Sustainable soil management in New Zealand: Farmer beliefs, attitudes and motivations

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Foreword

New Zealand has embarked on a sustainable land management strategy. This strategy reflects the goals and objectives set in Environment 2010 and in the principles and purposes of the Resource Management Act of 1991. The aim of the strategy is to enable land users to achieve a sustainable use of land and its natural resources.

Management requires good information on what is meant by sustainable resource use, how to recognise it and how to achieve it. The current development in New Zealand of an internationally recognisable set of soil quality indices and standards reflects the desire to achieve sustainable resource use and the need to provide good information on which decisions can be based.

Given the significant role of agriculture as a resource user, the development and implementation of soil monitoring measures will only be effective if consideration is given to farmer beliefs and attitudes regarding soil management. Indicators on their own are not going to achieve sustainable soil management. It is the use of those indicators by the landholders that will determine their usefulness. For the landholders to adopt them as useful tools in decision making requires that these indicators coincide with the way farmers see 'good' soil quality, that they are easy to use and can relate to practices within the control of farmers.

In this research the characteristics farmers associate with good soil quality and the language used to assess these characteristics is investigated. Next the factors underlying farmers' soil management behaviour is examined and an integrated model developed which examines the behavioural variables identified. The information was obtained by means of a survey, which elicited from farmers their key beliefs, attitudes, constraints and influences on soil management behaviour. Farmer motivations toward the adoption of sustainable land use practices is also assessed.

The reported research is part of a larger research project on soil quality, conducted by Landcare Research/Massey University. This preliminary work, undertaken by Rhoda Bennett and supervised by Professor Anton D Meister and Roger Wilkinson (Landcare Research), needs to be seen as qualitative in that only a small number of farmers was interviewed. However, notwithstanding the small size, the research has generated a valuable information base on the determinants and nature of farmer decisions regarding soil management. The broader implications of the work relate to both information transfer from soil scientists to farmers, and actual adoption of sustainable soil management techniques given the constraints facing farmers.

Appreciation goes to the farmers in Marton who participated in this research.

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Chapter 1

Introduction

"The soil is the mother of all things"

Chinese Saying

New Zealand is a small country with a temperate climate, whose agricultural sector remains the predominant export base. In 1996 combined food and fibre products (41.8%), forestry (12.4%), and other primary products accounted for 61.8% of total merchandise trade of $20.5BN. The addition of foreign exchange earnings from tourism to this figure increases the value of natural resource based trade by $3.5BN[1].

All food, fibre and forestry products are generated from the land, ie. the soil. Soil also has vital life-sustaining functions as an environmental filter that cleanses air and water, a sink for global gases, a decomposer and detoxifier of organic wastes, and a recycler of nutrients back to plants (Doran and Parkin, 1994). Maintaining the capacity of soil to perform these functions is crucial to the sustainability of productivity, environmental quality and animal/human health (Doran and Parkin, 1994).

The government has recognised the importance of sustainable management of the country's natural and physical resources in the Resource Management Act 1991. In the Act, "sustainable management means managing the use, development, and protection of natural and physical resources", to ensure the well-being of both current and future generations through safeguarding the life supporting capacity of air, water, **soil** and **ecosystems**, and by avoiding, remedying, or mitigating any adverse effects of activities on the environment (Part II section 5, emphasis mine). The Act places the responsibility of sustainable soil management on local and regional councils.

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[1] Admittedly not all tourism in New Zealand is natural resource based, but a significant proportion of tourism earnings are dependent on the natural environment.

At the international level the ISO 14000 series of environmental management standards emphasise the importance of sustainable soil use, reflecting international environmental values. The introduction of this standard has significant implications for New Zealand agricultural exports, with the possible threat of trade embargoes if non-sustainable soil use is demonstrated. Hewison (1995, p2) notes that "As a small nation, New Zealand is very vulnerable to the unilateral actions of other larger countries". Thus soil quality measures are necessary for both regional reporting and land management decisions, as well as for international reporting (MfE, 1997).

Landcare Research in New Zealand is currently working on the Soil Dynamics and Soil Quality research programme with the goal of developing an internationally recognised set of soil quality indices and standards, as a means of measuring and monitoring soils for sustainable use. Given that sustainable soil management combines the protection and conservation of soil with productive economic use (Brown, 1994), the relationship between farmers and scientists in developing soil quality measures is an important one. The government's 'Environment 2010 Strategy' recognises that environmental management is the product "of a complex interaction of economic, social, and environmental factors in decision making" (MfE, 1997, p12). The integration of farmer experiential knowledge with institutional analytical knowledge will enhance the development, introduction, and use of new soil quality measurement techniques.

Chapter 2

Research Objectives

This study focuses on farmer perceptions of soil quality and management. It addresses two central questions:

1. What characteristics do farmers associate with good soil quality, and what terms do they use to assess the level of these characteristics?

2. What do farmers believe about the relationship between levels of soil quality characteristics and farm management practices?

A further aim is to be able to assess farmer motivations toward the adoption of sustainable land use practices.

The first question addresses the need to integrate the language used to define, and to compare the methods used to assess characteristics of good soil quality by farmers with those used by scientists. The objective is to determine the extent that soil characteristics identified as important for soil quality by scientists correspond to those identified by farmers. Parminter and Tarbotton (1997) suggest that it would also be useful to identify "integrative" indicators, ie. those that incorporate several informal components of soil analysis.

The second research question targets the determinants of utility through investigating farmer beliefs and attitudes about the relationship between soil characteristics and management actions that affect those characteristics. The defining of beliefs and attitudes should indicate farmers' present beliefs and behaviours concerning sustainable land use. A measure of motivation toward land use practices would identify factors and constraints that may affect the adoption of sustainable management patterns.

Chapter 3

Literature Review

> *"The goal is: To achieve a comprehensive and reliable information base on the environment that will aid informed and sound decisions on the protection and sustainable management of New Zealand's natural and physical resources."*
>
> *Environment 2010 Strategy*

The vision of the Environment 2010 Strategy (MfE 1994) is "a clean, healthy and unique environment, sustaining nature and people's needs and aspirations." This statement recognises the interrelations between environmental, economic and social factors in decision making (MfE, 1997). Information and social participation are viewed as 'key conditions' for achieving the environmental vision. This raises the questions of how should an environmental information base be formed, and how can social participation be incorporated?

The Environmental Performance Indicators (EPI) programme involves the development of a core set of analytical environmental indicators that will assist in the monitoring of environmental quality (MfE, 1997). The EPI program for land will create a set of physical, biological and chemical soil quality indicators. Such analytical measures will form part of an environmental information base for official soil quality monitoring and reporting, but how useful will such data be for land user soil management decisions? Wilkinson (1996) emphasises that management decisions are based on information; data must be processed and integrated with other knowledge before it can become information.

The Role of Farmer Knowledge in Soil Management

A study undertaken by Harris and Bezdicek (1994) in the USA focussed on integrating farmer perceptions of soil health with scientific analytical knowledge. The Wisconsin Soil Quality Program was initiated in 1990, with the prime objective of evaluating farmer perceptions of soil quality as a foundation for the development of analytical soil quality measurement (Harris and Bezdicek, 1994). The study used a short questionnaire, followed by individual field interviews and regional public meetings with predominantly crop farmers over a two-year period. The process led to the development of an "interpretive framework" (Fig. 2.1) for soil quality utilising farmer perceptions of soil "health" (ibid.1994).

In this framework farmers' descriptive knowledge of soil qualities is necessary to contribute to the information base for soil quality, from which quantifiable analytical measures of chemical, physical and biological properties can be developed (Harris and Bezdicek, 1994). The relation between descriptive and analytical measures can be two-way; descriptive measures correlate with specific chemical, physical and/or biological measures, allowing prediction from one type of measure to the other. Providing translation between descriptive and analytical measures will facilitate the transfer of information between scientists and farmers, with the goal of promoting sustainable soil management.

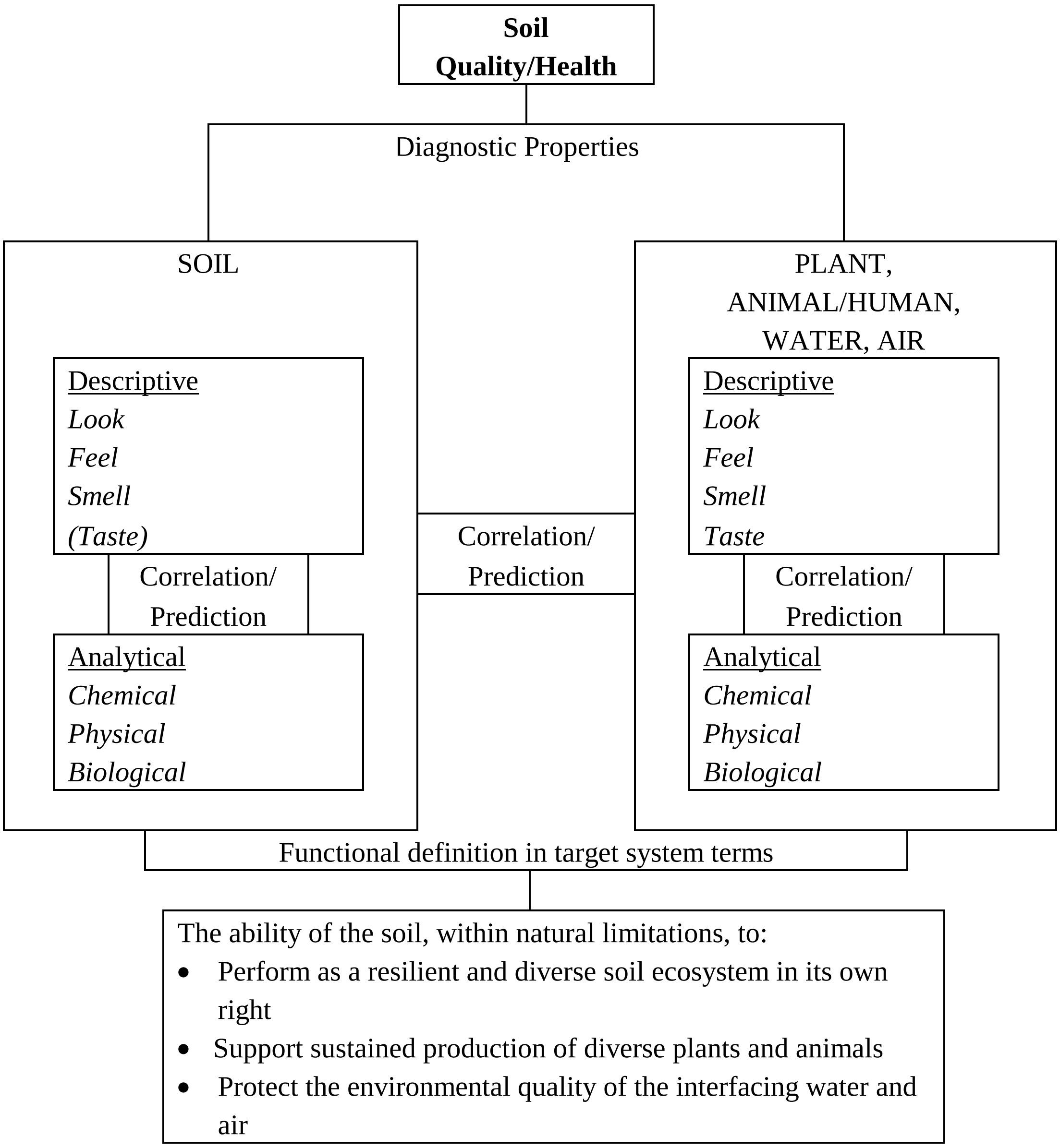

Figure 2.1 Soil quality/health interpretive framework. (Harris & Bezdicek, 1994,p 30)

The interpretive framework formalises the significance of soil quality in the environment. The framework stresses the interrelations, in both descriptive and analytical terms, between soil properties and other environmental target systems (plant, animal/human, air and water) of the farm. The implications of this interface for measuring and managing soil quality are captured in the resulting functional definition of soil quality:

> *"Soil quality is the capacity of a specific kind of soil to function, within natural or managed ecosystem boundaries, to sustain plant and animal productivity, maintain or enhance water and air quality, and support human health and habitation."*
>
> *Soil Science Society of America 1995*

This definition of soil quality corresponds with the E2010 policy goal for 'Managing our land resources': " To maintain and enhance the quality, productivity and life supporting capacity of our soils so that they can support a variety of land use options" (MfE, 1997). This suggests that Harris and Bezdicek's interactive framework could be a useful tool in developing an environmental information base for New Zealand. In particular, the areas of farmer descriptive analysis of soil quality properties, and farmer beliefs of interrelationships of soil with other environmental target systems, could contribute to the current development of soil quality indicators.

The analytical measures of soil quality are required for official measurement and monitoring purposes, such as State of the Environment Reports, and provide a formal basis for implementing sustainable soil management policies and practices. With increasing public pressure to manage the land sustainably, farmer use of formal measures allows transparency and accountability in farm decision making. The formal measures are not substitutes for informal descriptive measures; the two are complementary in the way they integrate to improve the information base for farm management decisions (Wilkinson, 1996).

How Farmers Make Decisions

Eliciting farmer descriptive knowledge of soil quality will contribute to the construction of soil quality indicators, which will provide an important tool for sustainable land management. The maintenance or improvement of soil quality however, requires more than accurate soil quality measurement; ongoing application of sustainable soil management techniques is needed. Finding out *what* soil management practices farmers currently use, and *why* they use them, will contribute to the environmental information base. Such information could provide understanding of both farmer knowledge of the effects of management practices on soil quality, and of the motivations behind choice of management practices. These understandings would be constructive in the formation and introduction of policies for sustainable land management in New Zealand. For instance, a gap in farmer knowledge of soil management may be revealed, or constraints on the adoption of new techniques may be identified.

Finding out 'what' soil management practices farmers use could be achieved in a straightforward manner through direct elicitation. Determining 'why' involves illuminating the cognitive and behavioural position of individuals; what thoughts do farmers have about soil management practices and how are those thoughts translated into behaviour? While the aim here is not to predict behaviour, it remains important to establish a theoretical base to model the relationships between beliefs, attitudes, motivations and behaviour. The model chosen will dictate the form of the data that need to be obtained, and its usefulness for further research in this area.

The Economic Approach

The economic approach is based on the traditional model of rational behaviour in which consumers maximise utility (satisfaction) subject to an expenditure constraint and producers maximise profits. This maximisation behaviour is based on a set of stable preferences.

Becker (1996) extends this traditional model by including influences that affect our preference. Those 'other' influences are captured in a 'human capital' variable. Becker divides this variable into personal capital, a measure of knowledge and experience from past choices and, social capital, the influence of an individual's social network and control system.

The inclusion of the human capital variable allows incorporation of past experiences, social forces and future considerations in explaining utility maximising behaviour. In this extended model of behaviour, beliefs and attitudes are confounded in the underlying preferences for goods as well as in those 'other' influences. Economic theory does not possess a cohesive conceptual framework for linking psychological processes to economic decision making. It is for that reason that in the next section the insights of behavioural psychology will be discussed to formulate, together with the economic model insights, a behavioural model to analyse farmers' attitudes and behaviour with regard to soil quality.

The Behavioural Psychology Approach

Much of behavioural psychology research has concentrated on both understanding and predicting behaviour, often through the study of attitude formation. An attitude is commonly defined as a persistent disposition to respond either favourably or unfavourably to a given object; it is an emotive disposition for behaviour towards an object (Fishbein and Ajzen, 1975). In contrast, beliefs are a cognitive disposition; thoughts about the relationship between an object/behaviour and its characteristics (Lea et al, 1987). Beliefs incorporate knowledge of behavioural consequences, while attitudes reflect feelings and motivations towards actual behaviours and consequences.

This paper proposes that the utility gained from soil management behaviour is derived from the beliefs and attitudes held about that behaviour. Lynne et al (1988) support this concept in their assertion that a strong attitude towards soil conservation behaviour corresponds to large utility gains from such behaviour. Taking a different example, the belief that smoking is damaging to your health would combine with an attitude towards being healthy. Other beliefs and attitudes about smoking may exist such as the belief that it eases stress and an attitude toward getting stress relief from smoking. Together the sum of beliefs and attitudes held by an individual generate the overall utility gain/loss for that individual from smoking. Thus the preferences underlying utility in an economic analysis of behaviour could be thought of as representing combined beliefs and attitudes.

Fishbein and Ajzen [F & A] (1975) suggest two main approaches towards the formation of attitudes: cognitive theories and learning theories.

