Chapter 1

INTRODUCTION

1.1 Introduction

This study examines the farm planning process from the strategic management viewpoint and, in so doing, argues for the use of a new combination of existing methodological tools to better inform and enhance strategic decision-making processes.

Stacey (1993, p. 7), in his description of strategic management, emphasises that the strategic management process, encapsulated as a process of 'connecting -- discovering -- choice -- action and reaction', is powerfully influenced by the manager's beliefs about what makes an organisation successful. The strategies, or 'action patterns', of the organisation's decision-maker are implemented within the specific enterprise environment, and these interactions with the enterprise are governed by the decision-maker's implicit or explicit models of the situation. Both conceptual (i.e. qualitative, mental) models and representational (i.e. quantitative) models are used by decision makers in furthering their understanding of their particular enterprise or in defining the system management problem.

Because the structure of the model is clearly a significant factor in how the decision-maker will approach and implement planning processes, this research study devotes considerable attention to examining the nature of these models. Whatever farm business management paradigm is current determines what the range of possible farm system models and management problems can be. These models and problems evolve with the prevailing paradigm (that is, the set of implicit rules of understanding and behaviour), and thus both the system model and the management problem emerge from a complex interaction between the economic, social, technical and political factors that influence society. As society's values change, existing viewpoints alter and new models emerge. The essential paradigms of society define the essentials of modelling behaviour and action for that society (Quinn *et al.* 1990).

What, then, are the key factors which might seek a place in a current representation of a farm system? A powerful social value in the current resource management environment is the demand for sustainability. Sustainability is defined in two ways: as economic sustainability, and as ecological sustainability (Conway 1987; Brewer 1988; Zarsky 1990; Savory 1991, and Stacey 1993). Considering sustainability in the economic context emphasises factors which preserve economic production. Issues of sustainability here are financial efficiency, investment, diversification and external balance (Zarsky 1990, pp. 1-2). Sustainability in ecological terms means preserving and improving the environment where biological populations and water, air, energy and soil cycles operate. Targets of ecological sustainability enhance biological diversity, conserving and developing ecosystems, examining interconnections, and avoiding risk. In both definitions, the fundamental principle of sustainability is intergenerational equity. Future generations, according to this particular sustainability model, should inherit a stock of capital -- capital in the natural environment, technology and welfare -- which is required to sustain life as biological and economic beings (Zarsky 1990, p.2).

Resource management practices which ignore the requirement of sustainability for the whole system have resulted in increasing ecosystem degradation from human impact (as in Africa or the Amazon river basin) or increased production costs from the impact of highly specialised technologies (e.g. USA and Europe). Situations in which only the financial arguments of farming systems management are considered in decision making have created serious risk to the long-term profitability of the farming systems and to the overall equilibrium of the natural environment. As cases of resource degradation and non-sustainability become more evident, there has been a growing interest in the holistic management framework (Savory 1991). In other words, attention is increasingly shifting towards the explicit consideration of feedback between the ecological and economic subsystems of agricultural systems, and it is necessary for an adequate model of an agricultural system to be able to give this feedback factor its full weight. This requirement has in part shaped the setting of this research problem, and indicated the need for the study to be informed by a holistic framework.

The systems approach is implicit in any holistic framework. While systems and non-systems approaches to management and resource policy have operated in parallel for some time, there has been increasing interest in the systems approach to managing resources, in which understanding the relationships and feedback mechanisms between components of the system is as important as analysing the components themselves. Savory (1991), for example, has developed and promoted a systems management procedure for agriculture. Senge (1990) has applied systems thinking in general management, and developed a management philosophy and procedure where progress results from understanding and exploiting successfully the strategic effect of system feedback relationships. Systems approaches range from reductionist approaches, where management processes are simplified into isolated components, to the holism of Ackoff (1973), Savory (1991), and lately Stacey (1993) in strategic management theory, who consider that entities in the world can only be understood as an integration of multiple, interrelated parts.

According to Ackoff (1973), problems are interrelated, and need to be addressed in an interrelated way. Rather than attempting to solve problems in isolation, and perhaps, by considering only the effects of a single solution, creating new and additional problems, the manager should be attempting to understand the dynamics of system relationships, at the aggregated system level, by exploiting strategic planning processes.

Because system approaches may be deductive, inductive or a combination of the two, the manager, in defining the system management problem, has to decide whether to define the problem in prescriptive terms or to allow a re-appraisal of the problem after further learning about the system: adherents of the inductive approach would see this as empowering the decision-making capacity. When deductive approaches are used, they tend to emphasise outcomes, not the experience of getting those outcomes. When inductive approaches are used, the learning process is embedded in the management methodology; the manager can increase his/her effectiveness through an improved understanding of how the system works. Appropriately, given the objective of this study on enhancing systems understanding, the conduct of this research has developed the inductive component in defining farm management problems. This component, which may be ordinarily part of the practice of the farm systems analyst, is nevertheless unacknowledged in previous methodologies: this apparent conflict is examined further in subsequent chapters.

For the farm systems analyst, performance variables can capture the dynamics of the system, depending upon what the objectives of the analyst are, but the challenge is to define the focus of the management problem so that both the decision-maker's individual objectives (which may include profit) and prevailing social concerns (such as the issue of sustainability) can be addressed. This challenge conditions the approach the analyst can take to the management problem, and redefines a management perspective that will highlight the role of the decision maker, who will discover, choose, process and act upon information according to his or her goals. (This is strategic management as per Stacey 1993, p.27.). From this perspective, this research emphasises the following aspects:

(a) Building a model of the farm system that becomes an integrative exercise focussed both on financial and on other objectives which are not easily quantifiable.

(b) Discovering the dynamics of the farm system, where each component has its own interactions with the rest of the system, its own feedback mechanisms, and its own adjustment process to overcome instability.

(c) Defining the value and place for non-economic variables, such as the expertise, intuition, aesthetic goals, beliefs and expectations of the decision-maker. Acknowledging the centrality of the human component of the farm system creates a different context for the use of optimal solutions in farm analysis, where quantitative techniques are not used prescriptively, but as tools for understanding the whole system.

(d) Accepting that risk is a normal part of the dynamic operation of the system. The impact of risk, that is, variability, on the performance of the system, is another factor which research into on-farm decision making must address.

The demands of this framework indicate the extent to which research in an inductive learning setting is more appropriate than a traditional research method. Any analytical exercise becomes an inductive rather than a deductive process, if management is to truly consider the ecological, economic and socio-cultural implications of resource management in an integrated way. Inductive approaches are consistent with learning and discovery, and ultimately, more sustainable system outcomes may emerge through a management attuned to the underlying dynamics of the system under its direction.

In the 'objective' science tradition, operating with a method of inquiry and problem solving (Rivett 1972, pp. 4-14), the role of humans is seen as a mechanistic one: the real world has objective problems that need to be solved in an objective manner, and so solution processes, too, are objective. Within this traditional, 'hard systems' thinking, there is no scope for phenomena and variables which 'soft systems' thinkers (Checkland 1981;

Forbes 1988; Rosenhead 1989a) would hold as important, such as subjectivity, expectations, and beliefs. Similarly, with the development of quantitative techniques for planning and decision making, the values of human creativity, perceptions of reality, and empirical awareness of natural interrelationships are diminished, at least in the operation of the techniques. In an extreme version of the hard systems approach, management becomes a mechanistic process employing mechanical processes and calculations to achieve structural solutions under predetermined goals and objectives. Hard system quantitative analysis typically ignores the 'human activity system' (Rosenhead 1989a):

(a) The process of inquiry and problem definition is given not from the perspective of the analyst, but starts from isolated phenomena and a clearly reductionist approach to problem solving. Once the problem objective has been defined, it is immutable, and there is no scope for rational inquiry about reality or adjustment according to new understandings of reality.

(b) The decision-model offers its deduced outcome as the ultimate system solution, fulfilling the pre-determined objectives of the system, rather than exploring the dynamic system relationships. The possibility that a systems approach or an inductive inquiry would best represent the underlying processes of cause and effect is not taken into account (Gill 1995).

In this research, then, the starting point adopted is to consider the researcher's perspective on resource management, and investigate the prospects for integrating hard systems thinking with soft systems feedback processes (Checkland 1983, Stacey 1993). Figure 1.1 gives one proposal for how this research might integrate both hard and soft system elements. Evident in Figure 1.1 are the interactions and feedback mechanisms, looping backward, while the system interrelationships proceed toward predetermined objectives.

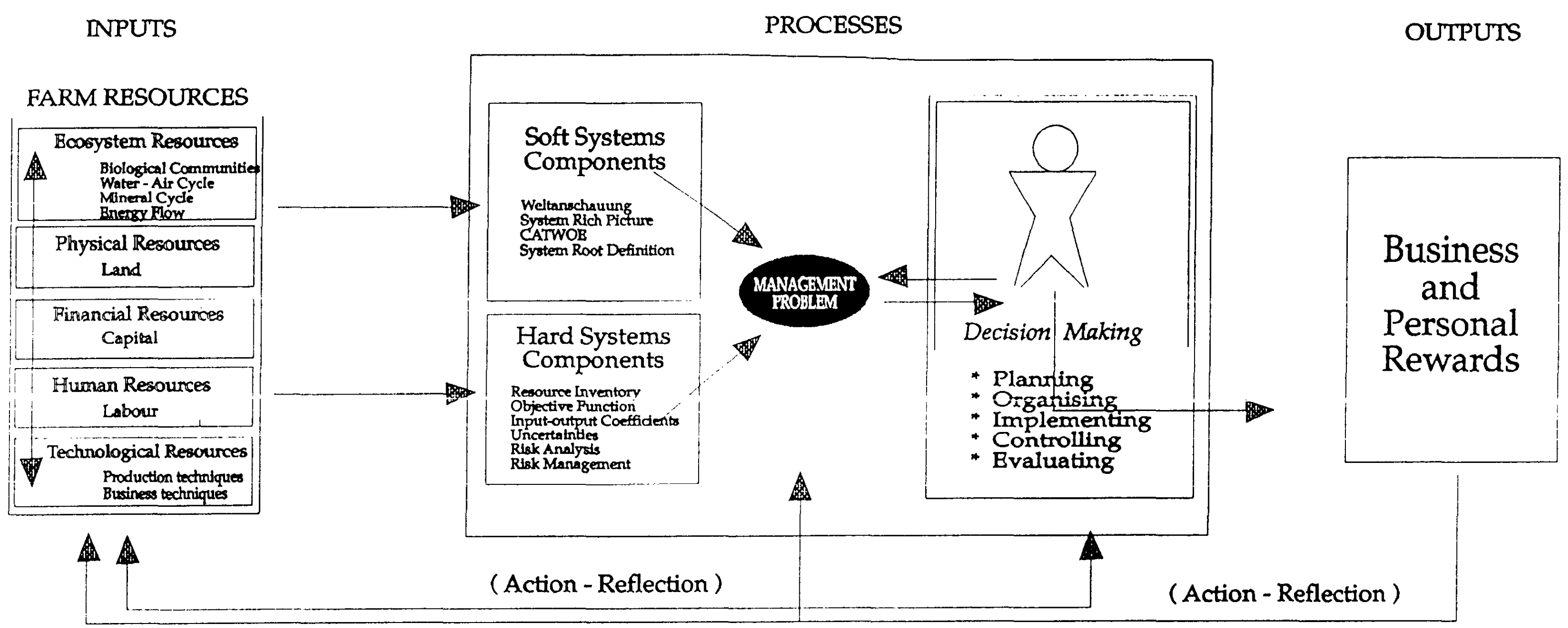

Figure 1.1 The Change of Paradigm in Decision Making for Farming Systems Management

1.2 General Research Objectives

The problem of agricultural management invariably involves complex dimensions -- ecologic, economic and socio-cultural. So, to deal with this complexity there is a need for a broad holistic perspective, accompanied by rigorous methods of analysis, which will contribute to creating a better environment where the decision maker will interact to make decisions that will ensure fulfilment not only of the immediate system objectives but also of long-term sustainable -- ecological, aesthetic, financial -- individual and social outcomes. Within this context the research seeks to test how far a pragmatic combination of hard and soft systems modelling techniques might go towards maximising real world relevance, or towards developing simply a learning context for management.

There is a methodological point that relates to the balance between prescription and description. There is an opportunity here to integrate 'optimising decision models' and 'information models' to enrich decision-making processes. This may be a place where deductive processes (i.e. operational research methods) and inductive modelling approaches (i.e. soft systems and organisational dynamics methodologies) may be put together in order to generate more powerful on-farm decision-making models. (These approaches are fully described in chapter 2, sections 2.2.1-2.2.3.)

More specifically, the objectives of this research are:

(a) To capture, at various levels, the integrative nature of the system by using holistic modelling. An approximation between hard systems and soft systems thinking will be attempted using some components of dynamic modelling. A whole-farm model will be constructed for the insights it may yield with regard to inherent processes of cause and effect.

(b) To explore operational programming farm models using quantitative algorithms which are flexible enough to allow for an integration between predetermined financial objectives and soft system perceptions for decision-making at the farm level. A subset of holistic stochastic modelling opportunities will be part of the quantitative exercise.

(c) To highlight the importance of systematic, holistic, decision-making processes for sustainable and efficient management of farm resources.

(d) To integrate conventional deductive modelling into a more flexible systems framework where system causalities may be explored not solely through their orientation to the prediction of future outcomes, but also by how well they succeed, for inductive purposes, in structuring management problems.

(e) To develop an operational systems analysis and planning procedure for application by farm extension professionals and other researchers with an interest in farm business management.

1.3 Research Strategy

The research strategy contains the following aspects:

(a) Development and specification of a theoretical argument that justifies the holistic and stochastic focus and the management orientation of this research within the framework of farm business management for operational decision-making.

(b) An exercise in on-farm modelling that integrates prescriptive systems design with inductive system analysis in order to demonstrate the capacities of an integrated soft/hard systems modelling approach to improve the level of information of the farm system.

(c) The use of an holistic on-farm planning perspective in the context of diverse planning scenarios. This encompasses an array of possibilities from deterministic assumptions to those that incorporate the management of changing (risky) relationships in the coefficients of the farm model (i.e. technical risk) and in the objective function (i.e. attitudinal risk) to define an holistic, more realistic handling of risk management. This implies the development of an analytical framework that integrates farm resources within a context that employs stochastic mathematical programming.

In broad terms the strategic setting of this research addresses the question of how useful or how much application conventional tools for farm business management analysis have when addressing sustainable resources management within a real holistic perspective. The relevance of this exercise is defined by the rigidity of the available tools, which deny the value of subjectivity and aesthetic perceptions, and isolate issues of sustainability. Rather than seek solutions to ultimate systems performance this exercise aims to discover better management components. This research operates in a new area, where conventionally tractable and intractable elements of the farm system are integrated using hard systems (i.e. quantitative) and soft systems (i.e. conceptual) methodologies, and uses a particular farm as the framework for an holistic modelling exercise.

The research uses a case study to test the usefulness or validity of this combination of techniques in an individual enterprise context, as a typical management exercise. It should also be possible to outline a process which farm advisers and analysts might follow in order to use the combination technique in real-world applications.

Building on the foundations of Stacey (1993) and Senge (1992), this study accepts that as the farmer develops the ability to understand the interrelationships of the farm system (aesthetic, ecological, physical, financial, human and technological) and is able to explore complex planning scenarios for decision making purposes, he/she will be in a position to make decisions that better contribute to enterprise returns (primary individual objective) and sustainability of the farm resources (primary social objective).

The research of this study aims to be descriptive (i.e. inductive) rather than prescriptive (i.e. deductive) in nature. It does not pretend to specify any set of general prescriptions that the decision-maker should apply in managing the farm system, but aims to tilt the balance towards describing what the manager can be observed to do, the rationale for doing it and the consequences of different kinds of decision.

1.4 Outline of the Study

Using a conceptual mapping approach, Figure 1.2 outlines the integrative process underlying the stages of this research. This method is developed in this research, and will be explained in detail in Chapter 2.

In Figure 1.2, the environment of the exercise is framed in Proposition 1 as on-farm systems research with farm business management as the disciplinary framework.

Proposition 2 defines the resources as the soft and hard components of the farm system. Proposition 3 states that this system's analysis has to be found within the context of strategic management.

Proposition 4 highlights the position of the hard systems perspective. Proposition 5 defines the purpose of the analysis, which is to improve the decision-making capacity of the

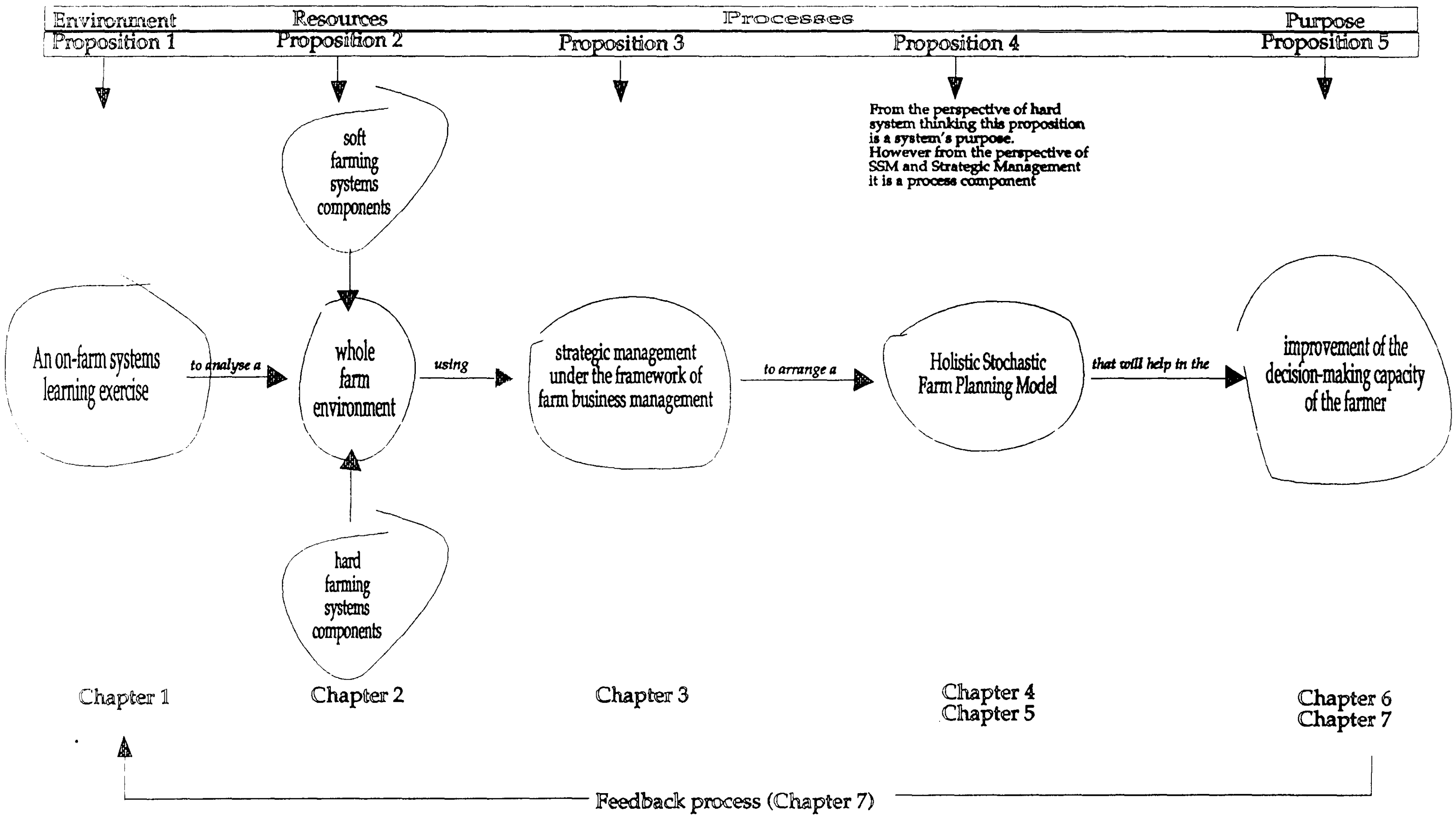

Figure 1.2 The Conceptual Map of this Research

farmer by producing a better picture of the farm system, according to both soft and hard systems principles. This would be the ultimate objective of this holistic on-farm management modelling exercise.

