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AN EXPLORATORY USE OF GROUP DECISION THEORIES IN EVALUATING FARM PLANNING PROGRAMMING MODELS

by

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ABSTRACT

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Farm management research has produced programming models capable of accurately simulating the interaction of physical, biological, and institutional factors and models of economic rationality. This precision has not resulted in significant farm usage. Normative assumptions implicit and explicit in these models may be major problems. If so, criteria reflecting the acceptability of normative assumptions should provide an effective means of model selection.

It is hypothesized that (a) it is possible to establish general criteria which distinguish normative propositions of programming models which will be usable in farm decision making from those that will not, and that (b) such criteria are implied by existing decision theory and research.

Working hypotheses were established regarding the nature of model normative assumptions. These served to guide a review of research in farm decision making which in turn implied general criteria of normative validity. Analysis of proposed planning models revealed a fundamental assumption of goal-directed maximizing behaviour by the

farm decision unit. Goals for the planning period are regarded as a static evaluative reference. They are assumed exhaustive in discriminating between alternatives and all significant goals are assumed to be quantifiable functions of measurable levels of economic goal achievement. Additional more specific assumptions operating within the scope of these fundamental assumptions are required by traditional analytical procedures or mathematical requirements.

A conceptual framework for group decision making established by rural sociology, group sociology, behavioural theory of the firm and diffusion theory suggests serious conflicts with modelled normative assumptions. Farm family goal formation and decision making are revealed as dynamic and simultaneous processes in which interpersonal goal-value conflicts play a major role. As a result hazy, ill-defined, and operational group goals are the normal case.

Although much research has been conducted on the importance, dynamic quality, and pervasiveness of group decision processes, no definitive theory exists which quantitatively describes the evolution of group goals and decision processes. Current farm management practice places the job of interpreting expressed goals and translating these intuitively into a mix of integrative and analytical tasks (and thus into resource allocations between integrative or harmonizing, and productive functions) in the hands of the decision unit and its advisors.

Research and theory reviewed indicate that the fundamental goal-directed maximizing assumption is representative of only a few short-run, technical decisions with globally accepted effects on income. More typically, expressed goals, values, and beliefs point not to ends for action but to needs for allocating resources between integrative and productive activities. Modelled goal structures must be explicitly recognized as conditional bases for intuitive allocations of resources between integrative and productive tasks.

Two strongly supported corollaries are possible. Firstly, the recognition that goal-directive maximizing behaviour is not possible indicates that model builders should focus on integrative requirements rather than normative exhaustiveness. No normative assumption is valid simply because it represents an expressed goal or value. Secondly, the large variety and dynamic nature of operational goals suggest that models should be capable of analysis conditioned on a wide range of firm goals. Weakly supported corollaries are possible in two additional areas. Firstly, utility functions are rejected for use in farm planning since they are part of an operational-goal oriented maximizing model and in addition focus on individual decision making. Secondly, extension agency objectives and techniques and diffusion theories imply that the conditioning base on which models should be built should be defined within the context of individual extension practices and objectives.

On the basis of the major criterion and its four corollaries it is concluded that the original hypothesis is acceptable. While no empirical test of the hypothesis was attemped it is notable that the criteria established are consistent with the degree of success encountered by existing farm planning programming models.

FOREWORD

The research on which this study is based has developed out of a concern that farm management research in the computer modeling era has grown out of touch with the human conditions surrounding farm decision making. While much effort in the farm management profession has been devoted to the building of normative models, farmers and extension workers have seldom found use for them in decision making. Is there something fundamentally wrong with the models? Do farmers and extension specialists not understand their potential? Are farm management researchers not sufficiently application-oriented?