- *The Cognitive Approach*

Fishbein and Ajzen's (1975) theory of reasoned action focuses on the cognitive process in the formation of attitudes. The conceptual framework involves causation from beliefs to attitude to behaviour, and consistency between cognitive factors. Generally, (i) attitude is learned from past experiences, (ii) it predisposes action, and (iii) such actions are consistently favourable or unfavourable toward the object (Fishbein and Ajzen, 1975). In this theory people are seen as rational creatures who "systematically utilise or process the information available to them" (Fishbein and Ajzen, 1975, p.iv).

The F & A model uses expectancy value theory which proposes a causal relation from beliefs to attitude that can be modelled mathematically. Bayes Law shows how rational individuals adjust their subjective evaluations of the likelihood of an outcome in the light of new evidence. Rationality in this context can be defined as procedural rationality: "an individual's ability to deliberate and reason within the constraint of circumstance and cognitive capacity" (Simon, 1976, cited in Lewis et al, 1995, p.8). Using this result, expectancy value theorists determined that overall attitude toward an object can be measured as the weighted sum of separate experiences with the object (Lea et al, 1987).

Separate experiences are defined in the F & A model as the formation of beliefs about an object, measured in terms of degree of probability that an outcome will occur, which are then weighted by subjective evaluation (negative-positive) of the outcome. For example, given the sentence "Good soil quality is achieved through application of chemical inputs", the F & A model assumes that the individual will hold a belief about the degree of association between achieving good soil quality (the behavioural outcome) and the attribute of chemical inputs. Similarly the individual will possess a subjective evaluation of the outcome from the attribute of chemical inputs; ie. an evaluative response of how one feels about achieving good soil quality through the use of chemical inputs. In this way an individual's overall attitude *(A)* toward some behavioural outcome (*B*) can be measured by combining their salient beliefs[2] that a set of attributes is associated with the behaviour, with their evaluation of each of these attributes:

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[2] Ajzen and Fishbein (1980) state that salient beliefs and attitudes are those that are recalled first, ie. those in the forefront of one's mind.

$$A_B = \sum_{i=1}^{n} b_i e_i$$

where A_B is the overall attitude toward the behaviour, b_i is the belief about the *i*th attribute associated with the behaviour, e_i is the subjective evaluation of the behavioural outcome from the *i*th attribute, and n is the number of salient beliefs. Individuals are required to gauge outcome probabilities on an evaluative scale, ie. extremely unlikely to extremely likely, rather than estimating actual numerical probabilities[3].

Analogous with Becker, F & A also consider social influences to be important determinants of behaviour. In addition to attitude toward the behavioural outcome, the F & A model also includes attitude towards social influences on the behaviour, termed 'subjective norm'. Normative beliefs represent the perception of whether most people who are important to the individual (referents) think that they should or should not perform the behaviour (Ajzen and Fishbein, 1980). These normative beliefs are then subjectively weighted by a motivation to comply with the referent, and summed to give what F & A call a 'subjective norm:'

$$SN_B = \sum_{j=1}^{n} b_j m_j$$

where SN_B is the overall subjective norm with regard to the behaviour, b_j is the normativebelief concerning referent j, and m_j is the motivation to comply with referent j. Here n is the number of beliefs linked to influential referents. In contrast to Becker's notion of social capital, this model assumes that individuals will not necessarily comply with members of their social network. This is a more plausible assumption.

Canter (1991) also supports this recognition of the social dimension of behaviour. In this preliminary study of New Zealand farmers I propose inclusion of this variable with possible important referents being consumers, regional council, government, processing companies, environmentalists, other farmers and family members. Given growing environmental awareness worldwide and government targets for the environment, farmers' perceptions of these referents' beliefs, and motivation to comply with them, is relevant for the assessment of current management practices.

The F & A model (Figure 2.2) predicts intention toward specific behaviour from combining attitudes with an individual's subjective norm. Ajzen and Fishbein (1980, p6) conclude that generally "individuals will intend to perform a behaviour when they evaluate it positively and when they believe that important others think they should perform it". The model recognises that other variables external to the model may indirectly influence belief and attitude formation, and/or the weightings of attitudinal and normative components that

[3]It has been shown that individuals do not reason probabilistically, perhaps because the numerical nature of probability does not represent the real world in which individuals reason (Plant and Stone, 1991).

determine behavioural intentions, however such variables are excluded from the direct causal chain (Ajzen and Fishbein, 1980).

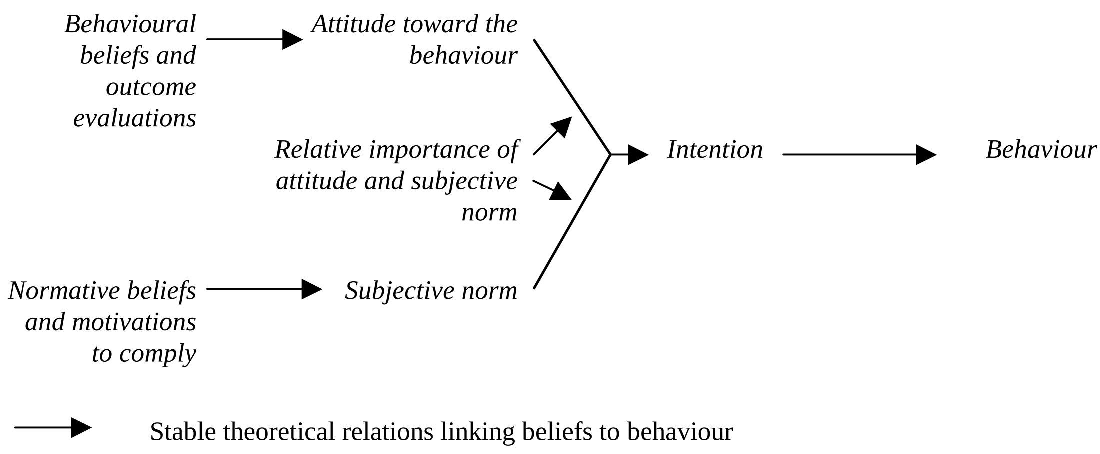

Figure 2.2 From Ajzen and Fishbein (1980). "Relations among beliefs, attitude, subjective norm, intention and behaviour".

The F & A model as described above is supported by other research in this field. Kaplan (1991) proposes that a model of how people make decisions should include cognitive aspects that reflect an individual's state of information, and must have affective consequences, ie. feelings that direct action. Moreover, Gärling et al. (1991) agree that research on environmental attitudes should include both descriptive (cognitive) and evaluative responses. In the F & A model the eliciting of beliefs *(b)* provides descriptive responses that indicate the information state of respondents. The inclusion of subjective evaluations of both beliefs about outcomes *(e),* and of motivations to comply with referents *(m),* provides the affective components that underlie eventual behaviour. Furthermore, the expectancy-value framework incorporates the potent factor of uncertainty in decision-making, and assumes that individuals have imperfect knowledge. These are realistic assumptions.

If an individual's knowledge is imperfect and increases slowly through the integration of experiences, Kaplan concludes that a negative behaviour may be "an expression of discomfort in the absence of sufficient information" (Kaplan, 1991). Vogel (1996) found that problem-based knowledge measured in terms of an agricultural environment information level was a significant determinant of farmer behaviour in Austria. This implies that 'information state' is a component of the cognitive process that may act as a direct determinant of behaviour, as opposed to only indirectly influencing beliefs. For example, a farmer may perceive that he or she lacks the 'know-how' to adopt a new management technique, and this prevents the adoption.

In recognition that many behaviours may not be under the complete control of the individual, Ajzen (1988) extended the F & A model to include perceived behavioural control, ie. control beliefs (C_B). Control beliefs refer to the perceived ease or difficulty of performing the behaviour, given past experience and anticipated external constraints. Behavioural control factors may include access to resources, opportunities and/or information. Control beliefs can influence behavioural intentions; even if individuals hold favourable attitudes towards the behaviour and believe that important others approve of their performing the behaviour, they are unlikely to form strong behavioural intentions if they are constrained by an external factor such as a lack of resources. (Ajzen, 1988).

Control beliefs toward a behaviour could be either outside the individual's control (c_b) or within the individual's control (c_d). Thus overall control beliefs are given by

$$C_B = c_b + c_d$$

In Figure 2.3 the dashed line indicates that perceived behavioural control may affect behaviour directly when there is some correspondence between perceived control and the individual's actual control over the behaviour (c_d); ie. in the situation of a lack of information, a farmer may have control over acquiring the necessary information. However, if the constraint on behaviour is financial, the farmer may have no direct control of the outcome (c_b).

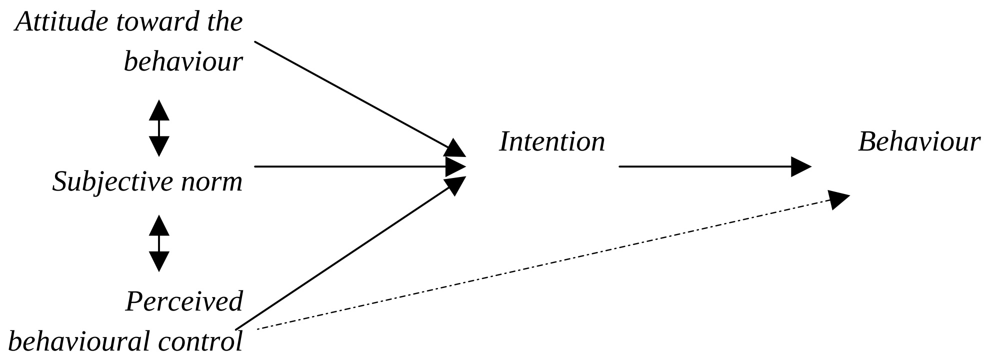

Figure 2.3 Theory of Planned Behaviour, from Ajzen (1988, p133)

The Hardaker et al (1997) definitions of risk and uncertainty can be used to classify control beliefs; uncertainty involves imperfect knowledge, while perceived risk is related to a situation of uncertain and undesirable consequences. Sources of risk in agriculture include both business risk (production, market, institutional, personal), and financial risk (leverage, credit). These uncertainty and risk factors suggest possible sources of perceived behavioural constraints.

Gorddard (1991) found that the inclusion of behavioural constraints increased the overall predictive validity of the F & A model in an agricultural application from $R^2 = 0.39$ to $R^2 = 0.45$. His results also showed that behavioural constraints were significant considerations by wheat farmers in Western Australia, especially with respect to health and safety.

Following the work of Ervin and Ervin (1982), and Lynne et al (1988), Gorddard (1991) added a risk variable to his specification of the F & A model. However, due in part to the difficulty of measuring risk, this variable did not test significant. Given that risk considerations will be included both in the subjective evaluation of beliefs, and in perceived control beliefs, the extended F & A model (Ajzen, 1988) should provide adequate incorporation of risk.

The cognitive approach described in this section concentrates on eliciting beliefs about behavioural outcomes b_i, what important others think about the behavioural outcomes b_j, and behavioural control factors C_B. These beliefs can tell us what farmers think about soil management practices. Such thoughts are translated into intentions toward actual behaviour through subjective evaluations of behavioural outcomes (e_i) and motivations to comply with important others (m_j). The resulting overall attitude toward the behaviour A_B, corresponds to what has earlier been described as preferences which underlie utility maximising behaviour. Strong positive attitudes toward a behaviour indicate that the individual gains a large amount of utility from performing the behaviour (Lynne et al, 1988). This implies that attitude is a psychological measure of economic utility (Vogel, 1996; Ritov and Kahneman, 1997).

Attitude and utility are not, however, interchangeable. The maximisation of economic utility assumes a rational agent who possesses a preference order that is stable over small changes in context. Thus the utility gained from performing a behaviour is assumed to be relatively static. In contrast, attitudes have been found to be potentially unstable with preference reversal common, and are also context dependent (Ritov and Kahneman, 1997).[4] Attitudes can change as a result of changes in either beliefs (*b)* or subjective belief evaluations *(e* and *m).*

The assumptions of instability and context dependence which underlie attitudes, can be understood with respect to environmental attitudes by considering the argument presented by Eagly and Kulesa (1997, p128) that "environmental attitudes are embedded in a network of broader values". These values have been defined as: (a) Economic/egocentric value which maximises self-interest, (b) Social/altruistic value which seeks to maximise societal interest, and (c) Universal/ecocentric value from contributing to the health of the ecosystem or biosphere as a whole (ibid.). Given that these broader values underlie both beliefs and subjective evaluations of behaviours, the balancing of these values in a given situation will determine the attitude of the individual in that situation. If these values are assumed to be changeable, then attitudes toward environmental goods will be unstable.

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[4] The context dependency of attitudes was illustrated by Friedman (1962, p 239 - 241), in his analysis of the first amendment of the U.S. Bill of Rights that deals with the guarantee of individuals' rights to freedom of speech. He argued that given many differing cases, "acting on the bundle as a whole, the people would vote exactly the opposite to the way they would have voted on each case separately". Thus attitudes towards rights to freedom of speech over particular issues are dependent on the context of the vote.

Economic and social values could either support or oppose environmental protection, depending on the situation (ibid.). Previous research has shown that New Zealand farmers tend to be primarily economically oriented, rather than environmentally oriented (Wilkinson, 1996; Townsley et al, 1997). Similar results have been obtained for farmers in eastern Australia (Cary et.al, 1993; Cary & Wilkinson, 1997).

This network of economic, social and universal values corresponds with motives of income, stewardship and conservation, as defined by Sinden and King (1988). Thus determination of the values held by an individual will indicate the motivations that underlie attitudes toward behaviours.

Ritov and Kahneman (1997) suggest that measures of attitude to public environmental goods are primarily determined by the perceived importance of the environmental good. The perceived importance is dependent on intensional[5] features of the environmental good such as the salience of a particular characteristic, rather than the magnitude of a characteristic (ibid.). Furthermore, Eagly and Kulesa (1997, p144) state with regard to attitudes that "heightened accessibility [salience] makes an attitude more likely to influence action". Salient attitudes will correlate with particular held values; ie. given that soil quality has external effects on the ecosystem, then a universal/ecocentric value of soil quality may influence farmer attitudes in addition to the economic value of production and consumption benefits. Thus the identification of attitudes should seek to elicit salient attitudes and address the underlying values upon which attitudes are based.

- *The Learning Approach*

An alternative approach toward attitude formation lies in learning theories. The central focus of learning theories is on how external stimuli affect evaluative responses such as attitudes and behaviours. Previous research has shown weak correspondence between external factors and specific behaviours (Ajzen and Fishbein, 1980). A focus on external socioeconomic factors which influence farm management practices has, however, driven much of the research and literature relating to farmer perceptions and attitudes towards adopting sustainable land management practices. A popular model of these external influences on behaviour has been the multistage decision model.

A multistage decision model was used by Ervin and Ervin (1982) and later in a modified version by Sinden and King (1990). The modified version involved a sequential system for decision making from perception to recognition to decision. The farmer must first perceive the condition of soil quality. This perception reflects the farmer's beliefs of what defines good soil quality. Recognition of a problem is dependent on whether the farmer believes that the consequences of the soil quality are good or bad. For example the farmer may perceive that some soil erosion is occurring but he may not believe that this level of soil erosion has bad consequences. If the farmer evaluates the consequences as bad, a problem will be recognised and the farmer will attempt to find a solution. This stage may include a search for remedies followed by an analysis of the effectiveness of possible solutions.

[5] "Intensional features" are the internal/inherent qualities that make up a good/commodity.

Finding a solution that the farmer believes will remedy the soil problem is a necessary but not sufficient condition for the final stage of decision to resolve the problem.

The emphasis in testing multistage models however, was not on the cognitive process described, but on the effects of and interrelationships between external factors (relating to personal, land, economic and institutional aspects) and the behavioural process. By neglecting the thought process itself, a fundamental aspect of decision making, such models cannot illuminate the thoughts of individuals, or explain how thoughts result in behaviours.

Sinden and King (1990) note that multistage models simplify a continuous and dynamic process. Models based on external variables thus lack a theoretical base for the role of information in updating perceptions and recognitions about management practices (Gorddard, 1991). Accurately modelling the thoughts behind behaviours is difficult, so learning theories place the thought process in a "black box" where thoughts are an unexplained influence on behaviour. These considerations may indicate reasons for the modest overall predictive validity of the multistage models. Ervin and Ervin (1982) achieved explanatory power for each of their three stages from perception to recognition to action of $R^2 = 0.31$, 0.26 and 0.25 respectively.