Chapter 2 provides a theoretical description and an application of systems analysis methodologies. Chapter 3 describes the components of the research within the framework of farm business management. Chapter 4 reviews the framework for risk analysis and develops components for holistic stochastic management in farming systems modelling. Chapter 5 develops the model structure that addresses the key concerns of this study. Chapter 6 integrates the on-farm results of applying this model and draws up the conclusions of the study. Finally Chapter 7 presents an analysis of the implications and limitations of the study. Appendix 5.1 contains the data collection formats for the farm enterprises under analysis. Appendix 5.2 describes the probability density functions of the variables deemed stochastic in the whole-farm model. Appendix 5.3 describes the incorporation of sustainability as a soft variable within the farm planning model. Appendix 5.4 provides the information of a demonstrative holistic optimal deterministic and stochastic farm model. Appendix 6.1 contains all the information about the programming matrices and output files of the different analysis scenarios of the on-farm application.

Chapter 2

THE FARMING SYSTEM ANALYSIS

2.1 Introduction

System analysis plays a major role in researching and addressing management problems. In SSM, the process of problem definition is an action-reaction exercise that compares a current world view with previous stages in order to delineate management problems at a highly accurate level of definition. After the problem situation is identified and defined as a "rich picture", a "root definition of the system" is completed, and this leads into an action scheme, within a context of continuous action and reaction.

Forbes (1988) argues that the modelling of farming systems should be attempted through heuristic methods, i.e. using a problem-solving approach for which no pre-conceived algorithms are defined and using instead an inductive reasoning where the modeller can play creatively with his/her particular way of making sense of the world *(Weltanschauung)*.

Anderson, Dillon and Hardaker (1985) suggest that modelling in farming systems research implies a scheme of the real world (including the farming system under study, and the rest of reality) which is separated from the farming system researchers' world (including their assumptions, concepts, models, insights and conclusions) by a "threshold of relevance". The farming system researcher can only cross this threshold by exploiting his or her personal creativity and intuition; the condition is therefore an artistic one. This statement links conceptual systems modelling (i.e. rich pictures, conceptual maps), which operate under SSM principles, and integrates it with deductive modelling approaches (i.e. OR tools). If this integration were achieved it would mark an improvement in the theory and application of holistic modelling.

Although modelling is not a panacea for management problems, it does offer the power of simulating the behaviour of the real world. Modifications may be introduced to the simulation at a low cost (or none at all) without perturbing the real world system performance. Nevertheless, Anderson (1972) highlights some limitations of farm modelling, warning against "false perceptions of reality" or "excess of self-confidence". These limitations are also noted by Hardaker, Pandey and Patten (1991). The researchers urge the modellers to avoid:

(a) inappropriate balance between data gathering, model building and model exploitation;
(b) inappropriate balance in the structure of the models;
(c) neglecting feed-back from on-farm trials in building the model specification;
(d) misunderstanding of technical problems;
(e) distancing themselves from their target domain of farmers;
(f) insufficient verification and validation; and
(g) inadequate representation of uncertainty.

In deductive techniques, modelling implies problem definition, systems analysis, systems synthesis, model implementation, model verification, model validation, model experimentation and interpretation, as defined by Dent and Anderson (1971). All these steps are taken by all modellers on their assignments, regardless of the point of reference for the modelling exercise. Indeed, the general process is remarkably similar across the spectra of socio-economic modelling in the agricultural sector: the differences are mainly found in the processes of the model, depending upon the defined purposiveness of the system. By contrast, with inductive techniques, modelling is a learning experience which leads to a better understanding of a managerial situation: the experience is not oriented to the prediction of specific outcomes. The messy world can be "organised" using experience, intuition and perceptions of the real world, which allow the modeller to identify the major components of the system in analysis and the system's interrelationships and to address the system's goals as well as the major opportunities for strategic management.

Stacey (1993) states that conventional wisdom in management should be used to understand the "momentary equilibrium of the organisation" and to acknowledge that modern managers, rather than working under conditions of uniformity, predictability and stability, have to cope with surprise, difference and instability. In these conditions, strategic management will be simply a "position" of the decision maker that will yield acceptable outcomes using a looping pattern of change and adjustment in the manager's behaviour, feedback processes and momentary stability. In this sense dynamic management does not imply only time, and the management process can be understood as the exercise of decision making at different levels of organisational management for achieving constantly the system objectives. This is a main point in holistic management where short-term and long-term objectives merge, since the former are organised according to the long-term context.

This research attempts to combine features from three different schools of systems thinking, each embodying a significant stage in the historical development of the systems concept: Operational Research (OR), Soft Systems Methodology (SSM) and Holistic Dynamic Modelling (HDM). By analysing and contrasting the characteristics of each school, this study should be able to arrive at a better, more integrative systems description.

The flow of decision-making processes and their effect in resource management can be mapped out using SSM and HDM principles (Checkland 1981, Stacey 1993) and bringing new elements to the conceptual mapping ideas of Novak and Gowing (1984). Using this method this chapter will review the characteristics and dynamics of the farming system in analysis.

2.2 Overview of Systems Thinking

If the different schools of systems thinking are analysed and contrasted, an outline of their similarities and differences should assist in the design of a better, more integrative system description. The evolution of systems thinking may be traced from a starting point in operational research (Ackoff & Sasieni 1968) through soft system methodologies (Checkland 1981) and lately dynamic modelling and organisational dynamics (Stacey 1993). The concept of systems as applied to agriculture can be traced historically through Spedding (1975, 1987, 1988), Haines (1982), Dent and Anderson (1971), Brockington (1979), Grigg (1974), Ruthenberg (1977), Bayliss-Smith (1982) and Wilson and Morren (1990). Some of these authors (i.e. Dent and Anderson (1971); Brockington (1979); Bayliss-Smith (1982)) summarise the systems approach in symbolic models of mathematical representations. These models can be adapted into operational research algorithms and then implemented into the framework of farming systems. This is, in part, what this research study is attempting to do.

2.2.1 Operational Research

Operational Research (OR) consists of systematically organised thinking which is concerned with solving well-structured problems. A quantitative approach to systems definition and problem solving with pre-determined objectives are the major characteristic of OR. Loomba (1978) states that OR became the paramount scheme in the early development of systems thinking.

The OR paradigm is built on two foundations, on the scientific method, and on systems thinking orientation and is defined as that branch of management science 'grounded in the discipline of deductive inference, theory construction and model building, i.e. scientific method, systems approach and quantitative modelling' (Loomba 1978, p. 19). The essence of this approach is that problems must be expressed quantitatively, and that symbolic rather than conceptual models of expression are to be preferred (Groebner and Shannon 1992 pp. 3-17). Therefore OR is closely related to mathematical programming and system simulation techniques.

OR practitioners develop formal models of standard assumptions that project assumed consequences of alternative courses of action. These models may incorporate the elements of risk that help managers to make rational choices under risk and to design optimal or quasi-optimal solutions to the operation (Loomba 1978, p.18).

OR is essentially normative in nature, that is, it prescribes a specific managerial course of action, telling the manager how to behave, and outlining specific solutions to specified problems based on a set of assumptions about interrelationships and system performance (Loomba 1978; Dent, Harrison and Woodford 1986; Gould, Eppen and Schmidt 1991; Groebner and Shannon 1992 and Taha 1992). Groebner and Shannon (1991, p.17) are explicit in stating that OR applications can only succeed when the problems are defined before the problem-solving technique is selected. Loomba (1978 p. 19) states that OR has yielded dividends in improving management processes, but contrasts its lack of effectiveness for making strategic decisions in organisational management.

Loomba (1978) also holds that further advancements in the application of OR can only be made by redefining several ideological premises, by finding ways of handling the changing nature of the system in analysis, by accommodating relevant behavioural aspects in the formal models, and by adjusting the model as the decision-making process unfolds.

OR is identified as 'hard systems thinking' as opposed to 'soft systems thinking' (Rosenhead 1989b, p. 5). The former structures quantitative solutions to perceived problem objectives, while the latter structures management problems in a conceptual manner (Checkland 1983). 'Hard system' variables are numerically tractable, and 'soft systems' variables are usually expressed in qualitative terms. Conceptually, the perceived purposes of 'hard systems' techniques, as an end point of decision-making processes, have raised criticisms about the suitability and effectiveness of the related techniques (i.e. the inadequacy of optimal solutions).

OR has a natural scientific bias appealing mainly to those who prefer to exclude ambiguity and subjectivity in favour of a world of clean certainties, substituting theory for judgement. The focus is on deduction. Models are not intended to reveal or facilitate insights into system function or causation, which, in conventional OR analysis, are predetermined. Judgement is excluded, and the complexity and comprehensiveness of the technique seems to substitute or overcome the need for inquiry into the validity of the decision-making process. This disjunction between judgement and analysis limits the social relevance of the ensuing decision making. Rosenhead (1989b, p.3) extends this observation, pointing out that OR is an example of 'rational comprehensive scientific planning", and defines five stages that the technique encompasses:

(a) identification of an overall objective function;
(b) identification of alternative courses of action;
(c) predicted consequence of actions in terms of objectives with weighting;
(d) evaluation of the consequences on a common scale of value; and
(e) selection of the alternative whose net benefit is the highest.

Diagrams of hard system characteristics can be generated in order to understand the system better, and they should define system relationships for prescriptive purposes. Through these diagrams the dynamic relationships within a system's resources and processes are quantified to facilitate their transformation into quantitative planning models.

As an example of this methodology an overall farming system is described in Figure 2.1 using an integrative diagram. Resources are *inputs*, either from the external environment that encompasses socio-economic, scientific, political, financial, and marketing structures, or from the internal farm components (ecological, physical, human, financial and technological inputs). The management functions consist of five basic components: planning, organising, implementing, controlling and evaluation.

These elements are put together in the *process* side of the farm system in order to highlight the integrative nature of management in farm operations. In a mathematical programming matrix, these functions are replaced by tangible relationships that integrate resources and activities (i.e. input-output coefficients). On the right hand side of the system diagram, the *output* component is represented by biological outputs (i.e. livestock and agricultural commodities) which can be represented in symbolic mathematical algorithms. For the components of personal rewards and social outcomes (i.e. sustainability and aesthetic goals) there is no universal solution within the framework of hard system methodologies. The optimising system will produce optimal biological outputs converted to financial rewards in the objective function of the system. The ultimate system objective will be an optimal financial value of the whole-farm operation.

2.2.2 Soft Systems Methodology

Eden and Simpson (1989), Rosenhead (1989b), Checkland (1983, 1989), Friend (1989), Hickling (1989), Howard (1989) and Bennett, Cropper and Huxham (1989) recognise that new paradigms which are different to the scientific method have the potential to overcome the constraints of 'engineered' solutions such as those of OR. Soft Systems Methodology (SSM) is one answer to this problem. It was originally developed by Checkland (1981) with further input from Wilson (1984), Forbes (1989), Avison (1988) and Gallier (1992).

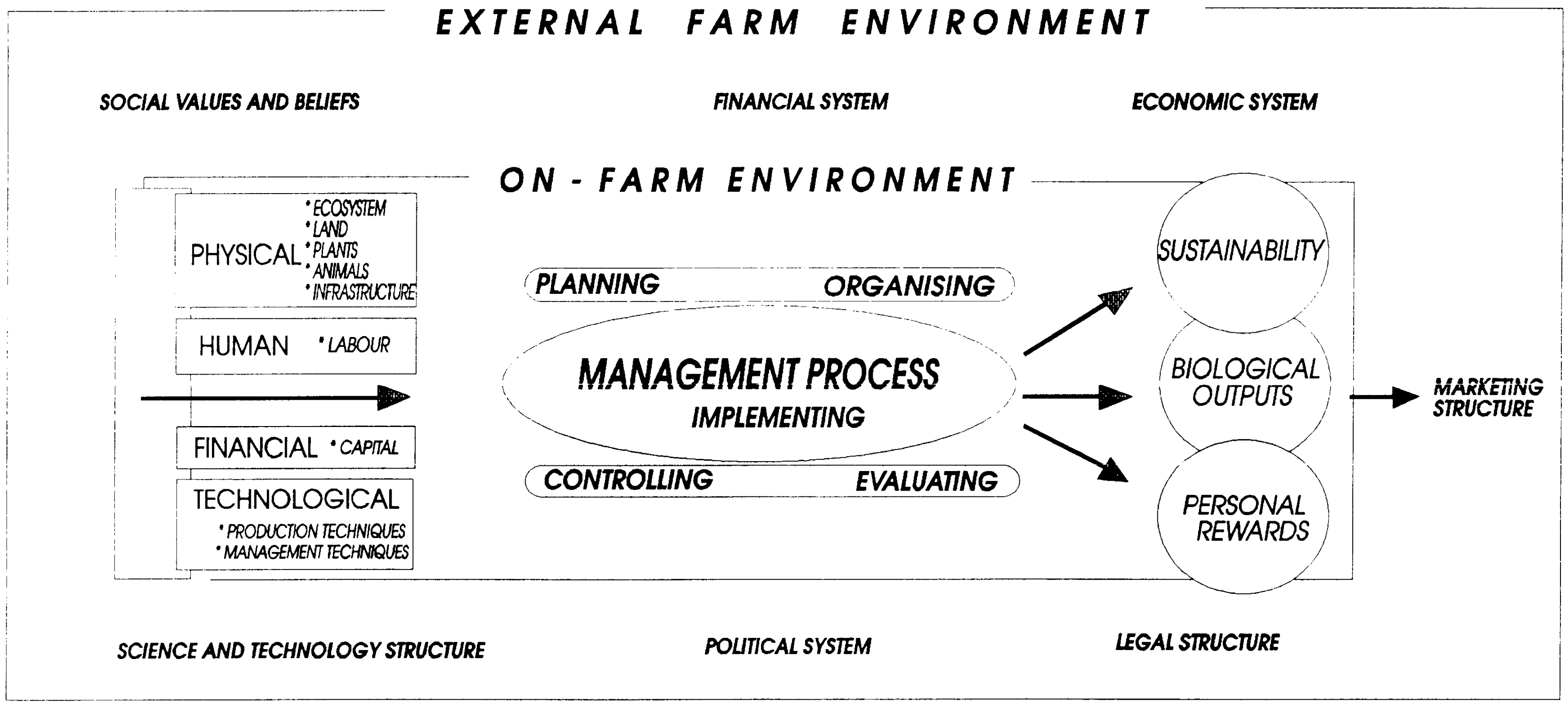

Figure 2.1 The Farm Management System: A Hard Systems Description

\TH-5-6.EPS

SSM is a collection of 'management learning' techniques for identification and resolution of management problems (Checkland 1983, p. 98), as opposed to an optimising procedure for explicit system objectives such as maximising profit (Rosenhead 1989b). The inductive nature of SSM is appealing for on-farm decision making purposes where fixed input-output relationships and the changing nature of the system, integrated through dynamic internal feedback processes, need to be combined.

SSM accepts that actions in the real-world are 'messier' than the actions described by optimising models with static and predetermined objectives. SSM uses conceptual models to structure a debate in which different and conflicting objectives, needs, purposes, interests and values need to be teased out and discussed. In this way, it tries to include cultural myths and meanings as well as testable facts and logic. It thus seeks to articulate a process in which an accommodation between conflicting interests and views can be sought, an accommodation that will enable action aimed at flexible improvement of the system under analysis (Checkland 1989, p.98).

As such, SSM is a non-optimising, learning-orientated system, where the flux of ideas and events moves on without permanent solutions: systems thinking has to be envisaged as an endless process. In effect this method can be considered as applying institutional economics to questions of change and dynamics in purposeful systems such as those of farming. In SSM the 'system' is not 'out there', to be managed through mechanistic processes of command and control; instead it requires introspection, and acknowledgment of its own dynamics and feedback processes as the forces behind adjustment and change. Systems analysis in a SSM perspective is an opportunity to develop a process of inquiry to identify the system components as a function of the human elements of the system. The whole set of interrelationships is given through the individual decision-maker logical perspective of reality (*Weltanschauung*). This part of the analysis of the management problem becomes 'what should be done' rather than 'what has to be done' (Checkland 1983, 1989).

The three components of SSM used to arrange system descriptions and management problem definitions are rich pictures, root definitions and CATWOE. The terms and the acronym are explained as follows:

(a) A rich picture is a pictorial representation of the overall situation under analysis. Its major function is to highlight the components of the system that will support a subsequent CATWOE analysis.

(b) A root definition is a description of what the system is, and it is used to explain the basic purpose of the system under analysis. It captures the fundamental interacting elements of the systems that Checkland (1981), Wilson (1984) and Forbes (1988) consider must be identified. An analyst can set as many root definitions as desired. An important part of the exercise is to establish with some clarity the nature or character of the system under analysis.

(c) CATWOE is an acronym that stands for the basic components of the system (i.e. **C**ustomers, **A**ctors, **T**ransformation processes, ***W**eltanschauung*, **O**wners and **E**nvironment of the system). These system components must be derived from a meaningful root definition. The CATWOE analysis marks the final stage in understanding a system from a SSM perspective.

The CATWOE components of the system are described as follows:

Customers are the consumers of the outputs of the system. As an example, if farming has a production-profit orientation the customers will be those at the end of the chain.

Actors of the system are the agents who carry out the transformation processes or activities of the system. For the farming example, the main actor is the farm business manager.

Transformation process involves the organisation of farming system resources towards the production of system outputs. For farming analysis, the transformation process is to produce farm commodities.

Weltanschauung is the particular framework or outlook which makes a particular root definition a meaningful one. The expression is originally derived from the German for "world view". This concept from SSM matches well with Anderson and Hardaker's (1979, p.25) support of the value of subjectivity and intuition in systems analysis. The *Weltanschauung* of an exercise in farm analysis is the profit orientation in the use of the farm resources, ecological and financial sustainability and self-fulfilment and enjoyment of the farming activity.

Owners defines the ownership of the resources and in the end those who will receive the system's profit. For the farm example these are the farm shareholders or proprietors.

Environment defines the impositions on and interactions with the internal components of the system and wider outside systems. A root definition may suggest that the system environment for a farm might be ecological-economic sustainability considerations.

An example of SSM rich picture application to a farming system may be observed in Figure 2.2.

2.2.3 Holistic Dynamic Modelling

Holistic Dynamic Modelling (HDM) is an integrative concept from recent developments in systems analysis which support a particular view of strategic management. It may be considered historically as one of the different approaches which have contributed to a better understanding of purposeful systems, systems where humans interact and integrate resources towards the achievement of specific individual and social objectives.