As usual a considerable amount of time was spent developing and refining a concept of the problem. At first, it seemed that the problem was in large part mathematical, or at least had to do with cataloguing and weighing the characteristics of quantitative techniques potentially useful in farm planning. Could it be that farm management researchers had not yet developed models of farm planning within realistic decision environments? It appeared from a review of conceptual research into methods of modeling the farm decision environment (in all its stochastic, non-linear, lumpy and institutional complexities) that, in point of fact, models were available which could cope with the major tasks of environmental description. The further research along these lines continued, the more it became apparent that the problem was the absence of criteria capable of assessing the worth of farm management models, and this had more to do with the normative aspects of farm management than mathematical models per se. The problems of farm management did not appear sufficiently well understood that "the model", which adequately accounted for the normative aspects, could be recognized if in fact it did exist.

A first reaction in pursuing this line was that since planning models are normative and aimed at the satisfaction of decision makers, utility theory offered a sound framework for assessing the worth of farm management models. After some inquiry it became apparent that utility theory offered no sound basis for viewing the problem since the decisions in question were "small group" decisions, not the decisions of isolated decision makers. At this point, it appeared that a slightly different tack might prove useful. The theory of social welfare functions developed by Arrow [6] and enhanced by Fishburn and others [43] appeared to provide a framework for normative analysis of decision making in a group context. Further review revealed that this body of theory could not yet provide a foundation for assessing small group decision models. However the welfare function concept did point out a major problem in assessing normative decision models for use in group decision making.

Any theoretic base for purposive behaviour at the group level has to provide for the problems imposed by conflicts between individual objectives. At this point, it appeared necessary to abandon the familiar axiomatic bases provided by economic theory and to fall back on a more general base for developing a means of model assessment by basing a set of criteria on accepted theories of farm family group decision making. This was the point of departure for the thesis presented below.

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CHAPTER 1

THE PROBLEM

Farm management research has produced a large number of models each proposed for use in farm decision making. Farm management advisory personnel and farmers have the task of selecting from these models for use in farm planning. Development of selection criteria which can discriminate between models with a high potential for acceptance in farm decision making and those with a low potential is the central problem addressed by this study.

The appearance of complex farm management models has been associated with increasing sensitivity of economic rewards to management performance and increasing availability of complex operations research techniques. On the farm side, dependence on unstable international markets, increasing use of capital-intensive production techniques, decreasing equity positions, production specialization, dependence on off-farm suppliers, increasingly commercial oriented farm goal-value systems and increased competition for labour have contributed to the critical dependence of farm firms on decision making rather than tradition. On the other hand, models developed during the last two decades have proved adept in simulating the effects of increasingly complex production processes, business systems, and resource and institutional constraints on economic decision making. Linear programming (L-P) and increasing availability of electronic computers have permitted the evaluation of large numbers of farming alternatives [56,50,5,86]. Integer programming has provided an answer to non linearity problems such as lumpiness in assest acquistition, selection between either-or alternatives and selection of all-or-nothing alternatives [40]. Separable programming has allowed the representation on non-linear functions as linearly segmented functions [111, 112]. Stochastic programming formultions (L-P and quadratic programming) have been developed and they provide for selection between alternatives with stochastic: levels of achievement, resource levels, and production coefficients [92, 31, 91, 96].

In spite of extensive developments in farm management modeling, only a small number of specialized models has been used in farm decision making. The 1972 "Inventory of EDP Programs" [78] used in U.S.A. Agricultural extension Programs indicates extension oriented services having "highly usable reports" and over 50 recorded uses were in the following categories: ration formulation or nutritional analysis, technical simulations (eg. breeding programs), crop operations scheduling, debt analysis (eg. loan repayment), long-run and short-run budgeting, discounting, and tax calculation.

All services available to farmers treat the firm as a series of independent subsystems. No attempt is made to achieve an overall optimum. Most models are static and aimed at improving technical efficiency in a way that can only have favourable effects on farm income. Long-run planning is restricted either to a relatively minor use of long-run budgets which incorporate no selection process or to discounting models.

All models reporting extensive usage incorporated only weak consideration of farm goals and objectives within various farm firm subsystems. Information provided is directed at "what-if" questions or at universally acceptable goals rather than at generalized "what-should-I-do" questions. Feed formulation models (which make up about half of the above uses of planning models) are aimed at reducing feed costs, budgeting, and simulation models are aimed at testing the implications of farmer formulated plans. Reported long term planning models utilize traditional discounting concepts. No models incorporating the selection of optimal long run planning strategies in complex whole farm decision environments have reported significant numbers of uses.