These multistage models have, however, contributed to the informational base for environmental behaviour, through identifying some significant external variables which could be considered behavioural constraints: risk aversion (Ervin and Ervin, 1982), quality of information, cost of sustainable practices, management experience, institutional support, productivity potential (Sinden and King, 1990).

An Integrated Model of Behaviour

Cary and Wilkinson (1997) criticise the conceptual basis of the multistage model in the first part of the sequential process, ie. from perception to recognition, arguing that rather than one-way, this relationship is two-way. Perception of soil condition which leads to recognition of a problem, in turn results in heightened perception as the problem is analysed more closely. This is supported by Rae's (1994) process of decision making.

Subsequently Cary and Wilkinson (1997) test a model using a shortened causal chain which explicitly links behaviour with predictor variables of perceived control factors (economic profitability, technical feasibility, scale of farm operation) recognition of an environmental problem, and environmental motivation. Results showed that both perceptions and recognition were significant predictors of behaviour. If perceptions are thought of as beliefs, while recognition of a problem reflects attitude, then the perception-recognition-decision model utilises a similar cognitive process to the F & A model. Gorddard's (1991) test of the extended F & A model (including behavioural constraints) shows highly significant coefficients for both behavioural beliefs and attitudes. These findings suggest that the condensed causal chain may be a better predictor of farmer behaviour.

This leads to the definition of an integrated model of behaviour that combines Ajzen’s (1988) version of the cognitive approach with Cary and Wilkinson’s (1997) interpretation of the multistage model. Here behaviour is a function of beliefs, attitudes, subjective norm and behavioural constraints:

$$B = f\{b_i, A_B, SN_B, C_B\}$$

Where

$$A_B = \sum_{i=1}^{n} b_i e_i$$

$$SN_B = \sum_{j=1}^{n} b_j m_j$$

$$C_B = c_b + c_d$$

A_B	attitude toward the behaviour
SN_B	subjective norm toward the behaviour
b_i	behavioural belief with respect to attribute i
e_i	subjective evaluation of attribute i
b_j	normative belief concerning referent j
m_j	motivation to comply with referen t j
c_b	control belief with respect to behaviour B
c_d	direct control perceived over behaviour B

This research will adopt this integrated model as a framework for generating an information base describing the determinants of farmer behaviour, including salient beliefs and evaluations of management practices, as well as beliefs and motivations with respect to normative influences (referents), and perceived constraints on behaviour. Motivations toward sustainable soil management will be reflected in the network of values underlying attitudes toward the soil and wider environment. These hypothesised components of behaviour are the determinants of preferences in farmer utility functions, and describe the process by which economic decision-making occurs.

Chapter 4

Methodology

A key purpose of this preliminary study was to generate an information base of salient beliefs held by New Zealand farmers with respect to the soil. Given this objective, a qualitative study was proposed in order to focus on eliciting farmer knowledge and perceptions of soil quality and management practices. This base will be used to prepare a questionnaire for much wider application. Due to time and cost limitations the format chosen for implementation was a small systematic sample survey, using personalised interviews with farmers that were conducted at their homes. Open-ended questions were considered an appropriate tool to elicit the unbiased viewpoints and salient beliefs of respondents' about soil quality. Personalised interviews also allowed the language of respondents to be directly recorded.

A total of 14 farmers were interviewed. Because the group was small, all of the farmers interviewed were located within the same geographical area of Marton in the Manawatu region, with the common soil type of Marton Silt-Loam. This was to isolate for variables of farm and soil type, so that the results will deal with common belief and behavioural aspects. The interview questionnaire was pilot tested on 2 farmers, one mixed cropping and the other a dairy farmer, from nearby areas. For the main study the farmers were chosen by their willingness to participate.

The Questionnaire

The questionnaire was functionally an interview guide, "an information-gathering and communication tool" (Garlynd et al, 1994). The structure loosely followed Gallup's "quintamensional" technique in attempting to construct a valid picture of farmers' past behaviour and present circumstances, and attitudes and values (Anderson et al., 1983, p203-204). This technique concentrates on eliciting knowledge or awareness of the issue, beliefs, attitudes, intensity of attitudes, saliency, future expectations, and perceptions of the beliefs of others (ibid.). (A copy of the questionnaire is included in Appendix A).

The format consisted of both open-ended questions, and conventional response item measures where specific statements were evaluated on a scale. Open-ended questions were used in situations where it was important that the respondent was not constrained by researcher-specified categories. In situations where this was not essential, where the categories were easily definable, closed-ended questions were utilised in order to apply rating scales for responses. In addition to the responses to specified questions, other comments were also recorded to supplement the data.

The terminology to describe the ‘state of soil’ used in the questionnaire was ‘soil condition’. This was a more familiar term with the pilot tested farmers than ‘soil quality’. Question 1 gathered farm background information including farm area, land use, farming history, soil types. This will be used to evaluate the sample and look for potential relationships between background information and other variables studied.

The format of the questionnaire was based on the models discussed in sections 2.1 and 2.2.3. The framework in section 2.1 formed the base for eliciting responses to the first research question. The responses to this question will indicate the use of descriptive compared with analytical measures for soil quality, current levels and methods of soil quality monitoring, as well as awareness of the effects of soil quality on the wider environment. This information is gathered in questions 2 to 5 of the questionnaire.

Question 2 addresses informal assessments of soil condition. The purpose was to determine the characteristics that farmers associate with soil condition, and the terms used to assess the level of these characteristics. Open-ended questions were used to capture both the language used and the word descriptions given for informal measurement and monitoring techniques for soil condition. The timing and purpose of informal information gathering was requested to facilitate comparisons with formal soil assessments.

Question 2.4 was designed to establish a measure of overall environmental awareness with respect to the soil. Harris and Bezdicek’s framework for soil quality (Figure 2.1) was used as a basis. That is, the question looks for whether and to what extent the farmer links descriptive and analytical soil properties, with effects on plant, animals, human, water, and air target systems. Given this defined range of environmental properties, a closed question with a uni-directional rating scale is used. This assumes the existence of a positive relationship between soil and the target systems. Question 3 covers formal soil assessments (soil testing), including reasons, methods and use of results, to investigate the relationship between formal and informal assessments.

Question 4 investigates perceptions of change in the direction and magnitude of soil condition over time. The responses are personalised for each farmer, as the soil condition characteristics used are based on those previously identified in questions 2 and 3. The charting of the dynamics of an ‘average paddock’ will reflect the respondent’s beliefs of how their management practices have affected soil condition.

Question 5 addresses formal scientific indicators of soil condition. Farmers were presented with a list of analytical indicators as identified by Sparling and Schipper (1998), and asked to indicate their familiarity with those indicators on an evaluative scale. Of those indicators recognised, farmers were asked to evaluate their perceived usefulness in practical terms on a uni-directional scale from no-use to very useful. These will be compared with the informal measurement patterns of soil condition used by farmers.

The second research question looks at the relationship between soil condition level and management practices. The model for behaviour developed in the section 2.2.3 defined a guide for gathering data. Questions to elicit beliefs will cover behavioural beliefs, normative beliefs, and control beliefs.

Given that the main goal is to determine salient beliefs, and also that attitudes are context dependent, it is appropriate to locate the questions within the farmers' immediate frame of reference ie. their own farm and management practices. In measuring behaviour, Ajzen and Fishbein (1980) show that correspondence between *action* (type of behaviour, specific or general), *target* at which the behaviour is directed, *context* and *time* will improve predictive accuracy. What this means in operational terms is that measures of beliefs, attitudes, subjective norm and control beliefs should specifically correspond to each other in action, target, context and time elements. For this purpose these elements were defined as follows:

Action:	*Management practices which either directly or indirectly affect soil quality*
Target:	*Soil quality*
Context:	*General farm operation*
Time:	*Current*

Question 6 elicited behavioural beliefs from farmers with respect to actual management practices used, and the reasons for use. An open-ended question was appropriate, with the previously identified soil condition factors used as a basis to discuss beliefs about management practices. Indicative ratings for belief strength were also requested. Responses will be aggregated across respondents to form a list of salient belief statements. These statements can be tested for attitudinal measures at the next stage of this research.

Normative beliefs were evaluated in question 7 using a restricted set of referents including economic, social, and universal influences: consumers, buyers (processing companies), regional council, government, other farmers, family members, and environmentalists. Farmers were also asked to identify other significant factors that were not included in the set. Measures of attitude and motivation to comply with referents were evaluated using uni-directional rating scales. Responses reflect the underlying environmental value structure for attitudes.

Control beliefs were elicited using an open question with a set of external factors included in a prompt: financial, informational, risk, management skills, productivity potential of the soil resource, institutional framework (property rights, legislation, and support systems).

Data Analysis

The data collected from the interviews was collated using either qualitative or quantitative methods as appropriate. The qualitative data was clustered into categories of same or similar responses, and the frequency of response for each category calculated. Quantitative data was used to generate averages to indicate the general position of the sample with respect to the question. Scatter-plots were used to explore relationships between variables.

The Interpretive Framework of Harris and Bezdicek (1994) was used as the base for analysing the informal soil assessment data from Q2. Responses were classified according to target systems (plant, animal, human, water, air) at the first level, followed by descriptive categories used for diagnosis (look, feel, smell, taste) at the second level.

The discussion in section 2.2.2 proposed that the structure of values underlying environmental attitudes would indicate motivation towards sustainable soil use. Values were classified into 3 groups (after Eagly and Kulesa, 1997): economic, social, universal. These classifications were used to sort the responses from belief questions 7 - 9, in order to evaluate motivations towards maintaining good soil condition.

The next section presents the data collected in the survey. These results highlight the key beliefs, attitudes, constraints and influences on farmer soil management behaviour. This information will be useful for both the development of ‘user friendly’ analytical soil indicators, and their effective introduction. The data could also be used to form the basis of a much larger survey seeking to establish the size contributions that each of these factors makes to actual behaviour.

Chapter 5

Results

In reading these results the preliminary nature of this study needs to be kept in mind. The consequent small sample size implies that although the results presented here are representative of the Marton area, they may not be generalisable across the country. The quotes inserted in the text here were recorded during interviews and therefore references are excluded in order to maintain the confidentiality of the respondents.

Property Information

All farms in the sample were located in the Marton area of the Manawatu region on the Marton Silt Loam soil type. Marton Silt Loam is a shallow, silty, topsoil lying on a dense clay bed. The average annual rainfall for the region is 960mm, with approximately 2000 hours of sunshine annually on average. Average daily temperatures range between 4 °C in mid-winter and 23°C in mid-summer.

The average farm size in the sample was 140 hectares, with the farms ranging from 84 to 256 hectares. On average the farms had been under the current ownership/management for 19 years. There was one dairy farm in the sample, and 2 farms that stocked bulls, but the majority of farms were mixed cropping and dry stock fattening. This was a fair cross-section of farm types for the Marton area.

Informal Soil Assessment

Informal soil assessment involves qualitative methods for assessing soil condition. Farmers were asked what they specifically looked for when determining soil condition. The characteristics furnished from the responses are listed in Table 4.1. The language used to describe and assess these characteristics is presented in the complete list of collated responses in Appendix B.

Table 4.1 Informal soil assessment variables. Unprompted, n = 14, 50 multiple responses

Responses	Target system	Descriptive category	Frequency of response (%)
Drainage/pugging	Water	Look/feel	86
Pasture/crop growth	Plant	Look	71
Soil structure	Soil	Feel	71
Pasture/crop colour	Plant	Look	43
Pasture species	Plant	Look	36
Worms	Animal	Look	29
Soil smell	Soil	Smell	14
Stock condition	Animal	Look	7

Soil condition was informally assessed mostly in relation to target systems of plants and water, primarily through observations of drainage/pugging (86%), pasture/crop growth (71%), and soil structure (71%). These corresponded with sensory properties of look and feel. Given the soil type, drainage is necessarily a priority concern for the farmers in this sample.

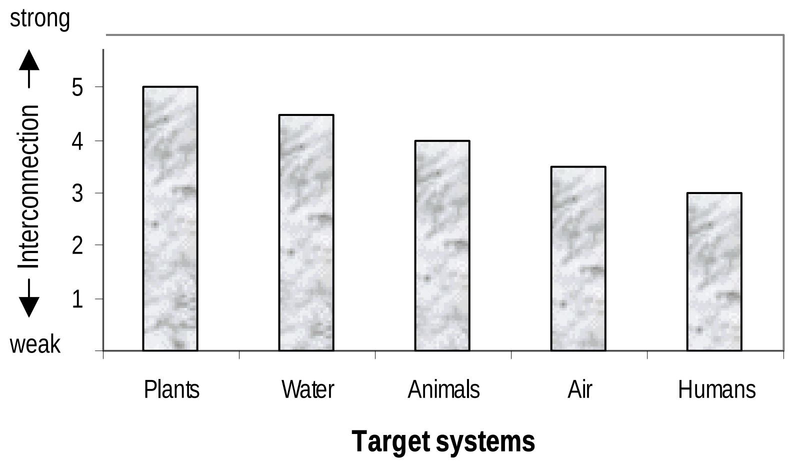
The predominant use for informal soil assessment was for cropping related decisions, particularly fertilising needs (Table 4.2). Livestock policy, drainage, and paddock rotation were also important uses. These uses are for both daily and seasonal decision-making, and for capital investment decisions.

Table 4.2 Ways of using informal soil assessments. Unprompted, n = 14, 25 multiple responses

Responses	Frequency of response %
Cropping policy/fertilising	64
Livestock policy	43
Drainage	43
Paddock rotation decisions	36

Figure 4.1 shows the average farmer perception of the role of the soil in the environment in general. The median responses from farmers showed that all environmental variables were perceived to have a significant connection with the soil. On a rating from 0 – 5 all variables scored greater than or equal to 3. The condition of plants was considered to have the strongest connection with the condition of the soil, followed closely by water and then animals.

Figure 4.1 Relationship between soil and other target systems of the environment



Beliefs of the role of soil in the environment reflect the relative importance to the farmer of economic, social and universal environmental values. The perceived interconnections between plants and soil, and animals and soil were production related. The interconnection between water and the soil reflected key concerns of drainage and plant production; run-off and leaching were minor concerns related to council regulations. This suggests that economic values are those most directly related to a stronger perceived role of soil in the environment. This idea is reflected in the following statement: "If you've got healthy soil, you've got healthy stock and crops, which gives you a healthy bank balance". The linkage of humans with soil condition was perceived to be the weakest.

The strong interconnection of soil with plants corresponds with informal soil assessment responses where all farmers assessed soil condition through plant growth, and 64% used informal soil assessments for cropping/fertilising policy. Likewise 86% of farmers referred to the target system of water when making informal soil assessments. The relationship between animals and the soil is perceived to be stronger here than was indicated in informal soil assessments as only 7% of farmers cited stock condition as an indicator of soil condition.

Formal Soil Assessment

All farmers in the sample used formal soil tests. Paddocks about to be cropped were the main choice for test paddocks (43%). Over a third (36%) of farmers in the sample chose a representative sample of paddocks, with an equal percentage targeting paddocks with specific problems. On average farmers tested 23% of their land annually, or approximately 4 paddocks. From each paddock tested, 16 plugs were taken on average.

Table 4.3 Ways of choosing paddocks to test. Unprompted, n = 14, 26 multiple responses

Responses	Frequency of response %
Before Cropping	43
Representative sample	36
Specific problems	36
Set rotation	29
Fertiliser application [after]	21
Fertiliser application [before]	14
After cropping	7

Table 4.4 Reasons for soil testing. Unprompted, n = 14, 20 multiple responses

Responses	Frequency of response %
To monitor fertility levels	50
Fertiliser application for cropping	36
Looking for trends/problems	14
Farm development	7
Recommendations for soil testing	7

There is some correspondence between the reasons for informal soil assessments and those for formal soil testing. Both informal (64%) and formal (86%) assessments are primarily used for cropping decisions relating to fertilising and soil fertility. Formal assessments were more specifically directed towards optimal fertilising for crops and soil fertility monitoring. Informal assessments are also used for broader management decisions, both daily and seasonal, as well as for capital investments. This suggests that these different methods of assessment may be complementary rather than substitutes. The formal tests may be a way of defining or confirming informal assessments of soil fertility.

Table 4.5 Nutrients tested for in soil tests, n = 14, 59 multiple responses

Nutrients	Frequency of response %
Potassium	100
Phosphate	93
pH	64
Sulphur	57
Calcium	36
Magnesium	29
Nitrogen	21
Sodium	14
Cation Exchange Capacity	7

The main nutrients tested for were potassium, phosphate, followed by pH, and sulphur. The average amount spent on formal soil tests was about $2 per hectare compared with the average annual fertiliser cost of $108 per hectare. This means that on average about 2% of the value of annual fertiliser costs is spent on soil tests each year. The highest proportion of fertiliser cost spent on soil tests was 8%, and the lowest 0.2%.