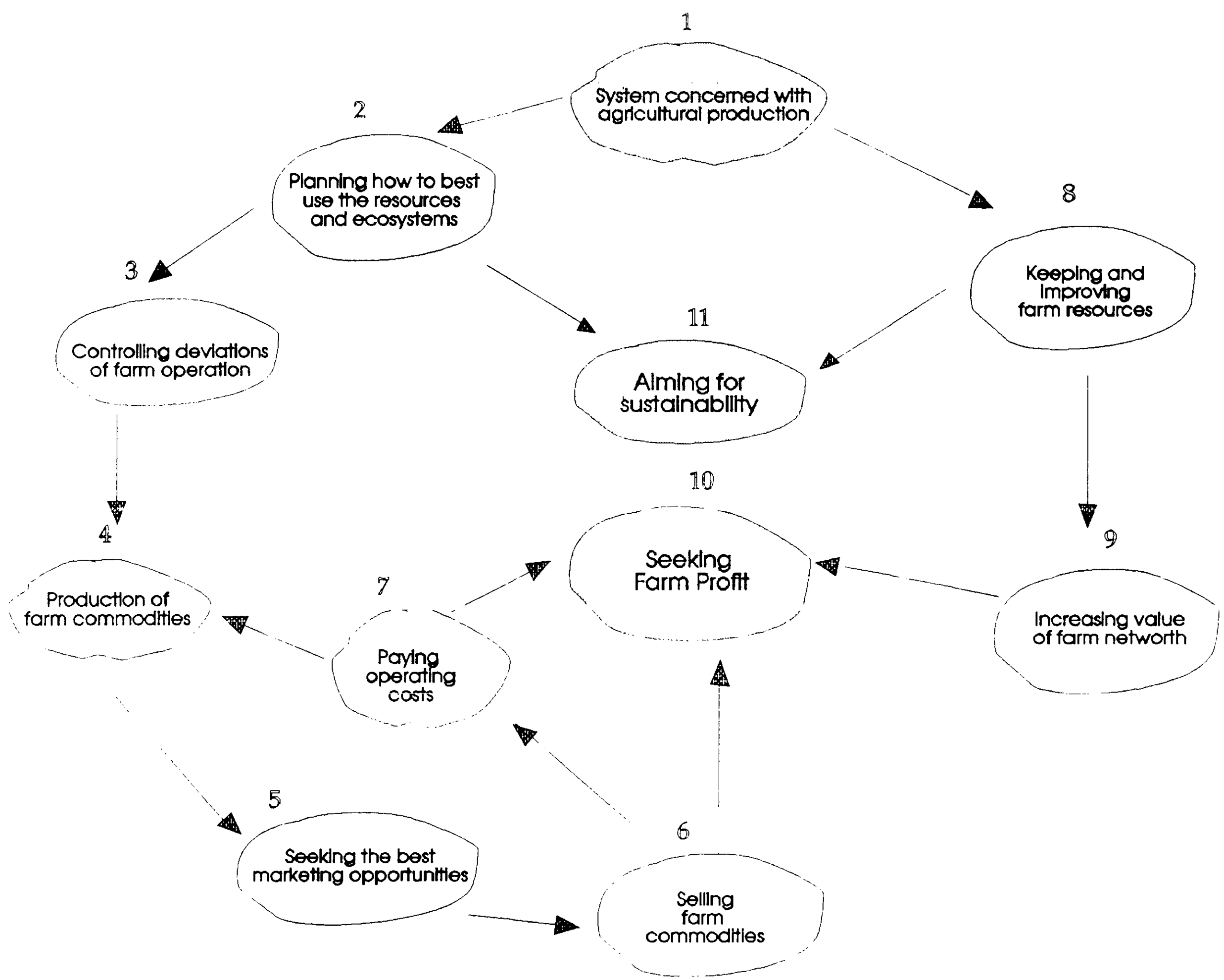

Figure No.2.2 A SSM Rich Picture of the Farming System

Within this context, rather than referring to the effect of time in the system operation, the dynamics of the system itself defines the causality in internal system relationships. Causality is driven by the internal complexity of the system and must be considered that way in order to generate meaningful management insights.

Roberts (1978), Wolstenholme (1982), Savory (1991), and Stacey (1993) have developed a new view of management resources using inductive modelling processes which are not outcome-oriented but focus on cause-effect analysis. The system purposes are left to the decision-making capacity of the manager, since these are changeable and adapt to specific internal and external conditions of the system under analysis. Applying these ideas to the agricultural sector would allow a consideration of the non-quantifiable dynamic variables in the causal analysis of the system under study. For example, the model can include, as components of the overall system of causation, the aesthetic goals of the farmer, sustainability of ecosystems, the dynamic evolutionary relationship between the system components, and the feedback effects of changing (stochastic) processes. This framework of management, though originally supported in the principles of systems dynamics (Karnopp, Margolis and Rosenberg, 1990), has evolved towards organisational dynamics (Stacey 1993), emphasising the value of the manager's action in the system operation. This framework has been applied to the management of natural resources in 'holistic management' (Savory 1991) and 'strategic management' (Stacey 1993).

HDM, therefore, is an inductive modelling process that focuses on building systems understanding, and fits within the overall paradigm of strategic management. Stacey (1993) emphasises that Western managers embrace strategic management in the belief that its purpose is to reduce the level of surprise and increase the level of predictability of the system's operation, and thereby improve the ability of the decision-maker to control the long-term destiny of an organisation. However, the belief that organisations succeed only when they operate in states of stability and harmony, or when they can be adapted intentionally to their environment, is too firmly held. Contemporary management systems, by reinforcing the importance of predetermined outcomes and underlying strategies, fail to explore opportunities to learn about the system, and hence also fail to develop management strategies that can recognise and weather the complex dynamics that any realistic management system must contain.

The dynamics of an organisation are the processes of change that organisations embody as they move through time, and the underlying patterns of cause and effect feedback which fuel those processes. Organisational dynamics is therefore a study of the properties and consequences of feedback relationships. Most management techniques focus heavily on the static analysis of competitive positions, and, because they fail to realise that an organisation is essentially a feedback system (Stacey 1993), largely ignore the organisational dynamics.

The particular concern of HDM is that, in detailing the behaviour of a system, the links between cause and effect may be lost if a reductionist approach to understanding the system is adopted. This is to say, a defective understanding of the whole organisation will result where the organisation is, in analysis, split into discrete components and subsequently re-integrated in order to attempt to understand the whole (Stacey 1993).

The major strength of HDM is that it is an approach for sustainable planning which explicates the dynamics of the model, the feedback character of the system interrelationships, and the stochastic (changing) nature of the system operation. It also encompasses the various soft systems components that are crucial as explanators of the overall system behaviour. In HDM a major imperative for subsequent analysis is to validate the various cause and effect relationships through scientific research (Gill 1995). Figure 2.3 is an integrative summary of HDM as applied to decisions in managing farm businesses.

2.3 Conceptual Farm Mapping

For this research, the initial step in analysing the farming system uses an integration of soft system principles. Though SSM offers specific methods for such a purpose, no individual SSM technique will be used within this analysis.

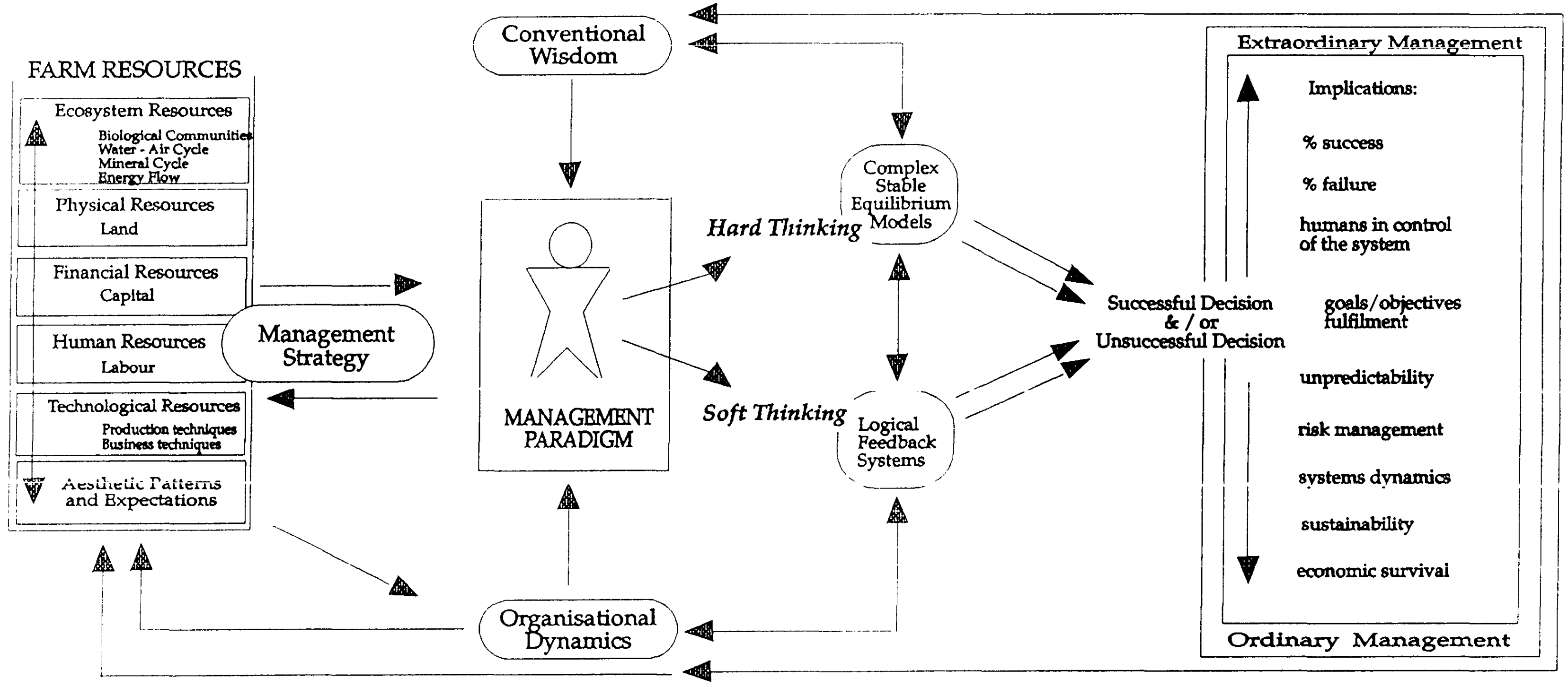

Figure 2.3 Holistic Dynamic Modelling in Farm Business Management

C:\GEMFILES\THESIS13.GEM

The limitations found in SSM are that the system's structure is forced through concepts (i.e. system owners, system actors, system customers) which do not seem to link or reveal system cause:effect components. The relationship between the system's components seems artificial, undermining the analysis of basic feedback processes, although the power which *Weltanschauung* brings to the system's definition should be emphasised.

A technique needs to be developed to integrate the way soft systems can structure management problems with an analysis of the causality of internal system relationships and system purposiveness. In this research conceptual mapping includes selected criteria from SSM (i.e. *Weltanschauung*), and from HDM (i.e. *short and long term system purposiveness)* to pursue that objective.

2.3.1 Basics of conceptual mapping

Conceptual mapping is an inductive technique that uses dimensional diagrams to isolate and interrelate system components in order to evaluate meaningful relationships and yield insights into the dynamics of the system (Fraser 1995). The technique was developed for exploring educational processes by Novak and Gowing (1984), with further improvements from Novak and Musonda (1991) and Fraser (1993, 1995). Fraser (1995) pointed out that the technique of conceptual mapping allows the individual to visually represent her/his cognitive structure of the system and thus see her/his conceptual web of interconnected meanings. Wilson and Morren (1990, p. 152-159)) use the concept of "mind mapping" within a SSM perspective for helping in the building of rich pictures, where the aim is to record accurately the views and perceptions of people involved in a situation. Because the technique offers a useful perspective on systems understanding, this research will attempt to use conceptual mapping in framing the research problem elaborating the technique, where necessary, for the purposes of the study.

Novak and Gowing (1989) mainly applied the technique for developing learning processes. Conceptual maps were intended to represent meaningful relationships amongst concepts in the form of "*propositions*". A proposition is a meaningful conceptual unit that reflects essential aspects of the system being described. Propositions are linked by connective words, which are usually verbs of action, e.g. "produces", identifies" in Figure 2.4. A complete conceptual map should therefore give a clear understanding of key elements of the system under analysis. Because of the inductive character of conceptual mapping, it is closely comparable to the SSM rich picture technique (Checkland 1981).

Conceptual mapping offers another outlook on systems understanding: this is where its aim is simply meaningful and systematic learning about the system components, interrelationships, simple feedback processes and purposiveness. Because conceptual mapping can flexibly capture the dynamic nature of the system, along with the misconceptions or subjectivity of the analyst, this research will use this technique to identify the farm system components. Here conceptual mapping provides a soft system view of management situations at the farm level. Because few identifiable references were found about the use of conceptual mapping for management purposes, this research has attempted to make full use of the benefits of this technique designing its own settings and applying them to the farming system in analysis.

The essential elements of conceptual mapping are therefore redefined as follows:

(a) Individual representation of the system under analysis to clarify and link the observed dynamics of the system with the behaviour of its components.

(b) A set of meaningful concepts embedded in a framework of propositions addressing meaningful management problems.

(c) Hierarchical scheme of system components defined through propositions and linkages.

(d) Simple feedback processes amongst the propositions identified to explain observed system behaviour with specific levels of detail relevant to the objectives of management.

(e) A system's definition depending upon the particular perception and needs of the decision maker.

The application of conceptual mapping to the specific managerial environment of a farming system requires a simple series of steps in order to complete the system definition at basic levels of resolution:

(a) A "process of abstraction" to identify the components of the system under analysis in terms of propositions and linkages.

(b) A "process of induction" to define causal relationships and identify the feedback mechanisms of the system.

(c) A "process of definition" to structure patterns of cause and effect that describe a management situation, and to identify critical points within the system in terms of instability, unpredictability and irregularity.

(d) A "process of description and understanding" for envisaging decisions that will contribute to the solution of the management problem.

Having completed the above process, it is possible to identify four operational areas in conceptual mapping as follows:

(a) **Environment area**: Proposition 1 should always present a definition of the environment in which the system is embedded.

(b) **Resources area**: Proposition 2 should define the resources that constitute the system under analysis and give meaning to the system from the perspective of the analyst.

(c) **Feedback management processes area**: It is the logical action-reaction element of strategic management that defines a purposeful system action. This is the most important part of a system analysis using conceptual mapping. The previous propositions of the conceptual map are essentially descriptive whereas the propositions for this area of the conceptual map encompass dynamic management elements which identify relationships, inter-connectedness, management of instability, management of surprise, and the significance of the actions, technical processes and human interaction within the system. The definition of relationships between propositions is always a dynamic one with two-way interactions constituting an important component of the feedback process. Within the processes area of the conceptual map the managerial functions are interconnected with the propositions.

(d) **Purposes area**: Because the system is a purposeful one the definition of the immediate objective(s) to be achieved is essential in the system description. The final propositions should comprise this component.

A basic example of conceptual mapping is illustrated in Figure 2.4. A set of propositions was identified and their interrelationships established for a specific management aim. The components of this figure show that conceptual mapping, applied to managerial decision making (*the environment area*), using multidimensional diagrams (*the resources area*), integrates a set of meaningful propositions and their linkages for describing the system components and their relationships in an inductive manner (*feedback management processes area*) from which the uppermost aim is to have a better understanding of the system (*purposes area*).

2.3.2 A basic farm system map

The whole conceptual mapping exercise was developed in a mutual "brain-storming" exercise between the farmer and the researcher, exploring the farmer's perception

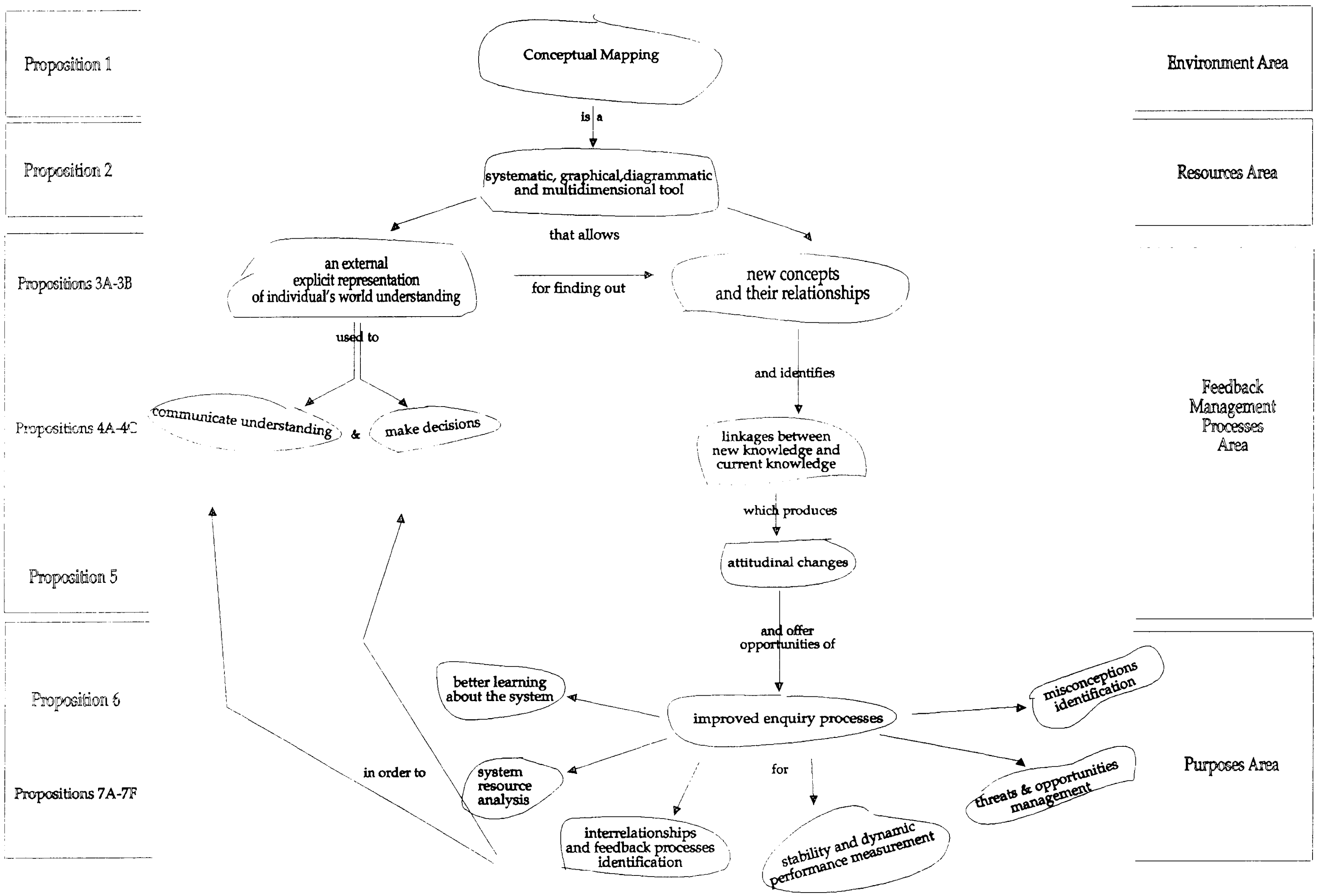

Figure 2.4 Description of Conceptual Mapping in Managerial Decision Making

about his own reality. In order to minimise the influence of the analyst in this exercise, a permanent feedback process was established: nothing should be written if the farmer was not in full agreement with the statement. A trial and error method was applied to determine the appropriate components and linkages of the different conceptual maps. Different aspects of the management problem were analysed using different inter-related but independent conceptual maps. It was evident that different conceptual maps present different levels of resolution depending on the initial reference point of the analyst. At each level of resolution, the process of conceptual mapping remains the same. These "levels of resolution" in conceptual mapping are discussed further in the rest of the chapter. Finally, a computer program was used for the elaboration of the conceptual maps.

An initial application of conceptual mapping produced two different perspectives of the farm system, as follows:

(a) Firstly, a simple description of the system where the farmer maps the most visible elements of the farming activity. This level of the conceptual map is called a "micro perspective" of the farm system. The farm, which is the environment of the system, has three broad components at this level: resources, activities (i.e. processes) and purposes, with a strong emphasis on the components that are relevant to the individual that manages the farm. In the traditional scheme of hard systems analysis these components would be identified as inputs, processes and outputs respectively, but the difference is that conceptual mapping demands a subjective or individual delineation of these components as a primary condition to map setting. Such an initial description of the farm system can be observed in Figure 2.5.

