THE USE OF SIMULATION

IN THE STUDY OF

GRAZING MANAGEMENT PROBLEMS

by

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CHAPTER I

INTRODUCTION

1.1 Definition of "A Grazing Management System"

Grazing Management is a large and integral part of farm management in New Zealand. It involves the making and implementing of all the decisions relating to the grazing of animals. This is a complex management function which necessitates the assessment and integration of a large number of factors.

Grazing Management involves decisions relating to all aspects of pasture production, its utilization by grazing animals, and the efficiency with which these animals convert the pasture ingested into useful livestock products. Many factors are involved. These include soil type, pasture composition, fertilizer, type, age and number of livestock, grazing method, and the influence of season. Many of these factors interact with each other. Pasture production for instance, is influenced by the number of stock present, and the grazing method. Equally, livestock intakes and productions depend on pasture availability and composition. These interactions are a major influence in grazing management.

The timing of events is also important in grazing management. Many decisions depend for their effectiveness on being made and implemented at the "right" time. Fertilizer applied in the spring or autumn, for example, is of more value in stimulating pasture growth and if applied in the slower growing periods of summer or winter.

Variability in most of the factors involved, is another characteristic of grazing management. Much of this is due to the influence of weather but the influences of variation in pasture and livestock factors apart from weather, are also significant. Frequently this variability is difficult to predict. This may be a consequence of lack of knowledge or the lack of

suitable methods for obtaining the measurements required. As a result uncertainty exists in grazing management about the possible outcome of any particular course of action. Risks, or alternatively insurance measures are therefore often associated with grazing management. Further when knowledge is limited, or objective methods for assessing the effects of particular actions are inadequate, (as in frequently the case in grazing management) reliance must be placed on subjective judgement of situations. This type of approach is typically that used in many practical grazing management situations.

Grazing management is thus a complex process involving decisions relating to all aspects of the grazing of livestock. As such, it is a difficult "factor of production" to measure. The value of grazing management as an input in an agricultural production situation is not measured by the number of decisions made. It is measured by the effectiveness of those that are made. This involves a consideration of the effectiveness of each decision in dealing with each of the features of grazing management described above. This is a very difficult task for which no satisfactory objective measures have yet been devised.

Against this background of the main characteristics of grazing management, a definition of a grazing management system can be introduced. Because of the nature of grazing management this takes the form of a strategy. 1/ A grazing management system is thus defined as

> "A set of decision rules which indicate the action to be taken in every possible contingency which might arise in grazing livestock in a particular manner."

1/ See Williams, J.D. (44)

In this way a grazing management system is defined according to rules to be followed in making decisions on how, when, where and why to graze livestock. This is the concept of a grazing management system adopted as the basis for the research of this study.

1.2 Analysis and Synthesis in Research

Generally speaking research on any subject can be divided into two phases: analysis and synthesis. The first of these, analysis, is concerned with breaking down a problem into its constituents and the analysis of the effects of the individual elements in the system. Typically this involves holding most factors constant whilst allowing one or two elements to vary. Examples of this type of work are to be found in laboratory experiments and plot trials. Usually this work is accompanied by some degree of experimental design and statistical analysis. The methods and practice of this type of research are well known.

The processes of synthesis in research are by contrast less well known. This phase of research is concerned with the assimilation and integration of analytical research results. When, for instance it is found from analytical work, that pasture under certain conditions grows most rapidly if maintained at a height of between three and seven inches, then it is also the function of research to integrate this knowledge by synthesising it into a workable grazing management system. In doing this one or more new grazing management systems may be proposed and appropriate research must be initiated to evaluate these.

In the past, methods for this type of grazing management research have been confined to small farm experiments and grazing management trials. Both of these involve an outlay of large quantities of research rescources (land,

livestock, labour and finance) and in consequence are expensive to operate. This has resulted in this type of research being restricted to a few trials or experiments each year. In view of this, new methods of research applicable to this phase of grazing management merit attention.