Table 4.6 Follow recommendations from soil tests, n = 14

Responses	Frequency of response %
Yes, for the most part	65
To some extent	21
No	14

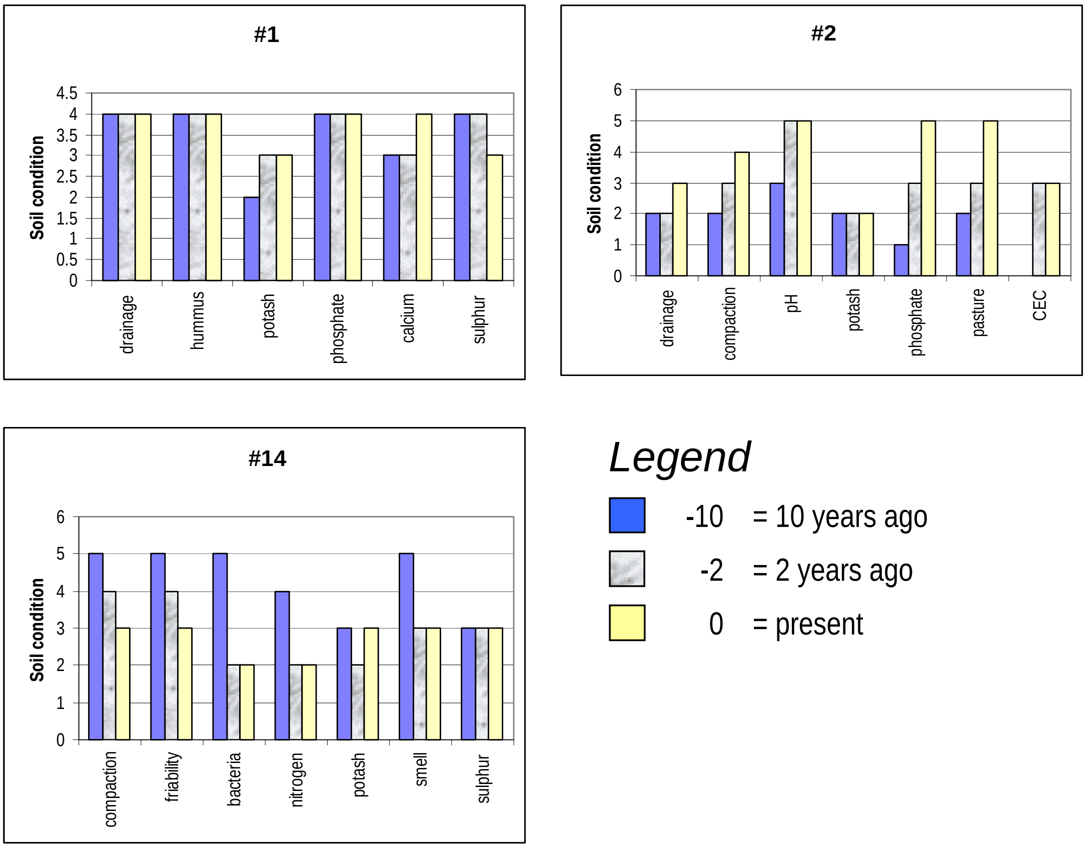
The majority of farmers (92%) used Analytical Services Ltd. to test the soil samples, often through an agent such as Ravensdown. The soil test results are combined with recommendations for fertilisation rates, and 86% of farmers said that they followed these recommendations either partly or wholly. All farmers in the sample cited cost as an important factor in following the recommendations: “A lot of people see fertiliser as a variable option because it’s such a big expense”.

Soil Analysis

Farmers were asked to consider how the soil condition in an ‘average’ paddock had changed over the last 10 years, with respect to the variables they had previously identified as important for informal or formal soil analysis. A bar graph for each farmer was constructed (Appendix B). These graphs were grouped into 3 categories according to perceived change in soil condition: improved, stable, or deteriorated. A representative sample of results is shown in Figure 4.2. The vertical axis represents soil condition where 1 = very poor, 2 = poor, 3 = average, 4 = good, 5 = very good. Graphs #1, #10 and #11 show no perceived overall pattern of change on average over the 10 year period.

Graphs #14, #12 and #3 show a perceived decline in soil condition in the average paddock over the 10 year period. All of the remaining graphs (#2, #4, #5, #6, #7, #8, #9, #13), representing a total of 61% of farmers sampled, indicate a perceived improvement in soil condition overall in the average paddock over the past 10 years.

Figure 4.2 Perceptions of change in soil condition over time



The three groupings of farmers with respect to perceived change in soil quality (improved, stable, deteriorated) were plotted against, (a) years of management, and (b) size of farm in hectares (Figures B 4.1, B 4.2). No relationship patterns were evident. For further examination of the data, the groupings were then plotted against annual expenditure on fertiliser per hectare (Figure 4.3), annual expenditure on soil tests per hectare (Figure 4.4) and percentage of fertiliser expenditure spent on soil tests annually (Figure 4.5).

The fertiliser and soil test expenditure figures were current, while the perceived change in soil condition was over the past 10 years. Figure 4.3 suggests that farmers who perceived deterioration in soil condition are currently spending more on average on fertiliser per hectare ($109 to $216 per hectare). This may indicate a cause and effect relationship from perception to behaviour, as these farmers attempt to restore some nutrient attributes of soil condition, or the pattern could reflect another factor which underlies both of these variables. Farmers who perceived stable or improving soil condition spent between $52 and $186 annually on fertiliser per hectare.

Figure 4.3 Annual expenditure on fertiliser per hectare and perceived change in soil condition over 10 years.

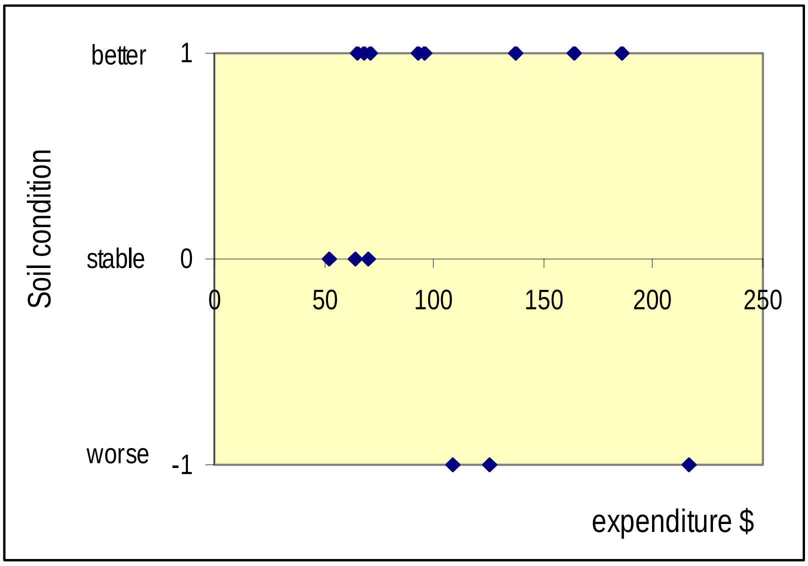


Figure 4.4 does not show any obvious relationship between perceived change in soil condition and expenditure on soil tests per hectare. If anything, the farmers who perceived deteriorating soil condition are spending less per hectare on soil tests on average.

Figure 4.4 Annual expenditure on soil tests per hectare and perceived change in soil condition over 10 years.

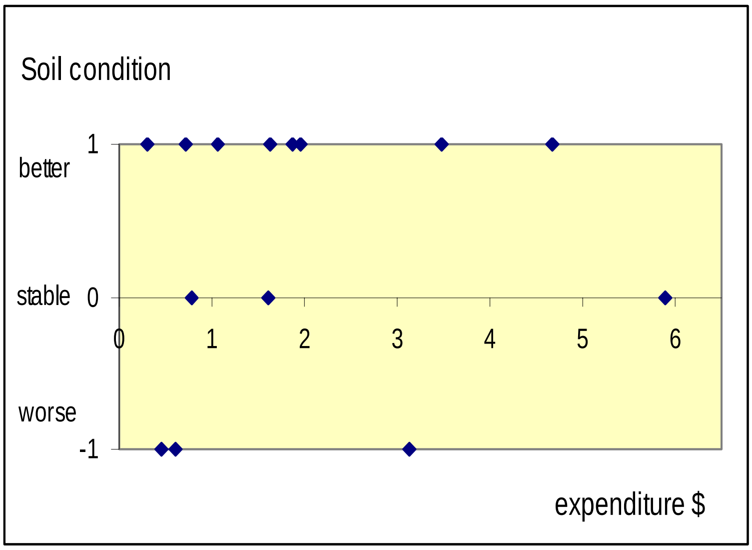
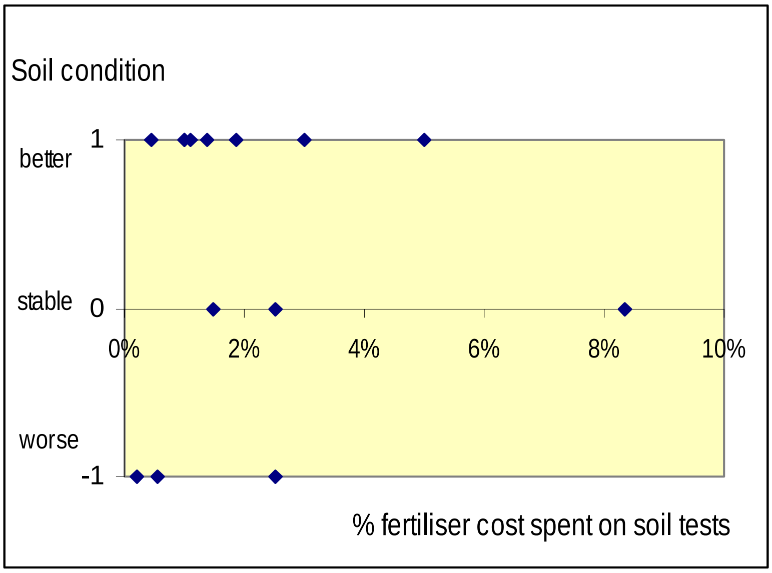


Figure 4.5 suggests that on average farmers that perceive deterioration in soil condition spend a lower percentage of their fertiliser costs on soil tests.

Figure 4.5 Percentage of fertiliser costs spent on soil tests and perceived change in soil condition over 10 years.



Scientific Indicators

Farmers were presented with a list of analytical indicators and interpretations. They were asked to rate them with respect to familiarity from 'Never heard of it' [0] to 'Heard of it and could explain it someone else' [3]. The mean response for each indicator is given in Table 4.7. Indicators coded C1 – C4 are chemical, B1 – B3 are biological and P1 –P4 are physical.

Table 4.7 Familiarity of Analytical Indicators n = 14

	Indicators	Mean response
C4	pH	2.9
C2	Total N Content	2.4
P4	Particle Size Analysis	2.4
P3	Hydraulic Conductivity	2.0
P1	Bulk Density	1.9
P2	Moisture Release	1.9
B3	Potentially mineralisable N	1.6
C1	Total C Content	1.6
C3	Cation Exchange Capacity	1.5
B1	CO_2 efflux	1.4
B2	Microbial Biomass/organic C	1.1

Scale for familiarity: 0 (low) – 3 (high)

The most familiar indicators to farmers were pH, Total N Content and Particle Size Analysis. These are chemical and physical indicators. A mean score of greater than 2 indicates that on average the farmers had heard of the indicator, knew something about it, and could possibly explain it to someone else. On average farmers had heard and knew something about Hydraulic Conductivity. For all other indicators, on average the farmers had heard of them, but knew little or nothing about them. Farmers were least familiar with the biological indicators.

Farmers were then asked to rate the usefulness, for farm management purposes, of the indicators which they considered that they knew something about or could explain [ie. those indicators that rated 2 or greater]. The rating scale was out of 5, where 0 indicated they were of no use, and 5 indicated they were extremely useful. Average usefulness would be rated as 2.5. The number of responses for each indicator range from 4 (Microbial biomass) to 14 (pH). The mean response for the usefulness of each indicator is given in Table 4.8. The indicators are ordered following Table 4.7 from most familiar to least familiar.

Table 4.8 Usefulness of Analytical Indicators

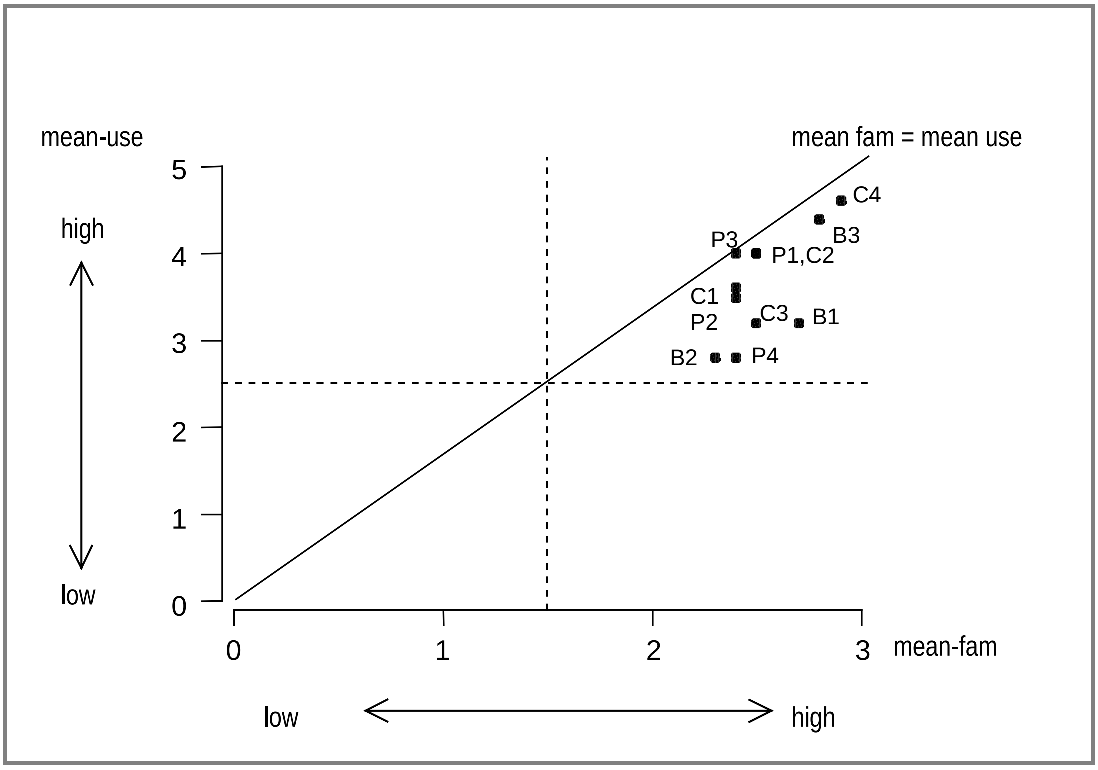
Indicators		n	Mean response
C4	pH	n = 14	4.6
C2	Total N Content	n = 13	4.0
P4	Particle Size Analysis	n = 13	2.8
P3	Hydraulic Conductivity	n = 10	4.0
P1	Bulk Density	n = 8	4.0
P2	Moisture Release	n = 10	3.5
B3	Potentially mineralisable N	n = 5	4.4
C1	Total C Content	n = 8	3.6
C3	Cation Exchange Capacity	n = 7	3.4
B1	CO_2 efflux	n = 6	3.2
B2	Microbial Biomass/organic C	n = 4	2.8

Scale for usefulness: 0 (low) – 5 (high)

All of the known indicators were considered to be of above average use. It is not surprising that pH, followed by Potentially Mineralisable Nitrogen were considered the most useful by cropping farmers. Total N content, Bulk density and Hydraulic conductivity were also very useful for soil management decisions for those farmers who were familiar with them.

To investigate the relationship between familiarity and usefulness, the familiarity ratings which had corresponding usefulness ratings were isolated, and the respective means for each indicator were plotted against each other in Figure 4.6. There appears to be a positive relationship between mean familiarity and mean usefulness for these responses. Greater familiarity with an indicator corresponds with perceived greater usefulness of that indicator for soil management decisions.

