in Chapter IV). Effect of planning based upon expected wheat pasture yield could also be discussed.

Strategy IV

The value of the linear programming solution and the distribution of annual residuals for it as decisioning guides was explained earlier in this chapter. The combination of these two techniques gives a basis for anticipating the probable performance of plan IV through time. They are inadequate for showing what actually can happen to net worth under time dynamic, uncertain conditions as they both center on profit maximization. The accumulative effects of sets of favorable or unfavorable events can only be displayed by the ten year simulations.

The high and high standard deviation curves show the possible level of attainment from favorable conditions. These curves for plan IV attain higher levels than five of the other six plans. Only plan VII has higher "high" curves than plan IV; however, plan IV has a much narrower standard deviation interval around the average curve than does plan VII. As a result the "low" curves for plan IV are superior to those of plan VII. In fact, the low and low standard deviation curves maintain levels superior to all other plans. The tenth year value of the low standard deviation curve, for example, is \$120,000. This value is highest of the seven plans. It should be exceeded by 83 percent of any other sample simulation runs for plan IV. Also, the lowest net worth ratio of any run and in any period for plan IV was .583. This is the highest low value of any of the seven plans. This net worth ratio consideration coupled with the \$120,000 ending S_L value indicate the linear programming solution displays the minimax characteristic over time better than plan I which was given the minimax label by game designers.

The ten year simulations show the plan developed using linear programming performs well over time. It gives the second highest average net worth of the seven plans simulated in this study. This is useful information to a decision maker in the game situation since net worth, not profit maximization, is the goal set up for participants.

Strategy V

Specialization in one crop and one livestock activity in plan V results in very erratic growth paths. Growth paths from representative simulation runs for plan V are given in Figure 18. The runs plotted are the same ones presented for plan I (Figure 15).

Using vacillation of growth paths as a measure of riskiness, plan V would be adjudged more risky than plan I. The volatility of plan V occurs because of the specialization in the single activity, grain sorghum. In plan I where the crop plan is about 60 percent wheat - 40 percent grain sorghum the effect of an unfavorable event for one crop may be offset by a favorable event for the other. In plan V there is no

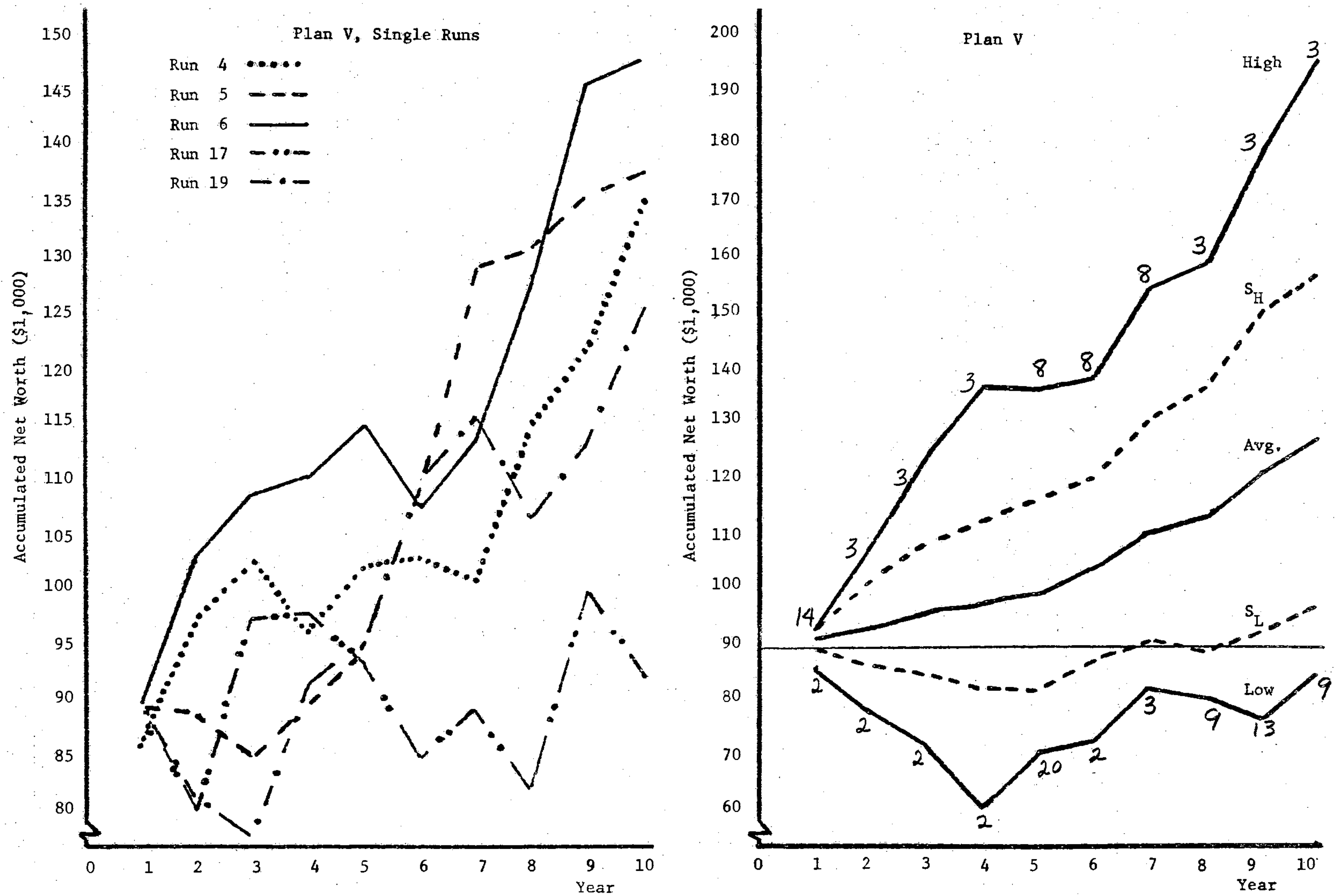


Figure 18. Growth Paths for Specialization Strategy

possibility of an offsetting effect. The growth paths for plan V indicate a favorable grain sorghum event can increase net worth approximately \$15,000 from one period to the next. An unfavorable event will reduce net worth approximately \$7,000.

The variability of individual runs is less obvious when the information is presented in aggregate form in plan V, Figure 18. The interval between the standard deviation curves is the primary indicator of variability. The position and level of the standard deviation curves for plan V have the widest range of any of the seven plans. Other indicators of riskiness in the aggregate graphs are the low and S_L curves. A player in the game using the data could compare the position of low and S_L curves relative to the \$90,000 helping line with corresponding curves for other plans. The S_L curve for plan V is the lowest of the seven plans simulated. The tenth period S_L value is only \$98,000 as compared with \$120,000 for plan IV.

Knowledge of these performance attributes of plan V would be useful in decisioning. If the student decision maker had a strong risk aversion, knowledge provided by these simulation results would likely serve as a deterrent to selection of this strategy.

Strategy VI

By comparing plans V and VI in Figures 18 and 19, a game participant could evaluate the probable effects of substituting 100 acres of broomcorn for grain sorghum. Although the corresponding curves in both figures are shaped much alike, the interval between the two standard deviation lines is narrower for plan VI than for plan V. On the other hand, the aggregate nature of these curves masks the difference between

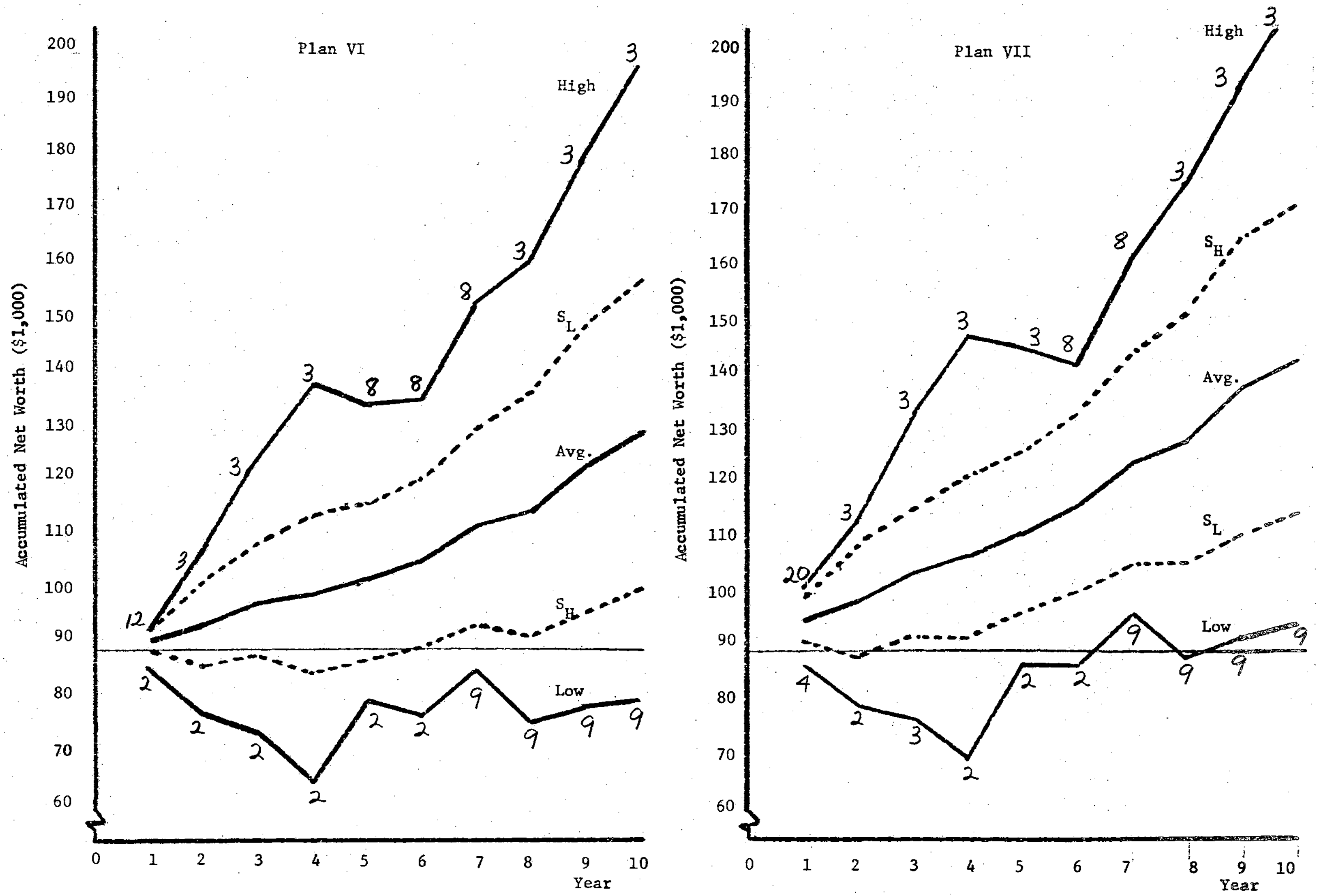


Figure 19. Growth Paths for Two Gambler Strategies

individual runs. The growth path graphs do not show participants that individual growth paths for plan VI can be more erratic than those of plan V.

The psychology of the individual game participant and information like that in the single-year simulation might determine his preference between plans V and VI. The ten year simulations cannot, by themselves, show that plan VI is superior (or inferior) to plan V.

Strategy VII

Altering plan VI by substituting cows for steers does not appreciably alter the shape of the high, low and average curves. The runs associated with the various points on the high and low curves are nearly identical from plan VI to plan VII, (see Figure 19). The change comes in the level of the curves for plan VII. Most points on the curves for plan VII are from five to fifteen thousand dollars higher than corresponding points for plans V and VI. The ending average accumulated net worth and "high" net worth values are greatest of the seven plans investigated. The standard deviation intervals are nearly as large as those for plans V and VI, and appreciably larger than those of plans I, II and IV.

Viewed in total, the ten year simulations of plan VII indicates a potentially lucrative payoff for taking some fairly high risks. The participant (decision maker) would have to weigh the possible gain against the possibility of ending with a very low net worth in evaluating the merits of this plan.

Summary

This chapter has reported the results of experimentation with the computer model of the Decision Exercise. The experimentation was conducted (1) to develop a better understanding of the Decision Exercise, (2) to evaluate strategies which might be pursued by participants in playing the game and (3) to generate data to be used by participants and other users of the Decision Exercise.

Improved Understanding

One finding contributing to game understanding was the income producing superiority of cows over steers. This was expected from computing expected returns per AUM for each class of livestock; however, the magnitude of the effect demonstrated in comparing plans I and VII with plans III and VI was not expected. A second finding was that it is more profitable on the average to use a conservative strategy in the short-run when deciding livestock numbers on wheat.

A third finding was the potential short run benefit of pursuing a diversified strategy. Given a starting balance of $2,000, not one annual residual value for plans I through IV fell below -$5,000 and the frequency below -$2,000 was small. Plans V and VI had 12 percent of annual residuals below -$5,000 and 30 percent below -$2,000.

Fourth, the lack of alternative uses for excess cash is an inadequacy of the Decision Exercise pointed out by simulation. In simulation the only alternative was to pay ahead on land debt and reduce interest payments. No interest is paid on excess cash nor are opportunities available to use cash to intensify production on existing acres in either the simulation or gaming models. In gaming experiences the plug-in opportunity for land acquisition is one use provided for excess cash.

Evaluating Strategies

Growth potential and stability, or variability, of outcomes from plans are used in evaluating the strategies simulated. Table XI summarizes some characteristics of each plan. Data on each plan are based upon an equivalent of 250 years of crop and livestock conditions.

Two measures of growth potential in Table XI are average net worth attained and mean of annual residuals (see columns 2 and 3). Using these two criteria, plans I, II, IV and VII all display about equal merit. Each of these plans gives approximately a three percent average increase in net worth each year plus a $4,000 payment for family living, or an annual return of approximately seven percent. Plans III, V and VI are only two-thirds as productive as the other four plans. The use of steers as the only livestock activities in plans III, V and VI was a major factor contributing the less favorable results from these plans.