The "micro-perspective" of the farm system is constituted by a set of propositions and their related linkages. Proposition 1 defines the nature and environment of the system. Propositions at level 2 define the resources of the system. Propositions at level 3 define the transformation processes of the system and propositions at level 4 define the ultimate system purpose.

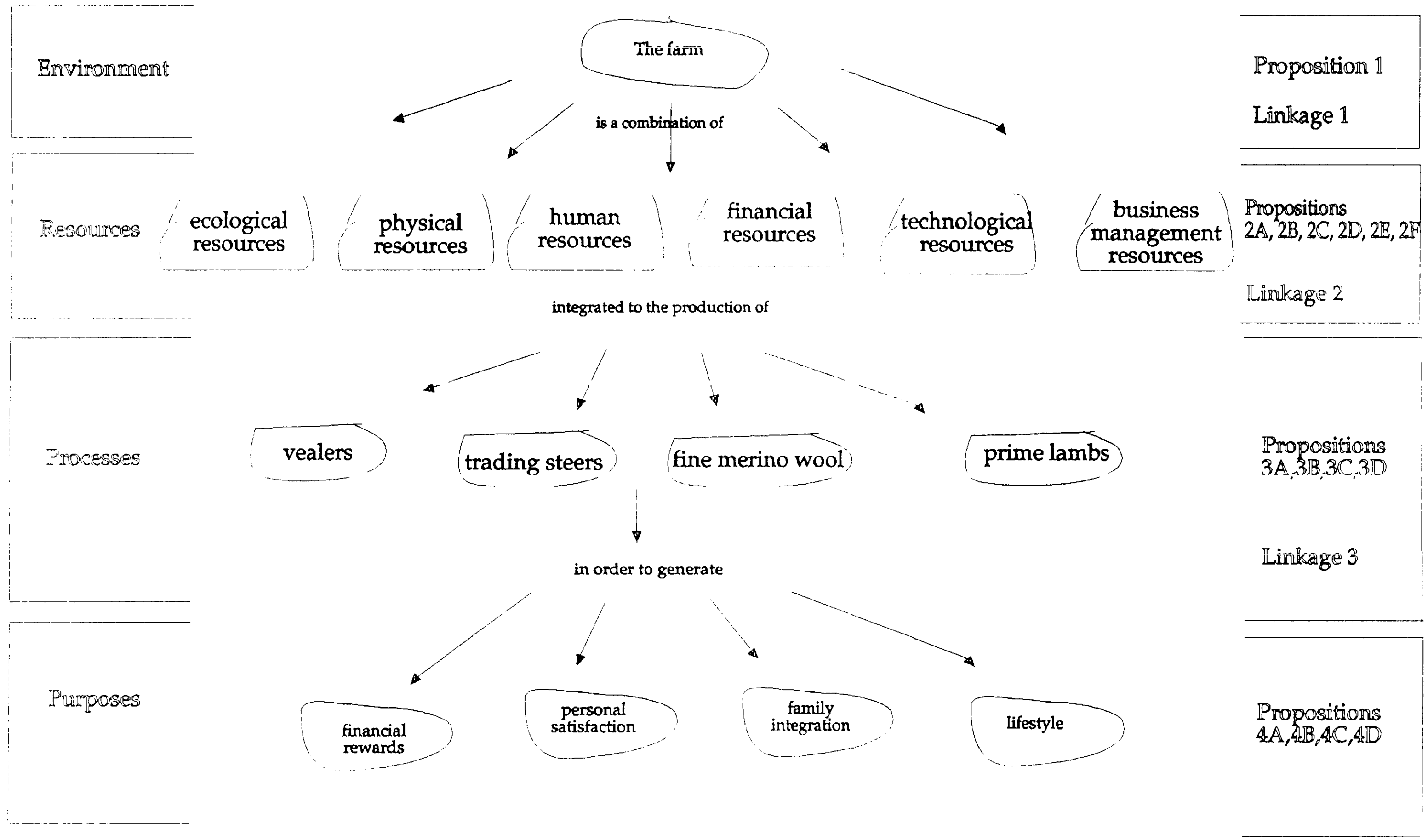

Figure 2.5 Farmer's Micro-perspective of the Farming System

Although the role of the manager is not listed as a specific discrete unit, Linkage 1 implies that the system has human components who combine resources, comparable to the *organising* managerial function. Linkage 2 is an *implementation* process using resources in specific activities (*management control*) from which the specific objectives from level 4 will be achieved as defined by Linkage 3. The feedback is then equivalent to the management function of *evaluation.* These linkages thus include managerial functions of different levels of complexity within the system operation.

(b) An extended perspective of the farm system was achieved after discussing with the farmer the farm-related elements that comprise the business environment, the ecosystems boundaries and the community associations. The concept of the farm as a production unit related to other production units in a competitive environment of ecological, financial and social characteristics highlights a broader perception of the farm system where rewards are allocated not only to individuals but also to society. The extended farm system of this conceptual map is labeled as "a wider perspective" of the farm system. There are several levels of decision-making linkages within the farm system: use of resources and *defining* production activities; *integrating* the farm with the overall socio-economic environment and *managing* it in an efficient manner; and finally *organising* the farm towards the achievement of rewards. The components of this conceptual map are described in Figure 2.6.

The extended first level farm map encompasses a set of propositions with related linkages. Proposition 1 defines the nature and environment of the system in analysis. Propositions at level 2 integrate the non-renewable natural resources and the production activities. Propositions at levels 3 and 4 identify the processes of the farm systems as part of a greater system of multiple interactions within which the system has to perform to achieve system purposes (Propositions 5 and 6). The linkages of this conceptual map include, as in the previous analysis, a series of action verbs which correlate to management actions.

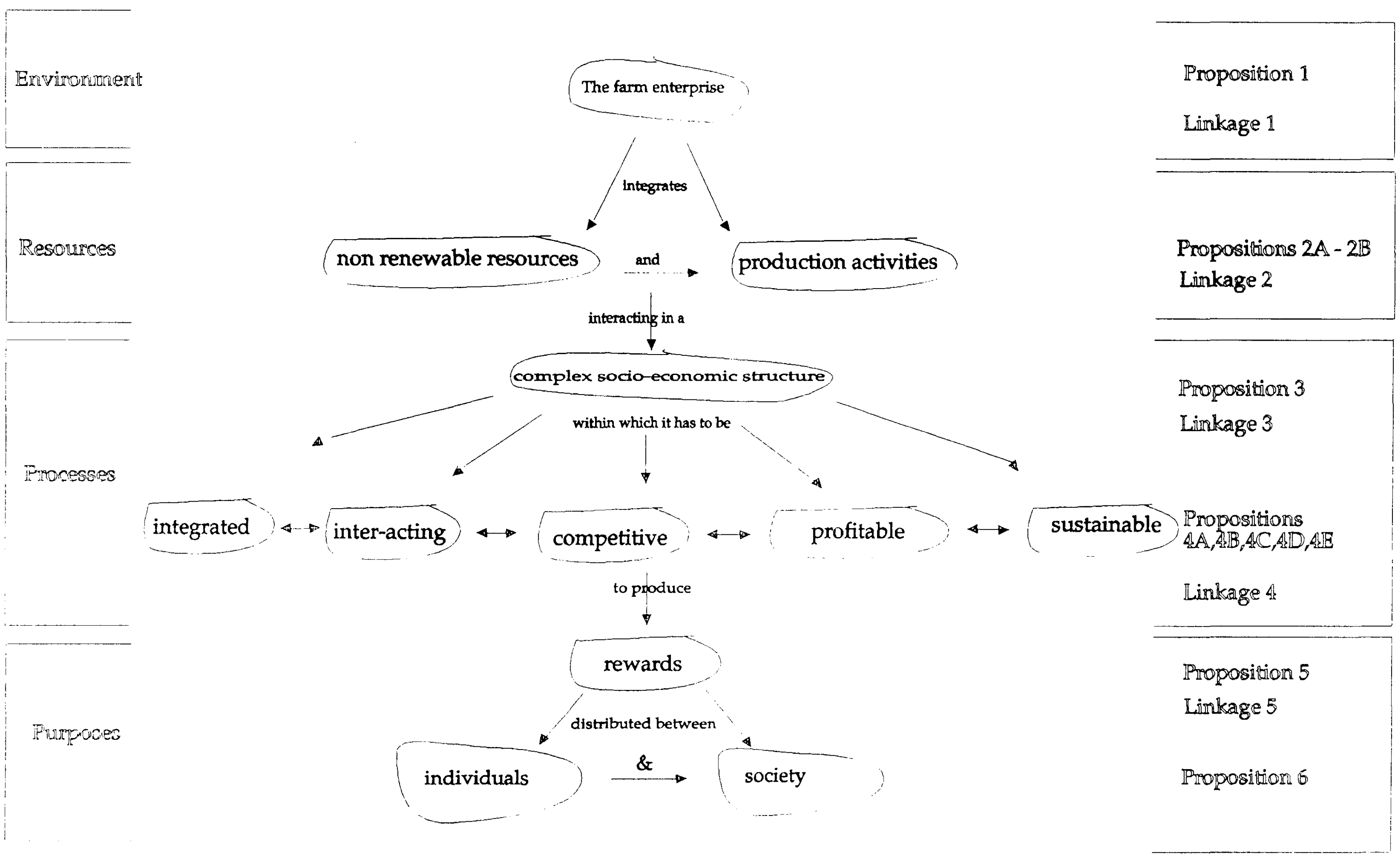

Figure 2.6 Farmer's Wider Perspective About the Farming System

2.3.3 Levels of mapping of the farm system

The first level of the farm mapping exercise showed that different perspectives of conceptual mapping can be undertaken depending on the individual perception of the decision maker. The propositions of these first level maps may be further broken down into maps of a higher descriptive resolution. For the particular purposes of this chapter a second level of mapping is developed to explore in more detail the farm system components for specific managerial implications. A third level of mapping will be attempted in later chapters to justify the stochastic and optimal aspects of this research.

Selected propositions of the first level of conceptual mapping can be further explored. To give more detail on the components of the farming the propositions on resources, production activities, socio-economic structure, management system and rewards were selected to build the second level maps.

Figure 2.7 offers a second level of resolution of the "farm resources" proposition. The system is identified at this level as follows:

(a) The relevant environment of the system is the *farm resources level* (described in Proposition 1).

(b) The *ecological* resources (i.e biological communities, air, water, light, energy, nutrients); *physical* resources (i.e. land, buildings, infrastructure); human (i.e. labour); *financial* resources (i.e. capital) and *technological* resources (i.e. production techniques and business management techniques) are represented in the proposition at level 2 as the system resources.

(c) The system processes are encompassed in propositions 3 and 4 through a *management resource program* and its interrelationship with *production activities*.

(d) The system purposes are defined as *ecological* and *financial* by Proposition 5.

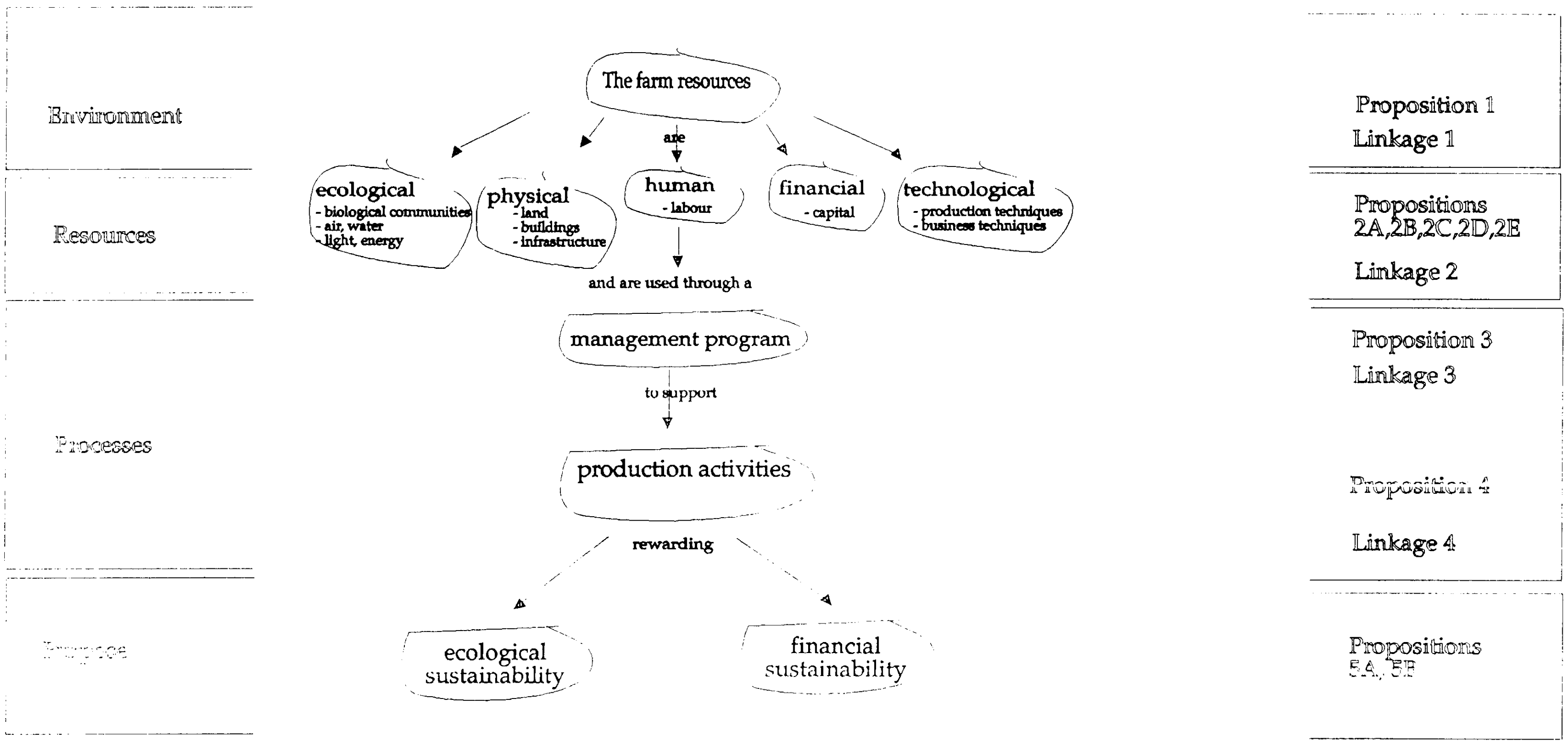

Figure No.2.7 Second Level of Resolution of the Conceptual Map of the Farming System: Resources Proposition

(e) The process of managerial decision making within the system is explained by the verbs linking the propositions. Management is considered as a dynamic process crucial to system performance

Figure 2.8 is the second level of mapping for the "production activities" proposition. The system involves the following aspects, at this level:

(a) The relevant environment is now at the level of *farm production activities* (as per Proposition 1).

(b) The resources of the system are the different enterprises running on the farm (as per Proposition 2).

(c) The system processes are encompassed in propositions 3 and 4 in a *management process* which integrates animal production activities (i.e. nutrition, genetics, reproduction and health). Each of these subcomponents has its own dynamics and can be re-drawn at further levels of resolution, depending on the objectives of the analysis.

(d) The system purposes refer to *biological optimisation* of the farm resources and of crop and animal enterprises as described by Proposition 5.

Figure 2.9 extends to a second level of resolution the "farm socio-economic structure". The system identified at this level involves the following aspects:

(a) The relevant environment of the system is the *socio-economic structure* within which the farm is a minor component.

(b) The resources of the system are described in propositions 2 and 3 at the sector level (i.e. primary, secondary and tertiary).

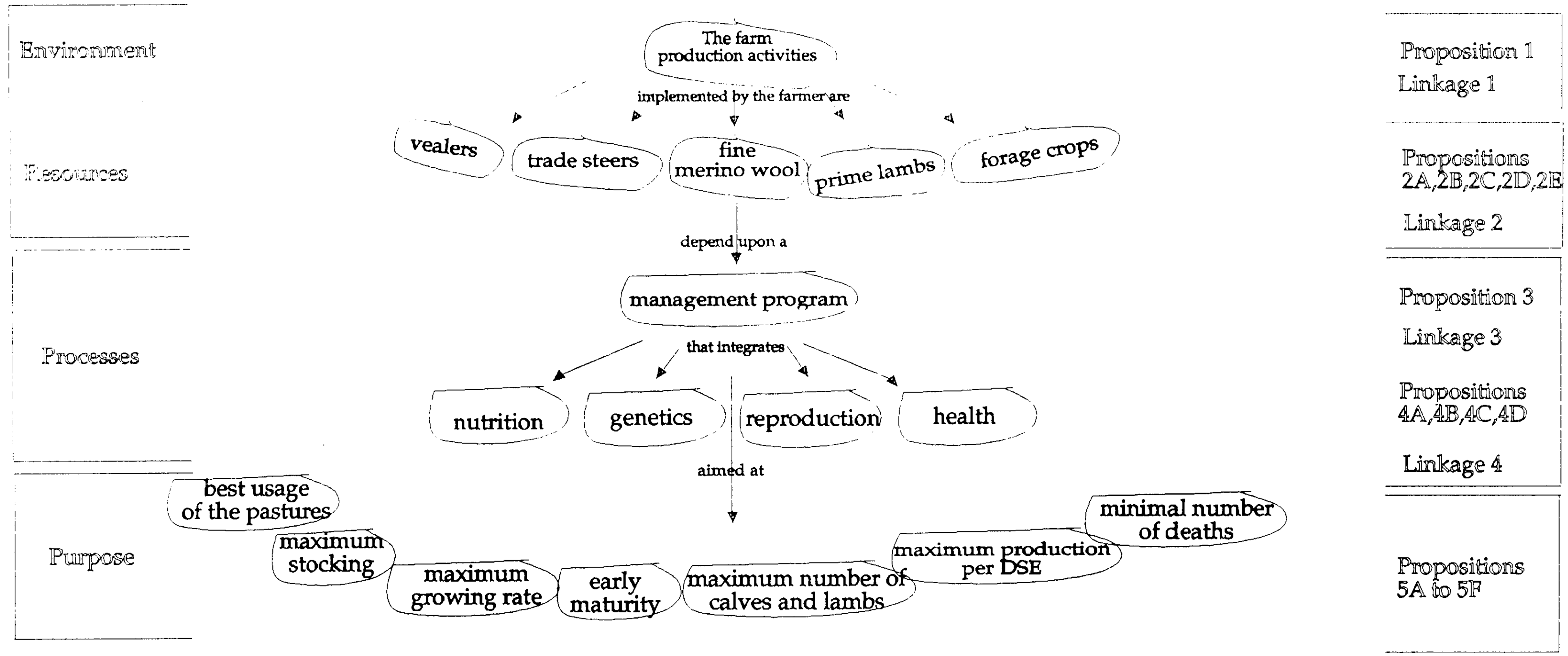

Figure No.2.8 Second Level of Resolution of the Conceptual Map of the Farming System: Production Activities Proposition