Figure 4.6 Mean familiarity versus mean usefulness of indicators



Farmers were also asked what they used these analytical indicators for. The responses are given in Table 4.9. All farmers responded in terms of aiding soil management decisions; "modern tools … add value to the quality of information from traditional methods". One farmer responded that they were also useful to provide a record of soil condition over time. The responses correspond generally with the reasons given for informal soil assessments, and support uses for formal soil testing with emphasis on fertiliser applications.

Table 4.9 Uses for analytical indicators. Unprompted, n = 14, 29 multiple responses

Responses	Frequency of response %
Fertiliser application	64
Supplement informal assessments	50
Cultivation	43
Drainage	29
Choice of crop/stock policy	14
Provide record	7

Behavioural Beliefs

This question elicited behavioural beliefs from farmers with respect to actual management practices used, and the reasons for use. The objective was to draw out salient beliefs about the effects of management practices on soil condition. Responses were unprompted, with a total of 130 multiple responses covering 59 different beliefs. The beliefs held by more than one farmer in the sample are listed in Table 4.10. (A full list of belief statements can be found in Appendix B). The strength of belief rating measured the extent that the management practice belief was perceived to affect the soil condition factor, on a scale of: [1] a little, [2] moderately, [3] alot. Strength of belief ratings were not obtained for all beliefs.

The most commonly held beliefs of the effects of management practices on soil condition are related to drainage problems, and the effectiveness of fertilisers. All beliefs listed here were considered to be either moderately or very effective for soil management. It should be noted here that the survey was conducted in August when both drainage and fertilising concerns were pertinent.

Table 4.10 Beliefs about management practices, n = 14, 130 multiple responses

Soil Condition Factor	Belief	Strength of belief 1-3	Frequency of Response %
Physical			
Drainage	Mole and tile draining improves drainage	3	93
	Cattle on wet soil pugs up the paddock/damages soil structure	2-3	93
	Heavy machinery on wet soil damages the soil	-	64
	Cleaning out field tile exits and re-draining every 10 years is necessary to maintain drainage		21
Compaction	Working paddocks when too wet compacts the soil	3	36
	"Grassing back down gives time to build root structure up again and reverses compaction"	2-3	21
	Subsoiling / Using a soil aerator reverses compaction problems	2-3	14
	The longer a paddock is cultivated the easier it will compact - breaks along unnatural fracture lines	3	14
Friability	Ploughing in maize /barley straw stubble improves friability	3	14
	Leaving a paddock in pasture for several years improves friability (reducing cultivation)	3	14
	Pugging /overstocking with heavy cattle reduces friability	3	14
	Continuous cropping destroys friability through overworking , more cultivation	2-3	14
Biological			
Organic Matter	Ploughing back in crop residue or composting crop increases organic matter	2	21
	An older uncropped paddock /A paddock left to go rank builds up humus level and gives a nice vegetable garden smell	3	14
	Over cropping/over working depletes the organic component of the soil	3	14
	Pugging when wet depletes humus/microbial activity	3	14
Worms	Worms don't like wet soil	3	14
Chemical			
Fertilisers	Applying fertilisers is effective in raising nutrient levels	3	100
	Clovers fix nitrogen	2-3	29
	Spreading effluent on the paddocks once a year (Autumn), or mob stocking in winter, is a good	3	14

	nitrogen fertiliser and keeps the council satisfied.		
	Avoid baling hay and straw to recycle and improve potash level	2	14

Normative Beliefs

Do farmers feel pressured or influenced by social groups to maintain good soil condition? Farmers were asked to rate perceived pressure on a scale of 5, where 0 indicated no felt pressure, and 5 indicated extreme felt pressure. The distributions were rather skewed so medians were calculated as a measure of average response. The results are presented in Table 4.11. Perceived pressure was the strongest from other farmers, but was still only moderate on average. Other pressure groups mentioned were research institutions, agriculture industry and self.

Table 4.11 Influence of social groups on management decisions regarding the soil, n = 14

Normative influences	Median response
Other farmers	3
Buyers (processing companies)	2
Family members	2
Regional Council	1.5
Environmentalists	1
Consumers	0.5
Government	0

Scale for perceived pressure: 0 (no) – 5 (high)

Farmers may feel pressure to maintain good soil condition from particular external groups or individuals, but does this felt pressure influence their behaviour? Farmers were asked to rate the level of consideration that they give each of these influence groups when they make decisions that affect soil condition. The rating scale was out of 5, where 0 indicated that the farmer gave the group no consideration, and 5 indicated that the group was given great consideration. The median response for each group is listed in Table 4.12, where the ordering of normative influences follows Table 4.11.

Most of the external groups/individuals were given minimal consideration for management decisions regarding the soil. Buyers were the only group to rate above the average rating for consideration of 2.5.

Table 4.12 Consideration given to pressure groups in soil management decisions, n = 14

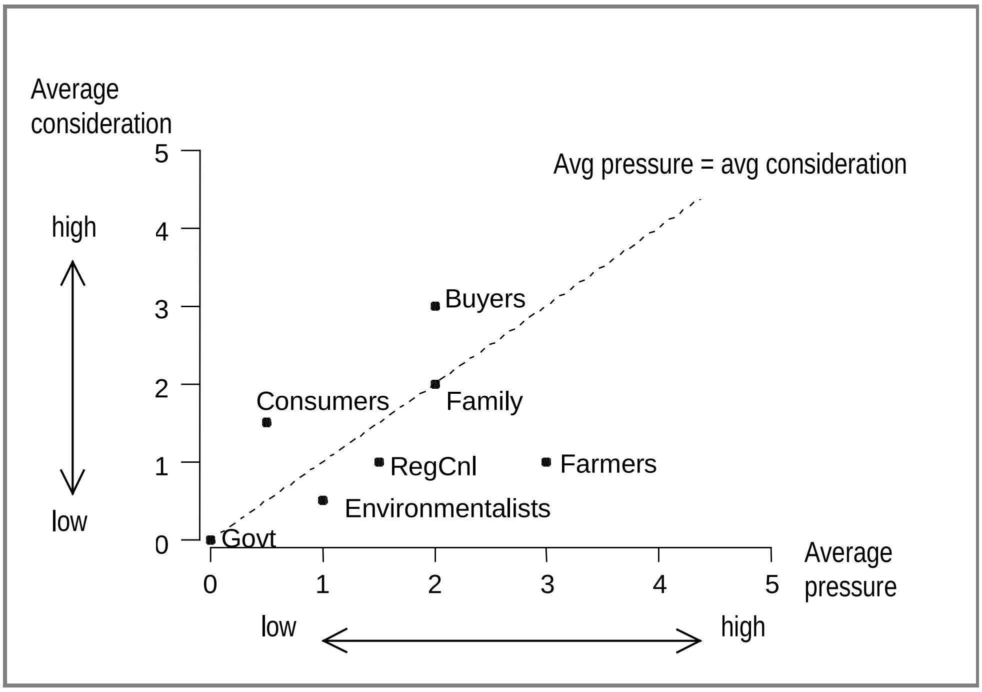
Normative influencers	Median response
Other farmers	1
Buyers (processing companies)	3
Family members	2
Regional Council	1
Environmentalists	0.5

Consumers	1.5
Government	0

Scale for consideration: 0 (no) – 5 (high)

The relationship between average perceived pressure and average consideration given to normative influences is plotted in Figure 4.7. The diagonal line indicates points where average pressure is equal to average consideration. The point representing family influences lies on this line. The government is noticeable in that it appears to play no role as a normative influence in this survey. Farmers felt slight pressure from environmentalists, but gave them almost no consideration in soil management decisions.

Figure 4.7 Average felt pressure versus average consideration given to normative influencers.



If environmental attitudes are embedded in a network of broader values as suggested by Eagly and Kulesa (1997), these values [economic, social, universal] will underlie attitudes towards normative influences of soil management. Attitudes towards each influencer here could be considered to correspond with particular values. Attitudes towards buyers and consumers reflect economic values; attitudes towards other farmers reflect primarily social values; attitudes towards family will reflect both social and economic values; attitudes towards Regional Council and government reflect combined economic, social, and universal values.[6] Attitudes towards environmentalists should primarily correspond with universal values. From this perspective it appears that perceived pressure to maintain good

[6] Regional Councils have the mandate to apply the Resource Management Act (1991). The RMA integrates social, economic, and universal environment values in its definition of sustainable management: "sustainable management means managing the **use, development, and protection** of natural and physical resources" (Part II section 5, emphasis mine).

soil condition is mostly related to social values, while consideration of external influences is mostly related to economic values. This importance of economic incentives corresponds with past research as mentioned in section 2.2.2. On average these farmers gave consumers and buyers higher consideration with respect to soil management than the level of pressure they felt from these groups.

Applying F & A's method, for each individual in the sample, the strength of belief about each external influence (perceived pressure) was multiplied by the subjective evaluation of that influence (consideration) to give a measure of overall attitude. These attitude measures were grouped over the sample for each external influence. The median attitude for each external influence is reported in Table 4.13. The median scores reported are low, for with using multiplication, any response of 0 will generate an attitude of 0.

Given a possible maximum score of 25 for the subjective norm, these results indicate that on average, external influences play a small to moderate role in affecting soil management behaviour[7]. The strongest normative influences of attitudes are family members followed by other farmers and buyers. These results indicate that economic and social values are more important direct normative influences of environmental attitude than universal values, for this group of farmers.

Table 4.13 Attitudes towards normative influence groups regarding soil management behaviour, n = 14

Normative Influencers	Median subjective norm
Other farmers	2
Buyers (processing companies)	1.5
Family members	4
Regional Council	0.5
Environmentalists	0
Consumers	0.5
Government	0

Farmers were also asked the following questions: (a) "Do you think that other countries will put up trade barriers against produce from countries that don't look after the condition of their soils?" and (b) "Does this concern you?" The results are given in Table 4.14.

[7] The maximum score of 25 for the subjective norm would be scored when the ratings given for both perceived pressure and motivation to comply with a specific grouping were equal to 5. Note that this gives a geometric type progression in scores: eg. 2x2=4, 3x3=9, 4x4=16, 5x5=25. This implies that a moderate score for the subjective norm with a rating of 0 – 5 would be 2.5x2.5=6.25.

Table 4.14 Attitudes towards the threat of trade barriers against soil condition, unprompted, n = 13

Response	Frequency of response %	
	Perceive trade barriers likely	Concerned about trade barriers
Yes	31	54
Possibly	31	8
No	38	38

From 13 responses, 62% either perceived that other countries would put up trade barriers in the future regarding soil condition, or thought it was a possibility. Sixty-two percent expressed concern about possible trade barriers, but these were not all of the same farmers who perceived trade barriers to be likely. Of the 5 farmers who believed that trade barriers against soil condition were unlikely, 2 indicated positive concern about the issue.

Control Beliefs

Control beliefs relate to external factors that are perceived to constrain behaviour. With reference to soil management, farmers were asked what were the main factors influencing their decisions. The responses were grouped together under control factors, and together with percentages of response are given in Table 4.15.

Table 4.15 Control belief factors, n = 14, 35 multiple responses

Factors	Frequency of response %
Finance/profitability	100
Weather	43
Environmental conditions	43
Experience/knowledge	29
Legal	7
Time limitations	7
Personal *	21

* Non-external factor

All farmers in the sample cited financial constraints as a controlling factor. Other key external constraints were weather factors and environmental limitations such as soil type. Finance and weather constraints are risk variables, those that a farmer has no perceived direct control over. Some environmental limitations can be directly controlled, such as using tiles and moles for drainage purposes, however cost may be a constraining factor in such situations, limiting the extent of perceived or actual control: “Finance is the number one thing, the arm up your back”. Almost a third of farmers stated experience and/or knowledge as a factor influencing their soil management decisions. Information is an uncertainty factor that a farmer is able to control directly.

Although this question was specifically seeking to elicit external factors, 21% expressed the importance of personal job satisfaction as a controlling factor. One farmer responded "I really do want to leave the farm in top condition". The "Personal" factor is an internal control factor relating to beliefs and attitudes about soil management behaviour.

Sustainable Land Use

What does sustainable land use mean to farmers? Responses to this question were grouped under the types of environmental values defined by Eagly and Kulesa (1997) in section 2.2.2: economic/egocentric value maximises self-interest, social/altruistic value seeks to maximise societal interest, and universal/ecocentric value is concerned with contributing to the health of the ecosystem as a whole. The results are presented in Table 4.16.

Table 4.16 Environmental values corresponding with definition of sustainable land use, unprompted, n = 13, 21 multiple responses

Value categories	Frequency of response %
Universal/ecocentric	77
Social/altruistic	46
Economic /egocentric	38

Sustainable soil use was defined mostly in universal terms, and most farmers (92%) were trying to farm sustainably in this sense (Table 4.17). Only half of the farmers were confident about the effects of their soil management practices. Overall the "No" responses corresponded with social and universal definitions of sustainable soil use, while the "Yes" responses corresponded mainly with economic and universal definitions. Given that attitudes based on economic and social values could either support or oppose soil protection, depending on the situation, motivation towards actual sustainable soil use is not clear from the responses to this question.

Table 4.17 Do you think you are farming your land sustainably? Unprompted, n = 12

Responses	Frequency of response %
Yes	42
I think so/ hope so	50
Probably not	8

To investigate this issue further, the responses from Table 4.17 were compared with the perceptions of change in soil condition from section 4.4 for the same 12 respondents that answered both questions. All of the “yes” respondents and the “probably not” respondent perceived an improvement in soil condition in the average paddock over the last 10 years. The “probably not” farmer was “trying to” farm sustainably, and this may explain the perceived improvement. This farmer’s definition of sustainability, which corresponded with universal values, clarifies the perception of not farming sustainably; “farming a piece of dirt *without having to add any other inputs*, and the environment is not changing”(emphasis added).

The “I think so/hope so” respondents’ perceptions of change in soil condition included all possibilities of better, worse and stable. Overall a slightly smaller percentage (83%) perceived stable or improving soil condition over the last 10 years. This implies that the definition captured here of sustainable soil use corresponds generally with perceptions of stable or improving soil condition.

Chapter 6

CONCLUSIONS

This section discusses the results in light of the research objectives and behavioural model variables (5.1), considers the limitations of this study (5.2), and suggests wider implications and future research directions (5.3).

Discussion of Results

Good soil condition is associated primarily with soil structure and target systems of plants and water: "Our soil is in good heart if the grass looks healthy", if the soil "rolls through your fingers"; "alive [soil] is healthy, free draining, free breathing, friable, plenty of worms". These soil characteristics are observed by looking at soil and related target systems, and feeling soil.

Formal soil tests were carried out by all farmers, with the main objective of assessing soil fertility and fertilising needs. The main nutrients of concern for these farmers were potassium and phosphate, and pH was also a key concern. Soil test results include information on target levels for soil characteristics, and most farmers use these as a guide as to what level to aim for. When presented with a list of chemical, biological and physical analytical indicators, farmers were most familiar with pH, Total N and Particle size Analysis. On average the farmers had heard of the biological indicators, but knew little or nothing about them. Farmers were also relatively unfamiliar with CEC and Total C Content.

Those farmers who were relatively familiar with the indicators considered all of them to be of above average usefulness. In particular, pH and potentially mineralisable N were rated the most useful. The results here display a positive relationship between familiarity and usefulness of analytical indicators for soil management decisions. This suggests that farmers would benefit from increased knowledge of analytical indicators. Formal soil assessments were considered complementary to informal methods.

The most salient beliefs about the effects of management practices on soil condition were related to drainage, compaction and fertilising. These reflect the particular soil characteristics of Marton Silt Loam and the sample type of mixed cropping farmers. Most of the belief responses relate to either chemical or physical soil characteristics. The lack of responses referring to biological soil characteristics corresponds to the lack of familiarity with biological analytical indicators. This finding suggests that a weakness exists in farmer knowledge in this area.

Perceived pressure to maintain good soil condition was connected mostly to social values, through the influences of other farmers and family members. Pressure was also felt from buyers of farm produce. Actual consideration of normative influences was connected primarily to economic values, reflecting the influence of buyers. Family members, reflecting both social and economic values, were also given moderate consideration. Farmers gave consumers and buyers greater consideration with respect to soil management than the level of pressure felt from these groups. This implies that increased pressure targeted towards sustainable soil management from these groups could be effective in influencing farmer behaviour with respect to the soil.

The Regional Council rated low in terms of felt pressure, and rated even lower in terms of consideration. Farmers motivations for considering the Council were in terms of compliance with regulations to "keep them satisfied", rather than support for the regulations. "I think the RMA is very good legislation, but it has major pitfalls in the people administrating it. The extreme people are the ones making the submissions – the wrong people are having the influence". The strongest positive attitude relating to normative influences was towards family members.

