THE EFFECTS OF INFORMATIONAL UNCERTAINTY ON AGRICHEMICAL TRAINING DECISIONS

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ABSTRACT

Participation in agrichemical training courses, and exposure to the benefits of information on safe and efficient agrichemical use and management, is ultimately dependant upon recognition of a need or a desire for such training on the part of primary producers (Bruner 1986). However, despite the significant benefits accruing to primary producers from being trained in efficient and safe agrichemical use and management (Martin 1992, Wilson-Salt 1993, Brush and Clemes 1994), the majority of primary producers undertake no formal agrichemical training (MacIntyre, Allison and Penman 1989, Robertson 1993). One reason identified for the low level of primary producer agrichemical training participation is an erroneous belief, held by many primary producers, that their current agrichemical practices are efficient and safe (Gee 1993).

The purpose of this paper is to develop a logistic regression model that evaluates the factors that influence primary producers' recognition of a need or desire for agrichemical training. Conclusions drawn from the logistic regression analysis are presented, and the implications for agrichemical training providers and primary sector policy analysts are considered.

Key Words:
AGRICHEMICALS, TRAINING, UNCERTAINTY, PROBLEM RECOGNITION

INTRODUCTION

The safe use and management of agrichemicals[1] is an important issue in the New Zealand agribusiness sector (Gray 1994). However, despite the substantial concern about the safe use and management of agrichemicals, there is evidence that a large percentage of New Zealand primary producers do not follow safe agrichemical practices (Pryde 1981, Houghton and Wilson 1992). These particular primary producers continue

[1] Agrichemicals, for the purposes of this paper, are defined as any substance, whether inorganic or organic, man-made or naturally occurring, modified or in its original state, that is used in any agriculture, horticulture or related activity, to eradicate, modify, or control, flora and fauna (New Zealand Agrichemical Education Trust 1991).

to expose themselves to serious acute and chronic health risks from agrichemical exposure through improper management and inefficient use of agrichemicals (Burgess 1987, Brush and Clemes 1994).

In addition to the health risk considerations that arise from agrichemical use, a considerable body of legislation mediates the use and management of agrichemicals. Non-compliance with this legislation and the associated regulations may result in considerable penalties being imposed. However, notwithstanding that considerable penalties may be imposed, there is evidence that primary producers are committing offenses when using and managing agrichemicals (Pryde 1981, Houghton and Wilson 1992, Ministry of Agriculture and Fisheries 1992, Gee 1993, Scully, Brush and Sheppard 1993).

Further, agrichemicals are also a major cost component for many primary producers in the New Zealand agribusiness sector (Mumford 1980). On average, primary producers spent NZ$2517 on weed and pest control in 1991.[2] There is also evidence that despite the technological advances in spray equipment and Integrated Pest Management,[3] that if applied would lower the costs of agrichemical use, many primary producers are not taking advantage of the rapidly developing technology (Martin 1992).

Although there is evidence on the health, legislative compliance, and financial benefits that accrue to primary producers through using and managing agrichemical safely and efficiently, recent research suggests that participation in agrichemical safety and management training courses is very low. Findings from MacIntyre, Allison and

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[2] This estimate is derived from agricultural production account figures (Statistics New Zealand 1994), and estimates of the number of primary producers currently using agrichemicals (Anon 1992). The production account figures state that $151m was spent on weed and pest control in New Zealand agribusiness. This figure is divided by the estimated 60 000 agrichemical users in the primary sector (Anon 1992).

[3] Integrated Pest Management (IPM) is an approach to pest control based on an understanding of ecological interactions within the crop, economic consequences of pest control designs, and the social impact of any interventions. IPM utilises all available control strategies to reduce pest populations below economically damaging levels. A key component of IPM is the use of monitoring techniques to assist in pest control decision making and, where appropriate, the use of economic thresholds as the basis for such decisions (Washington State Cooperative Extension 1991).

Penman (1989) and Robertson (1993) indicate that only 5 percent of New Zealand primary producers, who use agrichemicals, have participated in agrichemical safety and management training.

Despite the significant benefits accruing to primary producers in being trained in safe and efficient agrichemical use and management (Martin 1992, Wilson-Salt 1993, Brush and Clemes 1994), the majority of primary producers undertake no formal training. One reason proposed for this low level of primary producer agrichemical training participation is a belief, amongst some trainers in the agrichemical training industry and amongst a segment of primary producers, that agrichemical training is not cost effective for many primary producers (Scully, Brush and Sheppard 1993). Uncertainty about the extent and severity of agrichemical health risks (Sharp et al. 1986), and technological developments in IPM (Martin 1992), have however been found to lead primary producers into erroneously believing their practices are efficient and safe (Gee 1993). Primary producers have also been found to have a low awareness of their agrichemical use responsibilities under the Health and Safety in Employment Act 1992 (Gee 1993).

An investigation, into the effects of uncertainty on primary producers' recognition of a problem in their use and management of agrichemicals, and the factors that influence that Problem Recognition, may therefore provide important insights into the reasons for the low level of primary producers' participation in agrichemical training. The objective of the research is then to identify and describe the factors that influence Problem Recognition and evaluate the marketing implications resulting from these factors.

THE CONSUMER DECISION PROCESS

The consumer decision process (Engel, Kollat and Blackwell 1968), or problem solving process (McCarthy and Perreault 1987), is concerned with the procedure a consumer uses in reaching a decision. Dewey (1910) was the first to itemise what he termed "steps in problem solving" to explain the process an individual goes through in solving a problem or making a decision. Dewey (1910) defined the "steps in problem solving" as problem recognition, information search, alternative evaluation, choice and outcome.

Since that time, many conceptualisations of the steps or phases of problem solving have been advanced and used.[4]

PROBLEM RECOGNITION

Problem Recognition is generally regarded as the first stage of any consumer's decision process (Engel, Kollat and Blackwell (1968). Problem Recognition is also considered a necessary but not sufficient condition for consumer action, since a consumer does not make a purchase unless a problem is perceived, recognised and delineated (Bruner and Pomazal 1988).