As mentioned previously, the standard deviations on annual residuals are greatest for plans III, V, VI and VII (see column 6, Table XI). This means a participant would be less sure of maintaining a stable income from these plans.

Plans III, V, VI and VII also had wider standard deviation intervals on accumulated net worth in the ten year simulations. Because of the violation of assumptions for the standard deviation by the ten year simulations, coefficients of variability for periods 5 and 10 were computed to get a percentage measure of variability. The CV values are given in columns 4 and 5 of Table XI. By the tenth period, the CV values for plans III, V, VI and VII were appreciably greater than for the other three plans.

TABLE XI

SAMPLE INFORMATION FROM SINGLE-YEAR AND TEN-YEAR SIMULATIONS

(1)	(2)	(3)	(4)	(5)	(6)
	Average Net Worth	Mean of Annual	Coefficient of Variation[1]		Std. Dev. on Annual
Plan	Attained	Residuals	Period 5	Period 10	Residuals
I	$137,100	$6,533	11.5	14.6	$5,798
II	137,900	6,460	11.6	16.0	6,285
III	125,070	5,961	12.9	24.6	6,475
IV	140,520	6,254	10.7	14.7	6,008
V	127,500	5,878	17.4	23.2	8,708
VI	129,570	5,958	13.4	22.1	8,344
VII	143,660	6,262	13.5	20.1	6,420

[1] $CV = \frac{100\ S}{\bar{X}}$

Direct Use of Results

A game participant can develop one or more estimates of profitability of a particular plan by developing several projected profit and loss statements. It would take him many hours to develop a distribution of annual residuals or perform simulated runs for a strategy. However, such information would be very valuable in an imperfect knowledge situation as a decisioning aid.

The materials presented in the graphs of this chapter would be useful to game participants for both long and short-run decisioning. The materials allow participants to evaluate not only profit potential but to balance firm financial position and preference on risk against possible outcomes. They could see in Figure 13, for example, that plan I does possess the "minimax" characteristic in the short-run, yet it also gives a high tenth year average net worth and has few net worth values falling below $90,000 (Figure 16).

The results from plan II indicate the compatability of both a diversification strategy and a net worth maximization objective in the Decision Exercise. While ending net worth values for the ten year simulation are slightly higher for two other plans, the CV, standard deviation and mean of annual residuals for plan II are relatively quite favorable.

The flexibility-liquidity strategy, plan III, was less effective at reducing variability of outcomes than some other strategies. Because of the use of steers, it was also less profitable than four other plans. The flexibility attribute is attractive, especially in early plays of the gaming experience, as errors in planning can be altered with steers.

The linear programming solution looks more attractive in the ten year simulation than in the single year simulations. Average net worth and CV values for plan IV in each of the ten periods always compared favorably with the other plans.

Simulations for plans V and VI vividly display the potential opportunity cost of pursuing specialized strategies for which steers are the only livestock activity. The economic lesson taught by these plans focuses on the need for comparing activities before a final decision on organization is made. Inclusion of cows in plan VII, for example, shows the profitability of having cows rather than steers in plans for the Decision Exercise.

FOOTNOTES

[1]G. H. Orcutt, "Simulation of Economic Systems," American Economic Review, Vol. 50, 1960, pp. 893-97.

[2]Similar adjustments could be made in the histograms of annual residuals if the items of deferrable cash flows total something other than $8,500. If total deferrable cash flows exceeded $8,500 the histograms of annual residuals would be shifted to the left; if they were less than $8,500 the histograms would be shifted to the right.

[3]It is the responsibility of a game administrator to help participants understand that the objective of the data in the Decision Exercise is to show example analyses which can be made. Care must be taken not to teach incorrect facts or general rules, e.g., in the Decision Exercise not to induce the bias that steers are generally less profitable than cows.

CHAPTER VII

EVALUATION OF EXPERIENCES WITH THE OKLAHOMA FARM MANAGEMENT DECISION EXERCISE

Two experiments using the Oklahoma Farm Management Decision Exercise are described in this chapter. The purposes are to evaluate the usefulness of the Decision Exercise, relate student reactions, and provide guides for administering the game in different teaching situations. The teaching situations include nonresident (extension) adult education and resident university instruction.

An Experiment in Adult Education

Some educators and short course participants have criticized adult education efforts as dealing too much in abstract theoretical principles and concepts and ignoring many of the realities of the dynamic decision environment. Taking these criticisms into consideration, the staff of the two-and-a-half day 1967 Oklahoma Farm Business Training Conference tried to design a conference in which participants would develop and maintain an interest. The objectives for the conference were simply: (a) to get conference participants involved, interested and in a receptive frame of mind for "discovering" or "rediscovering" economic principles; and (b) to provide the opportunity for participants to apply economic principles, decision strategies and tools. The Decision Exercise served as the hub about which the conference was structured.

The participants were 120 O.S.U. students, vocational agriculture instructors, county agents and representatives of agricultural-finance institutions. Most participants had at least a B.S. degree.

Administration

The participants were divided into 15 groups which were called "communities" for purposes of adding realism to the conference. These groups were further subdivided into two-man teams. A community contained four to six teams. Each community was assigned an advisor who was to assist the teams in understanding the model and in using the computational forms. The advisors were Oklahoma State University Department of Agriculture Economics faculty members and graduate students with previous gaming experience.

At the beginning of the conference, participants were given a detailed description of the simulated farm and allotted sufficient time to develop a general appreciation of the model. This was followed by a brief review of the model by the game administrator and an explanation of an example organization to be used in the trial run of the game. Purposes of the practice session were to obtain (1) improved understanding of the game model and operating restrictions and (2) familiarization with the computational forms. The "community advisors" were invaluable in helping team members understand game mechanics during this introductory phase of the conference.

The two-and-a-half day conference afforded time for six plays of the game in addition to the practice session. Short lecture-discussion periods on economic principles and management strategies were periodically interjected in the schedule of the conference. These short lecture-discussions had at least three purposes. First, continual play of the Exercise can be very exhausting (as can any one teaching method, e.g., lecturing). Thus, it was thought a change of pace would make lectures and other problems more appreciated and the gaming experience more enjoyable. Second, as a means of providing intensity of learning, the discussion of economic principles could build on the game environment and model as a common base. Third, since the participants might not recognize some of the economic subtleties of the game, the lecture-discussions served as a means of bringing these concepts to the participants' attention. The schedule of the conference activities indicates the points at which new ideas, or ideas complementary to what was taking place in game play, were introduced. These points are marked with asterisks in the following conference schedule.

1967 Farm Business Training Conference Schedule

June 28, Wednesday

2:00 p.m.	Introductory session on the environmental restrictions of the game farm
*2:30 p.m.	Concepts for living with risk and uncertainty
2:50 p.m.	Hand out computational forms and discuss organizational plan to use in practice session
3:20 p.m.	Break
*3:35 p.m.	Basic accounting concepts and terms used in financial planning
3:55 p.m.	Game practice session
4:40 p.m.	Discussion of practice session
4:55 p.m.	First team decision
5:10 p.m.	Break

June 29, Thursday

8:30 a.m.	Complete first decision play - turn in results sheet
*9:30 a.m.	Building and using enterprise budgets
10:10 a.m.	Second decision
10:15 a.m.	Break
10:25 a.m.	Complete second play
*11:05 a.m.	Partial Budgeting a) Principles b) Class Participation 1) A partial budgeting problem on profitability of adding land 2) A partial budgeting problem on profitability of adding an enterprise
12:10 p.m.	Announce potential for buying and renting land
12:15 p.m.	Lunch
1:15 p.m.	Allocate land on basis of bids and complete third play
*2:00 p.m.	Farm size adjustments
*2:45 p.m.	Tax computations, examples based upon game farm
3:25 p.m.	Break
*3:40 p.m.	Analyzing performance of the business
*4:10 p.m.	The maximum profit point - principles and problems
5:10 p.m.	Fourth decision - marginal analysis of fertilizer use superimposed on the game

June 30, Friday

8:30 a.m.	Complete fourth play
*9:10 a.m.	Whole farm budgeting - intensive vs. extensive adjustments
10:20 a.m.	Fifth decision
10:25 a.m.	Break

10:40 a.m.	Complete fifth play
*11:15 a.m.	Machinery cost and budgeting problems
11:55 a.m.	Sixth decision
12:10 p.m.	Lunch
1:20 p.m.	Complete sixth play
*1:45 p.m.	Estate planning using the game farm as example
2:30 p.m.	Break
2:45 p.m.	Summarize exercise and discuss results of various teams
*3:15 p.m.	Integrating farm management training into a total educational program
*3:45 p.m.	Farm management education for youth and adults
4:15 p.m.	Adjourn.

The "plug-in" activities described in Chapter IV were used in conjunction with plays three and four of the Decision Exercise. Both plug-in experiences were preceded by lecture-discussions on techniques and/or concepts which would be useful in each plug-in experience. It was expected the plug-in experiences would provide an intensification and reinforcement of the lecture-discussions.

In the third play the teams in each community were given the opportunity to bid among themselves for one parcel of land for sale and one parcel for rent. They were advised that their existing machinery was sufficiently large to handle the addition of both parcels to existing land holdings.

In the fourth play the participants were informed, after all decisions had been made, that weather conditions and prices were known for certain. Participants were furnished production and cost data on top dressing wheat with nitrogen. From the data they were to decide the amount of fertilizer, if any, to apply.

In addition to the formal presentations by the conference staff there was continual informal discussion among the participants. This discussion centered on experience and experimentation with the model and the results in terms of profit and change in net worth.

Participant Reaction and Performance

Game administrators were particularly encouraged by the evidences of interest among participants. Many worked right through refreshment breaks in order to do additional figuring or evaluation. As many as half the participants voluntarily cut short their lunch periods to spend additional time in analysis. These are indicators the desired attitude of conference participants had been attained and the participants were deriving satisfaction from the experience.

Comments in praise of the conference voluntarily attached to a short questionnaire sent to participants and the many favorable letters received by the conference chairman were other evidences of interest.

Effects of Plug-In Activities

The plug-in activity had been preceded by a lecture explaining the technique of capitalizing expected returns, however, at the time of the lecture the participants were unaware they would have an opportunity to use the concept in the game situation. When the land acquisition experience was introduced following the lecture-discussion, the interest was high, but performance of participants was disappointing.

The 15 selling prices for the 200 acre parcels offered in each community ranged from $15,000 to $34,500. Several teams offering bids above $25,000 did use the income capitalization method at arriving on a bid value. Most teams adjusted the $70 per acre value of existing land holdings. The amount of the adjustment depended on debt position and a subjective evaluation of what other teams would offer. Several teams submitted bids below the $70 level.

Rental bids per acre ranged from $3.05 to $8.05. The staff received the impression rent bids were based upon existing rates with which participants were familiar. No actual varification of this hypothesis was attempted, however.

The instructors brought the land acquisition experience into perspective in the lecture succeeding the plug-in land activity. This was accomplished by re-emphasizing the method of the previous lecture, discussing strategies pursued by the different teams in deciding on a land bid, and by discussing differences in ability to pay for land.

In the plug-in fertilization activity many participants selected the fertilization level which maximized production. This was not the most profitable level and was a disappointing result since this experiment had been preceded by a lecture on marginal analysis. The selection of output maximization is explainable; most participants had a technical, or production, orientation rather than an economic background.

The conference staff capitalized upon this opportunity to improve understanding of the marginal principle by first helping the participants arrange the production and cost data in a manner readily amenable to economic evaluation. It was unnecessary to spend time explaining stage III of production as participants understood the irrationality of operating in the area of declining total product. The staff next helped participants develop an understanding of increasing marginal product and how, if it was profitable to produce, it was profitable to move to the point of maximum marginal product. Participants were then assisted in determining how marginal costs of inputs and marginal returns from output could be used to determine the maximum profit point for the fertilizer problem. Several participants expressed an appreciation for this method of presenting this basic principle.

Methods of evaluating the learning which took place because of game play and use of the computational forms have not been adequately devised. The conference staff observed that participants became more skilled in use and understanding of the forms with practice. Further, many did make side analyses, such as preparing additional profit and loss statements and/or budgeting, as a means of improving knowledge about the possible consequences of decisions. Some of this side analysis was likely prompted by lectures presented during the conference. Participant understanding of some concepts and materials presented during the conference was sampled in a follow-up questionnaire.

Sampling Participant Conduct and Comprehension

Games have been used previously as research tools to improve understanding of the learning process in a simulated environment and to evaluate the psychology of decision makers.[1] The desire to better understand actions and attitudes of participants in the 1967 Farm Business Conference led to the development and mailing of a follow-up questionnaire to 76 participants (see Figure 20). There were 38 respondents. The data collected by the questionnaire allowed evaluation of two objectives. The first objective was to determine if conference

Name ____________________

CONFIDENTIAL QUESTIONNAIRE

1. Do you do (or have you done) any farming or ranching?

   ______ yes

   ______ no

2. Did you live on a farm as a youth?

   ______ yes

   ______ no

3. Did you attend college?

   ______ yes

   ______ no

   If yes, how many semesters? ______

4. How many courses have you had in economics and agricultural economics? ______

5. Are you from Oklahoma?

   ______ yes

   ______ no

   If yes, in what part(s) of the state have you lived?

   ______ NW ______ SW ______ SE ______ NE

6. Is your age between: ______ 20-30 ______ 30-40 ______ 40-50 ______ 50-60

7. How would you classify your actions in the decision exercise?

   ______ conservative

   ______ somewhat conservative

   ______ somewhat gambler

   ______ gambler

   Did you consciously promote that type of strategy with your other team member? ______

8. In making your decisions on which enterprises to use did you (more than one answer may apply):

   a. ______ rely on average expected returns

   b. ______ play the odds (try to predict the event that might occur the next draw)

   c. ______ choose the enterprise with the largest potential winnings (i.e., choose cows on wheat and native over cows on native because you might get $70 rather than $65)

   d. ______ choose the enterprise with the smallest spread of returns (i.e., choose wheat over grain sorghum because the spread in returns was $15 for wheat rather than $19 for grain sorghum)

   e. ______ choose several enterprises so if one had a "bad year" another enterprise might offset it by having a "good year"

Figure 20. The Questionnaire Sent to Participants in the 1967 Farm Business Training Conference

9. Which return from steers on native did you consider the most likely return?

   ______ $0

   ______ $5

   ______ $20

   ______ $30

   ______ $40

10. Which return from grain sorghum did you consider most likely to occur?

    ______ $3

    ______ $11

    ______ $22

11. What would you have done in the game if the steers on wheat pasture alternative had been changed such that you could have made a contract for a sure $15.20 <u>before</u> the draw was made to determine the event or taken a 50-50 chance of getting either $0 or $40?

