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**The Impacts of Attitudes,
Information, Situation and
Behaviour on Problem Recognition:
The Impact on Agrichemical Training**

**Greg J Brush, Michael D Clemes
and Christopher E C Gan ***

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Department of Economics and Marketing
PO Box 84
Lincoln University
CANTERBURY

Telephone No: (64) (3) 325 2811
Fax No: (64) (3) 325 3847

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Abstract

In spite of the significant benefits that can be derived from training on safe and efficient agrichemical application and management, many primary producers do not undertake formal agrichemical training. An identified reason for the low level of participation in agrichemical training is that many primary producers believe their current agrichemical practices are safe and efficient (Gee, 1993). In addition, participation in agrichemical training courses, and exposure to the benefits of information on safe and efficient agrichemical use and management, is ultimately dependent upon recognition of a need or a desire for such training on the part of primary producers (Bruner, 1986).

The purpose of this paper is to examine the factors that influence producers' decisions or desires for agrichemical training. A qualitative choice model is developed to evaluate the influencing factors. Conclusions drawn from the analysis are presented, and the implications for agrichemical training providers and primary sector policy analysts are discussed.

Key Words: *Agrichemical, Uncertainty, Problem Recognition*

*Greg J Brush, Michael D Clemes and Christopher E C Gan, Graduate Student in Marketing, Lecturer and Senior Lecturer, respectively, Department of Economics and Marketing, PO Box 84, Lincoln University, Canterbury, New Zealand.

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1. Introduction

The safe use and management of agrichemical is an important issue in the New Zealand agribusiness sector. However, despite the substantial concern about the safe use and management of agrichemical, 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 to expose themselves to serious acute and chronic health risks from agrichemical exposure through improper management and inefficient use of agrichemical (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 agrichemical. 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 agrichemical (Ministry of Agriculture and Fisheries 1992).

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

Despite the significant benefits accruing to primary producers in being trained in safe and efficient agrichemical use and management, the majority of 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, et al., 1993). Uncertainty about the extent and severity of agrichemical health risks and technological developments in IPM 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).

Research into the effects of uncertainty on primary producers' recognition of a problem in their use and management of agrichemicals, and the factors that influence *problem recognition*, may therefore provide important insights into the reasons for the low level of primary producers' participation in agrichemical training. The purpose of this research is to identify and analyze factors which *precipitate* producers' problem recognition in their use and management of agrichemical. Problem recognition is modelled in this study as the intention to participate in an agrichemical training programme. Using primary data from a survey of New Zealand agrichemical users, the decision to participate in agrichemical training is considered in the framework of a qualitative choice model. Results of this research shed light on the factors that influence problem recognition and the implications of these factors on marketing programmes.

2. Problem Recognition

Problem recognition is generally regarded as the first stage of any consumer's decision process (Engel et al., 1968). The consumer decision, or problem solving, process 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. The steps involved problem recognition, information search, alternative evaluation, choice and outcome. 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).

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*. The authors emphasized that not every perceived discrepancy between actual and ideal states will result in problem recognition. They ascertained 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.

There is however 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, 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; Bruner and Pomazal, 1988).

Block and Roering (1976), state that *consumer analysts now believe that problem recognition can best be measured by obtaining information on purchase intentions*. The authors 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 conclude 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.

Even though problem recognition has been often mentioned in the consumer behaviour and marketing literature for more than 25 years, little empirical research 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. Subsequently, few researchers have addressed problem recognition as a multifaceted process.

There are also an unlimited number of factors that can influence a consumer's problem recognition process. Researchers in the marketing, economics, and risk management disciplines have however identified several of the more common influences as information sources; experience; overconfidence; perceptions, attitudes and concerns; the current situation; and marketing effort. Slovic et al. (1984) and Bruner and Pomazal (1988) present a detailed discussion on these factors.

3. Data

In this study, New Zealand growers are defined as those people who produce vegetables and pipfruits, and who have not undertaken previous agrichemical training. 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 et al., 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. 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 et al., 1989);*
- v. *recent developments in IPM and spray equipment technology have been estimated as providing significant production cost savings for New Zealand growers (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); and*
- 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, et al., 1993). Over 500 New Zealand agrichemical users from the primary sector were interviewed on a wide range of agrichemical related subjects. These subjects included problem recognition, attitudes, information sources, current situation and behaviour. For the purpose 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. This resulted in a usable sample of 227 growers.