The Cause of Problem Recognition

Engel, Kollat and Blackwell (1968) define Problem Recognition as occurring *"when a consumer recognises a difference of a significant magnitude between what is perceived as the desired state of affairs and what is perceived as the actual state of affairs" (p360-61)*. Engel, Kollat and Blackwell (1973) however consider that not every perceived discrepancy between actual and ideal states will result in problem recognition. They imply that there is a minimum level of perceived difference which must be surpassed before a problem is recognised and that this threshold level is probably learned and will vary with individual circumstances.

Several authors have suggested that the cause of Problem Recognition is a departure from homeostasis (Bruner 1986). In the physiological sense of the term, homeostasis is the process of body "steady states" being maintained. For example, in the case of an agrichemical user, when the brain perceives that the acute agrichemical exposure level (actual state) has deviated significantly from the individual's exposure tolerance level ('desired state') then corrective action of some sort is automatically triggered, such as sweating, head pain, or loss of motor functioning (World Health Organisation 1990).

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[4] See for example, Gagné, R.M. (1959), 'Problem Solving and Thinking', in Farnsworth, P.R. and McNemar, Q. (eds), *Annual Review of Psychology*, Palo Alto, California, 147-72., and Brim, O., Glass, D.C., Lavin, D.E. and Goodman, N. (1962), *Personality and Decision Processes*, Stanford University Press, Stanford, California, 9.

Homeostasis, also termed Compensation Theory (Cowie and Calderwood 1966, Wilde 1982), also holds that people have a certain desired or acceptable level of risk (probability of an undesirable event occurring) which functions within the motivation block. If the perceived level of risk is above or below the target level, people adjust their behaviour to compensate for their perceived level of risk and bring their behaviour back to the desired level.

The Conceptualisation of Problem Recognition

Even though Problem Recognition has been often mentioned in the consumer behaviour and marketing literature for more than 25 years, very little empirical work has been offered to substantiate the components and operation of the process. The empirical research that has attempted to conceptualise the Problem Recognition process is also generally fragmented and inconsistent. Further, few researchers have addressed Problem Recognition as a multifaceted process.

There is some debate in the literature as to whether Problem Recognition should be defined either as that state where a consumer becomes aware of a significant discrepancy between a desired state and actual state with respect to a particular want or need (Engel, Kollat and Blackwell 1968, Bruner and Pomazal 1988), or defined as occurring only when the perceived difference between actual and desired states is significant enough to activate an intention to purchase a potential problem solving instrument (Block and Roering 1976).

Block and Roering (1976), in their work based on Engel, Kollat and Blackwell's "Consumer Behaviour", stated that *"Consumer analysts now believe that Problem Recognition can best be measured by obtaining information on purchase intentions" (p261)*. Block and Roering (1976) considered that purchase intentions had become recognised as the intervening variable between the attitudes and the behaviour that is operative when a problem is recognised. They also stated that a consumer's indicated intention to purchase can be interpreted as an acknowledgement that a problem has been recognised and the consumer is in the early stage of problem solving activity. They concluded that a consumer's expressed intention to purchase a product or service indicates that the consumer perceives a discrepancy between the actual and desired states, and consequently will be seeking to facilitate resolution of the problem.

Burton et al. (1978) in a contribution to risk management theory has investigated people's response to natural hazards. Burton's research provided an insight into the relationship between the psychological state of hazard awareness (Problem Recognition) and a departure from homeostasis, to the physiological state or behavioural change termed the action threshold (purchase intention). In the study, Burton et al. (1978) traced four characteristic responses divided by three thresholds.

At the lowest threshold level people were entirely oblivious to the threat and would deny its existence even if the probability was pointed out. Above an awareness threshold level[5] there was no longer a denial of the possibility of a loss, but the response was entirely passive and no precautions were taken. Above the next threshold level (termed the action threshold[6]) where the reality of significant loss became accepted, there were active precautions. Kawash, Woolcott and Sabry (1980) also determined that different individuals pass these thresholds at different points, depending on personality factors such as an individual's anxiety level.

Factors Influencing Problem Recognition

There are estimated to be an unlimited number of factors that can influence a consumer's Problem Recognition process. Researchers in the marketing, economics, and risk management disciplines have identified and discussed several of the more common influences (Hale 1969, Slovic, Fischhoff and Lichtenstein 1984, Bruner 1987, Hale and Glendon 1987, Bruner and Pomazal 1988).

The factors that have been identified as contributing to Problem Recognition, either positively or negatively, and that are relevant to this study are:

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[5] The definition of the awareness threshold (Burton et al. 1978) appears to be synonymous with Bruner and Pomazal's (1988) definition of Problem Recognition as occurring when there is a significant difference between a person's desired and actual state. The magnitude of this difference, between a person's desired and actual state resulting in Problem Recognition, termed the awareness threshold by Burton et al. (1978), is however not significant enough on its own to cause consumer action to occur.

[6] The definition of the action threshold (Burton et al. 1978) appears to be synonymous with the definition of Problem Recognition as an intention to purchase (Block and Roering 1976).

(i) Information Sources

(ii) Thinking

(iii) Experience

(iv) Overconfidence

(v) Perceptions, Attitudes and Concerns

(vi) The Current Situation

(vii) Marketing Effort

Information Sources

The relationship of information sources to Problem Recognition is dependant on the nature of the source and the information that is dispersed from that source (Hale and Glendon 1987, McCarthy and Perreault 1987). Douglas (1985) has stated that a consumer's informal and formal relationships set constraints and obligations upon a consumer's behaviour, provide a broad framework for the shaping of his/her attitudes and beliefs, and are closely tied to questions of both morality and what is to be valued.