    ______ sold for a sure $15.20

    ______ taken the chance of getting either $0 or $40

12. If in the decision exercise you had 53 steers on native pasture and could have $1,000 for sure before the event was drawn against the opportunity of getting $500 or $1,500 with the flip of a coin, would you,

    ______ take the sure $1,000

    ______ take the chance of getting either $500 or $1,500

13. Assume you have the choice between two alternative farm plans. From the first you are sure of getting $5,000 and from the second you might get either $7,500 or $2,500. Would you?

    ______ prefer $5,000 for sure

    ______ prefer to take a chance on $7,500 or $2,500

14. What if the plans were for smaller amounts, but still applied to the whole farm plan, would you

    ______ prefer to be sure of $2,000

    ______ prefer to take a chance of getting either $3,000 or $1,000

15. Was there any time in the decision exercise when you added a crop or livestock enterprise above those of the previous year for the purpose of getting your eggs in more baskets?

    ______ yes

    ______ no

Figure 20 (Continued)

participants used any of the discussed strategies for living with uncertainty (e.g., diversification, minimax, expected returns) in playing the Decision Exercise. This was an important objective since (1) the first lecture of the conference was addressed to this point and (2) some plans selected for simulation (Chapter VI) were based upon strategies used by the participants in the conference.

The second objective of the questionnaire was to relate a participant's evaluation of his conduct in the gaming experience to (1) game performance evaluated by a game administrator and (2) answers on sure-chance questions. This objective was relevant since some games have received criticism because participants performed irrationally (e.g., took unrealistic chances, acted as though it was only a game).

Questions 1 through 6 were originally included in the questionnaire with the intent of classifying and comparing different groups of respondents. Responses were such that it was decided the cross-classification would reveal little valuable information; although, age and area groupings were large enough to allow comparisons on some items.

Strategies Used by Participants

Questions 8a through 8e were included in the questionnaire to sample participants' use of identifiable strategies in selecting farm plans used in the Decision Exercise. In this part of the analysis the respondents classifying themselves as somewhat conservative and conservative in question 7 were lumped into the "conservative" class. Gamblers and somewhat gamblers were both classed as "gamblers." (The next section deals with the ability of respondents to correctly classify themselves.) Table XII lists the number of "conservative" and "gambler" respondents checking the various strategies.

TABLE XII

STRATEGIES USED BY CONFERENCE PARTICIPANTS

	Respondent Category	
Number of Respondents	"Conservative"	"Gambler"
In each category	29	9
Choosing expected returns	24	4
Choosing "play the odds"	3	4
Choosing "activity with largest potential winnings"	8	1
Choosing "activity with smallest spread of returns" (minimax)	3	0
Choosing diversification	23	5

Expected Returns

A large percent of respondents checked expected returns as one strategy used in choosing among activities. This term had been used frequently during the conference, thus, it is possible respondents automatically checked it. Had more thought been given the questionnaire, the respondents should have been asked to demonstrate their understanding of E(R) by computing the E(R) of an event-probability set completely unrelated to those used in the Decision Exercise.

Responses on questions 9 and 10 tested participants' awareness of the most likely event occurrences and, thus, indirectly tested understanding of the expected returns concept. Of the 28 respondents indicating a reliance upon E(R) in question 8a, 21 knew the most probable grain sorghum event was $11 and 20 were aware $20 was the most probable steer event. Considering a two-week lag between the conference and the date of questionnaire mailing, the retention of these facts served as verification of participant's understanding of the events used in the Decision Exercise.

Responses on question 11 also provided insight on understanding of expected returns. The respondent could choose between a sure return with an expected value of $15.20 and a variable return with an expected value of $20. Twenty of the 38 respondents chose the variable return with the higher E(R). Discussion later in the chapter will show why this is such a high percentage choosing the response with the higher E(R).

Diversification

Questions 8e and 15 (see Figure 20) were included in the questionnaire to see if respondents understood and used the diversification strategy. Question 15 was included in addition to 8e to detect participants who did not pursue a diversified plan throughout game play, but did diversify from one period to another in an attempt to reduce risks. The organizational plans used by each respondent in the conference were checked to see if the plans indicated a use of the strategy. Plans available for 33 of the 34 respondents indicated that they could have pursued the diversification strategy at some time during game play.

Table XII indicates that 23 "conservative" and 5 "gambler" respondents chose answer e to question 8. Six additional "conservative" respondents chose the "yes" answer to question 15. Thus, all 29 "conservative" respondents chose either 8e and/or 15 "yes." The breakdown of the 29 conservative" respondents' choices on 8e and 15 are as follows:

1. 9 chose only 8e
2. 14 chose both 8e and 15 "yes"
3. 6 chose only 15 "yes"

It is possible that more "conservative" respondents did not select 15 because they started game play as diversified as the game model would allow. The results do show "conservative" managers rely on the diversification strategy in playing the game.

The choice of a diversification strategy by 5 of the 9 "gambler" respondents seemed incongruous. Four of these 5 classified themselves as somewhat gambler. Because the four categories are imprecise, it is possible that respondents classifying themselves as somewhat gambler were no less conservative than were some classifying themselves as somewhat conservative (i.e., this arbitrary classification may have been inadequate to effectively differentiate somewhat conservative and somewhat gambler managers).

Another possible inconsistency in Table XII is the choice, by 8 "conservative" respondents, of the "choose enterprise with largest potential winnings." Such an attitude could be logically explained for "conservative" managers only after they build up a financial position that would allow a little risk taking.

Classifying Respondent Actions

As previously stated, one objective of the questionnaire was to compare respondent's classification of their actions in the game (i.e., conservative, somewhat conservative, etc.) to a rating of their performance by the game administrator. The game administrator's rating was obtained as follows. First, during the conference, respondents were asked to keep records of their plans. Next, the game administrator obtained the records from 36 of the 38 respondents. These records were then classified into one of the four categories based on the following criteria. To qualify as conservative the respondent had to keep wheat acres at or near the maximum allowed and exclude broomcorn from his farm plan. The somewhat conservative manager was also assumed to keep his wheat acreage at or near the allotment maximum, but was allowed to include broomcorn. His livestock numbers had to be kept about the same from year to year, although minor adjustments were allowed. The somewhat gambler managers were assumed to be less rigid in their selection of a plan and were expected to put more emphasis on grain sorghum and broomcorn than somewhat conservative managers. To qualify as a gambler the respondent was assumed to vary crop acres and livestock numbers appreciably in an attempt to "hit it big."

The respondents' own ratings of their conduct in the Decision Exercise and the ratings given by the game administrator are summarized in Table XIII.

Column 1, Table XIII, shows the distribution of respondent's self-classification into the four conduct categories. Column 2 gives the number of respondents the game administrator classified in each category.

For example, three respondents classified their game actions and attitudes as conservative. On the basis of the criteria given above, and independent of any knowledge of respondent's classification, the game administrator classified four respondents in the conservative category.

TABLE XIII

A COMPARISON OF RESPONDENT AND GAME ADMINISTRATOR RATINGS OF CONDUCT IN THE DECISION EXERCISE

	(1) Participant's Own Classification	(2) Classification by the Game Administrator	
Conservative	3	4	(2)
Somewhat conservative	24	22	(18)
Somewhat gambler	8	10	(5)
Gambler	1	0	(0)

The numbers in parentheses in column 2 give the number of game administrator classifications which corresponded with respondent self-classifications. For example, two of the four respondents classified as conservative by the game administrator were respondents who had classed themselves as conservative. Of the 24 respondents classifying themselves somewhat conservative, 18 of the same respondents were given a somewhat conservative rating by the game administrator.

Sure-Chance Answers

All 38 respondents answered questions 11 through 14 on the questionnaire. These questions were included as a test to see if each respondent's self-classification of his gaming conduct was consistent with answers he gave on the set of "sure-chance" questions.[2] The questions relate to enterprise and whole farm risk taking (see questions 11-14, Figure 20).

Table XIV shows the distribution of sure and chance answers given by respondents according to their conduct categories. Of the four conservative respondents, for example, one respondent chose all four sure answers, two chose three sure answers and one chose two sure answers.

TABLE XIV

THE DISTRIBUTION OF ANSWERS GIVEN BY RESPONDENTS TO SURE-CHANCE QUESTIONS

	No. of Answers Chosen	-Respondent's Self-Classification- Conservative	Somewhat Conservative	Somewhat Gambler	Gambler
Sure	4	1	10		
	3	2	4		
	2	1	7		
	1		1		
	0		3	2	
Chance	1			2	
	2			2	
	3			1	1
	4			1	

The following criteria were used to determine into which conduct category a respondent would fall based upon his response to four sure-chance questions. A respondent was required to give three sure answers to qualify as conservative and two to rate as somewhat conservative. To qualify as somewhat gambler or gambler required selecting three and four chance answers, respectively. The difference in numbers required to qualify a respondent as conservative and gambler results from the complexities arising from using question 11. The expected return for the sure answer in question 11 is lower than the expected return from the chance answer, whereas, in questions 12 through 14 the expected returns are equal for both sure and chance questions.

On the basis of the criteria set, the responses to the sure-chance questions give the following results:

1. Three of four respondents rating themselves conservative also rated conservative on the sure-chance questions.
2. Twenty-one of 25 somewhat conservative respondents also rated somewhat conservative.
3. Two of eight somewhat gambler respondents gave sufficient chance answers to rate as somewhat gambler.
4. No respondent rated gambler on the sure-chance questions.

Thus, cross tabulation of the participants' own classification and their responses to the sure-chance questions shows 82.8 percent of those who visualized their performance in the game as "conservative" also rated conservative on their answers to the sure-chance questions. Only 33 percent classifying themselves "gamblers" met the arbitrary criterion for gamblers. Four of the nine "gamblers" selected three or more "sure" answers. These respondents either misunderstood the questions or incorrectly evaluated their own preferences. This result lends support to the possible inconsistency on selection of diversification strategies mentioned above.

Pattern of Choices

The tabulation of sure-chance answers in Table XIV indicates a risk aversion preference among respondents. To allow a question by question examination of the sure-chance questions, Figure 21 showing the pattern of choices was constructed.

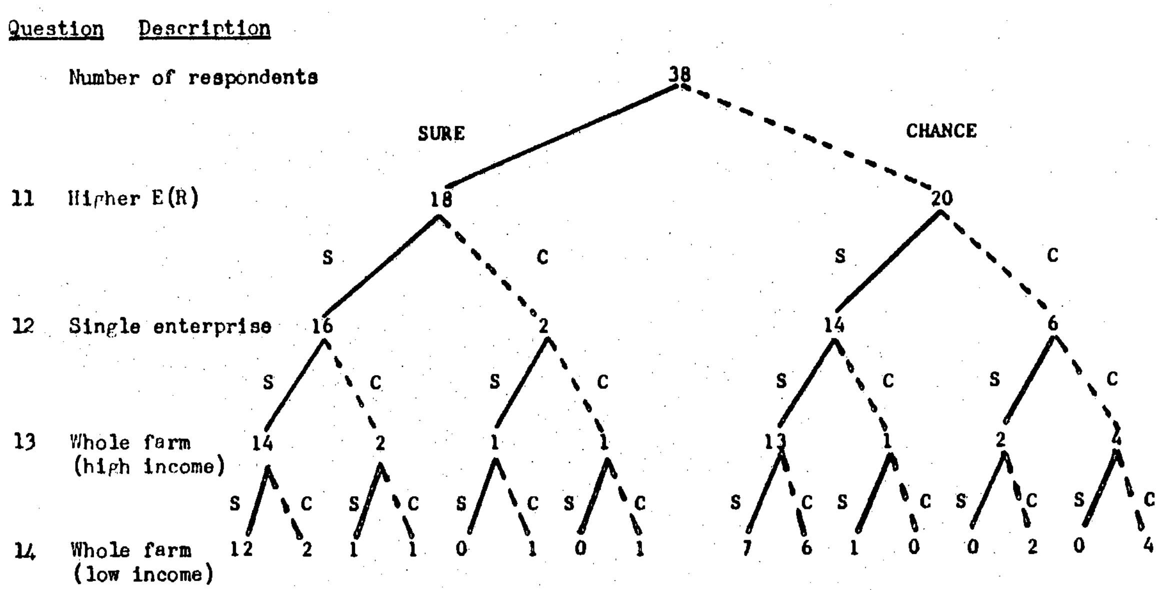


Figure 21. Pattern of Choices of Respondents to Sure-Chance Questions

Figure 21 lends support to the hypothesis that a majority of respondents are risk averters when the expected returns are equal for certainty and risk situations. Investigation of the figure indicates 21 respondents selected at least three "sure" strategies. These results indicate a strong preference for stable income rather than a variable income. This attitude is most noticeable in questions 12 and 13, and to a lesser extent in question 14. A comparison can also be made between answers given on questions 13 and 14 dealing with variability of whole farm income. Thirty of the 38 respondents preferred stable income from the large farm. Twenty-one of these also preferred the stable income under the small farm situation. The group showing a major shift in attitude from questions 13 to 14 were the participants who selected the "chance" answer in question 11. Responses of those who chose chance in questions 11 and 14 but sure in 12 and 13 indicates this group was willing to take risks when smaller income amounts were at stake. However, they preferred the sure, stable return when there was possibility of large losses.

As mentioned earlier, the responses to question 11 indicated an understanding of the expected returns concept. Question 11 was the only one of the four sure-chance questions for which the two answers had different expected returns. More than half of respondents chose chance on question 11, yet 70 percent of respondents that chose the chance answer on question 11 chose the sure answers on questions 12 and 13 (see Figure 21). This implies that respondents understand the expected returns concept and prefer the possibility of a variable returns with a higher expected value to a stable return with a lower expected value.