1.3 Motivation for this Study

With the development of high speed electronic computers and a new discipline known as Operations Research, increased attention has been given to management problems of the type encountered in grazing management. Operations Research, the study of the operations of businesses, industrial and defence organisation, has developed rapidly since World War II, and has provided a new philosophy and several new techniques for use in the study of business operations. 2/ One of these techniques is simulation.

Simulation, as applied to grazing management, involves mathematically programming, by means of equations and logical decision rules, the events involved in an actual grazing management system. Basic features of such a simulation are equations linking weather and pasture production, pasture production and animal intake, and animal intake and output. These equations can be loaded into an electronic computer together with the basic data for their solution. In this way an entire grazing management system can be studied at speed and in a manner which readily allows variation to be taken into account. Using this technique it is possible, at least conceptually, to test several grazing management systems over as many as 500 seasons in as little time as a few days.

Such a research technique offers considerable potential as a tool for synthesis in grazing management research. Compared with the existing methods (field trials and small farm experiments) simulation would appear to have

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2/ For a review of Operations Research see R.L. Ackoff Progress in Operations Research (1)

several advantages. These include speed in producing results, control over all variables, and scope for the incorporation of variation in all the important parameters by varying the information fed into the computer. The large apparent potential of the simulation method has been the reason for initiating this introductory study.

1.4 Limitations of the Study

Simulation is a research method which properly demands a team of research scientists, and, when a problem as large as grazing management is to be studied, a considerable period of time in which to conduct the study. In view of this, the contribution which a single master's degree student can make in the course of eighteen months is restricted. For these reasons, the investigation accounted in this thesis is necessarily shallow. It has not been possible, in the time available to both, cover the subject, and to expose it in detail. In these circumstances, it was felt that greatest value would be obtained from a shallow study of the overall situation rather than a detailed consideration of a section of the subject.

Further, no attempt has been made to take economic considerations into account. An endeavour has been made to understand and apply the principles of simulation to the physical processes of grazing management only. Costs and prices, and the influence of economic criteria in decision making have not been taken into account.

This study has also been influenced by the lack of suitable data for use in a simulation. Strictly speaking, simulation involves only the actual processes of combining equations to represent a real life situation, and the the solution of these under certain conditions. The location of data and the formulation of such equations is therefore not part of the simulation

per se. However, as grazing management information had not previously been assembled in this form, the work of locating and preparing this data was a necessary part of this study. This additional work meant that less time was available for the study and development of simulation as such. The depth of the study has been influenced accordingly.

1.5 Guide to the Thesis

This thesis gives account of a study conducted to investigate the use of simulation in the study of grazing management problems. In Chapter 1, the ideas of a grazing management system and simulation have been introduced. These are expanded in subsequent chapters. Simulation as a general approach to problem solution is discussed in detail in Chapter 2. In this chapter simulation is first defined and specific characteristics of the technique are then identified. The discussion of these characteristics is followed by the introduction and definition of a special type of simulation, Monte Carlo Simulation. This is the particular type of simulation proposed for grazing management and its characteristics are elaborated in the latter sections of Chapter 2.

Following the introduction of Monte Carlo Simulation, consideration is given to usefulness of this method in comparison with alternative methods which might be used to study grazing management problems. This discussion includes small farm experiments, farm surveys, and the subsidisation of farm practices, and is presented in Chapter 3. Chapters 4 and 5 introduce and discuss certain technical problems associated with the use of monte carlo simulation methods.

Chapter 6 then considers a general monte carlo simulation model for grazing management. Attention is given to specific aspects of grazing

management, and the formulation of a overall model to represent the grazing management, is discussed. This is followed in Chapter 7 by the formulation and exposition of a special monte carlo model of grazing management. The process of operating this special model for a simulated season is then described in Chapter 8. The results of this, together with those from a further four "seasons", are then discussed in Chapter 9. Finally, the overall value of the method is considered and conclusions are drawn.