Further, group norms are considered to be powerful controllers of behaviour. Consumers rely heavily on things they learn from their friends, neighbours and colleagues to determine whether they believe something is a problem (Hale 1969). For example, people trust friends, neighbours and colleagues far more than the media or abstract information sources when it comes to such things as taking precautions against, or evacuating before, natural disasters (Burton et al. 1978). However, one problem with learning from information derived from secondary sources such as friends, neighbours and colleagues is that the information may be inaccurate and therefore inappropriate.

Thinking

Bruner and Pomazal (1988) have stated that consumers possess the unique capacity to think, plan, and anticipate events unrelated to their current state of affairs. As an example, primary producers may be motivated to undertake agrichemical training merely by thinking about the possible positive consequences of undertaking such behaviour. This motivation may be activated even in the absence of a conscious recognition that their actual state is in some significant deficiency.

Experience

Hale and Glendon (1987) believe that experience can have either a positive or negative effect on behaviour, and that this type of behaviour is mediated in large part by the feedback mechanism. The absence of sufficient negative feedback (eg. the non-detection of the chronic health effects from long term agrichemical exposure, and minimal past enforcement of the agrichemical legislation) could result in stable behaviour and positive reinforcement, and consequently non-recognition of a problem state.

There also appears to be a relationship between perceived skill and experience. The more consumers have had the personal opportunity to experience problems, the more control they feel over the problems and the less they consider the problems to be serious (Rantanen 1981).

Overconfidence

A number of studies and reviews of the risk management literature have concluded that overconfidence is a major source of bias in consumer decision making (Stilwell, Seaver and Schwartz 1982, Slovic, Fischhoff and Lichtenstein 1984, Cooke et al. 1987). Further, it has been found that the more confident consumers are of their own judgement, the more overconfident they are likely to be (Fishhoff, Slovic and Lichtenstein 1977).

There is also considerable proof that people can have illusions of great control where none or less exists. For example, in a study of people trained in cardiopulmonary resuscitation, Ramirez et al. (1977) found that 80 per cent of respondents felt confident after an interval of several months to perform it, while only 1 per cent of respondents actually performed the task adequately.

Perceptions, Attitudes and Concerns

Problem Recognition is fundamentally a subjective concept and leads to a consideration of individual perceptions, understanding and behaviour. Numerous studies (See for example, Melinek, Wolley and Baldwin 1973, Ross 1974, Wilson 1975, Williams 1976) have found that those people who believe themselves knowledgeable about, and in control of a dangerous situation show little fear or concern about it. Further, consumers are not natural processors of probabilistic information, but they do have certain built-in biases in the way in which they collect and process information (Slovic, Fischhoff and Lichtenstein 1984).

The Current Situation

The current situation a consumer finds themself in also has an enormous influence on the Problem Recognition state (Bruner and Pomazal 1988). A primary producer who has significant physical and managerial agrichemical responsibilities and employees involved in agrichemical related tasks may *ceteris paribus* benefit from agrichemical training more than the average primary producer. The perception or expectation of significant benefits may result in an increased desire for agrichemical training. Further, the perception of significant benefits from training participation may "trigger" Problem Recognition even in the absence of a deficiency in the actual state.

Marketing Effort

Marketing Effort has also been observed to affect Problem Recognition. Bruner and Pomazal (1988) have stated that the usual opportunity for triggering Problem Recognition is in influencing the desired state in the minds of the target market. Advertising, publicity, personal selling and promotional displays are all direct attempts to affect consumers' perceptions of their desired state of affairs, and thus increase the likelihood of Problem Recognition. For example, advertising or publicity informing primary producers of the benefits of agrichemical training may increase primary producers' desire for training.

CONSUMER UNCERTAINTY

Consumer uncertainty in the form of incomplete or imperfect information has been found to be a significant factor in consumers' failure to recognise a problem (Fishhoff, Slovic and Lichtenstein 1978). The consumer's Problem Recognition process is also strongly associated to the information processing system and the behavioural effects of feedback. It has been noted that the existence of imperfect and incomplete information in the consumer's information processing environment may be a significant component of peoples limited ability to detect problems and take the required preventative action (Hale and Glendon 1987). Imperfect and incomplete agrichemical information exists in a number of areas. These include:

(i) *The health risks from chronic long term occupational exposure to agrichemicals (Sharp et al. 1986)*

(ii) *Technological developments in IPM (Martin 1992)*

(iii) *The willingness of a significant segment of consumers to pay a price premium for non-conventionally grown produce (Wilson-Salt 1993)*

(iv) *Minimal past enforcement of the legislation and associated regulations governing agrichemical use and management*

As an example, there are clearly some agrichemical health hazards (eg. cancer) whose presence is not directly perceptible to the human senses (Sharp et al. 1986). These hazards present a special problem as their very presence must be signalled by devices which translate the presence of the hazard into something that is perceptible.

Limitations in a consumer's hazard or problem perception has been found to be a significant cause of accidents. For example, in a study of gold mining accidents, Lawrence (1974) found that 50 percent of mining accident victims failed to detect the hazard to which they succumbed. Brown (1984) also reports that problems with hazard perception played a part in 49 percent of the automobile accidents attributed to drivers unimpaired by alcohol or other drugs. Dunn (1972) has also found that assessments given by chainsaw operators of the likelihood of different types of injury was a poor match with reality in many cases.

Further, numerous studies (see for example Tversky and Kahneman 1974, 1981) have observed the following information processing biases inherent in consumers' cognitive assessment of outcome and hazard probabilities and the severity of potential harm. These biases in consumer's assessment of outcome and hazard probabilities are:

(i) *Availability (considering recent and dramatic events as more probable).*

(ii) *Representativeness (considering small samples representative of large populations).*

(iii) *Overconfidence (being more certain of estimates than the data warrants).*

(iv) *Anchoring (not changing estimates enough with new information).*

Availability

Numerous studies have stated that consumers selectively process information. An absence of hazard vividness and identifiable cause(s) often leads to an under assessment of the probability of an event's occurrence (See for example, Lichten[illegible] et al. 1978, Bastide et al. 1989, Tversky and Kahneman 1974). The findings from [illegible]ohen (1964, 1972), Jones and Johnson (1973), Tversky and Kahneman (1974, 1981), and Hale and Glendon (1987), also appear to indicate that consumers are poor at making assessments about unusual or improbable events. Consumers are generally over-influenced by the features which they see as salient in a situation.