While important normative influences on motivation to maintain good soil condition are related to economic and social values, the influence of 'personal' reflects mainly universal values. This was captured in farmer definitions of sustainable land use. Many farmers see themselves as "custodians of the land". The response "myself" was given for both questions 7 and 8 which sought to elicit important external influences on soil management behaviour. This suggests that self-determination and self-motivation are very salient, and therefore significant, influences on soil management decisions. Given that 'personal/self' is the value structure underlying behavioural beliefs, personal attitudes and motivation may dominate other external influences.

If maintaining good soil condition leads to high production levels and associated economic profitability, then economic environmental values reflect motivation towards sustainable soil use. But motivation does not necessarily ensure behaviour. Some farmers admitted having gone for 10 years without applying fertiliser, with the production levels dropping only marginally for many years, before falling off significantly; they described an exponential deterioration in soil condition. It wasn't until the point of significant deterioration in soil condition was reached that these farmers realised they had a problem. Now they are trying to restore soil condition.

Approximately two-thirds of farmers were concerned about the possible threat of trade barriers against produce from countries that don't look after the condition of their soils. Some spoke of increasing demands from buyers with respect to livestock management practices, and could see this path leading towards concerns about soil condition; "As we rely on exports, we have to follow what buyers want". In contrast, another thought the trade barriers would not extend from the products to the soil. Others felt that New Zealand's international trading partners would go to any length to restrict our agricultural exports, as they could not match our comparative advantage in this area; "We have the best freezing works in the world, just because of pressure to kick us out".

The key external controlling factor of soil management decisions was perceived to be finance; "You improve your soil quality as much as finances will allow." Other important risk variables interrelated with finance and profitability were weather and environmental conditions. The main uncertainty factor mentioned was experience and /or knowledge of the effects of management practices on soil condition. This uncertainty is indicated in the results, where in response to the question "Do you think you are farming your land sustainably?", half responded with "I think/hope so", and of these, perceptions of change in soil condition were highly varied. These factors may significantly constrain soil management behaviour despite positive attitudes towards maintaining good soil condition.

The importance of economic values to farmers was highlighted through perceptions of the role of the soil in the environment, consideration of normative influencers, and major control beliefs. This finding supports previous research (mentioned in section 2.2.2) which has shown that New Zealand farmers tend to be primarily production/output oriented, rather than environmentally oriented (Wilkinson, 1996; Townsley et. al, 1997).

In contrast to this apparent economic orientation, three-quarters of farmers defined sustainable soil use on universal terms; "maintaining the soil in a better or same condition that you received it". Economic and social definitions were common, albeit fewer: " maximising returns while realising the limitations of your soil", "to maintain the farm to the best of my ability for future generations". Most farmers believe that their soil management practices are sustainable, and supporting this, the majority perceived stable or improving soil condition over the last 10 years. These results suggest positive motivation towards sustainable soil use in general, subject to economic concerns. Even the farmer who admitted that he wasn't farming sustainably (in social and universal terms) said that he was trying to.

In summary, the public visibility of soil management outcomes, the existence of peer and purchaser pressure, and an innate sense of being "custodians of the land" combine to generate motivation in farmers to manage the soil in a sustainable manner. This positive motivation, however, may be constrained by economic, external risk, and uncertainty factors: finance, physical environment and understanding of the effects of soil management practices.

Limitations

The key limitation to this study is the sample size and selection process. The small sample size and relatively homogenous farm type means that the results are not generalisable across New Zealand farmers. Farmers in other regions will face some different issues and concerns with regards to aspects of soil quality. However, the use of a homogenous group of farmers was necessary, given the preliminary nature and scale of this study.

The possible bias from self-selection of respondents should be noted. This research was dependent on finding enough farmers within the chosen area that were willing to participate.

The other point that should be noted is that an analysis at a single point in time gives a static picture of the dynamic behavioural process of an individual (Gärling et al (1991). This is particularly relevant where attitudes are involved, given the assumptions here that attitudes are potentially unstable and context dependent. Thus these results will be useful in the immediate future, but their validity for longer term reference is doubtful.

It is important to remind the reader that this study was about farmer *perceptions* of sustainable soil use, not the *actual* situation. The development of analytical indicators for soil will facilitate determination and monitoring of the actual situation.

Wider Implications and Future Research Directions

The purpose of the database generated by this study was for integrating the language used to define, and methods used to assess, the characteristics of good soil quality by farmers with those used by scientists. The aim is to facilitate the transfer of information between scientists and farmers, with the objective of promoting sustainable soil management. The main implications of this research are related to both information transfer and actual adoption of sustainable soil management techniques.

Providing translation between descriptive and analytical measures will facilitate the transfer of information between scientists and farmers only if the language used for information transfer is understood by farmers. This study provides a rich source of word descriptors and expressions to enable soil scientists to understand how farmers express themselves and make soil management decisions. Given that many farmers (particularly those without tertiary agricultural training) are unfamiliar with the language of agricultural scientists, the use of such language in information transfer will affect farmer motivations towards the adoption of formal soil monitoring. The effective uptake of analytical soil indicators requires the translation of scientific language back into the language of farmers as much as possible, so as to enhance further adoption of formal soil monitoring and motivation towards sustainable soil use.

Uncertainty with regard to experience and /or knowledge was noted as an important controlling factor in soil management. In the words of one farmer: "When I grassed down two years ago I thought strongly of using an organic fertiliser but wasn't sure of end returns, if they would be as good as what I'm doing now". In addition to production/output uncertainty, farmers may also experience universal/ecosystem uncertainty. Legg and Potier (1998) suggest that farmers are often not fully aware of the effects on the environment of their management practices, or of practical possibilities for improving their management techniques.

Some farmers referred to past MAF extension programmes (Farm Advisory Services) as being two-way relationships, beneficial to both parties in the diffusion and development of knowledge. In the current macroeconomic environment farmers have become detached from research institutions and government departments. If adoption of sustainable soil management requires "effective application, provision and dissemination of knowledge" (Legg and Potier, 1998, p36), the method used to achieve this must be evaluated in the light of information presented here.

In particular, the mode used for information transfer is important. This study indicates that farmers do not give much consideration to regional councils, but give most consideration to buyers of their produce. Can information be transferred effectively from scientists to farmers through buyers? What are the reasons for the lack of rapport with regional councils? What form do farmer attitudes and motivations towards research institutions take? These are questions that need to be addressed in order to select the best mode for information transfer.

Risk from financial, weather and physical environmental factors appeared to be the most significant external constraint for the farmers in this sample. Ervin and Ervin (1982) contend that the adoption of conservation practices is related to attitude toward risk. In particular, risk aversion has been described as a friction that restricts the efficient allocation of farm resources, such as causing slower adoption of improved technologies (Hardaker et al, 1997). Following Ajzen's (1988) reasoning, a positive attitude toward sustainable soil use is not enough to ensure such behaviour if the farmer perceives that external factors constrain the behavioural outcome. External constraints can change motivations towards behaviour. Given this understanding, estimation of the extent of business risk that farmers face, and its impact on attitudes and motivations toward soil management behaviour, would be useful for improved understanding of farmer decision-making. How risk averse are farmers, and how does risk averting behaviour affect soil condition in New Zealand?

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Appendix A

Questionnaire on farmer descriptions of good soil condition, and beliefs and attitudes towards sustainable land management practices.
August 1998

Q1. Information on Property

Farmer Name:
Farm location:
Predominant Soil Type:
Farm Area:
Years of present management:
Years of present ownership:
Type of Farm: (yrs)

Q2. Soil assessments

2.1 Think about how you tell what condition a soil is in.
What do you look for specifically?
(PROMPT: LOOK, FEEL, SMELL, CHEMICAL, BIOLOGICAL, PHYSICAL; HOW DO YOU DETERMINE IF A SOIL IS SUITABLE FOR CULTIVATION?]

2.2 How often do you make these assessments?

2.3 Having assessed the condition of the soil, how do you use this information?
PROMPT: HOW DOES KNOWING THE CONDITION OF THE SOIL HELP YOUR FARM MANAGEMENT DECISION MAKING?

2.4 If you think about the role of soil in the environment in general, how soil interacts with things like plants and water, and how they interact with soil…..
To what extent do you think the condition of the soil is connected with the condition of these other things? Can you rate them out of 5, where 0 means that they are not connected and 5 means that they are strongly connected.

Target system	rating
Plants	
Animals	
Humans	
Water	
Air	

Q3. Soil tests

3.1 Do you carry out any soil tests? [CIRCLE NUMBER]

no	(
yes	1

3.2 How do you decide which paddocks to test?

3.21 How many samples do you take in each paddock?

3.22 How often do you test? [HOW MANY PADDOCKS, HOW MANY TIMES]

3.23 Why do you test this often?

3.3 What do you test for?

3.31 Who does the tests?

3.32 Do you follow the recommendations from soil tests

3.4 Is cost an important factor in following recommendations? [CIRCLE NUMBER]

no	0
yes	1

3.41 Approximately how much per year would you spend on testing?

$

3.5 With the soil tests, are there critical levels that would make you concerned about the condition of your soil?

Q4. Soil analysis

4.1 Can you think of a paddock that performs about average for your farm?
On that average paddock, what condition do you think your soil is in?

Lets go through the different soil condition factors that you have identified (Q 2.1, Q 3.3) one at a time, and can you rate whether the soil is poor, below average, average, good or very good.

Soil Factor	Very Poor	Poor	average	good	Very good	2 yrs ago	10 yrs ago

4.2 Considering these different measurements, do you think the soil condition has changed over the last two years?
If we run through these measurements one at a time can you tell me if they have improved or become worse?

INDICATE IN RIGHT HAND COLUMNS BY + AND - AS DEVIATIONS FROM CURRENT STATE.

4.3 What about over the last ten years? Has the soil condition changed? Has it improved or become worse?

Q5. Scientific indicators

PRESENT FARMER WITH SHOW CARD OF ANALYTICAL INDICATORS AND INTERPRETATIONS.

5.1 This is a list of measurements for soil condition as used by some scientists we have spoken to. How familiar are you with these? Can you rate them as follows*:*

Never heard of it	0
Heard of it but know little or nothing about it	1
Heard of it and I know something about it	2
Heard of it and I could explain it to someone else	3

#	*Indicator*	*Soil condition*	*Rating*
C1	Total C content	Total Organic content	
C2	Total N content	Total Organic Nitrogen	
C3	Cation Exchange Capacity	Buffering and nutrient reserves	
C4	pH	Acidity or Alkalinity	
B1	CO_2 efflux	Soil respiration and microbial activity	
B2	Microbial biomass/organic C	Active soil organic fraction	
B3	Potentially mineralisable N	Readily mineralised nitrogen reserves	
P1	Bulk density	Soil compaction/root environment	
P2	Moisture release	Water retention/available water	
P3	Hydraulic conductivity	Infiltration rate/drainage	
P4	Particle size analyses	Sand/silt/clay contents	

5.2 Of the measurements that you have 'heard of and know something about or could explain' (2 & 3), how useful are they for your farm management decisions? Can you rate them out of 5, where 0 means that they are of no use to you, and 5 means that they are extremely useful to you.

#	Description	Rating

5.3 Of those which you have identified as of some use (rated 3,4,5), how do you use them? Do you test for them?

5.31 What do you do with that information?

Q6. Beliefs

6.1 What farm management practices do you use that affect soil condition? Lets go through the different soil condition factors one at a time [FROM Q2.1 AND Q5.3], and can you tell me what farm management practices you use that affect each one.

6.2 For each management practice that you have given, can you rate how much it affects the soil condition factor from:

a little	1
moderately	2
alot	3

Soil condition factor	Belief about management practice	rating

Q7. Normative beliefs

7.1 Thinking about the management decisions that you make which affect soil quality..

Do you feel pressure from any of the following groups to maintain good soil condition? Can you rate them on a scale of 5, where 0 means that you feel no pressure from them, and 5 means that you feel extreme pressure from them.

Group	Rating
Consumers	
Buyers (Marketers, Processing companies)	
Regional Council	
Government	
Other farmers	
Members of your family	
Environmentalists	

Do you feel pressure from any other group or individual to maintain good soil condition? Can you rate that pressure? INCLUDE IN BOX ABOVE.

7.2 In general, how much consideration do you give each of these ‘groups’ when you make decisions that affect soil quality? Can you rate them on a scale of 5, where 0 means that you give them no consideration, and 5 means that you give them great consideration.

Group	Rating
Consumers	
Buyers (Marketers, Processing companies)	
Regional Council	
Government	
Other farmers	
Members of your family	
Environmentalists	

7.3 Do you think that other countries will put up trade barriers against produce from countries that don’t look after the condition of their soils?

7.4 Does this concern you?

Q8. Control Beliefs

8.1 When you go to make a management decision on your farm that will affect your soil condition, what are the main factors that influence that decision? What is the most important factor?

[PROMPT: FINANCE, INFORMATION, PRICES, RISK (eg. weather /exchange rates), MANAGEMENT SKILLS, TRAINING, EXPERIENCE, SOIL PRODUCTIVITY, LEGAL FACTORS - legislation, property rights, INSTITUTIONAL FACTORS - support structures].

Factor	How it affects the decision

Q9. Sustainable land use

9.1 What does sustainable land use mean to you?

9.2 Do you think you are farming your land sustainably?

Table A 5.1 Showcard of Analytical Indicators

#	*Indicator*	*Soil condition*
C1	Total C content	Total Organic content
C2	Total N content	Total Organic Nitrogen
C3	Cation Exchange Capacity	Buffering and nutrient reserves
C4	pH	Acidity or Alkalinity
B1	CO_2 efflux	Soil respiration and microbial activity
B2	Microbial biomass/organic C	Active soil organic fraction
B3	Potentially mineralisable N	Readily mineralised Nitrogen
P1	Bulk density	Soil compaction/root environment
P2	Moisture release	Water retention/available water
P3	Hydraulic conductivity	Infiltration rate/drainage
P4	Particle size analyses	Sand/silt/clay contents

Appendix B

This section contains the collated responses from the questionnaire. The data is grouped under the same headings as the questions. Text in quotation marks indicates direct quotations that were recorded during interviews.

Informal Soil Assessments *B 2.0*

Table B 2.1 Informal Soil Assessments, n = 14, 50 multiple responses.
Sensory code: L = look, F = feel, S = smell

Variable	response	Code	Number [total]
Number of worms	"scratch back top 2-3 inches";	L	**4**
	"look for when cultivating - aerate soil"	L	
	"tremendous amount of worm action shows we've got air which will allow microbial activity to take place"	L	
	"plenty of worms"	L	
Pasture/crop growth;	"our soil is in good heart if the grass looks healthy"	L	**21**
growth	"how quickly it responds after being chewed out"	L	10
	"lack of grass/production/growth in winter"	L	
	"production"	L	
	"amount of feed growing"	L	
	size of turnips,	L	
	"grass cover - bare patches are possibly from too much pugging"	L	
	"grass not growing"	L	
	"speed of growth"[2]	L	
	"growth of ground cover"	L	
Species	"Clover content as opposed to weed invasion indicates something a bit wrong"	L	5
	"Pasture deterioration - change in grass species - can indicate poor drainage, ie. rushes - wet patches all year round"	L	
	"Flat weed"	L	
	"pasture quality"	L	
	"rushes - soil wet"	L	

Variable	response	Code	Number

Colour	“yellow spots on grass means its wetter and nitrogen deficiency,”	L	6
	“Colour of the grass, when it gets a bit pugged and hard it goes a bit yellow”	L	
	“colour of cover”	L	
	“colour: too wet, yellow, foreign, reverting to native grass”		
	“colour of the grass, dark green is good; yellow barley - nitrogen deficiency”	L	
Stock condition:	“stock quality indicates nutrients”	L	**1**
Drainage/ Moisture/pugging:	don’t plough when wet	L	**12**
	“if you grab a handful of soil and squeeze it into a ball, if it stays sticky its too wet, if it will crumble its not too wet”	F	
	“if it’s wet, if I walk on it and I’m leaving footprints on it, then I won’t put any beef on it”.	F/L	
Drainage/ Moisture/pugging cont.	“Mud”	L	
	“how quickly the surface water gets away after rain”[2]	L	
	“wetness is a sign of poor drainage or pugging”	L	
	“drainage: wet soils tend to be a bit sour”	L	
	“how long the water lies there”	L	
	“Drainage/pugging”[2]	L	
	how wet/dry it is. “I don’t like pugging my paddocks as a rule, but I will. I’m a rotational grazer/feeder. Stock does less damage if they are moved more frequently. Pugging is when animals break through the surface of the soil,” which leads to reduced growth, longer rotation, or recultivation.	L	
	“wetness, squelchiness feel, puddles lying on top, feed tramps into the mud - bad, pugging”	L/F	
Structure:	“friability- rolls through your fingers”	F	**10**
	“tillage, how it breaks up: if hard, too compacted or too wet, like the ground to be dry for ploughing; friability - looseness”	F	
	“Feel, crumbling through hands, breaks up easy, friable; tractor- how it cultivates, ploughs really nice; when you dig if its good and you drop it the clod will break; after ploughing a few years you lose the humus - less lumps - harder to cultivate”	F	
	“when cropping the ability to work up a fine tilth; if your soil structure is good it will break down easy, if there is plenty of humus, the organic content”	F	

Variable	response	Code	Number
Structure continued:	“when working up paddocks for cropping, friability - if you’ve got rock hard lumps you know your ground is not in good condition. If it comes up fine you know its in good condition”	F	
	Good condition - friable, not lumpy, “being able to grab hold a handful and crumble in your hands, breaks down easily”.	F	
	“How friable and how easy it cultivates up indicates what the soil structure is like”, “how much you have to hammer it down to break it up”, alot of organic matter “breaks down easily into a seed bed”.	F	
	“Compaction from animals, heavy vehicles. It’s vanilla ice-cream country, it’s got no hokey-pokey in it, very fine and not aerated”	L/F	
	compaction	L	
	“Whether I think the soil looks alive or dead; alive is healthy, free draining, free breathing, friable, plenty of worms. Free breathing- not smeared, not compact and lumpy/muddy. Friable - breaks up nicely in your hand”	L	
Smell:	“Good condition: earthy smell, enzymes, bacteria breaking down cow dung”	S	**2**
	“more compacted smells rancour; alot of vegetable matter (humus) smells good”	S	

Sensory code: L = look, F = feel, S = smell

Table B 2.2 How often do you make these assessments?