An Experiment in the University Classroom

The 1968 spring semester was the first time an entire farm management course at Oklahoma State University had been structured around a management game. Previous versions of the Decision Exercise and the Oklahoma Game II had been used as separate classroom exercises to stimulate interest to improve understanding of the concepts of expected returns and dynamic uncertainty. These previous uses had been single, independent learning experiences in a set of experiences designed to complement lecture materials. In 1968, the objective was an integrated set of learning experiences in which the Decision Exercise was the unifying element.

A senior level farm management course was selected as the structure within which this teaching innovation would be tried. As stated in the course catalogue, course objectives are: (1) to acquaint students with the principles and procedures of decision making and management as applied to farm and ranch businesses and (2) to assist students in applying managerial theory and techniques to the solution of specific farm-ranch management problems. Although stated much more briefly, these course objectives encompass the decision and concept objectives of the Decision Exercise explained in Chapter IV.

The course enrollment in spring, 1968, totaled 37 students. As is often the case with service courses (this course is one) the students had very heterogeneous backgrounds. Some students had only one or two previous courses in agricultural economics or economics, whereas, the majors in agricultural economics had considerable competence in economics theory.

The Course Plan

Implementation of the Decision Exercise necessitated altering lecture content and order to afford reinforcement of concepts the Decision Exercise was designed to emphasize and vice versa. The sequence was arranged in a manner the instructors felt would lend continuity and facilitation to the overall course objectives. The sequence of laboratory decisioning experiences and course lecture topics for the spring semester, 1968, are given below. The lecture topics are indicated by an asterisk.

Week	Topic
1.	Management seminar using Oklahoma Game II.
	*Management principles and procedures
	*The farming environment
2.	Inventory the resource situation in the Decision Exercise. Practice session with Decision Exercise. Make decisions for first decision period of game play.
	*Inventory of available resources, goals and institutional factors
	*Developing enterprise budgets
3 & 4.	Developing a "present normal" budget for the game farm. Complete first play of the Decision Exercise.
	*The cropping system
	*The livestock plan
	*Economic principles used in combining enterprises
	*Whole farm budgeting
5.	Selecting crop and livestock alternatives for developing a substitute plan
	*Long-run and short-run--their effects upon decisioning
	*Programmed budgeting

6, 7 & 8. Determining an optimum long-run plan using programmed budgeting

9. Complete second decision period for Decision Exercise

*Farm size adjustments

10. Third decision period--report on operations

*Budgeting resource additions

11. Fourth decision period--land purchase and rent alternatives

Fifth decision period--using the computer model

*Planning capital additions and flows

12. Sixth decision period--figuring cash flows for the game farm

*Planning uses of credit

*Planning leasing arrangements

13. Seventh and Eighth decision periods--supplementary problem on machinery purchase and replacement

*Budgeting machinery purchases

*Breakeven analysis

14. Critique of management experience

Two hours per week were spent in lecture and two hours were spent in decisioning activity.

Administration

The students were divided into teams of twos as was done in the conference. Students were allowed to choose the person with whom they desired to work as the course instructors knew considerable time would need to be spent in joint effort.

Setting the Stage

The Oklahoma Farm Management Game II was used as a prelude or warm-up for the Decision Exercise. This experience gave the student an understanding of discrete probability distributions and random occurrence of events. It also set the stage for general lectures on knowledge states existing in farming; kinds of decisions farm managers make, and strategies for decisioning under the various knowledge states.

Orientation

A slightly circuitous approach was taken to game orientation. The students were engaged in the topic of inventorying resources; the game farm was chosen as the example on which to base the discussion. The objective of this approach was greater identification on the part of the student with his role of manager of the simulated firm.

A set of enterprises suited to the game farm was also discussed during the orientation session. Prices, input requirements and output forthcoming from each enterprise were discussed as a means for studying cost and returns estimation. This discussion was supported by experiment station publications on normal yields, livestock gains and prices for the Panhandle area. These normal events were in turn related to the expected return concept used in the Decision Exercise. Again, the intent was student involvement as well as feeling for integrating technical and economic data and knowledge into the dynamic decision situation. The orientation session had the objective of building a base upon which future experiences could be developed.

The last phase of the orientation session consisted of an explanation of the computational forms and the development of a projected profit and loss statement for a present normal plan[3] for the game farm. Expected returns were used as a basis for projecting returns per unit for each activity. After the initial example by the game administrator, the students were asked to make plans for the first decision period in which they would act as managers of the game farm.

Game administrators answered questions related to game mechanics, but refrained from giving advice on organizational plans. An effort was made to impress students that decision making was their opportunity - and responsibility. The decisions, including irrational economic ones, would give the game advisers something to discuss with participants during the "Report on Operations."

The First Play

The first play of the Decision Exercise was completed in the third week of the semester. The game administrators purposely selected an unfavorable wheat revenue event as they hypothesized most teams would plant the maximum acreage of wheat allowed by the allotment restriction. The unfavorable wheat event was expected to put teams in a difficult financial position. It was hoped the financial problems would contribute to student interest in the static analytical techniques, budgeting and programmed budgeting which were to be discussed in future laboratory experiences.

Static Analysis of the Game Farm

The game farm situation was used for budgeting exercises. A present normal budget was developed using <u>total</u> expected revenue and <u>total</u> expected expenses. Students could see the total volume of sales and expenses and production practices, details not presented in the gaming experience. It was assumed the budgeting exercises would have integrating and intensifying learning effects by broadening the students' understanding of the game farm and giving them actual experience in using the analytical technique.

Results from the whole farm budget and the projected profit and loss statement for the present normal situation were compared in an attempt to give facilitation and intensity to the learning experiences. This session included a discussion of the similarities and dissimilarities of the budgeting and projected profit and loss techniques.

Concurrent lecture material focused on construction, uses and planning horizon for both enterprise budgets and whole farm budgets. The mechanics of programmed budgeting, selection of enterprises to include and the economic significance of its solution were also discussed.

Laboratory exercises in weeks 5 and 6 centered on selection of activities to be used in the programmed budgeting tableau and development of tableaus. Teams were allowed to select any reasonable activities which might be used on the game farm. A minimum of eight activities were required in the tableau developed by the teams.

Each team developed an "optimum" plan from the activities they included in their tableau by using the programmed budgeting technique. Because different teams used different sets of activities in their tableaus, different "optimum" plans were developed for the game farm. Discussion of the differences showed the influence of activities selected upon each organization developed and its profitability.

Game Play

The students were given an opportunity to manage the second decision period of the simulated farm during the ninth week. Students were encouraged to be thorough in their analysis and in filling out the forms used for hand computations. The game administrators reviewed all game forms. This double-checking procedure gave the administrator an indication of the students' understanding of the forms and competence in their use.

At the end of the third, and sixth decision periods the students were asked to report on their activities during the three proceeding decision periods. The reports were presented to the game administrator, and one other farm management instructor who was knowledgeable of the Decision Exercise. In the third period each team reported separately and was asked general questions about plans they had used in the first two decision periods. Questions asked of all teams related to (1) net worth position, (2) crop and livestock activities considered most desirable, (3) method used for meeting the fallow restriction, and (4) any strategies used for decisioning and planning in game situation.

The report on operations had several purposes. It gave the instructors an opportunity to subjectively evaluate the quality of managing which was taking place. Secondly, the instructors could develop some estimate of the effectiveness of lecture and gaming experiences to that point. Further, by asking probing questions and making suggestions the examiners could give the students concepts to consider in ensuing decision periods and reinforce desirable activity which had taken place.

The land acquisition plug-in experience was injected in conjunction with the fourth play of the Decision Exercise. Teams were given two days to decide the prices they would bid. Each team interested in buying or renting land was asked to submit a sealed bid giving price per acre and number of acres they wished to purchase or rent at that price. Sufficient land was made available to allow one-third of the teams to add land.

Firm size adjustment topics such as "pressures to adjust" and "breakeven size of firm" were concurrently being discussed in lecture. The question of how much to pay had not been discussed prior to the plug-in land buy opportunity. The course instructors wanted to see if players used economic analysis from other courses. It was realized some teams might have no previous knowledge upon which to draw.

By the end of the third decision period the course instructors decided the desired level of competence in use of computational forms had been attained. Thus, beginning with decision period 4, the computer program was used to make computations. Computations required of students were reduced to those necessary to keep a current comparative analysis sheet. The time saving afforded by use of the computer allowed more time for decisioning experiences related to the basic Decision Exercise model. The objective of the complementary experiences was a broader understanding of management analysis techniques. All these experiences were tied to the Decision Exercise to give them more realism (i.e., each team would have the opportunity to apply the techniques to their own simulated farm).

Complementary Exercises

A cash flow analysis for the game farm was conducted in the week 12 decisioning experience. The exercise required each team to determine total expected receipts and expenses for the plan they had used during the most recent period of game play.

Expense data for each activity in the Decision Exercise was supplied all teams. The data were broken down item by item (e.g., seed, fertilizer, fuel, hay, veterinary costs) and month by month. To get the monthly cost per activity the teams had to total all expense items incurred by the activity in each month and multiply the monthly expense by the number of units of the activity. Monthly expenses per activity were totaled for all activities to get total monthly expenses. Teams were required to use available economic and technical data to develop the monthly receipt figures.

By getting the difference between receipts and expenses in each month the teams determined in which months receipts exceeded expenses and vice versa. Accumulating cash surpluses or deficits month by month from January to December allowed teams to derive a more accurate estimate of borrowing needs than is supplied in the "lump-sum" approach of the Decision Exercise.

Analysis of cash flows showed ways expenses could be shifted between months to reduce loan requirements and interest payments on the game farm. This exercise also gave added realism to the Decision Exercise by illustrating some of the within year decisions required of managers.

The leasing arrangement problem in the week 13 decisioning experience was developed to complement lecture materials. This exercise required teams to determine an equitable distribution of profits for the game farm under a landlord-tenant agreement. It was assumed the landlord owned all land and paid real estate taxes and the tenant furnished all other inputs. The game farm was used to give the problem realism and enhance student interest.

The critique of management experiences was intended to summarize highlights of the decisioning experiences. A summary of the financial position of each team, the strategies used and comments on changes each would make if the game were played again was the first topic of discussion. The game administrator tried to reinforce learning which was correct and dispel any incorrect opinions. In the second part of the critique the game administrator reviewed some representative plans and possible consequences. The results from simulation in Chapter VI were used as a basis of this discussion.

Student Performance and Reaction

The overt display of student interest and involvement in the early weeks of the decisioning experiences was inferior to that shown by conference participants in early plays of the Decision Exercise. There were several possible reasons. First, the decision experiences were spaced at week intervals, hence, there was less opportunity to develop and maintain interest momentum under these conditions. Second, most teams failed to grasp the intended purpose of the change from dynamic to static conditions in week 3 and did not make the transition between knowledge states as well as was anticipated. This could have resulted from inadequate coordination between course instructors and/or insufficient preparation for and discussion of the change in knowledge states by the game administrator. A third confounding factor was the programmed budgeting experience. For some students this technique required more work than they wanted to expend. Further, after developing the "optimum" plan, students thought it unrealistic to go back to the original situation of only three crop and four livestock activities when the switch was made from static back to dynamic conditions in week 9. (Some overlooked the fact they had added a new analytical technique to their management kit.) The interest level of some teams was visibly reduced by this experience.

With the completion of the second decision period, teams began to compare their profit and net worth position with those of other teams. A difference in financial positions produced a competitive spark that gave the decisioning experiences needed momentum. Interest was further heightened by the report on operations. A summary of replies to questions asked during the report is given in the next section.

Summary of Report on Operations

A question posed the teams during their reports was "which crop do you consider most desirable? Why?" Eleven of the 15 teams gave wheat as their answer. The reasons given were: (1) higher returns, one team; (2) more stable return, four teams; (3) wheat pasture, eight teams; and (4) allotment, one team. The first two reasons are totally invalid and the game administrators made suggestions which would allow teams to determine for themselves why these reasons were invalid. Reason 3 is correct if the wheat pasture yield equals or is greater than .2 AUM's per acre. Questioning of teams giving this response indicated half the teams has completely ignored the surety of grain sorghum grazing vs. the variability of wheat pasture consideration. Allotments probably had a much greater effect than was verbalized. Thirteen of the 15 teams reporting had maintained allotment at the maximum per period during the first two plays.

The methods used by students in meeting the fallow restriction was disappointing to the game administrators. The restriction allows the flexibility to get as much as 600 acres behind; however, nine of the 15 teams maintained acres fallowed at a constant 300 acres per period in each of the first two periods. This strategy is not the one expected from a new manager with a debt position comparable to that of the teams in the Decision Exercise. He would be expected to defer fallowing land as long as possible to get in a better financial position. Questioning of teams showed most misunderstood the free fallow and/or deferred fallow alternatives for meeting the fallow restriction.

Five strategies for living with uncertainty [(1) using expected returns, (2) diversification, (3) minimax strategy, (4) liquidity and (5) flexibility] had been discussed in lecture some 5 or 6 weeks previous to the report on operations. During the report, each team was asked: "Have you used any of the strategies for living with uncertainty discussed in lecture? Which ones? Can you give an example of each?"

To be credited as having validly used a strategy, a team had to name a strategy and give an example of how they had used it in the game situation. Teams unable to verbalize and explain a strategy were not given credit as having used the strategy.

Fourteen of the fifteen teams giving reports had validly used at lease one strategy. Ten teams had used one strategy; three teams had used two strategies; and only one team used as many as three strategies.

Only four of the five strategies discussed in lecture were given as used in practice. Table XV gives the strategies used and their frequency of use.

The preference for sure activities and diversification indicates students play conservatively in the early periods of game play. This attitude is consistent with what would be expected from a young man taking over the management of a new farm.