Representativeness

Grey shadings around estimates are often transformed into black and white, and consumers are often far too willing to draw firm conclusions from small samples of behaviour or information. Even providing information about the unreliability of figures does not have as much influence as it should on the confidence with which conclusions are drawn (Tversky and Kahneman 1981).

Research on gambling by Cohen (1964, 1972) has also shown that consumers confuse long-run probability with short-run patterns, and believe that the latter is, or should be, representative of the former.

Overconfidence

Kahneman and Tversky (1979) have concluded, on the basis of their findings from prospect and gambling studies, that there appears to be risk-seeking over negative outcomes. Shackle (1952) has further observed that hope and fear can co-exist in a consumer's mind... even when both arise from a single issue and therefore cannot both be (objectively) well grounded.

Anchoring

Slovic, Fischhoff and Lichtenstein (1980) have found that consumers find the process of thinking about problems and hazards an uncomfortable one, and they want to round the process off as fast as possible. Consumers therefore often seek closure, and once a decision has been made they resist attempts to go back and reopen the issue, even to consider more evidence. In order to achieve closure consumers will often oversimplify situations by leaving out all but a few factors, or accept some action which gives at least the semblance of certainty, rather than ambiguity (Reason 1985). It also appears in some cases that consumers gain their certainty by ignoring the risk or problem altogether.

Hale and Glendon (1987) consider that the most pervasive example of this behaviour is the phenomenon called 'habituation'. Habituation is regarded to be the ability to ignore what does not change, leaving the limited processing capacity of the brain free to concentrate on what is changing. This can create problems when a hazard warning increases very slowly. For example, there is increasing evidence that long term chronic exposure to agrichemicals may not produce accompanying acute symptoms (Sharp et al. 1986). In addition, Scramm and Teichmann (1977) also indicate that it is impossible to determine a minimum exposure level for a chemical carcinogen below which level there is no carcinogenic risk. For example, the latency period for the onset of the chronic effects of long-term exposure to agrichemicals, for the chemical induction of solid malignant tumours in people, is generally estimated to be in the range of ten to thirty years (Smith et al. 1982, Sharp et al. 1986). The rate of change of the warning may also be so slow that it is treated by the habituation mechanism as a constant, and so is not registered until it is well above the theoretical threshold of detection. There is also a tendency for consumers to treat hazards which are familiar more lightly than those which are new to them (The Royal Society, 1983).

Finally, there is also significant evidence from experimental studies that show rational behaviour under consumer uncertainty is not a strategy used by many consumers,[7] even in decisions where only money is at stake (Pruitt 1962). Hale and Glendon (1987) have stated that the failure to recognise problems by consumers may be attributed to consumers' perceptions of a loss of control through incomplete knowledge and understanding, overload, biases in decision making, and pressures from outside and inside the individual system which make other courses of action, or inaction, more attractive. In addition, consumers will often use other decision criteria, such as accepting the first alternative which satisfies certain minimum criteria, without attempting to maximise gains (satisficing). In situations of uncertainty consumers are also inclined to use a minimax strategy; minimising the maximum loss they can possibly suffer, even if this means foregoing the chance of a large gain.

RESEARCH METHODS

Research Methodology

Theoretical constructs for the *a priori* determination of the factors that influence Problem Recognition are not well developed, therefore this study used exploratory factor analysis to statistically identify these factors. The methodology used to form and describe the factors that influence Problem Recognition involved two stages. These stages are shown below.

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[7] See for example empirical research in an industrial environment on bounded rationality behaviour (Winsemius 1971, Janis and Mann 1977, Rasmussen 1980), and Festinger (1957) and Akerloff and Dicken's (1982) work in the area of cognitive dissonance and decision making.

Stage 1

Identification of the underlying factor dimensions using factor analysis.

Stage 2

Subjection of the factor scores to a logistic regression analysis to determine the influence of the factor dimensions on Problem Recognition.

The sample derivation, descriptive statistics, and results of the factor analysis and logistic regression are presented below.[8]

Sample Derivation

New Zealand growers, defined in this study as those people who produce vegetables and pipfruits and who have not undertaken previous agrichemical training, are the focus of this paper. These specific growers have been chosen as the focus of this study for the following reasons:

(i) *The health risks, from occupational exposure to agrichemicals, have been found to be significant for New Zealand growers (Pearce, Smith and Fisher 1985).*

(ii) *Comprehensive legislation and regulations govern the production and supply of vegetables and pipfruits grown using agrichemicals.*

(iii) *Empirical evidence indicates that a segment of New Zealand growers are not complying with the agrichemical legislation (MAF 1992, Scully, Brush and Sheppard 1993). There is also evidence that growers are not using agrichemicals efficiently (Martin 1992).*

(iv) *Growers are the most intensive users of agrichemicals in New Zealand agribusiness (MacIntyre, Allison and Penman 1989).*

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[8] The factor analysis and logistic regression was carried out using SPSS/PC+ version 5.1.

(v) *Recent developments in IPM and spray equipment technology have been estimated as providing significant production cost savings for New Zealand growers (Dudley 1986, Cameron and Beck 1992).*

(vi) *New Zealand food consumers have expressed a high and increasing concern over agrichemical residues in vegetables and pipfruits (Lamb 1991, Wilson-Salt 1993).*

(vii) *A segment of New Zealand consumers have expressed a willingness to pay a price premium for vegetables and pipfruits grown using IPM (Fulton et al. 1991, Wilson-Salt 1993).*

The data for this study was derived from a wider survey undertaken for the New Zealand Agrichemical Education Trust (Scully, Brush and Sheppard 1993). Over 500 New Zealand agrichemical users from the primary sector were interviewed on a wide range of agrichemical related subjects for the original survey. As an example, some of the areas surveyed included problem recognition, attitudes, information sources and behaviour. However, for the purposes of this study attention was focused on a population of growers sufficiently homogeneous to permit factor structure consistency. Only those growers, who derived the majority of their income from pipfruit or vegetable production, and who had not been trained in agrichemical use, were included in the study. When subjected to editing and consistency checks, these restrictions resulted in a sample of 227 growers.