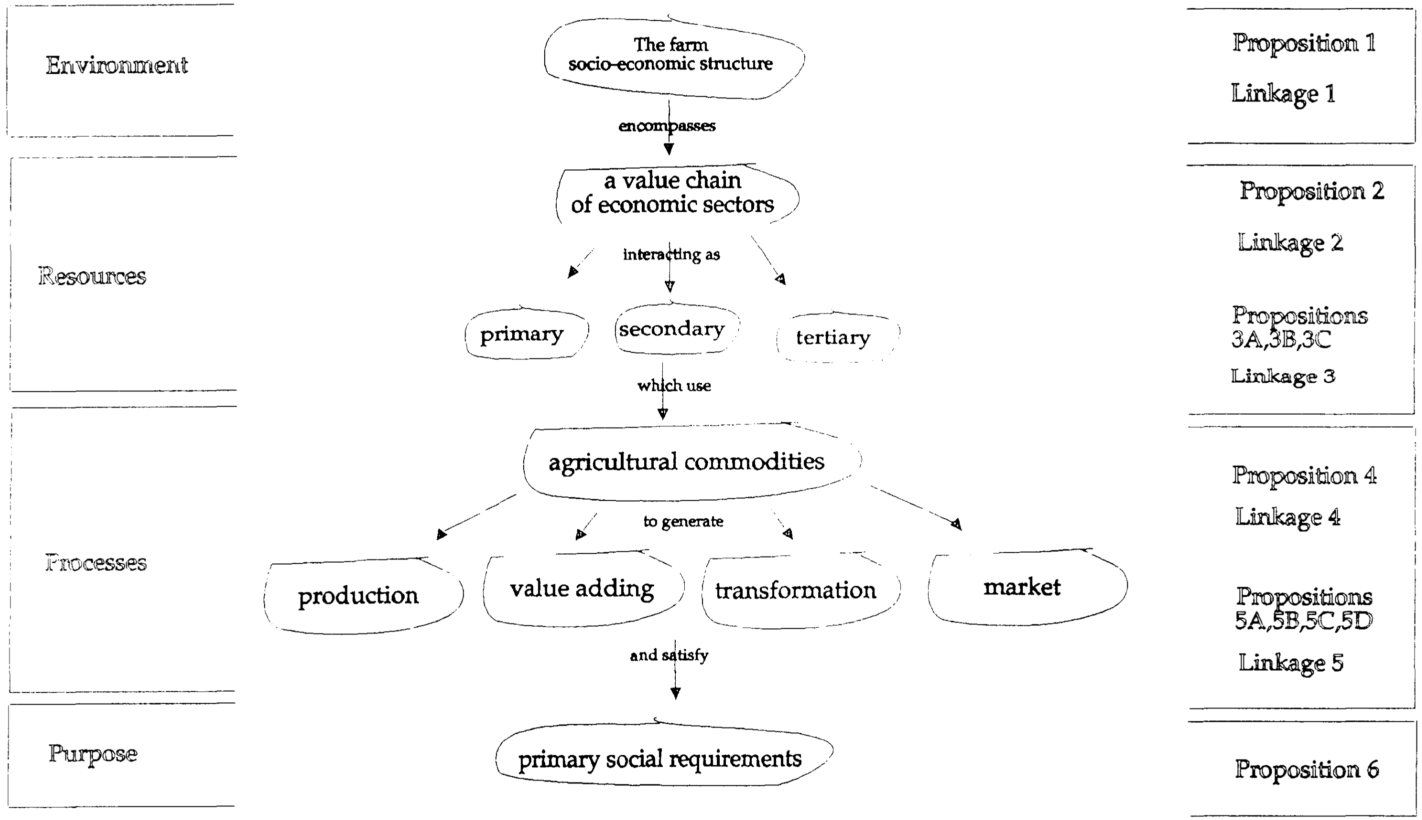

Figure 2.9 Second Level of Resolution of the Conceptual Map of the Farming System: Socio-economic Structure Proposition

(c) The processes of the system operate through the *production, transformation and marketing of agricultural commodities.* Each of these process components can be broken down in further levels of resolution, if necessary, as per Proposition 5.

(d) The relevant system purpose is the *social need for agricultural-based commodities*. This is defined in Proposition 6.

Figure 2.10 indicates a second level of resolution of the "farm management system". The system is identified at this level in the following aspects:

(a) The relevant environment is the *farm management system* as described in Proposition 1.

(b) *Farm production resources* are the relevant resources of this system as by Proposition 2.

(c) The *managerial decision-making processes* generate the dynamic feedback behaviour of the system as in Proposition 3.

(d) The purposes of the system involve both *intangible* and *tangible* components. These objectives are further extended in the conceptual map of Figure 2.11.

Figure 2.11 is the second level of resolution of the "farm rewards" proposition. The system is identified at this level as follows:

(a) The relevant environment incorporates the *rewards* that the farm operation produces for management.

(b) The resources of the system are the *tangible and intangible farm outcomes* that the decision maker is able to organise, as per Proposition 2.

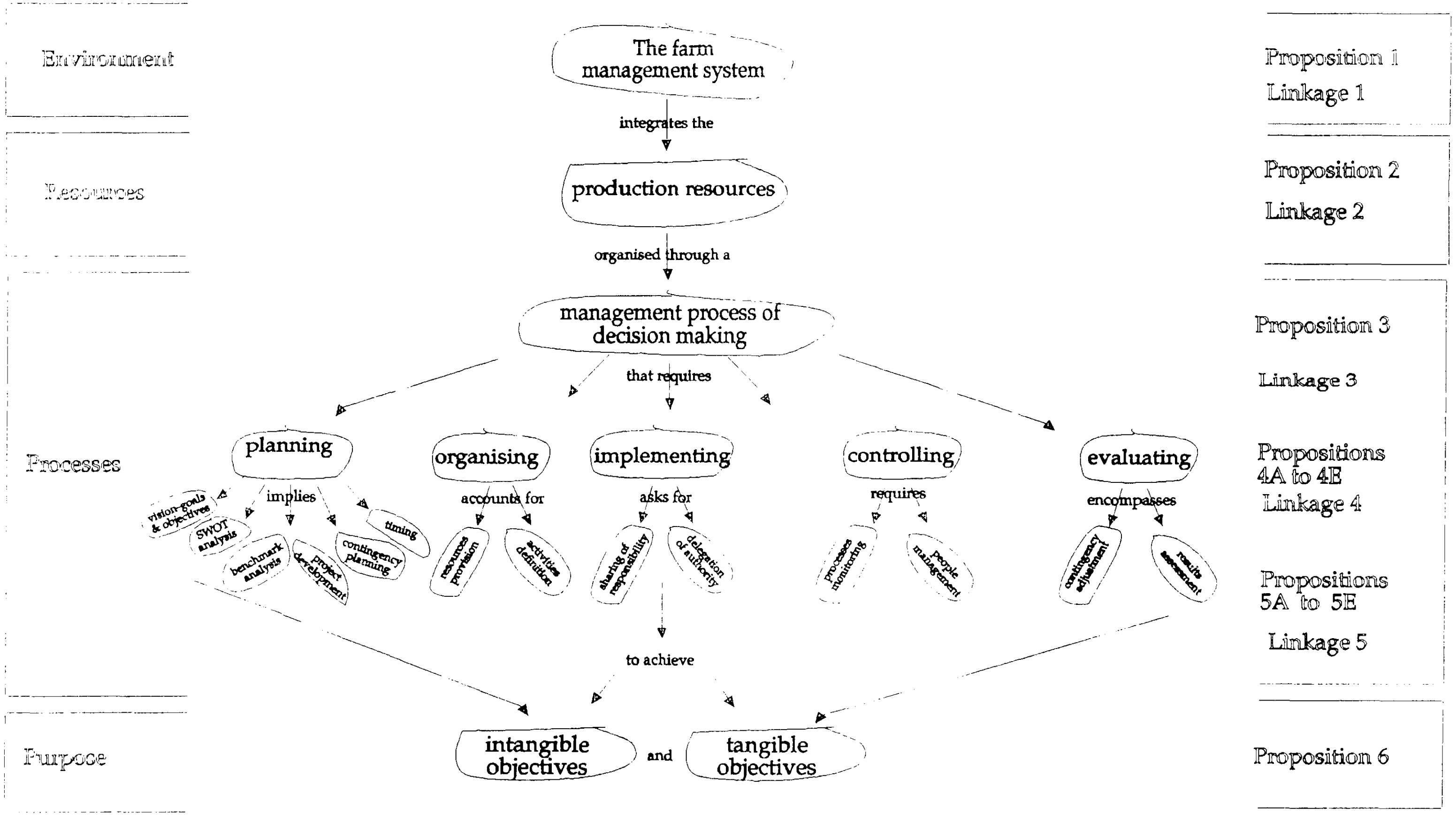

Figure 2.10 Second Level of Resolution of the Conceptual Map of the Farming System: The Farm Management System Proposition

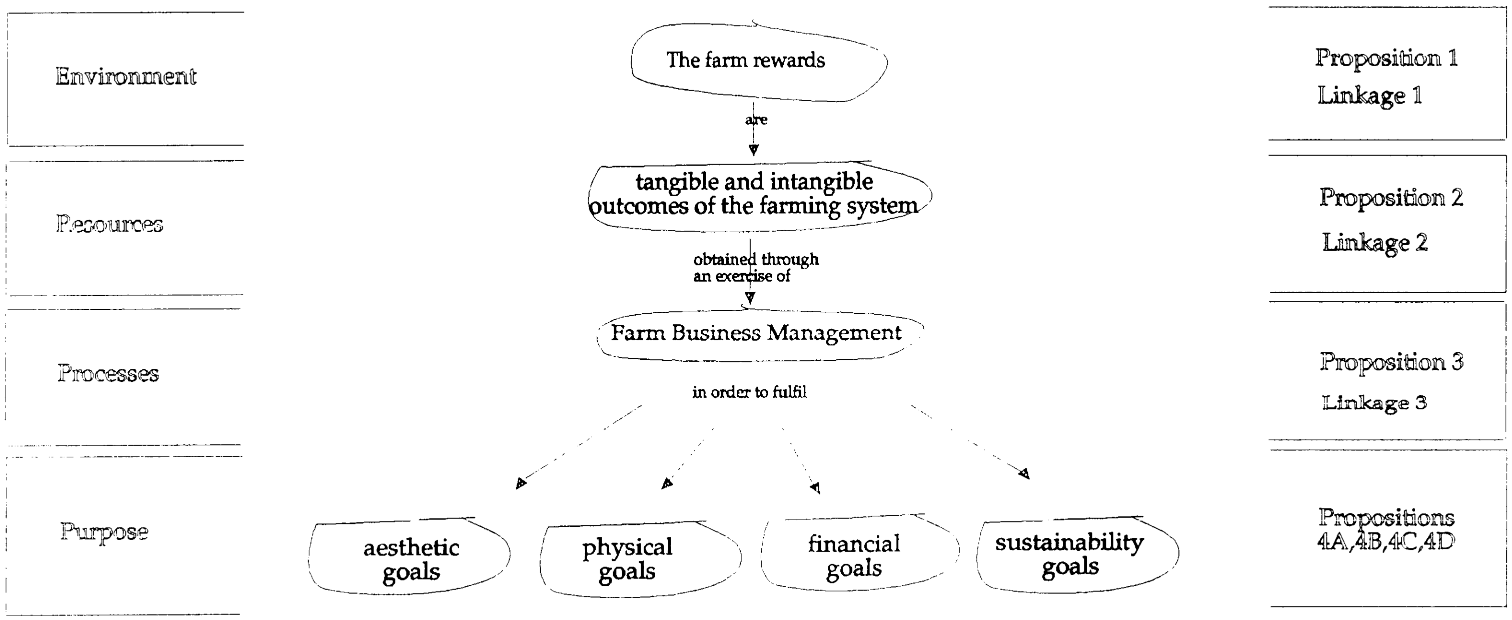

Figure 2.11 Second Level of Resolution of the Conceptual Map of the Farming System: Rewards Proposition

(c) Feedback process are described at the *Farm Business Management* level as per Proposition 3.

(d) The purposes of the system involve aesthetic goals, physical goals, financial goals and ecological goals, as per Proposition 4.

2.4 Dynamics of the Farming System

Within the context of decision making an holistic analysis of a system's dynamics should provide recognition of the impact and significance of human action in the operation of the system. It should acknowledge that "messy" conditions inside the system may be organised through bi-directional decision-making processes (i.e. positive and negative feedback) in both structured and unstructured forms. The particular way the decision maker perceives the world and targets his/her objectives will render the system operation meaningful and unsurprising.

Since the system's dynamics include the interaction of patterns of action, change and adjustment in the system, an analysis of what the conceptual maps reveal of the environment, resources, feedback processes and purposes of the system allows the analyst to identify specific dynamics of the farming system and trace the elements which are most important for understanding the system and designing its strategic management.

Feedback is simply a circle of interdependence or mutual causality. Across the conceptual system maps two types of feedback can be identified (as per Stacey (1993, p. 150), positive and negative feedback. Positive feedback produces growth and/or instability, depending on the efficiency of the management strategy. Negative feedback produces stability (or even stagnation) under a framework of contingency. The system adjusts itself to changes if the patterns of action do not match to the system's rules of performance. Alternatively the manager uses adjustment processes to level and harmonise the system (e.g. a manager cuts down on operational costs in response to uncertain commodity prices).

Management problems captured in conceptual maps represent a "dynamic causal flow" through the multidimensional diagram, and represent organisational relationships as a sequence of levels and linkages. Mapping can be as detailed as required to serve the strategic purposes of the analyst.

There are two levels of resources in the conceptual maps ranging from an *operational* set of resources (i.e. ecological, physical, human, financial and technological) up to a *structural* set of resources (i.e. socio-economic structure). The second level of resolution of the conceptual mapping exercise demonstrated the translation between a micro perspective (i.e. operational resources) and a macro perspective (i.e. economic sectors) and indicated how dynamics of the individual system interact with an aggregate dimension of the farming activity.

The system processes were identified as follows:

(a) a management resource program;
(b) management of farm enterprises;
(c) management of production activities, transformation and marketing;
(d) a farm business management program;
(e) a managerial decision-making process to lead the system towards purposeful consequences; and
(f) management of the conditions of the supra-farm socio-economic structure.

The system's purposive components were identified in the conceptual maps as follows:

(a) personal rewards;
(b) personal and society rewards;
(c) optimal performance (i.e. biological, financial, aesthetic);
(d) ecological and financial sustainability; and
(e) the satisfaction of social needs for agricultural-based commodities.

The analysis of rewards of the farm system show a dynamic ranging from immediate purposes (i.e. personal rewards, financial performance) up to longer term rewards (i.e. sustainable performance, optimal performance, welfare of society).

An analysis of the conceptual maps, at different levels of mapping, indicate that the linkages of the maps between the propositions are decision-making activities within managerial functions. The decision maker may be able to strategically manipulate the system and influence the feedback system's process without interfering with the system's dynamics. However, note the twofold element of risk within the flow of propositions of the conceptual maps. The first is related to the influence of the decision maker in the performance of the system. The farmer is aware that many factors and circumstances can condition his/her performance in areas which are modelled as specific nodes of the conceptual map (i.e. perception of problems, financial circumstances, weather conditions, family relationships, information, etc). This is a typical "attitudinal" influence on system performance which is correlated to human participation in the dynamics of the farm's operation. This aspect may be labelled as "attitudinal" risk and is clearly related to the effect of ill-defined decision-making processes in the whole-farm operation.

The second element of risk is located within the propositions. For example "resources", "activities" and "management processes" can be modified because there are factors outside the decision-maker boundaries that can create instability or surprise in the operation of the system. Thus, decision-making activities are not enough to guarantee that a normal system will adjust. These elements are labelled as "technical" risk and are related to the effect of uncertain factors outside the decision-making process, factors which condition the whole-farm operation (i.e. climatic, production, financial and marketing phenomena).

Analysing the system using different conceptual maps gives the researcher an holistic and dynamic view of the purposeful nature of the farming activity, since components, relationships and causalities are identified. The decision maker might envisage how resources may be used in a meaningful manner in terms of his/her own objectives and through specific management strategies that definitively condition the system's performance.

2.5 Summary

Three methods for system analysis were described in order to outline the nature of the dynamic systems perspective. This perspective will serve as the context within which subsequent analysis will be conducted and evaluated.

Conceptual mapping, being an integrative tool with components from both soft and hard systems, was proposed to support the value of heuristic processes in management modelling situations, and highlight the importance of *Weltanschauung* (i.e. world-view) in modelling setting and objectives definition.

The application of conceptual maps at different levels of mapping or resolution allow the researcher to include the fact that perceptions of reality are of a changing nature. It does not seem appropriate to implement structural approaches to problem definition and problem solving in isolation in a managerial context for on-farm decision making.

It is necessary to emphasise, however, that conceptual maps are not a tool in themselves: they simply produce a context for subsequent analysis, defining the system in a context of managerial functions where the consideration and interpretation of both hard and soft system components is considered important to the development of an integrated understanding of the underlying system's dynamics.

The major features of the conceptual mapping process include:

(a) the development of propositions to outline major system activities (i.e. combination of resources, multiple enterprises, etc);

(b) propositions which reflect a dynamic system of human intervention and which are interconnected and influenced by decision-making activities of managerial characteristics;

(c) relationships that are established at different levels within the overall dynamics of the system;

(d) actions which when charted indicate human intervention in a managerial context. This type of intervention is conditioned by the characteristics of the decision maker. This "attitudinal" component in the performance of the system is important to the overall system operation and is a primary source of instability or risk in the farm system (attitudinal risk);

(e) propositions which can be broken down at different levels of resolution, allowing for a more detailed explanation of the changing nature of the farming system. In this method, the acceptance of instability and unpredictability in system's performance are essential to understanding the nature of risk from the operational side (technical processes) of the farming system;

(f) in conceptual mapping, propositions encompass mainly quantifiable resources, activities, processes and system purposes (e.g. land area, labour hour, herd size, crop and livestock production performance and tangible rewards). Therefore it can be said that the propositions encompass the hard systems components of the organisation. On the other hand, the linkage elements of the conceptual maps define human actions that are difficult to quantify because they involve soft systems elements. One possibility for incorporating these components into whole-farm analysis is through the "indexation of aesthetic values" and factors that deal with "surprise, instability and unpredictability".

Hard systems appeal to the analyst because of their tractability in dealing with farm performance questions. Under this approach every system component and its linkages lead to a predetermined system objective. However, a system cannot be constrained by reductionist approaches of prescribed behaviour. The internal dynamics of any real system include imperfectly understood interrelationships where "decision making plays an organising role". Thus hard systems are useful for planning purposes as long as they are used in an integrated manner and are complemented by approaches which ensure the holistic perspective of management and decision making. In other words, it is dangerous to implement hard system analysis recommendations without due consideration (at least qualitative) of the soft system elements and interactions of the farming system.

For SSM purposes the farm is a "human activity system", a system where resources are organised and used in accordance with specific short-term perceptions of human nature. The central role played by *Weltanschauung* is to determine management actions that reinforce the inductive learning processes that are part of management in a dynamic decision-making environment where adjustment, contingency and creativity are normal short-term tools of management action.

From the perspective of organisational dynamics, the farm is an organisation with a specific environment of "momentary equilibrium" constituted not by inanimate things, but, and chiefly, by the people that give purpose to the system. Thus, managerial decision making has to cope with instability, surprise and irregularity in a situation where the individual perceptions of reality, rather than fixed actions patterns, will lead to success. Managing a farm implies the creation of conditions where the farmer discovers cause/effect relationships, and learns about system components, feedback processes and continuous adjustment in order to achieve pre-determined objectives, at variable time spans, through a flexible managerial process.

Chapter 3

THE FARM BUSINESS MANAGEMENT FRAMEWORK

3.1 Introduction

The context of this study is the farm as a business. The philosophical approach that underlies this exercise is Farming System Research (FSR), an approach which integrates research and development in on-farm analysis. Gryseels (1988) states that since FSR procedures are suited for generating, adapting, and upgrading appropriate technologies for farmers in diverse environments, the FSR approach is useful in understanding the farm system and increasing farm output, identifying the system's major constraints, and providing a solid understanding of farmers' circumstances and decision-making processes at the farm level.