Response	number
Daily /All the time /on going	11
Prior to cropping/ploughing	5
When doing soil tests	1
When Shifting stock	1

Table B 2.3 Uses for informal soil assessments

Use	Responses	number
	“Should totally determine your way of farming”	
	“You try to remedy the perceived problem, follow signs and take appropriate steps”	

Use	Responses	number
Paddock rotation decisions.	“If I think the soil looks wetter (compared with historical knowledge), or less friable, I’ll put a cropping paddock back into grass. Once you destroy your soil structure you need to get it back	5

	again to restore it and get grass back".	
	"If I think the soil is producing alot of feed - indicates how often can rotate back in to that paddock - feed utilisation",	
	Plough paddock when grass deteriorates - grass management decision "Grass is the objective; try to cultivate the ground to make it better for grass, while making money off of crops along the way".	
	New grasses have been disappointing- disappeared - may need new grassing.	
	next to be ploughed	
Cropping policy/Fertilising	Cropping plans, backed up with soil tests. "The soil tests indicated that the soil condition was low, but you knew that anyway just by looking at it." "The modern grasses don't last as long".	9
	"You put it into the mix of the way you look at improving the condition of the soil to improve the production of the crop"	
	What crop and when	
	Plan next move of cropping programme	
	Which implement to use for cultivation	
	What fertiliser and how much over and above basic dressing	
	Put fertiliser on to make the grass look green	
	"Whether I should be trying to improve fertility"	
	Amount of fertiliser/soil tests	
Drainage/ Compaction	Further draining if required (2)	6
	"whether I should be trying to improve drainage"	
	deciding which paddocks to mole-drain.	
	If draining is working or needs work - redraining	
	if too wet don't use tractor	
Livestock Policy	How many stock units and what description.	6
	plan next move of stocking program	
	"I'm very conscious of soil structure and the damage you can do to it... you can tramp a paddock for a day and it will recover, but if you do it for 2-3 days it won't recover for a very long time. When you tramp it you kill all the worms, they come to the top for lack of air."	
Livestock Policy	"If it's wet and soft I'll alter stocking program - take stock off".	
	If particularly wet, won't put cattle on; "the perfect way would be to de-stock this country in winter, but then we'd make no money".	
	"If bad- waterlogged- can't use for cattle"	

Table B 2.4 The role of soil in the Environment in general: To what extent do you think the condition of the soil is connected with the condition of these other things?

#	*Plants*	*Animals*	*Humans*	*Water*	*Air*
1	5	4	3	5	4
2	5	5	3	5	4
3	5	4	1	5	5
4	5	4	5	3	3
5	5	5	5	3	4
6	5	3	3	4	2
7	5	4	2	5	5
8	5	5	5	5	3
9	5	4	3	4	2
10	5	5	5	5	5
11	5	4	3	3	1
12	4	4	2	3	2
13	3	4	4	1	3
14	-	-	-	-	-
Total	**62**	**55**	**44**	**51**	**43**
Mean	4.8	4.2	3.4	3.9	3.3
Median	5	4	3	4.5	3.5

Rating scale 0 (low) – 5 (high)

Table B 3.1 Soil testing and fertilising statistics

#	size of farm hectares	soil plugs per paddock	percentage of farm tested annually	Number of paddocks tested annually	$per year on tests	$ per year on fertiliser, 00s	% of fertiliser costs spent annually on tests
1	93	15	0.09	2	150	6000	0.025
2	86	15	0.33	5	300	16000	0.019
3	160	17.5		13	500	20000	0.025
4	160	20	0.20	5	300	22000	0.014
5	235	20		2	70	16000	0.004
6	183	19	0.50		300	30000	0.010
7	150	5	0.25	6	700	14000	0.050
8	94	30	0.10	2	100	9000	0.011
9	153		0.11		300	10000	0.030
10	256	15	0.18		200	13500	0.015
11	85	3	0.33	5	500	6000	0.083
12	111	15		1	50	24000	0.002
13	84	12		1.33	60	6000	0.010
14	110	20		0.67	67	12000	0.006
Total	**1960**	**206.5**	**2.09**	**43**	**3596.67**	**204500**	**0.304**
Mean	140	16	0.23	3.91	256.90	14607	0.02

Table B 3.2 How do you decide which paddocks to test?

Response	number
For specific problems: production level of grass, selected for development, to find out what is needed to make them better,	5
Representative sample	5
Set rotation of all paddocks “want to build up a picture of what is happening”	4
To determine fertiliser for pasture and for future crops [ex ante]	2
Test same ones to see if fertiliser applications are effective[ex post]	3
Prior to cropping	6
After cropping	1

Table B 3.23 Reasons for soil testing. Unprompted, n = 14, 20 multiple responses.

Reason	Response	number
Cropping	For cropping, need to know what/how much fertiliser to put on	5
Fertility	➢ Fertility: to build a picture of fertility to determine the correct fertiliser application for each individual paddock so as to minimise costs; ➢ "to check that I haven't mined all the nutrients out of it"; ➢ " I want to know if we're spending our money wisely on fertiliser", ➢ to monitor fertility levels	7
Development	moving around the farm developing different areas	1
Trends/problems	➢ "looking for a change in soil environment with relation to management practices, must be done consistently over time to detect trends" ➢ "confirmation of a problem"	2
Recommendations	Recommendations for soil tests	1

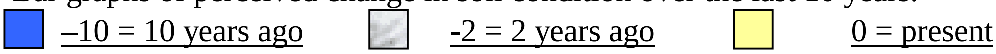
Table B 3.31 Who does the tests?

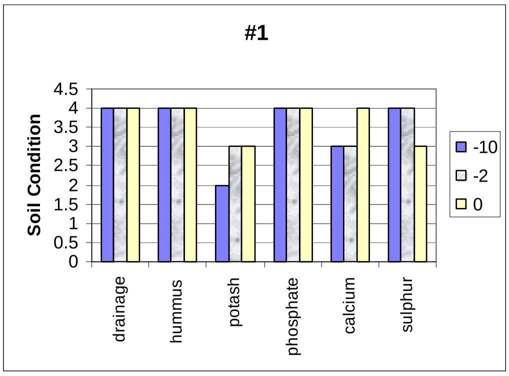
Response	number
Analytical Services Ltd. Cambridge	13
Perry Institute (U.S).	1

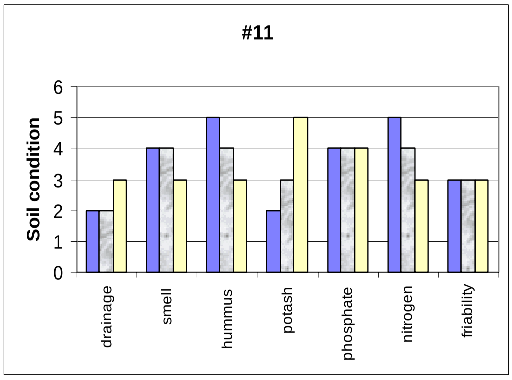
Table B 3.32 Do you follow the recommendations from the soil tests?

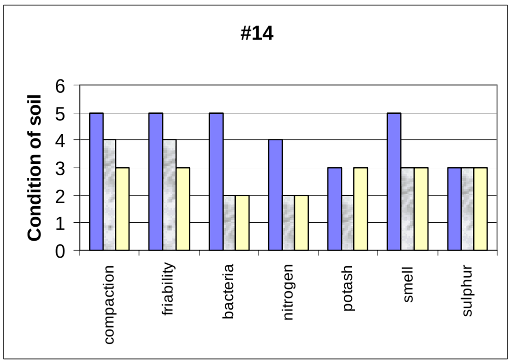
Response	number
Yes, for the most part	9
To some extent	3
No ➢ I usually make my own assessment" ➢ "the cropping recommendations are always far too low to maintain soil fertility"	2

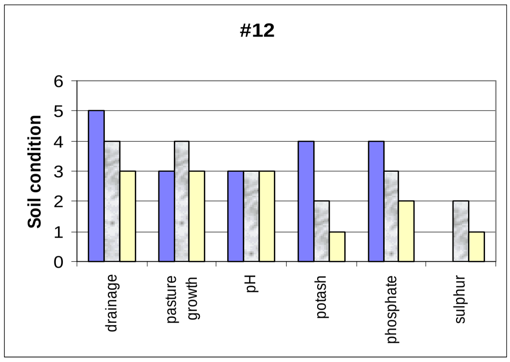
Bar graphs of perceived change in soil condition over the last 10 years.

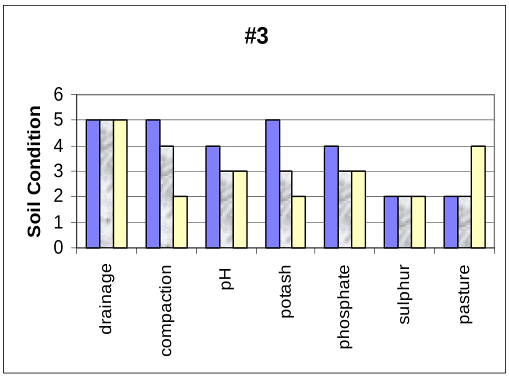


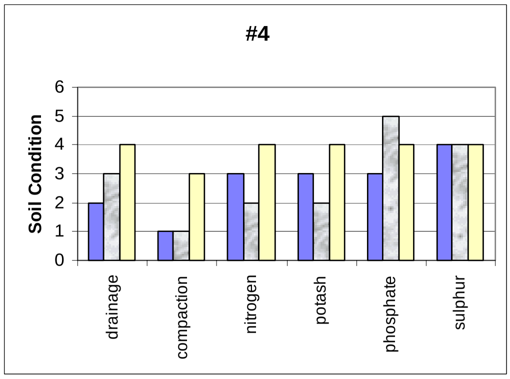


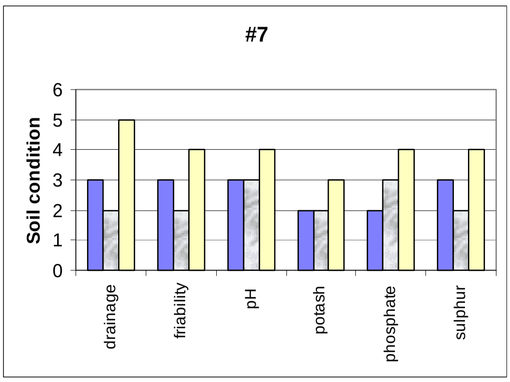


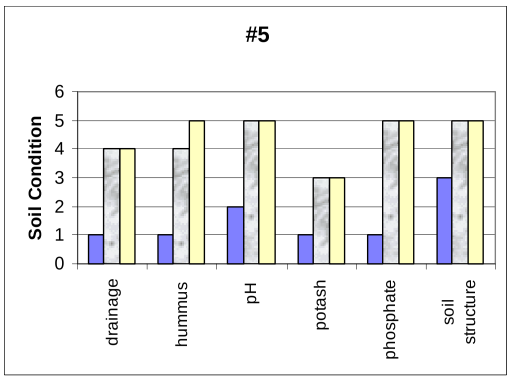


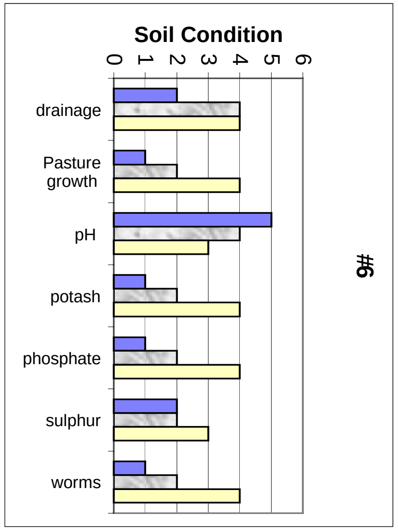


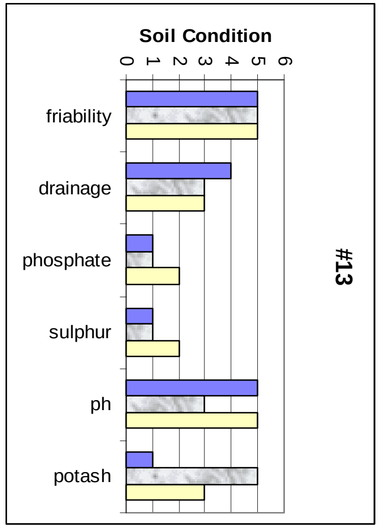


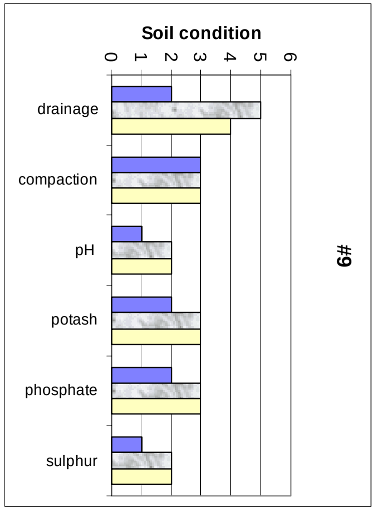


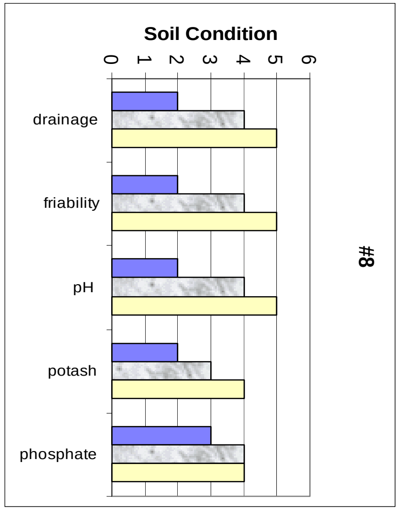





Soil Condition
0 1 2 3 4 5 6
drainage
Pasture growth
pH
potash
phosphate
sulphur
worms
#6


Soil Condition
0 1 2 3 4 5 6
friability
drainage
phosphate
sulphur
ph
potash
#13


Soil condition
0 1 2 3 4 5 6
drainage
compaction
pH
potash
phosphate
sulphur
#9


Soil Condition
0 1 2 3 4 5 6
drainage
friability
pH
potash
phosphate
#8

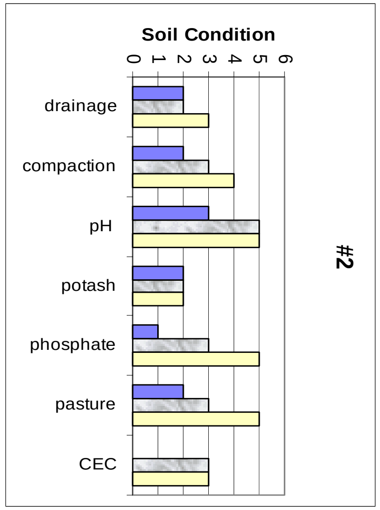
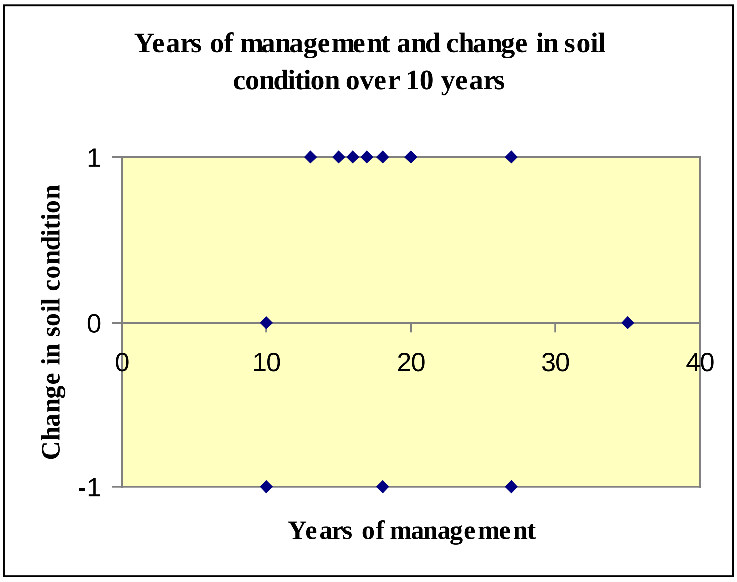

Soil Condition
0 1 2 3 4 5 6
drainage
compaction
pH
potash
phosphate
pasture
CEC
#2

Figure B 4.1 Years of management and perceived change in soil condition over 10 years.