Descriptive Statistics

Attitudinal, informational and behavioural questions, included in the survey, were identified by examining the Problem Recognition literature from the Risk Management, Economics, and Marketing disciplines. Focus groups with growers, agrichemical trainers, and academics also provided industry specific knowledge to help specify the questions. Forty eight attitudinal, informational and behavioural variables resulted from the survey. These variables examined growers agrichemical responsibilities, practices, sources of information, agrichemical knowledge evaluation, awareness of the New Zealand Agrichemical Education Trust's Agrichemical training programmes, agrichemical concerns and demographics. The descriptive statistics of the independent variables used in the analysis are presented in Table 1.

Table 1

Descriptive Statistics of the Independent Variables[9]

Variable	Mean	Standard Deviation	Range
Responsibilities			
Application	0.90	0.30	0-1
Storage	0.97	0.17	0-1
Calibration	0.81	0.39	0-1
Transportation	0.79	0.41	0-1
Container Disposal	0.93	0.26	0-1
Chemical Type	0.92	0.28	0-1
Decision Making	0.97	0.16	0-1
Employees			
Employee Involvement	0.22	0.41	0-1
Untrained Employee	0.11	0.31	0-1
Employee Training Need	0.11	0.31	0-1
Practices			
Protective Equipment	0.43	0.50	0-1
Chemicals Locked	0.77	0.42	0-1
Records	0.75	0.43	0-1
Warning Signs	0.08	0.28	0-1
Information Sources			
Own Experience	0.45	0.50	0-1
Grower Association	0.15	0.36	0-1
Chemical Industry	0.30	0.46	0-1
Previous Employer	0.03	0.16	0-1
Reading	0.34	0.48	0-1
Field Days	0.07	0.25	0-1
Product Labels	0.19	0.40	0-1
Other Chemical Users	0.17	0.37	0-1
Neighbours/Locals	0.04	0.21	0-1
Information Sources (cont)			
Local Council	0.01	0.07	0-1
Family	0.09	0.29	0-1
Ministry of Ag and Fish	0.02	0.15	0-1
Knowledge Evaluation	3.65	0.82	1-5
Course Awareness	0.31	0.46	0-1
Agrichemical Concerns			
Efficient Use and Timing	0.13	0.34	0-1
Application	0.03	0.16	0-1
Chemical Alternatives	0.04	0.20	0-1
Insufficient Knowledge	0.03	0.16	0-1
Safety	0.08	0.27	0-1
Storage	0.03	0.17	0-1
Mixing	0.03	0.17	0-1
Consumer Perceptions	0.02	0.13	0-1
Container Disposal	0.04	0.18	0-1
Chemical Disposal	0.06	0.24	0-1
Spray Drift	0.20	0.40	0-1
Environment	0.08	0.28	0-1
Withholding Period	0.04	0.20	0-1
Pest Resistance	0.03	0.17	0-1
Health	0.13	0.33	0-1
Chemical Cost	0.01	0.11	0-1
Demographics			
Age	3.37	0.95	1-5
Chemical Experience	19.37	12.43	1-55
Growing Area (size)	57.18	143.88	1-1729
Export	0.62	0.49	0-1

[9] The independent variables were coded as follows:

Responsibilities = 1 if the grower was fully or partly responsible, 0 otherwise
Employee Involvement = 1 if employee(s) were involved in agchem use, 0 otherwise
Untrained Employee = 1 if employee(s) untrained, 0 otherwise
Employee Training Need = 1 if employee(s) need further training, 0 otherwise
Practices = 1 if grower using safe practices, 0 otherwise
Information Sources = 1 if grower relies on that source for chem info., 0 otherwise
Knowledge Evaluation = grower evaluation of their chemical practices 1 = poor, 5 = excellent
Course Awareness = 1 if grower aware of Agrichemical Trust courses, 0 otherwise
Agrichemical Concerns = 1 if grower expresses a concern, 0 otherwise
Age = 1 = Under 25, 2 = 26-35, 3 = 36-45, 4 = 46-55, 5 = 56+
Chemical Experience = agrichemical work history (years)
Growing Area = growing area size (acres)
Export = 1 if any produce intended for export, 0 otherwise

The majority of growers indicated that they were involved in all aspects of agrichemical use and management. Growers also considered that their knowledge of chemical practices was very good, however a large segment of growers were not using the correct agrichemical protective equipment, locking their chemical storage areas, keeping chemical records or using warning signs when applying chemicals. The respondents however exhibited a large degree of variance on their sources of agrichemical knowledge and their concerns regarding agrichemical use. Reliance on personal experience and reading agrichemical literature were the two most common sources of information. Spray drift, efficient use and timing of application, and health concerns were the most predominant concerns.

RESULTS AND DISCUSSION

Factor Analysis

Because intercorrelations among some variables were expected to be significant, a second stage varimax principle components factor analysis was used to reduce the number of attitudinal, informational and behavioural variables to a smaller more focused set of dimensions.

Table 2 presents the principal factor solution after a varimax rotation of the independent variable set. The factors are presented according to the proportion of variance explained, and have been termed in accordance with the attitudinal, informational or behavioural variables they represent. For the purposes of this study an observed variable-common factor correlation of 0.3 or above was considered a meaningful loading of an observed variable on a common factor (Kim and Mueller 1978). After conducting the recommended diagnostics for testing the appropriateness of the independent data set for factor analysis,[10] standard latent roots greater than one (factors=19) and scree test (factors=19) criterion were used as guidelines to determine the number of factors to be extracted (Cattell 1978, Gorsuch 1974, Harman 1976).