Attitudinal, informational and behavioral 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 behavioral 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.

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 applicator health risks were the most predominant concern.

4. The Model

Theoretical constructs for the *a priori* determination of the factors that influence problem recognition are not well developed. This study used exploratory factor analysis to statistically identify these factors. The procedure used to form and describe the factors that influence growers' problem recognition involved two stages:

Stage I: identification of the underlying factor dimensions using factor analysis; and

Stage II: subjection of the factor scores to a qualitative choice analysis to determine the influence of the factor dimensions on problem recognition.

Since 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 behavioral 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 behavioral 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). Diagnostic testing for the appropriateness of the independent data set for factor analysis was performed. 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; Harman 1976). 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 provided the best representation of the underlying relationship among the variables. These include responsibility, employee involvement, safe use and export, experience, efficient use, experience and awareness, size, hazardous use, environmental concern, health ambivalence, unsafe practices, handling concern, spray drift concern, decision making, previous employment, immunity concern, disposal and information, overconfidence, and family influence.

Responsibility

Includes 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. However, they believe that their employees needed further training.

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 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. They also tend 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 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 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 not to 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

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 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).

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. The 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 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 qualitative choice analysis.

Recognition of a problem by growers in their use and management of agrichemicals (defined as the decision to participate in an agrichemical training program), is hypothesized to be a function of the identified nineteen factors. The model proposed can be written under the general form:

$Train = f(\text{responsibility, employee involvement, safe use and export, experience, efficient use, experience and awareness, size, hazardous use, environmental concern, health ambivalence, unsafe practices, handling concern, spray drift concern, decision making, previous employment, immunity concern, disposal and information, overconfidence, family influence, } \varepsilon);$ where

$Train = 1$ if the individual intends to engage in training in agrichemical application practices, 0 otherwise

A priori hypotheses can be made from above model. The current situation (Bruner and Pomazal 1988), and consumers' concern over the actual state of affairs (Engel, Kollat and Blackwell 1973), have been found to be related positively to problem recognition. In view of these findings, the following hypotheses are offered:

H₁: There is a positive relationship between *Responsibility* and Problem Recognition.

H₂: There is a positive relationship between *Employee Involvement* and Problem Recognition.

- H₃: There is a positive relationship between *Safe Use and Export* and Problem Recognition.
- H₄: There is a positive relationship between *Efficient Use* and Problem Recognition.
- H₅: There is a positive relationship between *Size* and Problem Recognition.
- H₆: There is a negative relationship between *Hazardous Use* and Problem Recognition
- H₇: There is a positive relationship between *Environmental Concern* and Problem Recognition.
- H₈: There is a negative relationship between *Health Ambivalence* and Problem Recognition.
- H₉: There is a negative relationship between *Unsafe Practices* and Problem Recognition.
- H₁₀: There is a positive relationship between *Handling Concern* and Problem Recognition.
- H₁₁: There is a positive relationship between *Spray Drift Concern* and Problem Recognition.
- H₁₂: There is a positive relationship between *Decision Making* and Problem Recognition.
- H₁₃: There is a positive relationship between *Immunity Concern* and Problem Recognition.
- H₁₄: There is a positive relationship between *Disposal and Information* and Problem Recognition.

The problem recognition literature also indicates that consumer experience (Rantanen 1981), and consumer overconfidence in their decision making (Slovic, Fischhoff and Lichtenstein 1984), is negatively related to problem recognition. Consequently, the following hypotheses are possible:

- H₁₅: There is a negative relationship between *Experience* and Problem Recognition.
- H₁₆: There is a negative relationship between *Overconfidence* and Problem Recognition.

The literature has however been contradictory on the effects on problem recognition of information sources (Hale and Glendon 1987, McCarthy and Perreault 1987), and marketing effort (Bruner and Pomazal 1988, Engel, Kollat and Blackwell 1973). Without clear evidence in the literature for the remaining dimensions of problem recognition, the following

hypotheses are possible:

H₁₇: There is no relationship between *Experience and Awareness* and Problem Recognition.

H₁₈: There is no relationship between *Previous Employment* and Problem Recognition.