1 = better, 0 = stable, -1 = worse

Figure B 4.2 Size of farm and perceived change in soil condition over 10 years
1 = better, 0 = stable, -1 = worse

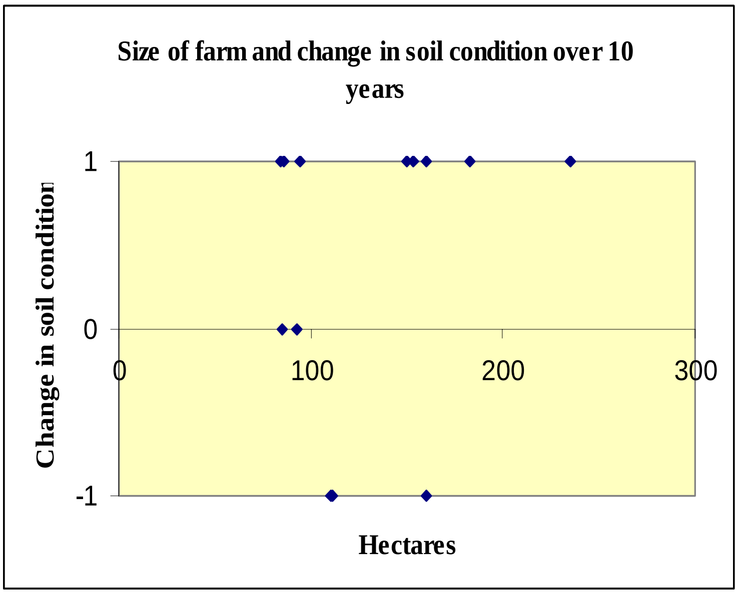


Table B 5.1 Familiarity with analytical indicators.

	C1	C2	C3	C4	B1	B2	B3	P1	P2	P3	P4
1	2	3	1	3	2	1	1	1	1	1	2
2	0	3	3	3	0	1	1	3	2	1	2
3	0	2	1	3	0	0	1	1	2	2	2
4	3	3	3	3	3	2	3	3	3	3	3
5	3	3	1	3	3	3	3	3	3	3	3
6	2	2	1	3	0	0	1	2	2	2	2
7	3	3	2	3	1	1	1	2	2	2	2
8	2	2	2	3	1	1	1	2	3	2	3
9	1	2	1	3	1	1	1	1	1	1	2
10	2	2	2	3	3	1	3	2	2	3	3
11	2	3	1	3	2	2	3	3	2	2	3
12	1	2	3	3	3	2	2	1	3	3	3
13	1	2	0	2	0	0	0	1	0	2	2
14	1	1	0	2	0	0	1	1	0	1	1
Total	**23**	**33**	**21**	**40**	**19**	**15**	**22**	**26**	**26**	**28**	**33**
Mean	1.6	2.4	1.5	2.9	1.4	1.1	1.6	1.9	1.9	2.0	2.4

Table B 5.2 Usefulness of analytical indicators.

	C1	C2	C3	C4	B1	B2	B3	P1	P2	P3	P4
1	3	4	-	4	3	-	-	-	-	-	3
2	-	5	5	5	-	-	-	4	2	-	1
3	-	5	-	5	-	-	-	-	2	4	1
4	4	4	4	4	2	1	4	5	3	3	2
5	5	5	5	5	5	5	5	5	5	5	5
6	2	4	-	5	-	-	-	5	3	3	2
7	4	4	2	5	-	-	-	1	1	3	1
8	5	3	2	5	-	-	-	5	5	4	4
9	-	3	-	4	-	-	-	-	-	-	4
10	3	4	3	4	5	-	5	3	5	5	5
11	3	4	-	4	1	3	5	4	4	3	2
12	-	4	3	5	3	2	3	-	5	5	3
13	-	3	-	5	-	-	-	-	-	5	4
14	-	-	-	5	-	-	-	-	-	-	-
Total	**29**	**52**	**24**	**65**	**19**	**11**	**22**	**32**	**35**	**40**	**37**
Mean	3.6	4.0	3.4	4.6	3.2	2.8	4.4	4.0	3.5	4.0	2.8

Table B 5.3 What do you use indicators for?

Response	Number
To aid Management decisions (fertiliser, drainage, cropping)	14
➢ ***"Adds value to the quality of the information from traditional methods"***	
➢ ***an overall picture***	
➢ ***"soil test results don't necessarily correspond with visual analysis"***	
➢ ***"if you've got healthy soil, you've got healthy stock and crops which gives you a healthy bank balance"***	
Provide record	1

Table B 6.0 What farm management practices do you use that affect soil condition?
Effectiveness rating scale: 1(low) – 3 (high)

Soil Condition factor	Belief about management practice *n = 14*	Rating, 1-3	number
Drainage/ Compaction	Mole and tile draining improves drainage	3	13
	Cleaning out field tile exits and re-draining every 10 years is necessary to maintain drainage		3
	Cattle on wet soil pugs up the paddock/damages soil structure	2-3	13
	Heavy machinery on wet soil damages soil structure/causes compaction/timing of when to use machinery to prevent compaction	3	9
	Avoiding pugging makes drainage last longer		1
	Putting a ripper through to break up pan can improve drainage	3	1
	Compaction will "stuff all the worms" by removing air holes	3	1
	Worms help drainage when you keep stock off		
	Level paddocks improve drainage	2	1
	Operate a rotational grazing system to avoid using supplementary feed in winter which would require using a tractor on wet soil		
	Applying lime frees up the soil, allows microbial activity, creation of air spaces and worm activity which affects drainage	1	1
Compaction	Using a loafing pad for calving prevents pugging	3	1
	Subsoiling / Using a soil aerater reverses compaction problems	3	2
	Grassing back down gives time to build root structure up again and reverses compaction	2-3	3
	A good crop rotation and grassing programme improves friability	3	1
	Ploughing improves compaction and drainage	2	2
	Working paddocks when too wet compacts the soil	3	5
	A good grass cover in winter helps prevent pugging		1
	Strip grazing causes compaction		1
	Every 8-10 years need to work the soil to aerate and keep performing at a good level		1

Soil Condition	Belief about management practice	Rating,	number

factor	*n = 14*	1-3	
Compaction cont.	Working the soil too fine ("as fine as an onion bed") causes compaction	3	1
	The longer a paddock is cultivated the easier it will compact - breaks along unnatural fracture lines	3	2
Friability	*" That lovely fresh garden soil… the right moisture content so that it has body, you can work it and it won't compact"*		
	Ploughing in maize /barley straw stubble improves friability	3	2
	Leaving a paddock in pasture for several years improves friability (reducing cultivation)	3	2
	Pugging /overstocking with heavy cattle reduces friability	3	2
	Higher fertility gives greater friability	2	1
	Continuous cropping destroys friability through overworking , more cultivation	2-3	2
	Applying lime improves friability	2	1
Organic matter	Ploughing back in crop residue increases humus; Planting a composting crop, fallowing over winter and ploughing it back in would improve organic matter	1-2	3
	Over cropping/over working depletes the organic component of the soil	3	2
	Pugging when wet depletes humus/microbial activity	3	2
	Laxed grazing allows more dead vegetative matter to go back into the soil		1
	Mole draining tends to improve humus levels as in winter grasses are putting down better roots than if it was waterlogged	2	1
	Seven year fallow would improve organic matter	3	1
	Not burning stubble stops bacteria from being killed	3	1
	An older uncropped paddock /A paddock left to go rank builds up humus level and gives a nice vegetable garden smell	3	2
	Stocking rate affects bacteria from dung and urine	1	1
CEC	Rotation from cropping to pasture allows CEC's to build back up		1
Worms	Worms don't like wet soil	3	2
	Worms like neutral soil		1
	Worms act as a soil aerator	3	1
	Compaction kills worm population	3	1
Fertilisers nitrogen	Applying fertilisers is effective in raising nutrient levels	3	14
	Clovers fix nitrogen	2-3	4
	Peas are a very restorative crop for nitrogen	2	1
Soil Condition factor	Belief about management practice *n = 14*	Rating, 1-3	number

	Less cropping and more fattening would deplete it less	3	1
	Keeping a healthy soil structure and plant population above ground allows microbial activity to take place	3	1
	Mob stocking in winter - Manure is very high in nitrogen; spreading effluent on the paddocks once a year (Autumn) is a good fertiliser and keeps the council satisfied	3	2
Sulphur	Apply fertiliser to increase sulphur levels	1-2-3	3
	Applying sulphur releases other chemicals in the soil		1
Potassium	Having your soil well drained will make the potash more available	2	1
	Avoid baleing hay and straw to recycle and improve potash level	2	2
	Dung and urine going back in to the paddock improves potash	1	1
pH	Stock prefer to eat off soils that have has lime put on them because they are sweeter to taste	2	1
	Acidic fertilisers cause the pH to drop	1	1
	Draining the soil decreases acidity	1	1
	A correct pH level will make the phosphorous and the potash more available		
Phosphorous	Fallowing and composting crops improve phosphorous levels	2	1
	Cropping, trading lambs removes phosphate	3	1
	Having your soil well drained will make the phosphate more available	3	1

Effectiveness rating scale: 1(low) – 3 (high)

Table B 7.1 Pressure felt from external groups on soil management decisions.

#	Cons	Buyers	Reg.Cncl	Govt	Farmers	Family	Envm
1	4	0	3	1	3	1	0
2	1	1	0	0	4	5	1
3	0	5	3	0	0	0	1
4	0	0	0	0	3	3	0
5	0	3	0	0	3	3	0
6	0	2	5	2	3	3	3
7	2	2	1	0	1	3	2
8	3	4	2	3	3	2	0
9	0	0	0	0	3	0	4
10	3	0	2	1	0	0	1
11	3	4	2	1	3	2	2
12	0	0	0	0	0	0	0
13	5	5	4	0	5	5	4
14	0	3	0	0	2	2	0
Total	**21**	**29**	**22**	**8**	**33**	**29**	**18**
Mean	1.5	2.1	1.6	0.6	2.4	2.1	1.3
Median	0.5	2.0	1.5	0.0	3.0	2.0	1.0

Table B 7.2 Consideration given to others in soil management decisions.

#	Cons	Buyers	Reg.Cncl	Govt	Farmers	Family	Envm
1	2	3	3	1	2	4	3
2	1	1	1	0	1	4	1
3	0	2	2	0	1	0	1
4	0	3	0	0	5	3	2
5	3	3	0	0	0	3	0
6	0	0	3	0	0	2	0
7	2	1	1	0	0	0	1
8	4	4	3	2	3	3	0
9	0	0	0	0	0	0	0
10	3	5	3	3	0	0	1
11	3	4	2	2	2	2	1
12	0	0	0	0	0	0	0
13	3	5	0	0	4	3	0
14	0	3	0	0	2	1	0
Total	**21**	**34**	**18**	**8**	**20**	**25**	**10**
Mean	1.5	2.4	1.3	0.6	1.4	1.8	0.7
Median	1.5	3	1	0	1	2	0.5

Table B 7.3 Do you think that other countries will put up trade barriers against produce from countries that don't look after the condition of their soils?

Response	*Number*
Yes	3
Possibly	5
No	5

Table B 7.4 Does this concern you?

	Response	Number
Yes:	➢ As rely on exports have to follow what buyers want ➢ "We have the best freezing works in the world just because of pressure to kick us out" ➢ "I personally think we're going to have a big re-evaluation of what we're putting into our soils"	7
Possibly:	"people have reasons for objections…if we are doing something wrong then maybe we should look at what we are doing"	1
No:	➢ The trade barriers will be on the products –nutrient levels or toxins – not on the soil ➢ "we will become more and more organic type farmers, it will be forced on us" ➢ "I don't think they care about our soil; they may care about animal welfare, growth hormones, … they don't give a rats rear end about our soil…that's our problem" ➢ "I don't think NZ farmers would allow the soil to get into such a state where it could happen" ➢ "I think it's quite important how other countries perceive you to be.. [in terms of greenness]"	5

Table B 8.1 What are the main factors that influence your decisions [which affect soil condition]?

Factor	How it affects the decision	Number
Finance/ Profitability	➢ "I try to keep the soil in as good as condition as I can because it determines my income…you have to make compromises but if I stuff up my soil I stuff up my income" ➢ "you improve your soil quality as much as finances will allow" ➢ important for major capital investment (eg drainage) ➢ "Any damage you do will reduce your productivity and your profitability" ➢ "Profitability is paramount…I could make more money in the short term if I didn't spend so much on drainage and manure but long term I'd be worse off, because I wouldn't be able to take advantage of opportunities if the pasture was run out" ➢ product prices ➢ "Biggest constraint is the bank manager…finance…the arm up your back"	14
Weather	➢ stock /pasture management ➢ can damage crops	6
Time	➢ Not enough time to do all the things you'd like to do	1
Crop limitations due to environmental conditions	➢ Soil type, fertility ➢ Landscape: "work a paddock with a machine…in rolling country you can take all the top soil off the top of the hill if you're not careful"	6
Experience/ Knowledge	➢ Of soil needs with respect to fertiliser ➢ Keeping reasonably accurate records of paddock history ➢ "When I grassed down 2 years ago I thought strongly of using an organic fertiliser but wasn't sure of end returns, if they would be as good as what I'm doing now"	4
Legal factors	➢ Pollution, too much nitrogen from cows, and too much effluent down the creek	1
personal	➢ How you feel...job satisfaction in developing your farm…huge motivation… I really do want to leave the farm in top condition"	3

Table B 9.1 What does sustainable land use mean to you?

Environmental Attitude	Response	Number
Universal	➢ "Not depleting soil reserves…treat it as a bank basically; being able to farm consistently...from here to eternity and not being worse off" ➢ "Maintaining the soil in a better or same condition that you received it...never treat soil like dirt"	9
Economic	➢ "Maximising returns whilst realising the limitations of your soil" ➢ "I used to run a sustainable operation…that just about sent me broke; we were put into free market, the playing field was full of lumps and bumps and hollows, it certainly wasn't level, and my attitude now is "stuff it" – I certainly won't rape it, but I'll take what I need from it, that's a swipe at the current system"	3
Social	➢ RMA: "I think the RMA is very good legislation, but has major pitfalls in the people administrating it…the extreme people are the ones making submissions…the wrong people are having the influence"	1

Table B 9.2 Do you think you are farming your land sustainably?

Response		Number
Yes	➢ "because of experience and observation and financial reasons' ➢ "we are naturally quite good conservationists, I'm reluctant to use insecticides and things like that" ➢ "look after your land and it will look after you"	5
I think so/hope so	➢ I'm endeavouring to put back what I take out ➢ "There's more and more pressure on farmers to not farm their land sustainably, to go for the economic short term returns" ➢ long term investment	6
No	➢ "trying to"	1