[10] Bartlett's test of sphericity was used to test the hypothesis that the independent variable correlation matrix is an identity matrix. An anti-image correlation matrix that indicates the extent the variables share common factors (ie. the partial correlation coefficients) was also specified. These two tests indicated that the data was highly suitable for factor analysis.

Table 3

Rotated Factor Matrix of Independent Variables

	Responsibility	Employee Involvement	Safe Use and Report	Experience	Efficient Use	Experience and Awareness	Size	Hazardous Use	Environmental Concern	Health Ambivalence	[illegible] Practices	Handling Concern	Spray Drift Concern	Decision Making	Previous Employment	Community Concern	Disposal and Info.	Overconfidence	Family Influence
Responsibilities																			
Application	.713	-.340																	
Storage	.777																		
Calibration	.576																		
Temperature	.482																		
Disposal (Container)	.685																		
Chemical Type	.572							-.359											
Decision Making														.543					
Employees																			
Employee Involvement		.803																	
Employee Licensed		.772																	
Employee Training Need		.457																	
Practices																			
Protective Equipment Use								-.647											
Locked Chemical Area			.427															-.339	
Records			.752																
Warning Signs											-.787								
Information Sources																			
On Experience						.727													
Grower Association						-.457				.358									
Chemical Industry										-.578									
Previous Employer															.728				
Existing Applicator Information					-.342			-.567							-.333				
Field Days								-.331											
Product Information (Labels)																	.379		
Other Chemical Users				-.430													-.420		
Neighbours/Locals									.371										
Local Council									.812										
Family																			.800
Ministry of Ag and Fish													-.751						
Chemical Knowledge Evaluation																		.313	
Course Attendance						.347													
Agrichemical Concerns																			
Efficient Use and Timing					.600														
Application					.671														
Alternatives					.319														
Insufficient Knowledge					.388														
Safety												.346			.476				
Storage												.804							
Mixing							.446					.347							
Container Preparation							-.722												
Container Disposal																	.796		
Chemical Disposal											-.820						.516		
Spray Drift													.322						.500
Environment									.307										
Withholding Period																		-.705	
Pest Resistance																.887			
Health										-.744									
Chemical Cost														-.766					
Demographics																			
Age				.764															
Chemical Experience				.779															
Growing Area (Size)							.772												
Export			.7[illegible]0																

The use of the roots criterion and the scree test has been considered to provide an effective means for determining the number of factors (Stewart 1981). Nineteen factors explaining 65.5 per cent of the total variation appeared to give the best representation of the underlying relationship among the variables. The following paragraphs describe the dimensions which each of the nineteen factors appear to represent.

Responsibility

The first factor is related to growers' agrichemical responsibilities. These responsibilities include agrichemical application, storage, calibration of spray equipment, transportation, disposal, and responsibility for making the decision on the type of chemicals to be used. Growers with high factor scores on this dimension were likely to be directly involved in agrichemical use.

Employee Involvement

This factor had high loadings on the variables that investigated employee involvement in agrichemical use. Growers with high factor scores on this factor were likely to have employees involved in agrichemical use. These growers, who had high factor scores on this dimension, also generally had employees involved in agrichemical use who were not trained in the use of agrichemicals. They did however believe that their employees needed further training. Growers with high factor scores on this dimension also tended to delegate the responsibility for agrichemical application.

Safe Use and Export

Growers who had high factor scores on this dimension were likely to lock their chemical storage area and keep chemical records. Correct identification of agrichemical through record keeping is advised for chemical identification in the event of poisoning and for efficient use and management of agrichemicals (New Zealand Agrichemical Education Trust 1991). This factor however also had a high loading on the question relating to export involvement. This association results from the mandate from the New Zealand Apple and Pear Marketing Board (NZA&PMB) and the New Zealand Kiwifruit Marketing Board (NZKMB) that growers keep agrichemical records. The use of sprays outside the NZA&PMB and the NZKMB recommended spray programmes for export fruit may jeopardise the acceptance of that fruit. Vegetable growers exporting certain vegetable varieties to Japan are also required to keep agrichemical records.

Experience

Growers who had high factor scores on this dimension were likely to be relatively older than the average grower and have had greater experience in agrichemical usage. Growers with high factor scores on this factor also tended not to rely on other agrichemical users for agrichemical information.

Efficient Use

This factor had high loadings on variables that indicate a concern with efficient use and management of agrichemicals. Variables which loaded highly on this factor included a concern about efficient use and timing of sprays, application, and agrichemical alternatives. Growers with high factor scores on this dimension were also likely to be concerned that they had insufficient knowledge to make agrichemical decisions, and tended not to read agrichemical related literature.

Experience and Awareness

Growers who had high factor scores on this dimension tended to rely on their own agrichemical experience to make their agrichemical decisions, and not to rely on Grower association sources. Growers who had high factor scores on this dimension were also likely to be aware of the New Zealand Agrichemical Education Trust's training programmes.

Size

Factor loadings indicated that growers with high factor scores on this factor had a large growing area and were concerned about agrichemical mixing and consumer perceptions of agrichemical use.

Hazardous Use

This factor is associated with a low usage of agrichemical protective equipment. Growers with high factor scores on this dimension were also likely to not use agrichemical literature or field days as sources of agrichemical information, and not be responsible for deciding on the type of agrichemical to be used on the property.

Environmental Concern

An examination of the factor loadings for this factor indicated that growers with high factor scores on this dimension had a high concern for the environment. The factor also had significant loadings on locals and neighbours and the local council as sources of chemical information. A possible explanation for the significance of the factor loadings on environmental concern and the local council as a source of information, is that the local council often provides information on unneeded agrichemical and chemical container disposal.

Health Ambivalence

This factor appears to relate to a perception that there are low health risks from agrichemical use. Growers having high factor scores on this dimension also indicated they tended to rely on their growing association as a source of information and not on chemical industry representatives.