TABLE XV

STRATEGIES USED BY STUDENTS IN DECISIONING IN THE DECISION EXERCISE

Strategy	Number of Times Used
Maximize expected returns	2
Diversification	6
Minimax ("Sure" activities)	8
Liquidity	3

Plug-In Activities

Student interest in the land acquisition plug-in activity was quite high. More than half the teams visited with the game administrator during the two-day interval between the announcement of the land acquisition opportunity and the day bids were submitted. Twelve of the 16 teams did analyses outside class to arrive at a price to bid. A breakdown of the methods used are given in Table XVI.

Of the 16 teams bidding, six indicated they had discounted their highest bid to allow for uncertainty and/or to have some added return to labor and management. The proportion of students using the capitalization technique was much greater among students than among conference participants. Students appear to recognize opportunities to use previously learned materials from other courses (e.g., appraisal) in addition to those of the course within which the Decision Exercise was integrated.

TABLE XVI

METHODS USED BY STUDENTS TO DETERMINE BID
IN LAND ACQUISITION OPPORTUNITY

Method Used	Number
Capitalized Expected Returns	6
Capitalized Net Return From Programmed Budgeting	3
Developed Several Projected Profit and Loss Statements to Find Expected Annual Return	1
Used Current Land Value as a Base	2

The Computer Model

Response to use of the computer model was favorable. Teams were usually impatient to have the results of their decisions returned and would drop by the office of the game administrator ahead of the scheduled pick-up time in hopes of getting an early look at their results.

Some teams were skeptical of the print-out the first time the computer model was used. Most teams checked their results carefully. In fact, nearly half the teams discovered an error in the tax computations subsection of the computer program. After the tax error was corrected, the teams were satisfied to take results with only spot checks to make sure the decisions they made were the ones processed.

That teams were involved and interested in what was happening to "their farm" was evidenced by the unwillingness of teams to use the feasible cash flow solution generated. Several teams altered the feasible cash flows to better fit their particular management strategy.

Complementary Exercises

Team performance on the cash flows and leasing arrangements problems was such that most teams graded above 80 percent on both. It is possible performance was enhanced because grades were given on these exercises. Familiarity with the game farm did permit an easy grasp of the problems by the students. Discussion was easier and freer because of the common interest in the game farm.

The critique of management experiences was held the last class period of the semester. Students were attentive and alert to presentation of financial positions attained by the various teams and to the simulation results from Chapter VI of this study. Numerous questions were asked and evidence given of sincere interest in reasons for differences in ending results.

Comprehension of Basic Concepts

Upon completion of the decisioning experiences the students were again quizzed on attributes of the activities included in the Decision Exercise. This time each student was tested individually and the possibility of one team member speaking for both, eliminated, as could have been the case in the report on operations. Only the responses of students who had given reports on operation are summarized.

The first question again asked was "Which crop do you consider most desirable? Why?" Fourteen students gave grain sorghum and 15 gave wheat. In the earlier report on operations 11 of 15 teams gave wheat; two gave grain sorghum and two did not know.

Nine of the students selecting grain sorghum as most desirable gave both higher expected returns and a lower probability of getting the unfavorable grain sorghum event as reasons. Five students gave only the higher expected returns criterion. Both these reasons are logically and economically defensible.

Reasons given for selecting wheat as the most desirable crop activity were less concrete, but generally superior to the reasons given in the report on operations. Column 1 in Table XVII indicates 8 of 15 students recognize wheat is particularly desirable if some minimum income must be guaranteed in the Decision Exercise. Five teams continued to be enamored with the wheat pasture produced. This indicates these persons or teams did not heed (or understand) the suggestions made during the reports on operations. These persons were possibly influenced by an attitude and were disinterested in computing the economic facts for the Decision Exercise.

Only 3 of 29 students listed more than one reason, steers could be preferred to cows. However, more than 70 percent of the students gave either liquidity or flexibility as reasons. These responses indicated a greatly improved understanding of the two concepts for living with uncertainty between the report on operations and the final period of the semester.

The percent of students realizing (1) returns per AUM are higher for cows than for steers and (2) that cows are a "surer" activity than steers was up 20 percent from the report on operations. Over 79 percent of the individuals gave the lower risk-higher expected returns answer (see last column in Table XVII).

Understanding of the expected value concept was also sampled during the quiz over comprehension of basic concepts. The students were given a set of yield data completely unrelated to the Decision Exercise. They were asked to compute the expected yield and were asked to what concept

TABLE XVII

RESPONSES TO QUESTIONS ON ATTRIBUTES OF ACTIVITIES INCLUDED IN THE DECISION EXERCISE

Answer Given	Reason Wheat Was Considered Most Desirable	Reason Grain Sorghum Was Considered Most Desirable	Reason Steers Could Be Preferred to Cows	Reason Cows Could Be Preferred to Steers
1. Higher expected returns		14		13
2. Lower probability of unfavorable events		9		10
3. Avoiding very low events - minimax strategy	6			7
4. More stable returns	2			7
5. Provided input for a supplementary activity	5			
6. Flexibility			8	
7. Liquidity			14	
8. Lower capital requirement			4	
9. Increased net worth				4
10. No valid reason given	4		6	3

used in the Decision Exercise this was most related. Twenty-two of 35 students related the expected yield to the expected value concept used in the Decision Exercise. It is possible a greater number of students could have identified the concept had a previous similar example been given. This was not the intent, however. The game administrators wished to know what percent of the students could generalize from the experience in the Decision Exercise to another problem with only the basic concept the same. The 2/3 performance on the expected value question was satisfactory to the course instructors.

Summary

This chapter summarized two uses which had been made of the Decision Exercise. Both the continuous play (conference) experience and the weekly classroom use were new in farm management training at Oklahoma State University. Never before had a management game served as the organizing hub for an entire set of learning situations.

The learning situations were developed consistent with learning principles. For example, the use of profit and loss and comparative analysis statements gave the gaming experience continuity. At the same time, repetitive use of these forms was giving participants (students) practice in the use of these important management instruments.

Reiteration of concepts and techniques was consciously promoted. The concept of expected returns, for example, was first introduced in the classroom situation via Game II; this was followed by lecture discussions of the concept. Expected returns were again considered and the relation to "normal" returns explained when activity budgets and programmed budgeting were discussed and used. Finally, opportunities for using expected values under dynamic conditions were provided by the Decision Exercise. This should have given integration of experiences and intensity to the specific concept expected returns.

Facilitation was intended by sequencing experiences to build on previous ones, i.e., the effect of former decisions upon future conditions in the Decision Exercise. Cash flow analysis, land purchase opportunities and credit considerations were also a means of broadening the basic game situation. Further, many assumptions and conditions were meant to build on previous economic and technical training, as well as, give the participant an opportunity to use some of his previous training.

The actual use of the Decision Exercise as a foci of teaching situations met with varied degrees of success. Viewed ex post, several observations can be made about game play and learning in a gaming situation when the Decision Exercise was the model.

First, the continual play situation (conference) allowed more effective use of the intensity principle than did the weekly classroom experiences. Reiteration of concepts and techniques could be accomplished within a very short time span, whereas, effect was sometimes lost because of time lag in the weekly experiences. The rapidity of feedback of outcomes from decisions made also provided intensity to both learning situations.

Maintenance of interest also was tied to time. Momentum, once generated, was easier to maintain in the conference situation. Feedback of results only a short time after decisions were made did have interest generating effects.

Practice in decisioning and use of business forms was accomplished in both situations. Competence in use of forms was accomplished more rapidly in the continuous play situation. In both situations, about 5 percent of the teams never developed competence. Part of the ineptitude could be contributed to a lack of interest, hence, no desire to understand computational mechanics.

There was little evidence of completely irrational play in either gaming situations. It is possible there would have been more had community adviers not been used in the conference. The tendency for both conference participants and students was toward conservative rather than gambling or irrational strategies. Some of the prices offered in land buy and rent opportunities were outside the range expected; however, no barometer of subjective economic attitudes was used to prove these bids were unreasonable.

FOOTNOTES

[1]Contributions from research with games include:

E. M. Babb, M. A. Leslie, M. P. Van Slyke, "The Potential of Business Gaming Methods in Research," Journal of Business, XXXIX (1966), pp. 472-475.

B. M. Base, "Business Gaming for Organizational Research," Management Science, V (1964), pp. 545-556.

G. H. Symonds, "A Study of Management Behavior by Use of Competitive Business Games," Management Science, V (1964), pp. 135-153.

J. L. McKenney, Simulation Gaming for Management Development, (Boston, 1967), pp. 114-135.

C. I. Fife, "The Management Decision-Making Process as Revealed in a Competitive Game," (unpub. Ph.D. dissertation, Purdue University, 1966).

[2]The sure-chance questions are based upon, and almost identical to questions used by D. B. Williams in a study of farmer attitudes. Williams found these questions to be valid in testing attitudes. One goal of the sure-chance questions was a measure of the attitude of farmers to uncertainty situations. A complete discussion of Williams' uses are in:

D. B. Williams, "Price Expectations of Illinois Farmers," Journal of Farm Economics, XXXIII (1951), pp. 20-39.

[3]A present normal plan does not necessarily refer to a plan for any one year; rather crop acres and livestock numbers assume normal operations (those pursued on the average) for existing farming situation. A present normal plan is similar to a long-run average plan.

CHAPTER VIII

SUMMARY AND CONCLUSIONS

Summary

The basic problem which led to this study was a felt need that existing methods of farm management education were inadequate for accomplishing the educational task. Farm management teaching endeavors to (1) foster greater understanding of farm management activity and (2) develop student's managerial capabilities, but ignores many of the basic planning and coordination problems required of management in the real world. Many of these problems are associated with decisioning over time and under imperfect knowledge, and developing consistency between short-run and long-run goals.

University classroom farm management education is confounded by a large enrollment of non-agricultural economic majors. These students are generally more difficult to motivate toward economic analysis than are majors. For example, some students find the static economic models presented by the lecture method too abstract for their interest.

Management games have gained substantial recognition as tools for effectively generating intense interest and involvement from participants. An elementary farm management game at Oklahoma State University has received favorable response in both the university classroom and in adult education. It also has been adapted for use at other institutions. The Oklahoma Farm Management Decision Exercise was an outgrowth of these favorable experiences with games.

The Decision Exercise evaluated in this study was conceived with the purpose of developing a game which provided players an opportunity to use a large number of management and economic concepts and procedures. Besides development and explanation of the Decision Exercise, purposes of this study were to explore uses and evaluate their effectiveness in teaching economic and management concepts.

The basic procedure of this study was to (1) explain the Decision Exercise model and educational objectives for the Decision Exercise, (2) develop a computer model to provide ease of administration and reduce calculations required of participants in learning situations using the Decision Exercise, (3) generate and evaluate data from simulations using the Decision Exercise and (4) describe teaching experiments using the Decision Exercise and report observation and findings.

The Oklahoma Farm Management Decision Exercise is a non-competitive, probabilistic model of an Oklahoma Panhandle farm. The situation is based upon cost and returns data for the high-risk Panhandle area. A farm of 1600 acres cropland and 400 acres pasture is the basic situation. Initial conditions include (1) adequate machinery to farm the cropland, (2) no livestock and (3) a $2,000 beginning cash balance. There is an 800 acre wheat allotment and land debt of $50,000. Payment on debt, family living and machinery average $8,500 but can be varied within limits.

Gaming with the hand-computed Decision Exercise relies on five basic planning and analysis forms as a means for calculations. The forms (profit and loss statements, a native and wheat pasture balance sheet, a credit planning form and a comparative analysis sheet--including a net worth statement) are very much a part of the training that goes on within the Decision Exercise. Use of these forms gives game participants experience in handling the instruments as well as in decisioning. The forms are consistent with work tables and financial forms recommended for manager use by the American Bankers Association.

The computerized version of the Decision Exercise, developed to satisfy study objective 3, is an exact duplication of the hand-computed model. The computer model makes all computations, checks all restrictions and prints out a profit and loss statement almost identical to the one used in the hand-computed model. Use of the computer model eliminates almost all calculations required of game participants and releases time for analyses. The game administrators used some of that time to superimpose supplementary exercises on cash flows, leasing arrangement and land acquisition on game play. The computer model also allowed a simulation of possible outcomes from playing the Decision Exercise. Simulation results provided improved knowledge about possible gaming outcomes. The results were used by the game designers in evaluating the Decision Exercise. The data were also developed for use by game participants as decisioning guides.

In the simulation, seven plans are selected as possible representations of strategies game participants might follow in playing the game. One plan was the optimum plan developed using linear programming. Other plans represented minimax, diversification, flexibility and specialization strategies.

Two kinds of simulations were generated for the Decision Exercise. One set, "the set of annual possibilities," was developed using single-year simulations to show the range of incomes which could occur for each plan. Annual residual (profit) was the variable observed in the single-year simulations. The annual simulations show short-run profitability characteristics of the seven plans. The ten year simulations, "ten year growth sets," give indications of performance of the seven plans over time. These data are useful in long-run planning. Net worth was the variable observed in the growth simulations. Net worth maximization is the stated objective for players in gaming situations using the Decision Exercise.

The Decision Exercise has been used on two occasions as the integrative force to give continuity and intensity to learning situations. One use was the 1967 Farm Business Training Conference, a two-and-one-half day adult education conference. The second use was a one-semester, senior level farm management course. In the classroom, 14 two-hour laboratory decisioning experiences, and most of the 28 lectures, were structured around the Decision Exercise.

Conclusions and Implications

A review of farm management teaching indicates it is ready for new techniques to better communicate the functional processes of management and the application of farm economics. On-the-job training is capable of providing experiences which illustrate management through time (decisioning, implementing decisions and bearing responsibility). This method of learning is generally not feasible. The Decision Exercise is a superior substitute for communicating management processes and illustrating use of economic principles under uncertain and time-dynamic conditions. The Decision Exercise affords a participant opportunities to (1) assess and classify decision results (feedback) as a means for new planning, (2) alter plans to facilitate goal attainment through time and (3) experience the responsibility for decisions made.

The development of a workable computer model of the Decision Exercise to rapidly process decisions is a contribution of this study. Besides reducing time-consuming calculations, the computer model requires fewer persons to administrate a gaming experience than does the hand-computed Decision Exercise.