The next section, on the framework of the research, gives overviews of FSR and FBM components. The chapter finishes with a description of essential components of planning farming systems with a holistic perspective.

3.2 Farming Systems Research (FSR): An Overview

FSR is a farmer-based approach to research and development that includes the farmer in the generating, adapting, testing and implementing of farm technology. According to Simmonds (1984), FSR is research - description, analysis, and classification - on farming systems as they exist in real life. FSR is not only a method of identifying research problems, but is also an academic activity in which further elaborations of the systems approach can evolve.

FSR analysis can be conducted at various levels, but typically it looks in some detail at the agriculture, economics and social context of the system studied. By appreciating both the production systems of the farmer and also the environmental variables (ecological, biological, socio-cultural, economic and political) which influence the farmer's decisions, FSR creates an holistic, farmer-oriented, and problem-solving approach to agriculture (Dillon *et al.* 1978; Norman 1980; Dillon and Anderson 1984; Simmonds 1984; Norman and Collison 1985; Petheram 1986; Byerlee and Tripp 1988; Ruiz 1988; Ruthenberg 1980; Sands 1985; Charry and Dillon 1989). FSR is an approach to agricultural research and extension based on an appreciation of farm production systems and the human interactions which influence farmers' decision making (Charry, Daramola and Dillon 1992). It is not a new technique for doing farm-oriented research, but a way of thinking about the management of the whole farm business (Charry and Dillon 1989).

FSR applies methods and knowledge from various disciplines, first to define the constraints on improvement, and then to overcome these constraints (Dillon 1976; Dillon and Anderson 1984; Simmonds 1984; Spedding 1988). Farm management requires more than simple practical skills: it also demands having and integrating knowledge across many discipline areas. Traditional research often fails to solve problems or to enhance the productivity of farm resources when it focuses on a single commodity or discipline. The major reason why the traditional approach fails is the researchers' lack of understanding of farmers' circumstances, needs and aspirations (Dillon *et al.* 1978; Dillon and Anderson 1984). This is being increasingly recognised in developing countries, and international research agencies use FSR to integrate outcomes from the experimental research station with on-farm needs and farmers' expectations (Hardaker, Anderson and Dillon 1984).

Despite the traditional disciplinary organisation of science, the world does not in fact impinge on us in a 'disciplinary' form. This fact provides one logical basis for using a systems approach in attempting to improve the performance of agricultural systems. Such an approach has profound methodological implications, because any system of interest typically involves not merely the interaction of physical factors but also decision making and contests of will arising from the purposiveness of behaviour of animate elements in the system (Dillon 1976). Therefore in technology generation and technology testing the research approaches adopted must be of the type described by Anderson and Hardaker (1979), assimilable to FSR schemes, and having the following features:

(a) oriented to problem-solving;

(b) possessing a holistic outlook and approach;

(c) based across many disciplines and involving the co-ordinated use of base data, surveys, modelling, ex ante analysis, laboratory investigations, and on-station and on-farm trials;

(d) linked effectively to, and influencing, the related upstream components and basic research, and linked downstream to extension officers and farmers;

(e) based on farmers' participation, emphasising bottom-up communication and recognising the farmer as the key element of the farming system;

(f) following a dynamic, action-oriented and adaptive approach, enabling tentative solutions to be tested, modified, redesigned or rejected on the basis of accumulated knowledge, understanding and feedback from farmers; and,

(g) assessable by the extent to which it leads to the development of cost effective and socially desirable improved farming systems that are readily adopted by the client farmers.

The discovery of the value of FSR has given new insights into the role of social science and biological researchers in the agricultural research and development process. Through its recognition of interrelationships between different elements of the farming system, FSR provides a framework for cooperation between the different agriculture-related professions, and also a new and clearly entrepreneurial outlook on farming.

A major task for FBM professionals in their role as members of multi-disciplinary FSR teams is to assist in identifying and defining not only the biological and business components of the farm system, but also the socio-economic circumstances of the target group of farmers. Dillon and Anderson (1984) suggest that the more important socio-economic circumstances that FSR has to consider are:

(a) the resource and production possibilities available to the farmer;
(b) the social milieu in which farmers' decisions are made, including customary values of farm sharing and property inheritance;
(c) the setting and policy environment in which farming is conducted;
(d) the economic environment of farms, including farm-household relationships, short- and long-term market prospects for inputs and outputs, and, most importantly, an understanding of the opportunity and transaction costs faced by farmers;
(e) the attitudes and personal constraints of farmers, including their attitudes to risk, and their desire or otherwise for change, leisure, education, safety;
(f) the risk characteristics of the ecological, economic and socio-political environment within which the farmer's decisions have to be made; and
(g) the aesthetic values of farming---these are not normally taken into account in analytical decision making models currently available.

Activities conducted under FSR range widely from computer modelling to integrated rural development and from complex studies on research stations to simple farm trials. Although FSR as a formal concept has developed in the past two decades, it was essentially practised long before that. It may be argued that much successful research, historically, has been conducted with a farming systems orientation. In developed countries this systems framework seems to be implicit in agricultural research activities. The institutional services for land protection, land mapping and climate, agricultural statistics bureaux, farmer-run organisations, marketing information services, and research and advisory boards are some of the facilities available to farmers who need to solve problems (Dillon and Anderson 1984). Much of the organisational role which FSR plays in developing countries is achieved in developed countries by extension services and the existing agricultural infrastructure.

Dillon (1976) emphasises that the partial reductionist approach of traditional agricultural research towards commodities and disciplines does not necessarily mean integration. By contrast, FSR takes a holistic view of farmers' systems, seeking to understand the interactions between the main biological, economic and social factors, and then to manage the constraints on the system by appropriate application of knowledge. Petheram (1986) states that FSR is a research philosophy that differs from traditional agricultural research mainly in terms of approach and organisation.

Hildebrand (1986) and Petheram (1986) have stated that the need for a FSR approach is greater and perhaps useful only for the farmers of developing countries. Although the statement rightly emphasises the importance of FSR in that context, this does not preclude using the approach in developed environments to enhance through integration the work of farmers, researchers, extension officers and policy makers. All farmers, irrespective of location, operate in a complex system which is characterised by interactions between economic, ecological and sociocultural influences. The characteristics of the FSR approach mean farmers from developed countries can also be included in the process of technology testing and technology generation.

It has been common to distinguish between two types of FSR: 'upstream' and 'downstream' research. Downstream FSR programs involve farmers directly throughout the research process. They aim to develop and introduce strategies that will improve the well-being of farmers in the short run. Upstream FSR (or resource management research) uses a systems approach aimed at alleviating major constraints to agricultural improvement in a region. This starts with an analysis of the existing farming system, but then involves long-term research in field stations. Ultimately, the results of upstream FSR should contribute to the body of knowledge used in downstream FSR, but, as the time frames are different, the two approaches tend to be conducted separately (Petheram 1986; IOC 1990).

Simmonds (1984) equates FSR to on-farm research with a farming systems perspective. It is a style of doing agricultural research founded on two well-justified assumptions: that changes need to be adapted to the circumstances of their users; and that research station experiments by no means always predict farm experience. The on-farm research scheme broadly assumes that progress will be stepwise (evolutionary) rather than revolutionary. Therefore, the process also is cautious, empirical, and evolutionary. Proponents of FSR claim that the FSR approach has the potential to help provide the basis for evolutionary progress and, with specialist research and extension, to advise government of the policy changes that are needed to support this development (Petheram 1986).

FSR analyses farming systems as they exist in real life. For this research method, therefore, the farm is itself the most dynamic research tool. Since the focus of analysis is on technology and its effects in the farm system organisation, performance (biological and financial) and sustainability, and on the socio-economic environment where farming is conducted, the value of the individual farm in the research exercise is paramount. Although according to traditional research practice this use of this method limits any generalisations made from the results, the individual farm provides an indispensable learning tool for holistic farm system performance.

Anderson and Hardaker (1979) support the case-study approach as one instance of how FSR may be usefully applied, and consider that on-farm (or downstream) research is an important component in the overall process of generation, adaptation, transferring of technology and development because it implies a systems adjustment process involving stepwise modifications introduced one at a time in a real farm environment. Norman (1980), Norman and Collinson (1985), Byerlee, Heisey and Hobbs (1989), Heidhues (1989), Gryseels (1988), Doppler (1989) and Horton and Prain (1989) also support this view. Dillon *et al.* (1978) classify FSR activities under the main headings of base-data studies, research station studies and on-farm case studies, arguing that the last is the most appropriate place to formulate solutions for real farming systems.

The case-study approach is justified, sometimes implicitly, on the grounds that, from an intensive study of a few cases or a single case, an insight of general or widespread relevance to the population of farms may be gained, although the conclusions may only be cautiously applied to the extended population. In case-study approaches, one farm or a small set of farms is chosen not so much for their representativeness as for their availability for analysis. Any unusual features of the particular farm studied are accepted and accounted for in interpreting the results. Although statistical representativeness cannot be claimed for case studies, this does not negate the value of this method as a useful technique for research purposes, since the results can have immediate relevance to the farm(s) under study. Furthermore, when modelling exercises are conducted within a real holistic perspective, incorporating both soft and hard systems, it is only under the framework of a case-study that the results have relevance. Forrester (1961) and Stacey (1993) state that the highest level of relevance can only be achieved within the context of case studies, under the framework of organisational analysis.

Farm business managers can build better, although not necessarily bigger, models when the modelling exercise is oriented under the framework of FSR to a single farm (Hardaker, Pandey and Patten 1991). It is within the individual farm situation that the farm manager must test his/her ability to cope with a complex and changing environment, allocating productive resources through specific production processes (farm activities) in order to achieve the farm purposes that mean wealth and competitive survival. In a management context, where functions are the instruments for decision making, the availability of individual enterprise environments allows processes dealing with cause and effect to be implemented. The individual enterprise is a meaningful instrument for strategic management, since the looping interaction of the feedback component of the management process can be supported and enhanced using real individual data. This is a managerial implication of farming systems analysis within a FSR framework.

3.3 Farm Business Management: An Overview

Farm Management, Farm Economics, Farm Management Economics or Farm Business Management (FBM hereafter) started in Australia as a field of academic inquiry around the 1940s (Malcolm 1990), and was basically similar to that developed in post-World-War II America (Callaghan 1939; Jensen 1977; Henry and Charry 1992). For a long time, according to Jensen (1977), FBM faced an identity crisis: in America, between two prevailing streams in farm management, empiricism and theoricism, a conflict identified by Heady (1948), Johnson (1957) and Jensen (1977). In Australia, led by Dillon (1965), farm management developed under the umbrella of agricultural economics, but later Dillon (1979) shifted to the increasingly accepted view that farm management based on economics had lost touch with farmers' needs and with practical farming because of its emphasis on logically attractive but - due to data limitations - largely inapplicable theory. Dillon acknowledged that all farm-related economic knowledge deserved a professional status as a separate entity because of the special characteristics of farm production and on-farm decision-making processes. Dillon (1965) envisaged FBM as emphasising business skills and economics principles, while requiring competencies in financial management and in the techniques of agriculture.

Jensen (1977) interpreted FBM as the study of the broad principles of comparative advantage, interregional competition, cost analysis, and production adjustments to markets and prices of the farming activity---in effect, simply the economic evaluation of the agricultural system.

Malcolm (1990) argued that the scope of agricultural economics has little influence on farm organisation, farm activity and farm production itself. He saw FBM as a multidisciplinary, uncertain and changing area where business management and agricultural technology combine, broaching the boundaries of agricultural economics.

Henry and Charry (1992) and Charry and Henry (1993) thoroughly reviewed the evolution of FBM and proposed that in Australia professional farming (i.e. FBM) should be viewed as a multi-disciplinary professional decision-making activity which manages farm resources in order to achieve individual and community goals, goals which are both tangible and intangible. In this definition, FBM is a systematic approach to the management of farm resources which integrates technology and business management. Decision-making processes are highlighted as a primary professional activity. Figure 3.1 highlights the more important components of this FBM definition.

3.3.1 The professional perspective of farming

The Rural Training Council of Australia (1994) has developed a set of competencies for professional farm business managers that will have profound implications in the way farming is done in the future. This is an acknowledgment by industry of the specific characteristics and skills required for competitive successful farming. From this foundation, professional organisations (i.e. associations and tertiary institutions) are deriving patterns of action.

With the current changes in tertiary education in Australia, FBM is becoming a separate area of training, research and development (McColl, Robson and Chudleigh, 1991). As traditional tertiary agricultural institutions lose touch with farmers, emerging institutions move to specialise in training professional farmers through an integrative approach encompassing different modes of learning and recognition of learning in a consistent pathway for achievement of different levels of skills ranging from intermediate tertiary education (i.e. associate diplomas and diplomas), to a basic professional level (i.e. bachelor) and higher education (i.e. honours, master and doctorate) (Charry and Henry, 1993; Charry and Nielsen 1996).

Recently the Australian Farm Management Society (1995) proposed a professional accreditation scheme that would give farm business managers a professional status comparable to other economic managers. This process would accredit empirical and formal skills within an overall systematic framework. Technology components, systems thinking, business acumen, ecosystems management, administration and management skills, accountancy, finance and marketing competencies are the major areas recommended for the evaluation of successful professional farmers. This follows Dillon's (1987) recommendation, when analysing FBM, that training in farm management should be re-oriented away from the traditional disciplinary framework to a systematic approach oriented to successful management of the farm business. Gill (1995, and *pers. comm.* 1996) makes similar statements emphasising the holistic nature of natural resource management as a way to ensure long-term sustainability.

It follows from the previous analysis that this research should centre on FBM in order to meet its aims to take the theoretical developments of agricultural business management and make them more useful for real-world farm management. In doing this the research will contribute to the improvement of the analytical decision-making capacity of farmers and their advisers, and to the integration of the soft systems approach with farm resource management.

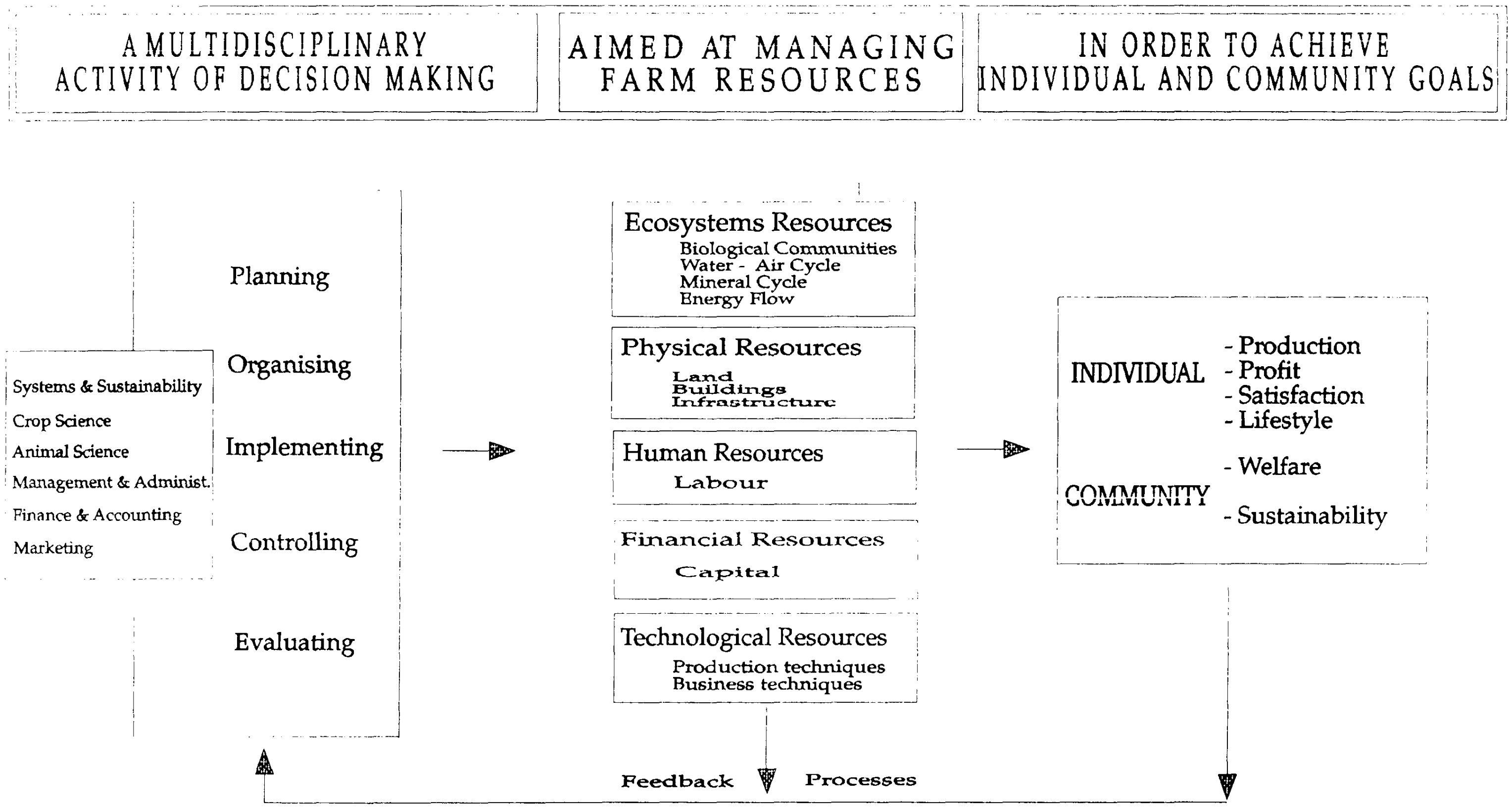

Figure 3.1 A Systematic Definition of Farm Business Management

Source: Henry and Charry (1992)

3.3.2 Strategic management in farm business management

Management can be understood as a decision-making process of planning, organising, implementing, controlling and evaluating organisations. Strategic management is concerned with successful decisions which address the dynamic and changing nature of the organisation and ensure its purposiveness.

Stacey (1993, pp. 5-27) makes a lengthy critique of how conventional wisdom in management uses the concept of strategic management. He argues that most management schools have taken strategic management in a prescriptive manner, thereby constraining the dynamics of the system and limiting the capacity of the decision maker for creative management. In this way strategic management, rather than being an empowering tool that interprets the dynamics of the system with a soft systems treatment of management problems, has become instead a conventional hard system tool.

There are, in Stacey's (1993, p. 23) definition of strategic management, three components that are essential to understanding the task of strategic management as producing a position for a particular organisation that will yield acceptable performance at some point in time. In Stacey's terms, strategic management can be described as a feedback loop connecting 'discovery, choice and action' to define patterns of action (i.e. strategies) that will allow management of the dynamic and changing nature of the organisation.

The 'discovery' function is demonstrated in learning from the consequences of experimental action and in searching for management problems within the system. This contrasts with the traditional approach of hard systems thinking which involves systematic gathering and analysis of facts and monitoring outcomes of actions. The 'choice' function operates within a shared ideology which governs the political choices of trial actors: this contrasts with the setting of objectives, generation of options, and evaluation and selection of the most acceptable and feasible option, in the prescriptive approach. The 'action' function is management by trial-and-error, rather than a structured hard systems process where options are chosen and implemented. When the looping process is applied, the consequences for environmental actors feed back into the beginning of the decision-making exercise, enriching through feedback the 'discovery' environment. This integration of elements can be observed in Figure 3.2.

Note that there are many different positions on strategic management. The elaboration in this chapter arose following a review of the relevant aspects of management change and decision-making discussed in Mumford and Pettigrew (1975), MacMillan (1978), Pugh (1984), Bowman and Asch (1987), Mintzberg and Quinn (1991), Mintzberg (1993), Ritchie and Marshall (1993) and Stacey (1993). Descriptive aspects of organisational management are discussed by Fayol (1949), Dessler (1985), Calvert (1981), Anderson (1988), Kreitner (1989), Stoner (1984, 1989) and Bedeian (1991) and this research applies these aspects, in part, to the farm system environment.