As a result of adherence to static programming procedures which closely parallel the approach of traditional farm management extension, normative considerations are usually relegated to the pre-optimization (defining alternatives) and post-optimizing (interpreting model solution) stages in programming approaches to farm planning. For example, Tennessee's use of static linear programming in the "Rapid Farm Adjustment Program" [115] has aimed at suggesting adjustments necessary to maximize net returns to the operator, given available resources without regard to the size of the production unit. Adjustments are made to resulting plans on the basis of the planner's judgment and farmer's preferences. Major emphasis appears to have been on using L-P to arrive at a basis from which acceptable farm plans could be developed rather than explicitly introducing normative elements to arrive at the farm plan.

In Chapter IV of his thesis, which led to the Oklahoma L-P Farm Program[1], Bitney [13] notes that the programming approaches to farm planning can only be successful as an integral part of an education program. Apparently, current educational (extension) programs are structured in such a way that normative elements enter the programming process in roughly the same way that they have traditionally entered budgeting-oriented farm planning, since in developing his area information system in a programming context, a normative content is not elaborated.

In contrast with the type of models in current use, research in the programming area has concentrated on the modeling of long run planning under complex decision environments and consequently on producing models with strong normative assumptions. Programming offers rapid calculation of a best possible solution from a wide range

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1/ L-P Farm is a static farm enterprise selection L-P model used in Oklahoma's farm management extension program.

of alternatives. As a necessary part of the processes, decision criteria are explicitly incorporated into the planning model. Decision makers are required to define best solutions before they can be calculated, rather than simply recognizing best solutions when they see them. Thus normative propositions are a required component of all programming models. In contrast with budgeting procedures, programming sacrifices active involvement in planning decisions in some measure in order to implement the optimizing concept.

The more complex the modelled decision environment, the more complex the set of normative propositions that are required to support choice between alternatives. For example, if the problem situation is the formulation of dairy rations given fixed nutrient requirements, feedstuff analysis and costs, a simple normative statement that cost should be minimized is sufficient to justify the use of a least-cost feed formulation model. Normative propositions in existing farm management use are of this type.

If, on the other hand, the problem situation is the determination of a mix of capital purchases required in a stochastic production process subject to stochastic resource constraints, more complex decision criteria are called for. At the very least, normative propositions are required to support choice between levels of achievement over time. Since levels of achievement are a function

function of production processes, choice between levels with varying probability distributions is required. Since the modelled production system has implications for a wide range of conceivable goals (eg., debt avoidance) choice between them must be supported by a prior normative proposition. Even the use of simple choice criteria in a complex decision environment does not reduce the complexity of underlying normative assumptions since they must in this case imply the insignificance of other more complex criteria.

Model acceptability in a farm planning setting can be pictured as having a normative and a technical component. A high level of technical acceptability has been achieved in many programming models. The limits of tractability are apparently sufficiently wide to permit accurate portrayal of the bounds imposed by the decision environment. Illustrations are in recent conceptual research in stochastic programming (eg. see Cocks [30] or Rae [112, 111] and in recent attempts at designing linear programming based decision systems (eg. Harter [56], Goldschmidt [50], Acton [5] and Marceau [86]. Normative acceptability is, however, an unknown quantity.

In general, model normative content has been defined à priori as a matter of expedience to allow illustration or use of other concepts. Those who have attempted to develop operational programming systems for farm management decision making have concentrated on the modeling of generally recognized elements in the decision environment or some aspect of such modeling.

Goldschmidt [50], for example, has concentrated on data acquisition techniques to provide information for a decision environment described by linear programming. Farms studied were generally large and had a relatively highly developed organizational structure within which profit maximization provided a reasonable objective function. Acton [5] has concentrated on the integer aspects of the decision environment while superimposing an admittedly hypothetical normative intent for illustrative purposes. Marceau [86][2] has used the general linear programming model to investigate the feasibility of a commercial short-run planning system using a cost reducing method of automatic generation of required program input. Profit maximization is assumed for illustrative purposes. Harter [56] has conducted a field study, incorporating data acquisition, problem formulation and solution interpretation elements in a linear programming based system. His major intent was to assess the generality and operationality of the linear programming approach in an actual extension setting. In the main, satisfaction with the system was expressed by both farmers and extension agents, but little attention was paid to feasibility of the role played by the profit maximizing choice function postulated in the model.