Because the hand-computed and computer models of the Decision Exercise are identical and the forms very similar, the models can be easily substituted for each other. In the classroom experience with the Decision Exercise, the computer model was substituted for the hand model once competence in the mechanics of using the data and computational forms was attained. The transition from hand-computed to computer model was accomplished with ease and interest was enhanced. The increased interest resulted because this was the first experience most students had had with the computer.

The use of simulation results to test the responsiveness of a probabilistic farm management game to different organizational plans is a unique contribution of this study. The simulation results have both short-run and long-run implications. In the Decision Exercise, the short-run annual income data indicate the possibility of incurring losses can be minimized by using a diversification strategy and a conservative estimate for wheat pasture. The distributions of annual income values for specialized strategies are more variable and generally have lower means than do diversified strategies.

Ten year growth simulations indicate that a specialized strategy of grain sorghum, broomcorn and cows on native pasture can give the highest average net worth. The variability of net worth through time and the possibility of having very low, ending net worth are undesirable characteristics of the specialized plan. The optimum plan developed using linear programming gave the second highest ending average net worth, but had a much smaller variation in year-to-year net worth values than did the specialized strategy.

The simulation results indicate it generally is both more profitable and less risky to pursue a diversification strategy and have cows rather than steers. Specialized plans which include steers have the most variable and lowest returns of any plan simulated.

The first use of the simulation results with game players was in the critique of classroom decisioning experiences. Student interest in these results was intense. Questions asked by students indicated a high appreciation for the simulation results and a realization of the potential use of the data as decisioning guides in game play. The use of simulation results as a decisioning input is a gaming modification which may be inaugurated as a result of this study. For example, in future uses of the Decision Exercise, the single-year and ten year simulation results can be furnished game participants at the beginning of game play. These data can then be used by the player as normative guides for decisioning under imperfect knowledge.

Use of the Decision Exercise in extension and classroom education indicates it can be an effective educational tool. The most effective uses were in illustrating the planning and coordination activities of management. However, the Decision Exercise is not intended to substitute for more formal methods of presenting economic theory.

Learning did occur from the use of the Decision Exercise. Students and conference participants both exhibited improved understanding (1) of the expected returns--"normal" returns concept; (2) of strategies for living with uncertainty; (3) of partial budgeting; and (4) of the composition of business management forms and their use as decisioning aids.

Using the Decision Exercise to augment lecture provides participants an opportunity to see how principles and procedures can be used in real life situations. This attribute of the Decision Exercise can be very useful in adult education where participants are not motivated to review materials presented. By reiterating and intensifying lecture materials with the Decision Exercise, the educator can be more confident the concepts he presents will be understood.

In education, the Decision Exercise can serve as a device to evaluate the level of comprehension of lecture materials. For example, in a recent adult education conference had the Decision Exercise not been used, the lack of participant comprehension of budgeting land acquisition opportunities and marginal analysis would have gone undetected. Had lecture only been used, many participants would have gone away from the conference without understanding the principles discussed.

Another observation from educational use of the Decision Exercise is the feeling of management which participants develop. There is little evidence the players treat the Decision Exercise experience as purely artificial. Most participants are earnest in their effort to achieve the highest possible financial position. Some participants did get more interested in year to year management and never really grasped the long-run situation. It is possible the simulation results can bring the long and short-run considerations into better focus.

Several implications for educational uses of the Decision Exercise can be drawn from this study.

1. The concepts and procedures to be taught using the game should be easily recognized by students or made explicit by the game administrator. Previously learned concepts can also be reinforced by gaming experience.

2. The impression of realism can be achieved with few activities. By limiting the number of activities, the management problems are more easily grasped by game participants. Use of few activities also makes the mechanics of game administration simple.

3. Interest in farm management economics can be enhanced with the Decision Exercise. Students who are generally the most difficult to motivate enjoy gaming because of the feeling of realism.

4. The Decision Exercise provides an excellent framework upon which supplementary exercises can be superimposed. Examples of supplementary exercises are: (1) marginal analysis problems on level of input use; (2) land buy opportunities and analyses for determining an economically justifiable price to pay; and (3) cash flow analysis to illustrate money management and within-year decisions.

5. A game administrator can be more effective in helping students learn and in evaluating game activity if he has a thorough knowledge of the game, including the range and frequency of outcomes which can be expected. Simulation results provides this unique dimension to the Decision Exercise.

6. Fewer administrative personnel are required for gaming when

the computer Decision Exercise model is used.

Future Uses

This study has shown the Oklahoma Farm Management Decision Exercise can be an effective educational tool. It has not shown it to be more or less effective than other methods. Future study could compare the learning of students using the Decision Exercise with the learning of students taught with other methods. Another extension of this study might evaluate the effect of incorporating more activities and/or allowing participants to choose among input levels.

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APPENDIX A

COMPUTER PROGRAM FOR OKLAHOMA FARM MANAGEMENT DECISION EXERCISE

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$IBFTC DCKNAM
      DIMENSION COWCAP(500),CARRYO(500),COWLON(500),ALOSES(500),
     1AFALO(100),FAMLIV(100),EFALO(100),PLAND(100),AMACH(100),OFREE(99),
     2BFALO(99)
      DIMENSION A(500)
 1000 FORMAT(I3)
 1001 FORMAT(40F2.0)
      READ(5,1000) N
      READ(5,1001) (A(K), K=1,N)
      DO 999 K=1,100
    1 FORMAT(2F3.0,F6.0,9F5.0)
    2 FORMAT(4F8.2)
    3 FORMAT(10F5.2)
    4 FORMAT(8F9.2)
    7 FORMAT(3F6.0,2F7.0,F6.0)
    8 FORMAT(5F6.0)
    9 FORMAT(I2)
      I=0
      L=1
      RNTLND=0
      BFALO(L)=0
      READ(5,1)PPANDL,TEAMNO,CRPLND,PASTR,ACWHT,ASORG,ABROM,AFALL,CC1,
     1CC2,STR1,STR2
      EVNAT=.6
      EVSORG=.2
      EVBROM=.2
      IF(PPANDL.EQ.0.) GO TO 100
      EFALO(L)=0
      READ(5,3)EVWHT,PWHT,PSORG,PBROM,PCC1,PCC2,PSTR1,PSTR2,PRICWP
      READ(5,4)COWCAP(L),CARRYO(L),ALOSES(L),BALAN,Z,AMACH1,PLAND1,FAMLI
      GO TO 241
  100 CONTINUE
      READ(5,7) COWCAP(L),ALOSES(L),CARRYO(L),BALAN,Z
      READ(5,8) AMACH(L),PLAND(L),PLAND(L-1),FAMLIV(L),PRICWP
      READ(5,9) JYR
   34 L=L+1
      BADWHT=0
      BADSOR=0
      BADBRO=0
      I=JYR*7-7
      I=I+1
      IF(ACWHT.GT.CRPLND/2.) GO TO 2002
      IF(A(I).LE.33.) GO TO 202
      IF(A(I).LE.66.) GO TO 203
      IF(A(I).LE.99.) GO TO 204
  202 PWHT=5.
      BADWHT=ACWHT/2.
      GO TO 205
  203 PWHT=10.
      GO TO 205
  204 PWHT=20.
      GO TO 205
 2002 IF(A(I).LE.33.) GO TO 2003
      IF(A(I).LE.66.) GO TO 2004
      IF(A(I).LE.99.) GO TO 2005
 2003 PWHT=0
      BADWHT=ACWHT/2.
      GO TO 205
 2004 PWHT=5.
      GO TO 205
 2005 PWHT=15.
  205 I=I+1
      IF(PWHT.GT.5.)GO TO 250
      IF(A(I).LE.33.)GO TO 206
      IF(A(I).LE.99.)GO TO 207
  206 EVWHT=0
      GO TO 211
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207 EVWHT=.1
    GO TO 211
250 IF(PWHT.GT.10.)GO TO 251
    IF(A(I).LE.12.)GO TO 208
    IF(A(I).LE.87.)GO TO 209
    IF(A(I).LE.99.)GO TO 210
208 EVWHT=.1
    GO TO 211
209 EVWHT=.2
    GO TO 211
210 EVWHT=.3
    GO TO 211
251 IF(A(I).LE.66.)GO TO 252
    IF(A(I).LE.99.)GO TO 253
252 EVWHT=.3
    GO TO 211
253 EVWHT=.4
211 I=I+1
    IF(A(I).LE.24.) GO TO 212
    IF(A(I).LE.74.) GO TO 213
    IF(A(I).LE.99.) GO TO 214
212 PSORG=3.
    BADSOR=ASORG/2.
    GO TO 215
213 PSORG=11.
    GO TO 215
214 PSORG=22.
215 I=I+1
    IF(A(I).LE.49.) GO TO 216
    IF(A(I).LE.99.) GO TO 217
216 PBROM=0.
    BADBRO=ABROM/2.
    GO TO 218
217 PBROM=25.
218 I=I+1
    IF(A(I).LE.33.) GO TO 219
    IF(A(I).LE.66.) GO TO 220
    IF(A(I).LE.99.) GO TO 221
219 PCC1=47.20
223 PCC2=50.30
    GO TO 222
220 PCC1=62.20
224 PCC2=65.30
    GO TO 222
221 PCC1=77.20
    PCC2=80.30
222 I=I+1
    IF(A(I).LE.9.) GO TO 227
    IF(A(I).LE.29.) GO TO 228
    IF(A(I).LE.69.) GO TO 229
    IF(A(I).LE.89.) GO TO 230
    IF(A(I).LE.99.) GO TO 231
227 PSTR1=0.
    GO TO 232
228 PSTR1=5.
    GO TO 232
229 PSTR1=20.
    GO TO 232
230 PSTR1=30.
    GO TO 232
231 PSTR1=40.
232 I=I+1
    IF(A(I).LE.9.) GO TO 233
    IF(A(I).LE.29.) GO TO 234
    IF (A(I).LE.69.) GO TO 235
    IF(A(I).LE.89.) GO TO 236
    IF(A(I).LE.99.) GO TO 237
233 PSTR2=2.
    GO TO 238
234 PSTR2=5.
    GO TO 238
```

```
  235 PSTR2=15.
      GO TO 238
  236 PSTR2=20.
      GO TO 238
  237 PSTR2=40.
  238 CONTINUE
      OFREE(L)=BADWHT+BADSOR+BADBRO
      BFALO(L)=AFALO(L)+OFREE(L)
  241 CONTINUE
      ZNATIV=PASTR*EVNAT
      SORGP=ASORG*EVSORG
      BROMP=ABROM*EVBROM
      ANATPA=ZNATIV+SORGP+BROMP
      AWHTPA=ACWHT*EVWHT
      PROPTX=1600.00
      EFALL=AFALL*4.0
      CSALES=0
      OTHRCC=0
      OTHRST=0
      CAP1=0
      CAP2=0
      CAP3=0
      CAP4=0
      OTHR=0
      WPSALE=0
      WPCOST=0.
      ENSWHT=ACWHT*PWHT
      ENSORG=ASORG*PSORG
      ENSBRO=ABROM*PBROM
      ENSCC1=CC1*PCC1
      ENSCC2=CC2*PCC2
      ENSTR1=STR1*PSTR1
      ENSTR2=STR2*PSTR2
C     PASTURE REQUIREMENTS DETERMINATION
      PACC1=CC1*13.0
      PACC2=CC2*10.0
      WHCC2=CC2*3.0
      PASTR1=STR1*6.0
      PASTR2=STR2*0.5
      WHSTR2=STR2*2.5
      REQNAT=PACC1+PACC2+PASTR1+PASTR2
      REQWHT=WHCC2+WHSTR2
      EXCESN=ANATPA-REQNAT
      IF(EXCESN.LT.O.) GO TO 320
      EXCESW=AWHTPA-REQWHT
      IF(EXCESW.EQ.ACWHT*EVWHT) GO TO 20
      GO TO 21
   20 WPSALE=(ACWHT*EVWHT)*PRICWP
   21 IF(REQWHT.LE.AWHTPA) GO TO 22
      WPNEED=REQWHT-AWHTPA
      WPCOST=WPNEED*PRICWP
   22 CONTINUE
C     CAPITAL COMPUTATIONS
      IF(CC1.EQ.0.) GO TO 30
      CAP1=CC1*200.00
   30 IF(CC2.EQ.0.) GO TO 31
      CAP2=CC2*200.00
   31 IF(STR1.EQ.0.) GO TO 32
      CAP3=STR1*120.00
   32 IF(STR2.EQ.0.) GO TO 33
      CAP4=STR2*120.00
   33 CONTINUE
      COWLON(L)=0
      COWCAP(L)=CAP1+CAP2
      COWCOL=(COWCAP(L)*.70)-CARRYO(L-1)
      IF(COWCAP(L).LE.COWCAP(L-1)) GO TO 41
   35 CHANGE=COWCAP(L)-COWCAP(L-1)
      IF(CHANGE)36,37,37
   36 CSALES=-CHANGE
      GO TO 41
```