Organisational strategic management is not simply a matter of structure (which is considered by prescriptive techniques). The claim, as considered by Mintzberg and Quinn (1991, p. 309), is that effective organisational management is really an outcome of the relationships between structure, management strategies, system dynamics, and the skills, style and superordinate goals of the decision maker (i.e. the decision maker's perception of the purposes of the system). Management analysis elaborates aspects of management change, decision making processes and the organisational structure in which the decision maker implements his/her management action:

(a) **Managing change:** Strategic management is all about managing enterprises in a strategic sense, about formulating and implementing strategies to manage the changes that happen in the operation of an organisation (Bowman and Asch 1987, p. 213). There are key features to this process which need to be addressed from the perspective of FBM. First, Bowman and Asch (1987, p. 216) have noted that the variety of strategic formulation processes can be reduced to the impact of either technical or social aspects of the organisation. The second point to highlight (MacMillan 1978) is that strategic selection is not a precise analytical process. Intangible situational factors, subjectivity, creativity, and judgement must be integrated to re-direct management resources toward the specific objectives. Thus, strategic selection is not a technique, it is a managerial skill.

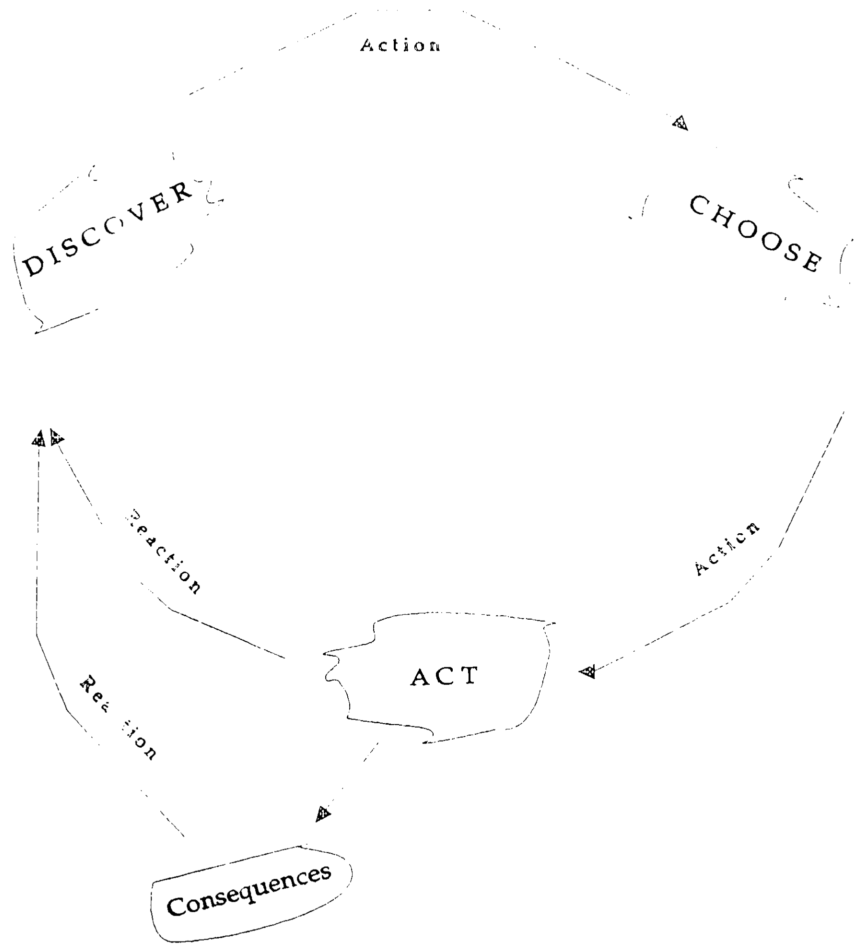

Figure 3.2 Strategic Management After Stacey (1993)

A third point, following Bowman and Asch (1987, p. 169) and Pugh (1984), is that measures of performance are necessary to evaluate how successful a strategy is. The determination of whether or not a particular strategy option is acceptable depends upon objective measures like profitability, risk and changes in the organisation. At one level it is reasonably easy to test acceptability (i.e. using financial measures of performance) but underlying these conditions there are non-quantifiable objectives of performance that should also be taken into account.

Finally, attitudinal responses to change depend on the character of the strategy in implementation. Bowman and Asch (1987, pp. 213-236) emphasise that people are wary about strategies dealing with social matters rather than those relating to modification of technical processes. Mumford and Pettigrew (1975) comment that the acceptability of a technical change is often related to the extent to which those affected can participate in the decision process concerning the proposed installation. In strategies that deal with modifications of the social environment there are a wider variety of factors to consider: status modification, risk implications, perceived accountability, rewards and aesthetics. Attitudinal responses to change are conditional not only on "outcome expectations" but primarily on "status modifications". A farm business manager is resistant to change while he/she is able to identify the implications in terms of organisational management rather than resources performance. There are sociological, cultural and environmental reasons that justify this behaviour: personal factors (e.g. age, self-confidence, attitude to management, creativity, risk capacity); group factors (e.g. peers' consideration, cohesiveness, attitude of the social group to change, challenge and commitment) and organisational factors (e.g. record of past changes, structure, management style) are important and relatively stable influences in the change process at the farm level. This situation is not dramatically different from other types of organisations as discussed by Bowman and Asch (1987), Mumford and Pettigrew (1975) and MacMillan (1978).

(b) **Strategic decision making**: For the purposes of this study "decision and decision making is a simple process of implementing action to the solution of a management problem" (Ritchie and Marshall 1993, p. 48 and Eardley, Marshall and Ritchie 1991,

p. 35).

Using a conceptual map and analysing Figure 3.3, a more elaborate description of decision making in strategic management can be achieved. The propositions are consistent with the scheme previously defined for conceptual maps. Proposition 1 defines the environment of description. Proposition 2 specifies that the resources of this system (i.e. the decision-making environment) are the whole set of alternatives available to the decision maker. Proposition 3 clarifies and defines the character of these resources of the system. Proposition 4 spells out the system processes reinforced by Proposition 5. Finally Proposition 6 explains how the system functions to achieve its purposes. Within these conceptual maps the linkages, rather than being conceptual, are defined by the internal dynamics of the relationships between the propositions.

Analysing the components of the decision-making process will allow us to identify the role played by the uncertain elements of problem-solving management actions. Ritchie and Marshall (1993, pp. 49-50) state that the major elements that combine to form the decision-making process are:

(i) personal characteristics of the decision maker (attitudes, perception of problems, access and use of information);

(ii) working environment that reflects the culture of the specific organisation;

(iii) dimension and attributes of the decision (number of variables recognised as relevant, interaction between the variables, resources required to implement the decision, time framework and level of people's involvement);

(iv) the decision process itself, which implies an orderly set of major stages involved in the decision-making process, i.e. problem perception, problem identification, problem structuring and management of information, analysis of alternative solutions, analysis of consequences, selection of an eventual solution, decision/commitment to choose the solution and implementation, communication and control of the overall process (Mintzberg 1975, 1977). These series of stages and their interrelationships are described in Figure 3.4.

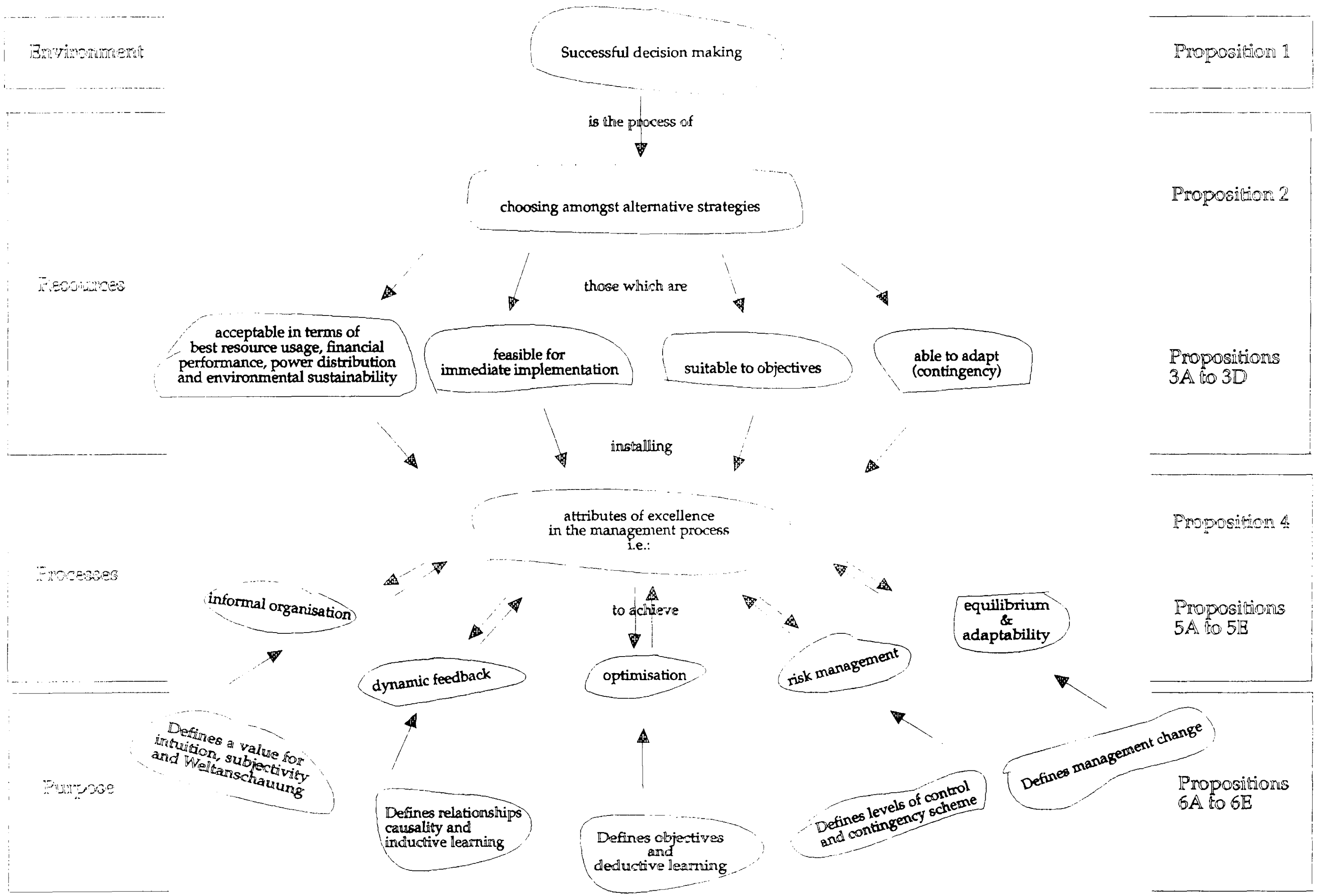

Figure 3.3 Conceptual Map of Successful Decision Making

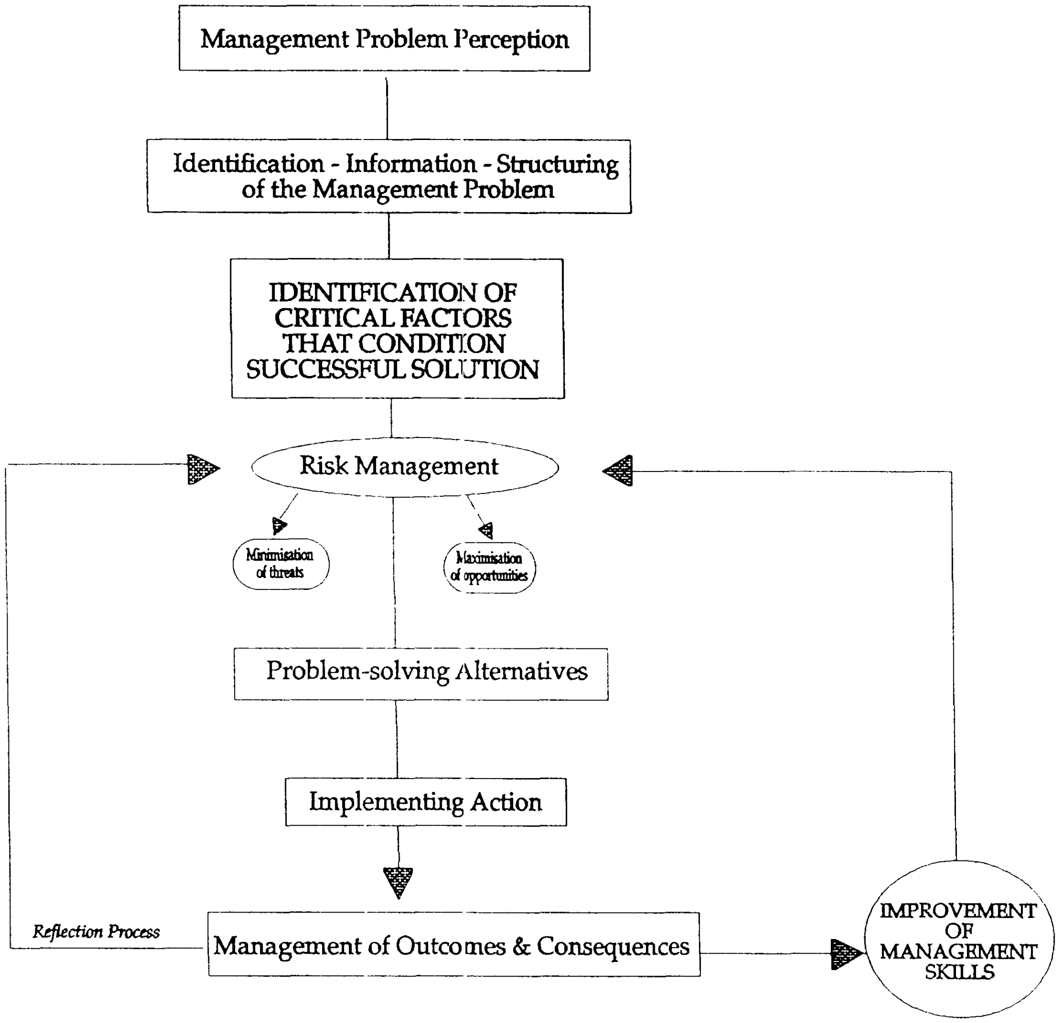

Figure 3.4 Instability, Surprise (i.e. Risk) in Decision Making

(c) **Managerial functions:** The management functions in operational FBM involve four primary elements or steps constituting an operational farm model:

(i) **Knowing the farm** implies an inquiry process aimed at becoming familiar with the farm environment (i.e. resources - processes - opportunities). The identification of on-farm problems, management possibilities and a farm resource appraisal are elements of this stage. The decision maker may undertake this action through a direct empirical process drawing on day-to-day familiarity with the farm or by a more formal approach based on such procedures as record analysis and resource appraisal. Here an attempt at self-awareness in terms of attitudes to risk, expectations and aesthetic perceptions of farming is desirable, since the farm is a human activity system conditioned by the characteristics of the decision maker.

(ii) **Planning the farm** activity is an holistic concept that aims to measure the future and organise resources within the operational objectives of the decision maker. Partial and holistic planning techniques are available for the strategic and operational purposes of the farm manager.

(iii) **Running the farm** is the hands-on activity of acquisition, allocation and management of resources and farm production processes. The development of managerial functions such as organising, actioning, leading, and monitoring are components of this stage. The farm manager can rely solely on his/her personal experience or draw on formal training in biological and business processes.

(iv) **Evaluating the farm performance** is the process of controlling the use of resources and production activities. Adjustment in the day-to-day operation and comparative analyses at the end of the productive cycles are desirable.

A summary of this simple operational farm model from Henry and Charry (1992) is depicted in Figure 3.5.

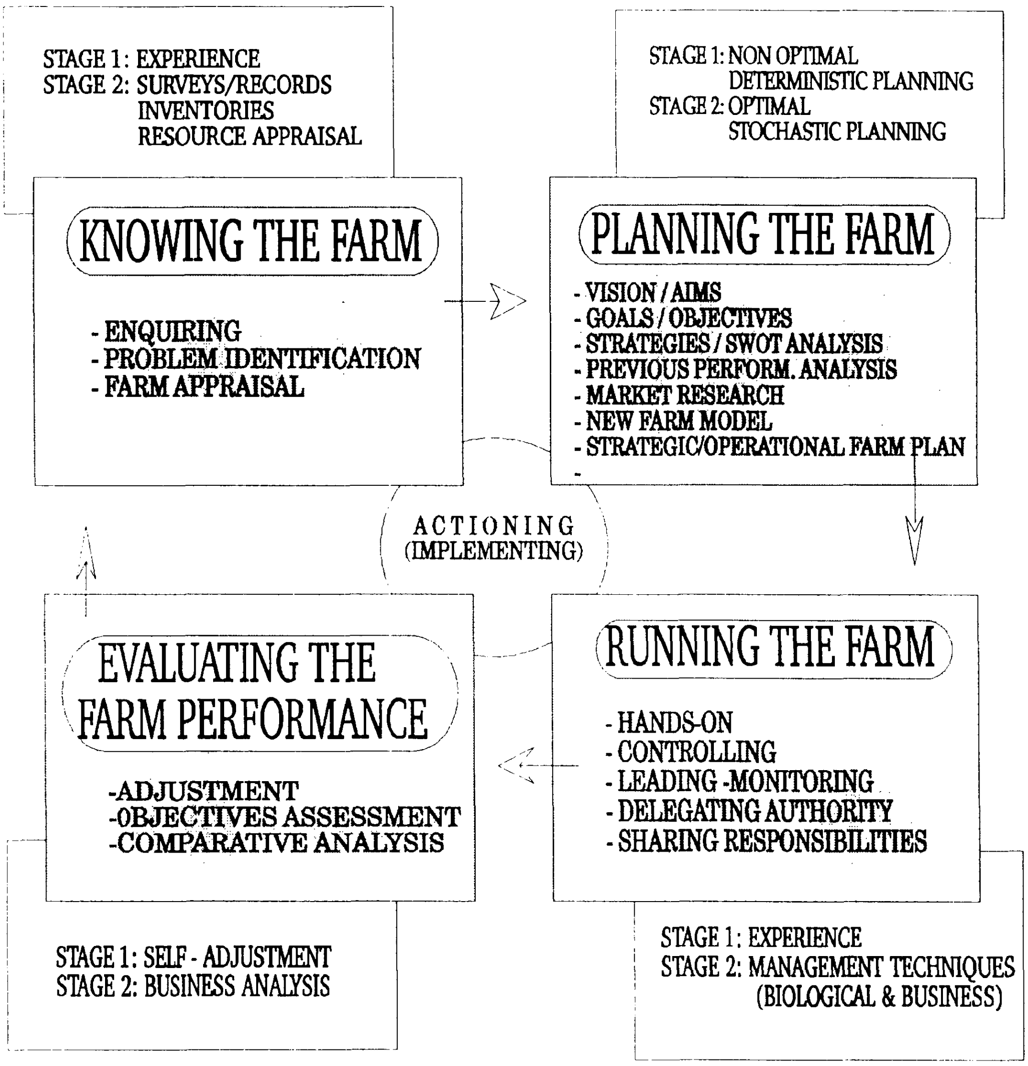

Figure 3.5 The Operational Farm Model

Source: Henry and Charry (1992)

As shown above, FBM as a management resource and decision-making discipline follows the basic stages of the management process. According to Fayol (1949), the management process involves planning, organising, motivating, co-ordinating and controlling. Kreitner (1989) adds leading and decision making functions. Other authors, including Drucker (1954, 1977a, 1977b, 1985), Brech (1965), Dessler (1979, 1985), Bedeian and Glueck (1983), Hanf and Schiefer (1983), Stoner (1984, 1989), Calvert (1981), Koontz, O'Donnel and Weihrich (1986), Anderson (1988), Kreitner (1989), Bedeian (1991) and Schermerhorn (1991), highlight the functions of planning, organising and controlling. The business management literature, as evidenced from Fayol (1949), Calvert (1981), Drucker (1985), Stoner (1989), Schemerhorn (1991) and Certo (1992), has long reflected the interest in a broad and comprehensive view of planning as a management function.