Unsafe Practices

This factor was associated with unsafe practices. The high negative loading on the use of warning signs when spraying, and a low concern about chemical disposal indicates that growers with high factor scores on this factor were generally not following, or concerned about, safe agrichemical practices.

Handling Concern

This factor was associated with a significant concern for the safe handling of agrichemicals. This factor had a high positive loading on variables that measured growers concern for chemical safety, storage of chemicals and mixing of chemicals.

Spray Drift Concern

This factor was associated with a high level of concern about spray drift by growers and a low use of the Ministry of Agriculture and Fisheries as an information source.

Decision Making

Factor loadings indicate that growers with high factor scores on this factor were likely to be responsible for agrichemical decision making on their property and significantly unconcerned about the cost of chemicals. A logical explanation for this relationship is that growers tend to be more interested in whether a product works than what it costs (Martin 1992). Martin's surveys of growers indicated there was no clear preference for cheaper products.

Previous Employment

An examination of the factor loadings for this factor indicated that growers with high scores on this dimension relied significantly on previous employers for their agrichemical information. This factor also had a significant negative loading on the reliance on agrichemical literature as a source of information and a significant positive loading on concern for chemical safety.

Immunity Concern

This factor had a significant loading on concern for pest resistance. Growers who had a high factor score on this factor were likely to be concerned about pest immunity and the effectiveness of agrichemicals on their property.

Disposal and Information

An examination of the factor loadings for this factor indicated that it appeared to represent a high concern for the disposal of unneeded agrichemicals and agrichemical containers. Growers with high factor scores on this dimension were also likely to rely on information from agrichemical labels, which provide some information on agrichemical disposal, and shy away from using information from other agrichemical users.

Overconfidence

This factor is associated with a grower's perception that he/she had sufficient agrichemical knowledge. However, the factor also exhibited a high negative factor loading on the use of a locked agrichemical storage area. This significant negative factor loading on chemical storage indicates this factor is also related to unsafe agrichemical practices.[11] This perception of a high level of agrichemical knowledge by growers, combined with a low level of safe use of agrichemical, indicated that the grower exhibited a degree of overconfidence relating to his agrichemical practices. Growers with high factor scores on this dimension were also more likely to have a low concern for the agrichemical withholding period.

Family Influence

This factor was associated with a significant dependence on family sources for agrichemical information. Growers with high factor scores on this factor also indicated a significant concern about agrichemical spray drift.

After completing the factoring procedure, orthogonal or uncorrelated standardised factor scores (mean=0, Standard deviation=1) were saved for subsequent logistic regression analysis.

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[11] Storage of agrichemicals in an unlocked area has resulted in accidental death from chemical poisoning (New Zealand Toxicology Group 1993).

Logistic Regression Analysis

To investigate the factors that influence Problem Recognition, logistic regression analysis was used to estimate a model in which the likelihood of Problem Recognition is a function of the set of factors derived from the factor analysis.

For the purposes of this analysis growers' Problem Recognition was derived from a question that asked:

" Do you feel you would like further training in chemical application practices?"

Although, as noted earlier in this paper, there is some debate over the conceptualisation of Problem Recognition, consumer analysts have demonstrated that purchase intention data provide marketing strategists with accurate measures of Problem Recognition (Pratt 1965, Grauber 1970).

The objective of this study, to provide a behavioural rather than a psychological measure of Problem Recognition, also supported the decision to adopt purchase intention as a conceptualisation of Problem Recognition. For the purposes of this analysis Problem Recognition was modeled as a discrete (binary) variable. Fourty four per cent of growers exhibited Problem Recognition in their use and management of agrichemicals.

Since the dependent variable is discrete, the analysis relies on the use of a qualitative choice model. However, although the linear probability model, the probit model, and the logit model are possible alternative specifications of qualitative choice models (Pindyck and Rubinfeld 1991), Maddala (1983) has considered that the logit technique is preferred over other categorical variable estimating techniques. The logit of the multiple logistic regression model is presented in Equation 1.

$$g(x) = \beta_0 + \beta_1 x_1 + \beta_2 x_2 + ... + \beta_p x_p \qquad (1)$$

where there are p independent variables denoted by the vector $\mathbf{X}' = (x_1, x_2, \ldots, x_p)$. In logistic regression, the parameters of the model are estimated using the max imumlikelihood method.[12] That is, the coefficients that make our observed results most 'likely' are selected. Since the logistic regression model is non-linear, an iterative algorithm is necessary for parameter estimation. The logistic model can be written in terms of the log of the odds, which is called a logit:

$$\log \left[\frac{Prob(event)}{Prob(no\ event)} \right] = \beta_0 + \beta_1 X_1 + ... + \beta_p X_p \qquad (2)$$

From Equation 2, the logistic coefficient can be interpreted as the change in the log odds associated with a one unit change in the independent variable. The logistic equation can also be written in terms of odds as:

$$\frac{Prob\ (event)}{Prob\ (no\ event)} = e^{\beta_0 + \beta_1 X_1 + ... + \beta_p X_p} = e^{\beta_0} e^{\beta_1 X_1} .... e^{\beta_p X_p} \qquad (3)$$

In Equation 3, e raised to the power β_i is the factor by which the odds change when the ith independent variable increases by one unit. If β_i is positive, this factor will be greater than 1, which means the odds are increased. If β_i is negative, the factor will be less than 1, which means that the odds are decreased. When β_i is 0, the factor equals 1, which leaves the odds unchanged.

The Maximum Likelihood beta(β) coefficient estimates, the odds change(e^{β}), Wald test statistics and Wald test probabilities from the logit analysis are presented in Table 3. Sixty seven percent of the growers were correctly classified as recognising, or not recognising, a problem in their use and management of agrichemicals. When considering the 50-50 nature of the classification scheme this result indicates the model has a reasonable predictive capability. The Model Chi-Square diagnostic, which tests the null hypothesis that the coefficients for all of the terms in the model are 0, is highly significant (χ^2=46.52, p<0.001), which indicates the estimated model is a good fit of the data.[13]

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[12] The use of the maximum-likelihood method in logistic regression analysis is in contrast to the use of the least-squares method in linear regression. In linear regression the regression coefficients that result in the smallest sum of squared distances between the observed and the predicted values of the dependant variable are selected.