```
   37 IF(CHANGE.GE.Z) GO TO 39
      Z=Z-CHANGE
      GO TO 41
   39 ANEDED=CHANGE-Z
      Z=0
      IF(ANEDED.LE.COWCOL) GO TO 40
      COWLON(L)=COWCOL
      OTHRCC=ANEDED-COWCOL
      GO TO 41
   40 IF(ANEDED.LE.0.) GO TO 41
      COWLON(L)=ANEDED
   41 STRCAP=CAP3+CAP4
      STRCOL=STRCAP*.70
      IF(STRCAP.GE.Z)GO TO 42
      Z=Z-STRCAP
      GO TO 44
   42 ANEED=STRCAP-Z
      Z=0
      IF(ANEED.LE.STRCOL)GO TO 43
      STRLON=STRCOL
      OTHRST=ANEED-STRLON
      GO TO 44
   43 STRLON=ANEED
   44 CONTINUE
      COWNOW=COWLON(L)/2.
      CARRYO(L)=COWLON(L)/2.
      OTLOAN=OTHRCC+OTHRST
      OTHR=WPCOST+RNTLND
   45 COWINT=COWLON(L)*.10
      STRINT=(CAP3*.7*.1)+(CAP4*.7*.05)
      OVERIN=CARRYO(L-1)*.10
      ALOSSI=ALOSES(L-1)*.10
      ALANDI=BALAN*.05
      OTHRIN=(OTHRCC*.10)+(OTHRST*.10)
   46 SHTERM=COWINT+STRINT+OVERIN+OTHRIN+ALOSSI
   47 TOTNET=ENSWHT+ENSORG+ENSBRO+ENSCC1+ENSCC2+ENSTR1+ENSTR2+WPSALE
   48 SALES=TOTNET+STRCAP+CSALES
   49 EXP=PROPTX+EFALL+SHTERM+ALANDI+OTHR+EFALO(L)
      ESTITX=(TOTNET-EXP)*.10
      IF(ESTITX.LE.1000.)GO TO 50
      ESTITX=1000.
   50 TAX=TOTNET+CSALES*.5-EXP-ESTITX-1800.
      IF(TAX.GE.2000.)GO TO 51
      RATE=.145
      GO TO 55
   51 IF(TAX.GE.4000.)GO TO 52
      RATE=.165
      GO TO 55
   52 IF (TAX.GE.8000.)GO TO 53
      RATE=.18
      GO TO 55
   53 IF(TAX.GE.12000.)GOTO 54
      RATE=.205
      GO TO 55
   54 IF(TAX.GE.16000.)GO TO 55
      RATE=.235
   55 TAXPD=TAX*RATE
      IF(TAXPD.GT.1.) GO TO 60
      TAXPD=0.
   60 CANET=SALES-EXP
      CSHFLO=ALOSES(L-1)+CARRYO(L-1)+STRLON+COWNOW+OTLOAN+TAXPD
      XNET=CANET+Z-CSHFLO
      IF(PPANDL.EQ.0.) GO TO 70
      BALAN=BALAN-PLAND1
      TOT=AMACH1+PLAND1+FAML1
      W=XNET-TOT
      IF(W) 61,62,62
   61 ALOSES(L)=-W
      Z=0
      GO TO 63
```

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   62 ALOSES(L)=0
      Z=W
   63 CONTINUE
      GO TO 99
   70 W=XNET
      FAMLI=2000.
      W=W-FAMLI
      PDMACH=AMACH(L-1)-2000.
      IF(PDMACH)81,82,83
   81 AMACH(L)=4000.-AMACH(L-1)
      W=W-AMACH(L)
      GO TO 85
   82 AMACH(L)=2000.
      W=W-AMACH(L)
      GO TO 85
   83 IF(PDMACH.GE.2000.)GO TO 84
      AMACH(L)=2000.-PDMACH
      W=W-AMACH(L)
      GO TO 85
   84 AMACH(L)=0
   85 IF(PDLAND.EQ.5000.)GO TO 86
      PLAND(L)=2500.
      W=W-PLAND(L)
      GO TO 860
   86 PLAND(L)=0
  860 IF(FAMLIV(L-1).GE.4000.)GO TO 89
      PAYFAM=8000.-(FAMLIV(L-1)+FAMLI)
      IF(W.GE.PAYFAM)GO TO 88
      IF(W.GE.0.)GO TO 87
      BORROW=PAYFAM
      ADDMAC=0
      ADDFAM=0
      GO TO 95
   87 PAYFAM=PAYFAM-W
      BORROW=PAYFAM
      W=0
      ADDMAC=0
      ADDFAM=0
      GO TO 95
   88 W=W-PAYFAM
      BORROW=0
      GO TO 890
   89 CONTINUE
      BORROW=0
      PAYFAM=0
  890 IF(CARRYO(L).LE.0.)GO TO 91
      IF(W.GE.CARRYO(L))GO TO 90
      IF(W.LE.0.)GO TO 91
      CARRYO(L)=CARRYO(L)-W
      W=0
      GO TO 91
   90 W=W-CARRYO(L)
      CARRYO(L)=0
   91 CONTINUE
      IF(W.LT.2500.)GO TO 92
      IF(PLAND(L).GE.2500.)GO TO 92
      PLAND(L)=2500.
      W=W-PLAND(L)
   92 TOTFAM=FAMLIV(L-1)+FAMLI+PAYFAM
      IF(TOTFAM.GE.8000.)GO TO 93
      IF(W.LT.1000.)GO TO 93
      W=W-1000.
      TOTFAM=TOTFAM+1000.
      GO TO 92
   93 TOTMAC=AMACH(L)+AMACH(L-1)
      IF(TOTMAC.GE.4000.)GO TO 94
      IF(W.LT.1000.)GO TO 94
      W=W-1000.
      TOTMAC=TOTMAC+1000.
      GO TO 93
```

```
   94 ADDMAC=TOTMAC-(AMACH(L)+AMACH(L-1))
      ADDFAM=TOTFAM-(FAMLIV(L-1)+FAMLI+PAYFAM)
   95 CONTINUE
      Q=0
      IF(W.GE.0.)GO TO 96
      Q=-W
      W=0
   96 FAMLIV(L)=FAMLI+PAYFAM+ADDFAM
      AMACH(L)=AMACH(L)+ADDMAC
      PYMT=FAMLIV(L)+AMACH(L)+PLAND(L)+(COWNOW-CARRYO(L))
      ALOSES(L)=BORROW+Q
      BALAN=BALAN-PLAND(L)
      Z=W
      VALULB=(CRPLND+PASTR)*70.
   99 ASSET=VALULB+COWCAP(L)+Z
      DEBT=CARRYO(L)+ALOSES(L)+BALAN
      WORTH=ASSET-DEBT
      RATION=WORTH/ASSET
      RATIOE=(VALULB-BALAN)/ASSET
      RATIOC=DEBT/WORTH
      IF(PPANDL.EQ.0.) GO TO 115
  111 FORMAT(1H1,43X,41HPROJECTED PROFIT AND LOSS STATEMENT  TEAM,F3.0//
     1/10X,4HITEM,21X,8HDECISION,6X,18HEXPECTED NET SALES,8X,4HITEM,16X,
     217HEXPECTED EXPENSES//10X,5HWHEAT,17X,F10.2,5X,F18.2,8X,12HPROPERT
     3Y TAX,8X,F17.2//10X,13HGRAIN SORGHUM,9X,F10.2,5X,F18.2,8X,6HFALLOW
     4,14X,F17.2//10X,9HBROOMCORN,13X,F10.2,5X,F18.2,8X,13HLAND INTEREST
     5,7X,F17.2//10X,6HFALLOW,16X,F10.2,31X,20HINT ON SHT-TERM LOAN,
     6F17.2//10X,11HCOWS-NATIVE,11X,F10.2,5X,F18.2,8X,5HOTHER,15X,F17.2
     7//10X,22HCOWS-N AND WHT PASTURE,F10.2,5X,F18.2//10X,13HSTEERS-NATI
     8VE,9X,F10.2,5X,F18.2,8X,14HTOTAL EXPENSES,6X,F17.2,//10X,20HSTEERS
     9-WHEAT PASTURE,2X,F10.2,5X,F18.2//)
      WRITE(6,111)TEAMNO,ACWHT,ENSWHT,PROPTX,ASORG,ENSORG,EFALL,ABROM,
     1ENSBRO,ALANDI,AFALL,SHTERM,CC1,ENSCC1,OTHR,CC2,ENSCC2,STR1,ENSTR1,
     2EXP,STR2,ENSTR2
  112 FORMAT(10X,17HWHT PASTURE SALES,20X,        F18.2//10X,15HTOTAL NE
     1T SALES,22X,        F18.2//10X,17HCOW CAPITAL SALES,20X,F18.2//
     210X,19HSTEER CAPITAL SALES,18X,F18.2//10X,19HTOTAL NET SALES AND,
     344X,18HNET CASH AVAILABLE/12X,10HL.S. SALES,25X,F18.2,10X, 18HFOR
     4DEBT REPAYMENT,2X,F17.2/75X,25HFAMILY LIVING AND INVSTMT)
      WRITE(6,112)WPSALE,TOTNET,CSALES,STRCAP,SALES,CANET
  113 FORMAT(1H0,48X,22HANTICIPATED CASH FLOWS//10X,13HNONDEFERRABLE,44X
     1,10HDEFERRABLE/15X,10HSTEER LOAN,25X,F12.2,10X,9HMACHINERY,16X,
     2F12.2/15X,32HLOANS TO COVER LAST YEARS LOSSES,3X,F12.2,10X,12HLAND
     3 PAYMENT,13X,F12.2/15X,31HCOW LOAN CARRYOVER FROM LAST YR,4X,F12.2
     4,10X,13HFAMILY LIVING,12X,F12.2/15X,12HNEW COW LOAN,23X,F12.2/15X,
     515HINCOME TAX PAID,20X,F12.2/15X,19HMISC.SHT-TERM LOANS,16X,F12.2)
  118 WRITE(6,113)STRLON,AMACH1,ALOSES(L-1),PLAND1,CARRYO(L-1),FAMLI,
     1COWNOW,TAXPD,OTLOAN
  114 FORMAT(1H0,50X,21HAUXILIARY INFORMATION//10X,19HNATIVE PASTURE USE
     1D,11X,F12.2,15X,12HCASH ON HAND,18X,F12.2/10X,24HNATIVE PASTURE AV
     2AILABLE,6X,F12.2,15X,20HVALUE OF COW CAPITAL,
     3                 10X,F12.2/10X,18HWHEAT PASTURE USED,12X,F12.2,15X,
     421HOUTSTANDING COW LOAN,9X,F12.2/10X,23HWHEAT PASTURE AVAILABLE,
     57X,F12.2,15X,22HOTHER SHORT TERM LOANS,9X,F12.2)
  117 WRITE(6,114)REQNAT,Z,ANATPA,COWCAP(L),REQWHT,CARRYO(L),AWHTPA,
     1ALOSES(L)
      GO TO 999
  115 CONTINUE
```

```
1014    311 FORMAT(1H1,43X,32HACTUAL PROFIT AND LOSS STATEMENT,10X,4HTEAM,
           12X,F3.0//10X,4HITEM,21X,8HDECISION,3X,5HPRICE,7X,9HNET SALES,8X,
           24HITEM,16X,17H         EXPENSES/54X,           /10X,5HWHEAT,17X,
           3F10.2,F9.2,F14.2,8X,12HPROPERTY TAX,8X,F17.2//10X,13HGRAIN SORGHUM
           4,9X,F10.2,F9.2,F14.2,8X,6HFALLOW,14X,F17.2//10X,9HBROOMCORN,13X,
           5F10.2,F9.2,F14.2,8X,13HLAND INTEREST,7X,F17.2//10X,6HFALLOW,16X,
           6F10.2,31X,20HINT ON SHT-TERM LOAN,F17.2//10X,11HCOWS-NATIVE,11X,
           7F10.2,F9.2,F14.2,8X,5HOTHER,15X,F17.2//10X,22HCOWS-N AND WHT PASTU
           8RE,F10.2,F9.2,F14.2,//10X,13HSTEERS-NATIVE,9X,F10.2,F9.2,F14.2,8X,
           914HTOTAL EXPENSES,6X,F17.2//10X,9HSTEERS-WP,13X,F10.2,F9.2,F14.2/)
1015         WRITE(6,311) TEAMNO ,ACWHT,PWHT,ENSWHT,PROPTX,ASORG,PSORG,ENSORG,
           1EFALL    ,ABROM,PBROM,ENSBRO,ALANDI,AFALL    ,SHTERM,CC1,PCC1,ENSCC1
           2,OTHR,CC2,PCC2,ENSCC2,STR1,PSTR1,ENSTR1,EXP,STR2,PSTR2,ENSTR2
1016    312 FORMAT(10X,17HWHT PASTURE SALES,20X,F18.2//10X,15HTOTAL NET SALES,
           122X,F18.2//10X,17HCOW CAPITAL SALES,20X,F18.2/ 10X,19HSTEER CAPITA
           2L SALES,18X,F18.2//10X,19HTOTAL NET SALES AND,44X,18HNET CASH AVAI
           3LABLE/12X,10HL.S. SALES,25X,F18.2,10X,16HFOR DEBT PAYMENT,2X,
           4F17.2/75X,25HFAMILY LIVING AND INVSTMT)
1017         WRITE(6,312)WPSALE,TOTNET,CSALES,STRCAP,SALES,CANET
1020    313 FORMAT(1H0,10X,27HFEASIBLE CASH FLOW SOLUTION//12X,23HCARRYOVER CO
           1W LOAN PAID,11X,F12.2/12X,28HPAID LOAN ON LAST YRS LOSSES,5X,F12.2
           2/12X,15HSTEER LOAN PAID,18X,F12.2/12X,25HPRINCIPLE ON NEW COW LOAN
           3,8X,F12.2/12X,15HINCOME TAX PAID,18X,F12.2/12X,19HMACHINERY PURCHA
           4SED,14X,F12.2/12X,12HLAND PAYMENT,21X,F12.2/12X,13HFAMILY LIVING,
           520X,F12.2/12X,19HMISC.SHT-TERM LOANS,14X,F12.2//
           6            12X,21HAUXILIARY INFORMATION//12X,12HCASH ON HAND,21X,
           7F12.2/12X,20HVALUE OF COW CAPITAL,13X,F12.2/12X,23HVALUE OF LAND A
           8ND BLDGS,10X,F12.2/12X,20HOUTSTANDING COW LOAN,13X,F12.2/12X,20HDE
           9BT TO COVER LOSSES,13X,F12.2/12X,17HLAND DEBT BALANCE,16X,F12.2)
1021         WRITE(6,313)CARRYO(L-1),ALOSES(L-1),STRLON,COWNOW,TAXPD,AMACH(L),
           1PLAND(L),FAMLIV(L),OTLOAN,Z,COWCAP(L),VALULB,CARRYO(L),ALOSES(L),
           2BALAN
1022    314 FORMAT(1H0,10X,16HNET WORTH RATIO,17X,F12.2/10X,17HLAND EQUITY RAT
           1IO,16X,F12.2)
1023         WRITE(6,314) RATION,RATIOE
1024         GO TO 999
1025    320 CONTINUE
1026    321 FORMAT(1H1,10X,23HNOT A FEASIBLE SOLUTION,20X,4HTEAM,3X,F3.0)
1027         WRITE(6,321)TEAMNO
1030    999 CONTINUE
1032    130 STOP
1033         END
```