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[2] Essentially the same research has been reported by Tongate [119].

Cocks [30] investigated the ability of linear programming and quadratic programming to accommodate stochastic elements in long-run decision making. Here again little attempt was made to reconcile normative propositions with firm decision processes.

In contrast with the *à priori* rationality assumptions in most programming models, it is interesting to note complex decision making patterns presented in sociology. Keefe and Burke [71] have noted that,

> "The family farm is a complex entity. It is composed of a great variety of expensive physical facilities and carries on a variety of production activities. But human beings are involved, tied together in a unique family relationship. In addition to the family and its individual members counted demographically, roles (father, son, mother, manager, parent, etc.), power relationships (head, subordinate), and interaction patterns, eg. autonomic, autocratic, syncratic, are also important components. All of these interact in varying degrees during decision making and planning situations, with the amount and quality of interaction influenced by personality and family characteristics."

Four points suggest that criteria of normative acceptability are required. Firstly, programming models which are potentially useful in farm planning are capable of incorporating wide range of normative concepts. Secondly, where normative elements in decision making are clear, their inclusion in a planning model can only render its search for solutions more efficient. Thirdly, it is to be expected that as new and more comprehensive models and data sources are brought to bear on increasingly complex farm decision situations, the volume of information available to decision makers will be increased to the point where a need for choice criteria will arise to limit the flow of information to a manageable level. Lastly, it appears that the farm decision processes with which programming models must interface, result in complex and dynamic normative standards as a result of continually adapting goals and "hands on" control of production and investment processes.

In summary, farm management research has produced many programming models capable of simulating in detail the effects of decision environments on variously defined models of economic rationality. Increasing precision in the simulation of physical, biological, institutional effects in the decision environment has not increased farm management use of these models. The normative assumptions implicit and explicit in these models may be a major factor in their apparent unacceptability for farm planning use. If this is the case, criteria reflecting the acceptability of model normative assumptions should provide a means of selecting models of potential use in farm planning.

CHAPTER 11

METHODOLOGY

The notion of "optimization"[1] is fundamental to farm management advisory services since it provides a means of determining the validity of normative propositions on which management recommendations are made. It is the intersection of a philosophical proposition and a convention or rule of prescriptive analysis. The convention of prescriptive analysis is that the prescriptor must continually seek an optimum. Even "better" plans are to be based on some conception of "best" or optimum". The philosophic position is that the something to be optimized must, to the greatest extent possible, come from within the individual decision unit. Simply stated, the principle of opimization is that individual farming units should try to achieve <u>something</u> inherent in <u>their own</u> social and psychological makeup. That wished-for something may be ill-defined, seldom achieved in practice, possibly inconsistent with physical reality and fleeting in its existence, but it must be the only standard by which alternative decision paths may be judged.

Decision making in a prescriptive sense may follow many non-optimizing patterns but it does not suit the

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1/ "Optimization" as used here explicityly includes the usual notion of less than universal optimality since a contextual framework is always implied.

normative approach of farm management to consider these. A convention of optimization gives direction to the search for better farm plans and is therefore a necessary start-

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2) It is often implied in farm management literature, (for example, see Strickland [130 Ch. 3], or Eisgruber [41 p. 127]) that simulation yields intrinsically more realistic solutions than programming because of its greater flexibility in describing behavioural processes as compared to the obvious optimizing context of programming (i.e. because other processes, not optimization, are observed in practice). This however, amounts to a confusion between "optimization" in the sense used above and optimization in the narrower sense imposed by individual programming models.