[13] The Model Chi-Square is comparable to the overall F test for regression.

Table 3

Maximum Likelihood Estimates of the Logit Model

Factor	β Coefficient	Standard Error	Odds Change (e^{β})	Wald	Sig
Responsibility	0.0875	0.1444	1.0915	0.3673	0.5445
Employee Involvement	0.2573	0.1513	1.2935	2.8919	0.0890
Safe Use and Export	0.2727	0.1546	1.3136	3.1128	0.0777
Experience	-0.8128	0.1718	0.4436	22.380	0.0000
Efficient Use	-0.0186	0.1502	0.9816	0.0153	0.9016
Experience and Awareness	-0.0418	0.1498	0.9591	0.0777	0.7804
Size	0.0780	0.1425	1.0811	0.2995	0.5842
Hazardous Use	-0.1427	0.1462	0.8670	0.9539	0.3287
Environmental Concern	0.0035	0.1380	1.0035	0.0006	0.9798
Health Ambivalence	-0.3555	0.1523	0.7008	5.4459	0.0196
Unsafe Practices	-0.1516	0.1532	0.8594	0.9786	0.3225
Handling Concern	0.1892	0.1477	1.2083	1.6412	0.2002
Spray Drift Concern	-0.0564	0.1550	0.9452	0.1324	0.7160
Decision Making	0.0263	0.1609	1.0266	0.0266	0.8704
Previous Employment	-0.1430	0.1490	0.8667	0.9212	0.3372
Immunity Concern	-0.1795	0.1869	0.8357	0.9229	0.3367
Disposal and Information	-0.0144	0.1445	0.9857	0.0099	0.9206
Overconfidence	-0.3384	0.1517	0.7129	4.9786	0.0257
Family Influence	0.0517	0.1436	1.0531	0.1299	0.7186
Constant	-0.3383	0.1521		4.9439	0.0262

The β coefficients for the factors Employee Involvement, Safe Use and Export, Experience, Health Ambivalence and Overconfidence are all significant at the 0.1 level or lower. The significant positive coefficients on Employee Involvement and Safe Use and Export factors indicate that growers who have employees involved in agrichemical use, export fruit or vegetables, and use safe agrichemical practices, including locking their chemical storage area and keeping records, have a significantly higher degree of Problem Recognition. Conversely, the significant negative coefficients on Experience, Health Ambivalence, and Overconfidence indicates that relatively older growers, growers with many years of chemical experience, growers who have a low concern for agrichemical related health risks, and growers who have a belief that they are knowledgeable about chemical practices, to the point of being overconfident, have a significantly lower level of Problem Recognition.

These findings appear to concur with the Problem Recognition theory presented earlier in the paper. Further analysis of the β statistics indicates that Hazardous Use and Unsafe Practices are negatively associated with Problem Recognition, and a Concern for Handling is positively associated with Problem Recognition. Hazardous Use, Unsafe Practices, and Handling Concern are however not significant at the 0.1 level of significance. Pearson correlation coefficients also indicate that a dependence on agrichemical experience as a substitute for training is unjustified. Growers with considerable agrichemical experience were less likely to wear protective clothing and keep chemicals in a locked area. Experienced growers were also significantly less likely to keep chemical records ($p < 0.01$).

CONCLUSIONS AND IMPLICATIONS

This study presents an empirically based classification of the factors that influence New Zealand growers' recognition of a problem in their use and management of agrichemicals.

The results derived from the logistic regression analysis are in general consistent with the Problem Recognition theory. Growers' perceptions and concerns appear to dominate their Problem Recognition process. The effects of uncertainty about both the consequences of their practices, and the benefits from agrichemical training, which has been discussed earlier, appears to inhibit growers' recognition of a problem. This is when an agrichemical use and management problem is defined in terms of a deviation from recommended practices.[14]

The findings from this research present a number of challenges for providers of agrichemical training programmes and primary sector policy analysts. The unjustified reliance by growers on experience as a substitute for agrichemical training, and a stated overconfidence by growers of the extent of their knowledge of agrichemical practices, presents a marketing challenge to agrichemical training providers such as the New Zealand Agrichemical Education Trust, which is the largest New Zealand provider of agrichemical training.[15]

In response to this marketing challenge, the Agrichemical Education Trust has specifically targeted grower intermediaries, such as the Apple and Pear Marketing Board (A&PMB) and the Kiwifruit Marketing Board (KMB) in an apparent response to a perceived problem, due to uncertainty and overconfidence, in attracting growers most at risk to participate in training. The A&PMB and the KMB have now mandated that their growers must obtain an agrichemical training certification by 1995 and 1996 respectively.

Agrichemical training providers and primary sector policy analysts may also consider, in the absence of grower intermediary support, seeking a non-market response as a potential solution to the inhibition of growers' Problem Recognition process from the effects of uncertainty and overconfidence. This could involve lobbying government for agrichemical training to be made compulsory for growers under the provisions of clause 59 of the Occupational Health and Safety Bill 1991.

The conclusions from this research also present a number of avenues worthy of future research. An examination of other primary producer groups Problem Recognition processes would be valuable in order to explore the extent of factor consistency, and

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[14] The findings infact point to a negative association between Problem Recognition and a deviation from safe and efficient agrichemical practices.

[15] The New Zealand Agrichemical Education Trust provides specifically targeted agrichemical training courses for growers.

the influence of their attitudes, information and behaviour on their assessment of Problem Recognition. These findings would have important implications for training programme promotion and primary sector policy analysis. Developing more comprehensive measures which relate attitudinal, informational and behavioural measures to Problem Recognition would also allow a better understanding of the relationship between these factors and Problem Recognition. A longitudinal study may also provide information regarding how primary producers attitudes, information sources and behaviour change over time and how these changes influence Problem Recognition.

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