APPENDIX B

COMPUTER PROGRAM FOR GENERALIZED GAME MODEL

```
$IBFTC MAIN    NODECK
      DIMENSION CROP(10,16),COW(8,14),ACRES(10),HEAD(8),FXCOST(5,4),RAND
     1(10,6,10),NAME(3)
    1 FORMAT(2A6,A3,F5.1,F5.3,F5.2,5F5.3,2F6.2,F5.2,F4.2,F3.2)
    2 FORMAT(2A6,A3,2F7.2,2F5.2,2F7.2,3F5.2,2F4.2)
    3 FORMAT(3A6,I1,7F8.2/11F7.2/20F4.0)
    4 FORMAT(1H1,10X,25HPROFIT AND LOSS STATEMENT,10X,3A6,5X,4HYEAR,I3//
     12X,10HACTIVITY   ,9X,8HDECISION,8X,5HPRICE,13X,5HSALES,6X,17H
     1 EXPENSES   ,/)
    5 FORMAT(1X,2A6,A3,4X,I8,5X,3(F10.2,8X))
    6 FORMAT(  16HOTOTAL NET SALES,35X,F10.2/1X,23HTOTAL EXPENSES
     1   ,45X,F10.2)
    7 FORMAT(1HO,24HNET CASH FROM OPERATIONS,26X,F10.2//1X,24HNON-ALLOCA
     1TABLE EXPENSES,/)
    8 FORMAT(1X,2A6,A3,8X,F10.2)
    9 FORMAT(1HO,15HNET FARM INCOME,34X,F10.2)
   11 FORMAT(1X,25HINT ON SHORT TERM CAPITAL,F8.2)
   12 FORMAT(A6,6F11.4,I2,4HYEAR,I2)
   13 FORMAT(1HO,28HLOANS NEEDED TO COVER LOSSES,22X,F10.2)
   14 FORMAT(1HO,76(1H*)/,35X,9HNET WORTH,/,1X,
     1           ,6HASSETS,34X,11HLIABILITIES,/,1HO,5X,10HSHORT TERM,,7X,
     1F10.2,8X,5X,10HSHORT TERM,7X,F10.2,/6X,17HINTERMEDIATE TERM,F10.2,
     113X,17HINTERMEDIATE TERM,F10.2,/6X,9HLONG TERM,8X,F10.2,13X,9HLONG
     1 TERM,8X,F10.2,//46X,    17HTOTAL LIABILITIES,3X,F10.2//46X,9HNET W
     2ORTH,8X,F10.2,//6X,12HTOTAL ASSETS,8X,F10.2,10X,16HN.W.+LIABILITIE
     3S,4X,F10.2//1X,15HNET WORTH RATIO,8X,F10.2/,1X,17HLAND EQUITY RATI
     4O,6X,F10.2/1X,76(1H*))
   15 FORMAT(5F5.2)
   16 FORMAT(1X,20HHAY PURCHASES NEEDED,48X,F10.2)
   17 FORMAT(1HO,5X,30HADJUSTMENTS FOR CAPITAL CHANGE//21X,9HLIVESTOCK,(
     1X,9HMACHINERY/20H BEGINNING INVENTORY,1X,F10.2,5X,F10.2/10H PURCHA
     2SES,11X,F10.2,5X,F10.2/6H SALES,15X,F10.2/13H DEPRECIATION,23X,F10
     3.2/11H NET CHANGE,10X,F10.2,5X,F10.2,5X,F10.2//32H RESIDUAL RETURN
     4 TO LAND, LABOR,,/21H MANAGEMENT, AND RISK,,30X,F10.2)
      DATA FALLOW,BLANK/6HFALLOW,6H      /
      DATA END,SOLVE,COMPUT/3HEND,4HREAD,6HCOMPUT/
      NOCROP=0
      NOCOWS=0
      ZERO=0.0
      READ(5,15) HAYPRI,FLWCST,RINT
      I=0
   10 I=I+1
      READ(5,1) (CROP(I,J),J=1,16)
      IF (CROP(I,1).NE.END) GO TO 10
      NOCROP=I-1
      I=0
   20 I=I+1
      READ(5,2) (COW(I,J),J=1,14)
      IF (COW(I,1).NE.END) GO TO 20
   70 NOCOWS=I-1
      I=0
  120 I=I+1
      READ(5,2)(FXCOST(I,J),J=1,4)
      IF (FXCOST(I,1).NE.END) GO TO 120
      NOFIXD=I-1
      I=0
  140 I=I+1
      DO 160 K=1,10
      READ(5,12) ACT,(RAND(K,J,I),J=1,6)
  160 IF (ACT.EQ.END) GO TO 80
      GO TO 140
   80 IYEARS=I-1
   30 READ(5,3) NAME,IYEAR,WORTHL,WORTHI,WORTHS,DEBTL,DEBTI,DEBTS,CASH,P
     1URLR,PURIR,DEPIR,PAYSR,PAYIR,PAYLR,STKVAL,VALMCH,BUYSTK,BUYMCH,SEL
     2STK,ACRES,HEAD,PASTR,AUMS
```

```
      IF (IYEAR.LE.IYEARS) GO TO 170
      IYEARS=IYEARS+1
      DO 60 I=1,10
      CALL NORNUM(X)
      RAND(I,1,IYEAR)=CROP(I,5)*X+CROP(I,4)
      IF (RAND(I,1,IYEAR).LT.0.0)RAND(I,1,IYEAR)=-RAND(I,1,IYEAR)
      CALL NORNUM(X)
      RAND(I,2,IYEAR)=CROP(I,9)*X+CROP(I,8)
      IF (RAND(I,2,IYEAR).LT.0.0)RAND(I,2,IYEAR)=-RAND(I,2,IYEAR)
      CALL NORNUM(X)
      RAND(I,3,IYEAR)=CROP(I,7)*X+CROP(I,6)
      IF (RAND(I,3,IYEAR).LT.CROP(I,14)) RAND(I,3,IYEAR)=CROP(I,14)
      CALL NORNUM(X)
      RAND(I,4,IYEAR)=CROP(I,11)*X+CROP(I,10)
      IF (RAND(I,4,IYEAR).LT.0.0)RAND(I,4,IYEAR)=-RAND(I,4,IYEAR)
      IF (I.GT.8) GO TO 60
      CALL NORNUM(X)
      RAND(I,5,IYEAR)=X*COW(I,7)+COW(I,5)
      IF (RAND(I,5,IYEAR).LT.COW(I,12) ) RAND(I,5,IYEAR)=COW(I,12)
      CALL NORNUM(X)
      RAND(I,6,IYEAR)=X*COW(I,6)+COW(I,4)
      IF (RAND(I,6,IYEAR).LT.0.0)RAND(I,6,IYEAR)=-RAND(I,6,IYEAR)
   60 WRITE(7,12)BLANK,(RAND(I,J,IYEAR),J=1,6),I,IYEAR
  170 RETCRP=0
      AFTGRZ=0
      CASHAX=CASH
      TOTSMG=0
      TOTOP=0
      TOTAN=0
      REQNAT=0
      REQSMG=0
      RETLS=0
      WRITE(6,4)   NAME,IYEAR
      FALLCS=ACRES(10)*FLWCST
      RETCRP=RETCRP-FALLCS
      DO 100 I=1,10
      IF (ACRES(I).EQ.0.0) GO TO 100
      KACRES=ACRES(I)
      IF (I.EQ.10) WRITE(6,5) FALLOW,BLANK,BLANK,KACRES,ZERO,ZERO,FALLCS
      IF (I.EQ.10) GO TO 100
      OPCAP=CROP(I,13)*ACRES(I)
      SAVE=CROP(I,13)
      IF (CASHAX.LE.0.0) GO TO 190
      CASHAX=CASHAX-OPCAP
      IF (CASHAX.GE.0.0) GO TO 180
      CROP(I,13)=-CASHAX
  190 TOTAN=TOTAN+OPCAP*CROP(I,16)*0.5
  180 AFTGRZ=AFTGRZ+ACRES(I)*RAND(I,4,IYEAR)
      CROP(I,13)=SAVE
      TOTSMG=TOTSMG+ACRES(I)*RAND(I,2,IYEAR)
      SALES=ACRES(I)*RAND(I,1,IYEAR)*RAND(I,3,IYEAR)*(1.0+CROP(I,15)*FLO
     1AT(IYEAR))
      RETCRP=RETCRP+SALES
      TOTOP=TOTOP+OPCAP
      WRITE(6,5)(CROP(I,J),J=1,3),KACRES,RAND(I,3,IYEAR),SALES,OPCAP
  100 CONTINUE
      DO 110 I=1,8
      IF (HEAD(I).EQ.0.0) GO TO 110
      REQNAT=REQNAT+HEAD(I)*COW(I,10)
   90 REQSMG=REQSMG+HEAD(I)*COW(I,11)
      SALES=HEAD(I)*RAND(I,5,IYEAR)*RAND(I,6,IYEAR)*(1.0+COW(I,13)*FLOAT
     1(IYEAR))
      RETLS=RETLS+SALES
      OPCAP=HEAD(I)*COW(I,9)
      TOTOP=TOTOP+OPCAP
      SAVE=COW(I,9)
      IF (CASHAX.LE.0.0) GO TO 200
      CASHAX=CASHAX-OPCAP
      IF (CASHAX.GE.0.0) GO TO 210
      COW(I,9)=-CASHAX
  200 TOTAN=TOTAN+OPCAP*COW(I,14)*0.5
```

```
  210 KHEAD=HEAD(I)
      COW(I,9)=SAVE
      WRITE(6,5)(COW(I,K),K=1,3),KHEAD,RAND(I,5,IYEAR),SALES,OPCAP
  110 CONTINUE
      ATIVE=PASTR*AUMS
      TOTNAT=ATIVE+AFTGRZ
      DEFICT=0.0
      REQNAT=REQNAT-TOTNAT
      REQSMG=REQSMG-TOTSMG
      IF (REQNAT.GT.0.0) DEFICT=DEFICT+REQNAT
      IF (REQSMG.GT.0.0) DEFICT=DEFICT+REQSMG
      HAYPUR=DEFICT*HAYPRI
      IF (HAYPUR.GT.0.0) WRITE(6,16) HAYPUR
      CASHAV=RETCRP+RETLS-TOTOP-HAYPUR
      SALES=RETLS+RETCRP
      TOTAN=TOTAN+DEBTS*RINT
      WRITE(6,6) SALES,TOTOP
      WRITE(6,7) CASHAV
      CASHDB=0
      DO 130 I=1,NOFIXD
      WRITE(6,8)(FXCOST(I,J),J=1,4)
  130 CASHDB=CASHDB-FXCOST(I,4)
      WRITE(6,11) TOTAN
      CASHDB=CASHDB+CASHAV-TOTAN
      IF (CASHDB.GE.0.0) WRITE(6,9) CASHDB
      IF (CASHDB.LT.0.0) CASHH =-CASHDB
      IF (CASHDB.LT.0.0) WRITE(6,13) CASHH
      STOCK=BUYSTK-SELSTK
      AMACH=BUYMCH-DEPIR
      TOTAL=STOCK+AMACH
      RETURN=CASHDB+TOTAL
      WRITE(6,17) STKVAL,VALMCH,BUYSTK,BUYMCH,SELSTK,DEPIR,STOCK,AMACH,T
     1OTAL,RETURN
      WORTHL=WORTHL+PURLR
      WORTHI=WORTHI-DEPIR+BUYSTK+BUYMCH-SELSTK
      DEBTS=DEBTS-PAYSR
      DEBTI=DEBTI-PAYIR
      DEBTL=DEBTL-PAYLR
      WORTHS=WORTHS-CASH+CASHDB
      IF (WORTHS.LT..0) WORTHS=0.0
      ASSETS=WORTHS+WORTHI+WORTHL
      DEBT=DEBTS+DEBTI+DEBTL
      WORTH=ASSETS-DEBT
      RATIO1=DEBT/WORTH
      RATIO2=DEBTL/WORTHL
      WRITE(6,14) WORTHS,DEBTS,WORTHI,DEBTI,WORTHL,DEBTL,DEBT,WORTH,ASSE
     1TS,ASSETS,RATIO1,RATIO2
      GO TO 30
  150 CONTINUE
      STOP
      END
```

APPENDIX C

TABLE XVIII

SETS OF RANDOM EVENTS FOR FIVE TEN YEAR GROWTH RUNS

Activity	Year 1	2	3	4	5	6	7	8	9	10	X̄
					Run 4						
Wheat	$20	20	5	10	10	20	10	5	5	20	$12.50
Grain Sorghum	3	22	11	3	11	11	3	22	11	22	11.90
Broomcorn	0	25	25	25	25	0	25	0	0	0	15.00
					Run 5						
Wheat	$20	5	5	5	5	10	5	10	10	5	$ 8.00
Grain Sorghum	11	11	3	3	22	22	22	11	11	11	12.70
Broomcorn	0	25	25	0	0	0	0	0	0	0	7.50
					Run 6						
Wheat	$ 5	5	10	20	10	5	20	20	10	10	$13.50
Grain Sorghum	11	3	22	3	22	22	11	11	22	3	11.50
Broomcorn	0	0	25	0	0	0	0	0	0	0	5.00
					Run 17						
Wheat	$20	5	5	5	20	5	5	5	5	20	$ 9.50
Grain Sorghum	11	3	22	11	3	3	11	3	22	3	9.20
Broomcorn	0	25	0	0	0	0	0	25	25	0	7.50
					Run 19						
Wheat	$ 5	5	5	5	10	5	5	20	20	10	$ 9.00
Grain Sorghum	11	3	3	22	11	22	11	3	11	22	11.90
Broomcorn	25	25	0	0	0	0	0	0	0	25	10.00

VITA

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