Behavioural theory supports the notion that firms do not always follow a single and logically consistent goal structure, that multiple and changing goal structures occur, and that inconsistency may persist over long periods. However, the empirical fact that firms apparently do not optimize in their decision processes does not imply that it is a wrong strategy for prescriptive analysts to try to optimize something in their decision processes. A principle of "optimization" states only that the prescriber should act as though there is something in the nature of human affairs to be optimized. It does not fail when that something is difficult to describe or does not permit analytical solutions. The principle is proposed as a grand strategy after the manner of a principle of causation in the logic of scientific discovery. It is acceptable not because of its own empirical validity, but because, only by pursuing it can it be assured of not moving away from better solutions (in terms of current ethical standards) if they exist. Since some solutions are preferred to others, we cannot go wrong by continually pursuing a "best" among these even though it may not be unique and it may be difficult or even impossible to identify. Optimization viewed in this manner implies that simulation models may in fact be better "optimizers" than mathematical optimizing models. This is however, not an intrinsic superiority. If optimization models do not optimize, it is because they are not, or cannot be, correctly specified, not because they are "optimizing" models.

ing point. This is not to imply that approaches employing non-optimizing (in a mathematical sense) models have no part to play in farm management. They too, may be a part of attempting to "optimize" in the sense given above.[2]

The adoption of optimization as a strategy for farm management is not ethically neutral. It rejects the notion that there exists what Arrow [6, p. 22] has called a "social good" which can be defined independently of individual desires. Rather, it adopts from the beginning the philosophic proposition that decision makers should act as though there exists something in the nature of human desires to be maximized.

In general, this proposition makes no empirical assumption beyond the existence of human desires and an ability of prescriptive analysts to derive some direction of purpose from these. It is not necessary, in the adoption of such a strategy, to postulate that some measurable funtion, subject to mathematical optimization procedures, actually exists since, as Arrow [6, p. 22] states, all that is required for an unambiguous choice to be made is that there exists weak ordering of preference on the set of alternatives being considered. However, in the context of the present study of programming feasibility this necessity is imposed. Some minimum mapping of decision space into preference levels is required by mathematical programming procedures.

A clear distinction between alternate approaches and optimization is required because of the strong tendency for farm planning models to evolve out of economic models of rational entrepreneurial behaviour (eg [36]). Several alternate philosophic positions are possible in lieu of a principle of optimization in prescriptive analysis. One could hold that an objective good quite apart from human preference exists and should be the goal of all human action. The difficulty of establishing such a universal rule is apparent given the unlikelihood of political concensus on one hand as a pragmatic vindication, and the certainty of infinite regress involved in argumentation basing such a rule on a higher order objective good on the other hand. Appeal to authority provides another inadequate basis for prescriptive analysis, for it leads to the possible dogmatic acceptance of rules which may be neither strategically efficient nor based on currently acceptable ethical standards. A variant of such a position is to appeal to the authority of tradition which has the same basic fault as other appeals to authority.

Optimization has been presented as the objective of farm management and thus the normative content in programming models. It has been presented as a philosophic and strategic proposition and is quite distinct from optimization in the narrower mathematical sense. Acceptance of optimization implies that the validity of normative elements can only be determined in an examination of the social and psychological makeup of farm decision groups. Other approaches have been rejected as being either strategically inefficient and/or founded on unacceptable philosophic propositions. To the extent that optimization has been practised, it can be regarded as having resulted in a number of proposed decision criteria for use by farm managers. It is equally likely that normative elements have not been generated by a concept of optimization but rather from more specific models of economic rationality.

During the last two decades, research in small group and farm decision making has developed a theoretical framework for decision making within the farm decision unit. Research in the sociology of small groups has developed an individual and group value based theory for action in situations where choice prevails [29]. Rural sociologists have studied farm goal holding and decision patterns which support and specialize generalized group decision theories [36,56]. Extension education and farm management research have studied the disemination of concepts among farm decision groups [120,118]. Behavioural theories of the firm have developed concurrently with group decision theories and explicitly integrate the role of individual value conflicts in firm decision processes [11,28].

It is hypothesized in this study that (a) it is possible to establish criteria which distinguish between