For the purposes of this study the management process will be confined to the management functions of: (a) planning; (b) organising; (c) implementing; (d) controlling; and (e) evaluating. A description of these functions may be found in Drucker (1977b), Desler (1979), Stoner (1987), Calvert (1981), Wright (1985), and Certo (1989). Figure 3.6 describes the relationships amongst the different functions of the management process.

3.3.3 Holistic dynamic planning

The concept of holistic farm planning has been used to define the application of the planning function to the management process in relation to the farm as a whole (Trebeck and Hardaker 1972; Anderson *et al.* 1977; Wright 1985; Warren 1986). Wright (1985) points out that the concept of whole-farm planning does not in fact seem to be as comprehensive as its name implies. The focus of attention has tended to be on the development of individual techniques of planning rather than accepting the implications that the holistic concept suggests. Whole-farm planning seems to have been more of a partial exercise of enterprise development scenarios rather than an overall forecasting of future action that considers the hard and soft components of the system.

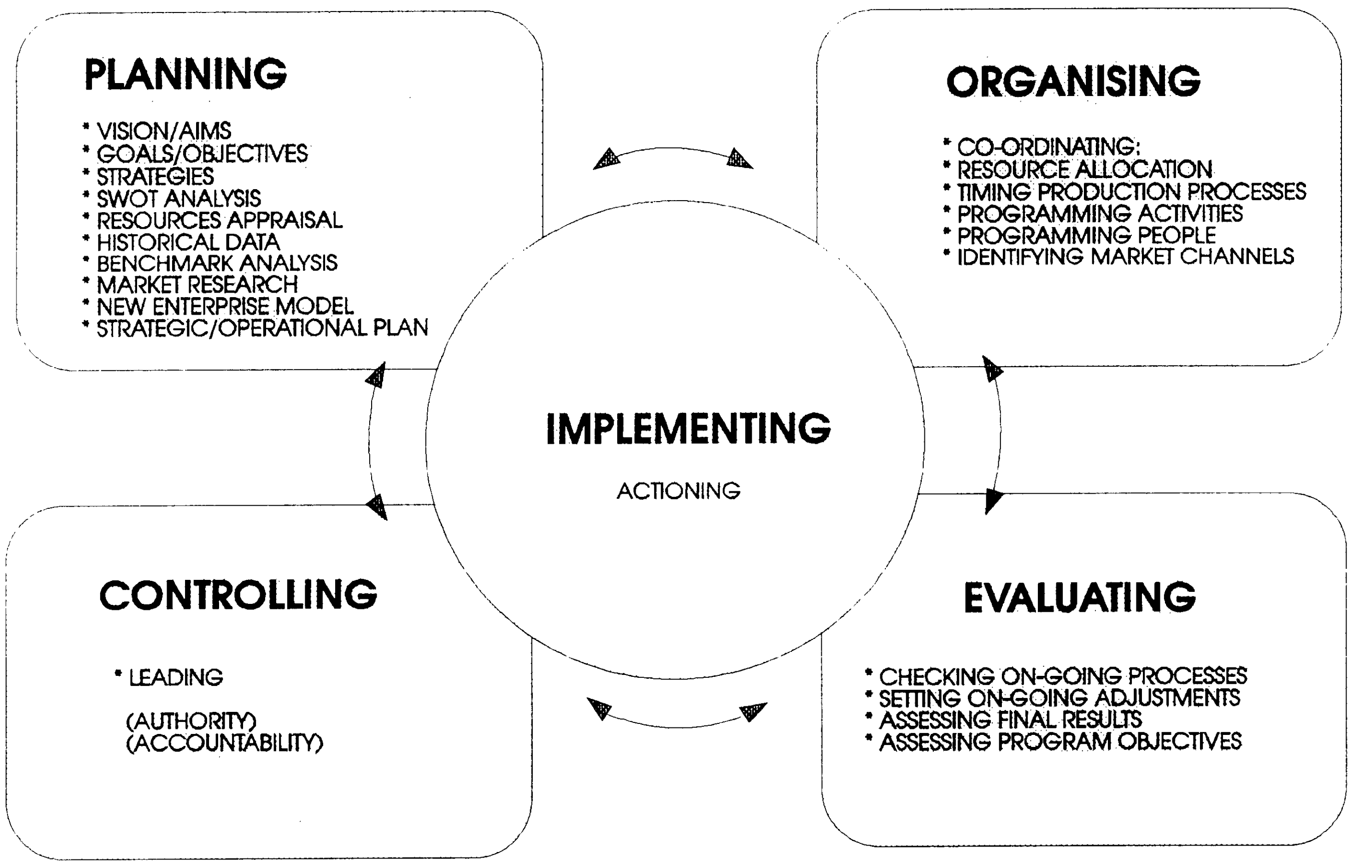

Figure 3.6 The Functions of the Farm Business Management Process

Elements from SSM (Checkland 1981, 1988a, 1988b, Wilson 1984, Forbes 1988) and from the traditional systems approach (Dent and Anderson 1971; Anderson 1971; Anderson, Dillon and Hardaker 1977; Anderson and Hardaker 1979; Norman 1980; Ruthenberg 1980; Anderson, Dillon and Anderson 1983; Anderson, Dillon and Hardaker 1985; Norman and Collinson 1985; Petheram 1986; Spedding 1987; Pandey 1986) will be integrated to develop a framework that is believed to be more suited to the purposes of this research.

The state of the art in whole-farm planning offers a wide set of sophisticated quantitative techniques to simulate scenarios that range from deterministic through stochastic. Developments in advanced whole-farm planning may be found in such sources as Cocks (1968), Rae (1971b), Anderson, Dillon and Hardaker (1977), Wicks and Guise (1978), Tauer (1983), Barry (1984), Bertelsen (1985), Dent, Harrison and Woodford (1986), Fletsher (1990), Kingwell and Pannell (1987), Patten, Hardaker and Pannell (1988), Parton and Cummings (1990), Hardaker, Pandey and Patten (1991), and Parton (1991), all stemming from hard systems thinking. The theoretical models of these authors, however mathematically sophisticated, lack a substantial practical application for functional whole-farm planning: they give no scope for soft systems elements significant in holistic decision-making models (Rosenhead 1989b). Their studies remain therefore mainly academic and without value to FSR analysts, farm management consultants, trainers and operators. Within the context of FBM, further development and integration is desirable, since the major problem is that these sophisticated quantitative approaches are removed from the complexity that defines operational farm management, that is, they lack the integration of intuition, socio-cultural and ecological interactions that are part of any realistic farm planning situation. It could be said that the hard systems approaches are really only sophisticated in terms of mathematical application, not realism.

When analysing the components of planning decision models Anderson (1971) points out three criteria that may determine the basis for holistic models, depending on the complexity of the analysis:

(a) **Whether or not a model is explicitly time-dependent**: The criterion is whether the model takes into account the effect of time in the planning environment. Therefore, the most important consideration is discrete versus continuous time analysis. The former is an approximation of dynamic reality. The latter is a realistic perception of system performance in time periods.

(b) **Whether or not a model intrinsically involves an optimisation process**: Models that are based upon determined empirical relationships or are based upon physical laws are classified as deterministic by Wilson (1984). Those in which the parameters are uncertain and are based upon expected values from a statistical distribution are non-deterministic and, by their nature, cannot be analysed to yield a sure optimum. The distinction is important because of the appeal of the optimum for economic analysis, and because the availability of an optimising algorithm usually affects the way the model is used. The tradition in economics is deduction, not induction. Therefore the previous analysis can be reversed to clarify the distinction between inductive, learning oriented procedures and deductive, outcome oriented procedures. From this perspective when optimal analysis is considered it is not because it enhances the learning system possibilities, but because it improves the framework of analysis through the provision of system alternatives with holistic resource usage.

Much economic production theory is concerned with the maximisation or minimisation of some aspects of the production process, such as profits or costs. The general term *optimisation* is applicable to this class of problem. Dealing with unconstrained optimisation problems where the aim is to determine the best point of the firm's production function is a matter of differential calculus. Under conditions of perfect competition, the firm maximises its expected profit by producing at the point where the marginal value product equals the marginal cost for all the inputs (Loomba 1977). However, depending on the nature of the production function, there may be several points at which this relationship holds. In this regard, to distinguish between maxima and minimal, a set of second order conditions is used.

In general, firms are subject to a number of resource constraints which may prevent them from attaining their unconstrained optimum. Nevertheless, these constraints may be incorporated in the objective function by the use of Lagrange multipliers. Within this technique all the first partial derivatives of the Lagrange function are set to zero, and the resulting set of equations is solved simultaneously. In this way the objective function is optimised subject to the constraints. The values of the Lagrange multipliers give the shadow value of each constraint, which is the change in the value of the objective function which would result from a unit-change in the constraint (MacAulay 1987). Although the Lagrange multiplier technique is appropriate for dealing with constrained optimisation, it becomes difficult when there are several alternative production activities between which to allocate resources. In this case mathematical programming techniques provide a feasible alternative approach to finding the optimal solution.

(c) **Whether or not a model incorporates probabilistic elements**. The management of uncertainty has become an area of increased interest in the design of decision models. When uncertainty is measurable it involves the use of probability distributions of events that create conditions of risk to achieve the expected outcome. Under risk, the outcomes of a decision situation are defined either by a probability distribution based on previous information or by a subjective set of probabilities. Integrated with the optimisation option, the possibility of considering processes to manage the stochastic components in a whole-farm planning framework has become an increasing area of interest from a hard systems perspective.

The absence or presence of risk analysis for the critical variables of the farm model sets the limits for deterministic and stochastic scenarios. A deterministic farm plan assumes certainty for all the values of the farm model. A risky or stochastic farm plan accounts for the impact of probabilistic variability in the parameters of some critical technical components of the farm model and in the attitude towards risk of the decision maker.

It seems logical that whole-farm planning should suggest an organised path of analysis to achieve the farmer's objectives both in non-optimal and optimal scenarios whether deterministic or stochastic. However it is necessary to emphasise that prescriptive tools do not provide the scope to allocate hard-to-define variables in quantitative discrete terms. After identifying meaningful variables of the system (initially using a conceptual mapping approach), attempts should be made to incorporate those variables which are not naturally quantifiable (i.e. soft variables) so that their effect in the system operation can be perceived. Indexation of soft system thinking variables such as that used by Gill (1995) is attempted in later chapters. The decision model will be influenced by giving value to the soft system variables and by working out a compromise between the traditional approach and the approach undertaken within the framework of this research.

Strategic and operational plans are the two broad options open to enterprise management. Wright (1985) and Anderson (1988) state that strategic planning is a continuous process involving irregular decision-making provoked by the emergence of new opportunities or threats, new ideas and other irregular stimuli. Tactical or operational planning, in contrast, is more short-term and regular and is therefore commonly determined according to periodic cycles or repetitive situations. Evaluating these viewpoints, there seems to be a scope for integration, within a hard systems plan framework, of soft elements like those discussed by Stacey (1993) in his implementation of strategic management and organisational dynamics.

At the end of the exercise it is important to observe that there is no conflict in the integration of soft and hard system characteristics in terms of the overall setting of the planning process. While the traditional prescriptive approach is followed, the integration of soft system variables basically strengthens an understanding of the system in terms of its components and highlights the crucial value of the human influence in the system's operation, the dynamics that the system generates by itself, its self-adjustment processes and its purposiveness, which is not always described in quantitative terms.

Figure 3.7 offers a conceptual map of holistic dynamic planning. It shows that a whole-farm plan is a naturally integrated set of sequential steps in enterprise planning that brings together the management of hard variables (time, financial efficiency) and soft variables (aesthetic values, risk and sustainability). The explanatory diagram in Figure 3.7 is based on this view of strategic holistic and dynamic planning, a modification of Anderson (1971) and Antony and Hardaker (1991). It should be stressed, following Pandey and Anderson (1988),

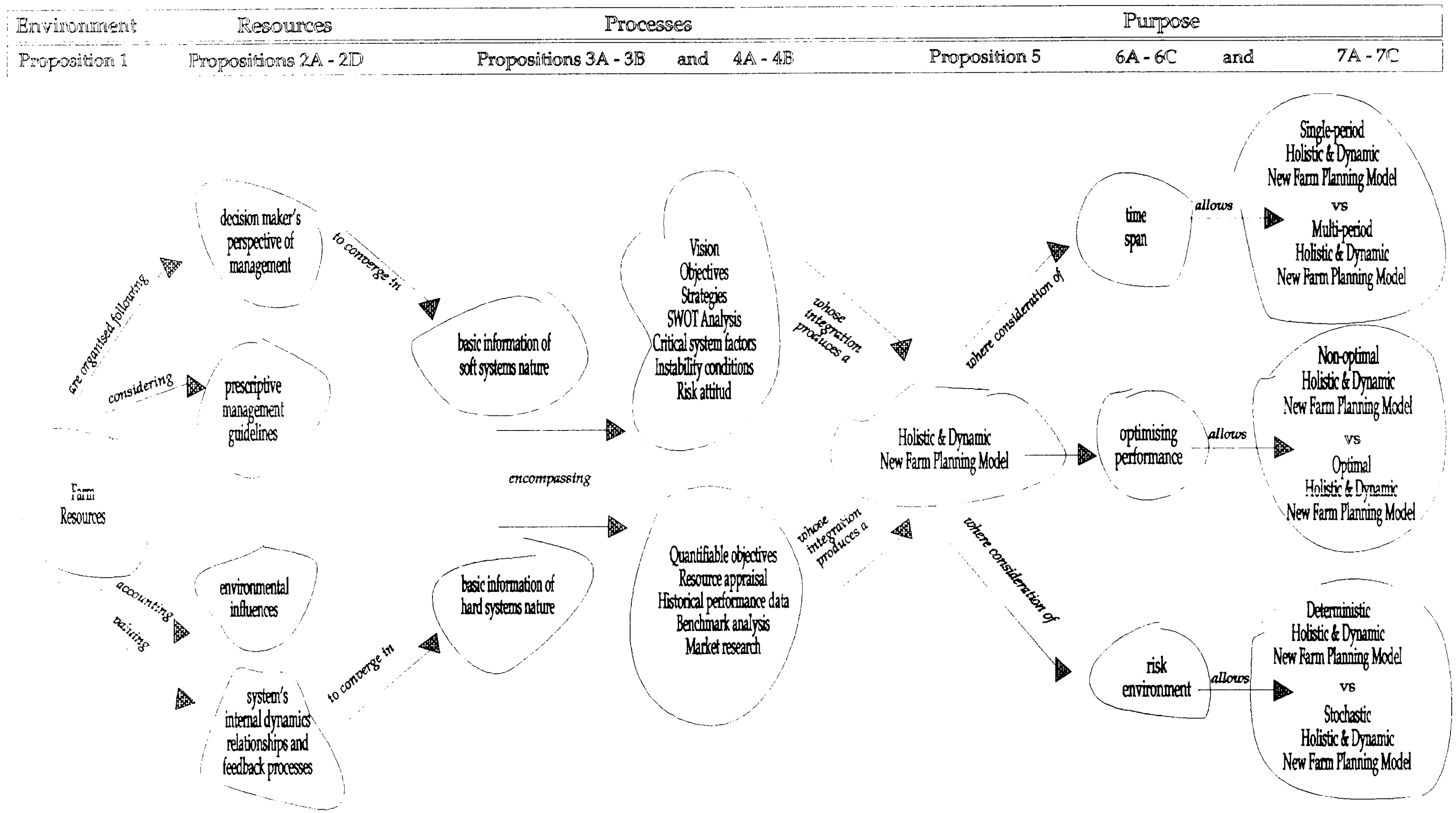

Figure 3.7 Conceptual Map of Holistic Dynamic Planning

Source: Based on Anderson (1971), Antony and Hardaker (1991) that planning is just an aid, and not a substitute for human rationality, expertise and intuition. It is a systematic process to guide the consideration of risky situations and opportunities.

Proposition 1 of Figure 3.8 defines the environment relevant to the management of the farm resources. Proposition 2 defines the management tools to consider in the process of setting the holistic plan. Propositions 3 and 4 list the processes required to achieve the specific purposes of the system (Proposition 5), a revised holistic and dynamic model of farm planning. Propositions 6 and 7 present a choice of particular models, depending on the purposes of the system, and whether the decision maker wants to include time spans, optimising algorithms or risk analysis.

A further analysis of Figure 3.7, complementary to the above description of the conceptual map, indicates that holistic dynamic farm planning models are of two types. The first type is a planning model used for unchanging operational purposes, as a valuable information tool supporting the empirical decision making capacity of the manager. Organisational management at this stage means in essence that the decision maker uses his/her particular perception of management for problem-solving in order to achieve the system's purposes. Basically this type of planning model is assimilable to traditional budgeting techniques which do not incorporate time, optimising tools and risk analysis, and so a farm plan using merely budgeting techniques is not necessarily the best, although it is valuable and widely used. Budgeting based approaches to farm planning may well be appropriate to the consideration of the more routine operational features of a farming system, where an understanding of the interaction of sociocultural, economic and ecological farm system characteristics is not critical to the achievement of specific, usually 'hard' system goals.

The second type of holistic planning decision-making model is that which encompasses algorithms and structure for measuring time effects, optimal combination of resources criteria and risk analysis and management in the simulation of system performance. Though this type of planning model is highly attractive, from a theoretical point of view, the increasingly changing socio-economic conditions in which farming is implemented makes continuous time planning an unsustainable and possibly irrelevant activity. This research uses a discrete time approach, justified on two grounds: computational convenience, and the short time frame for the given objectives of the decision making exercise.

3.4 Summary

The major aspects discussed in this chapter are:

(a) FSR is the theoretical approach to research within which this study is organised. Downstream FSR provides an appropriate support for a management exercise in on-farm research which considers components of organisational dynamics and strategic management as per Stacey (1993).

(b) FSR provides logistical opportunities for integration between theoretical resource management developments and on-farm decision-making processes. Variables from soft and hard systems can be integrated in decision planning models under the FSR approach.

(c) FBM is the most appropriate disciplinary framework for an exercise which seeks to increase the relevance of formal farm planning to real farming situations.

(d) FBM is a new discipline in Australia which needs to be developed. Professional farming implies and reinforces a professional status for farm business managers as strategic managers involved in highly complex and purposeful planning activities.

(e) Strategic management is a management position that enhances a system's performance and where the decision maker's capacity and his/her particular world-view play a key role throughout the processes of 'choosing, acting and reacting' towards planning, organising, implementing, controlling and evaluating organisational performance.

(f) Strategic management implies that strategic decisions are applied to the planning managerial function, highlighting the value of the manager's capacity to understand the system's reality, its internal dynamics and its self-adjustment processes towards achieving the purposes of the system.

(g) Holistic dynamic planning models are useful tools for improving the decision-making capacity of managers. Simple (i.e. single-period, non optimal and deterministic) and complex models (ones which encompass time spans, optimising algorithms and risk analysis) will strengthen the manager's position to make successful decisions, provided such analyses are set within a larger, holistic context that integrates and incorporates important soft system variables.

(h) This study encompasses an holistic and dynamic planning farm model at different levels of complexity which aims to make knowledge more accessible to decision makers and close the gap between the theory and reality of farming systems management.