H₁₉: There is no relationship between *Family Influence* and Problem Recognition.

These nineteen hypotheses are intended to test the prediction that the derived factors are associated with growers' problem recognition in their use and management of agrichemicals. Collectively, they represent a synthesis of current marketing, economics and risk behaviour literature with respect to problem recognition and decision making concepts.

5. Qualitative Choice Theory

Amemiya (1981) identified an important reason for the recent upsurge in the use of qualitative choice modelling in economic applications--the existence of many naturally discrete variables. Economic agents often are observed making choices between activities rather than only making choices involving levels of participation in markets. Qualitative choice models have been used in analysing participation in a variety of activities.

Economic theory can be applied to choices between activities as well as levels of activities. Models for determining the choice of discrete alternative activities are known as qualitative choice models. Consider a simple logistic model.

Utility from the choices can be defined as the average utility from each choice plus a random error:

$$(1.1) U_{i0} = U_{i0ave} + \varepsilon_{i0} = \mathbf{z}'_{i0} \delta + \mathbf{w}'_i \gamma_0 + \varepsilon_{i0} = \text{utility from choice 0}$$

$$(1.2) U_{i1} = U_{i1ave} + \varepsilon_{i1} = \mathbf{z}'_{i1} \delta + \mathbf{w}'_i \gamma_1 + \varepsilon_{i1} = \text{utility from choice 1}$$

where U_{i0} and U_{i1} are the utilities from the two choices, U_{i0ave} and U_{i1ave} are the average utilities, \mathbf{z}'_{i0} and \mathbf{z}'_{i1} are vectors of attributes of the two choices as perceived by the i^{th} individual, \mathbf{w}'_i is a vector of the characteristics of the i^{th} individual, and ε_{i0} and ε_{i1} are random errors (Judge, et al., 1982).

The individual chooses to participate in an agrichemical training programme if $U_{i1} > U_{i0}$. The observable choice of participating is denoted by $Y_i = 1$ and the observable choice of not participating is denoted by $Y_i = 0$. An unobservable choice variable, Y^*_i is given by $Y^*_i = U_{i1} - U_{i0}$. If $Y^*_i > 0$ then participating is chosen.

Y^*_i can be rewritten as:

$$\begin{aligned} (1.3) \quad Y^*_i &= (\mathbf{z}_{i1} - \mathbf{z}_{i0})' \delta + \mathbf{w}'_i (\gamma_1 - \gamma_0) + (\varepsilon_{i1} - \varepsilon_{i0}) \\ &= [(\mathbf{z}_{i1} - \mathbf{z}_{i0})', \mathbf{w}'_i] [\delta, (\gamma_1 - \gamma_0)]' + \varepsilon^*_i \\ &= \mathbf{x}'_i \boldsymbol{\beta} + \varepsilon^*_i \end{aligned}$$

Explanatory variables (agrichemical use and management attributes) are represented by \mathbf{x}'_i , $\boldsymbol{\beta}$ is the vector of parameters associated with the variables, and ε^*_i is the error for the model for Y^*_i . The probability that the choice for the i^{th} individual (Y_i) is equal to one is:

$$(1.4) \quad \Pr_i = \Pr[Y_i=1] = \Pr[Y^*_i > 0] = \Pr[\varepsilon^*_i > -\mathbf{x}'_i \boldsymbol{\beta}]$$

Qualitative choice models are used to predict probabilities of choices being made and attempt to relate the probability of making a particular choice to various explanatory factors (Sellar, et al.). Probabilities must be between zero and one. Estimation of parameters to maximize the probability of the choice $Y_i = 1$ by use of a linear probability model and ordinary least squares (OLS) is not acceptable due to the return of probabilities outside the unit interval (Stynes and Peterson, 1984). In addition, use of a linear probability model results in heteroscedastic errors and as a consequence, t-tests of significance are not valid (Maddala, 1991). For these reasons it is preferable to use a logit model.

Use of the logit model involves maximum likelihood estimation methods in analyses such as this one in which repeated observations for each individual decision maker are not available

. A likelihood function is defined and usually the natural logarithm of the function is taken. This log likelihood function is then maximized with respect to the β vector in order to estimate the individual parameters that maximize the probability of each individual's choice being $Y_i=1$. Rather than the use of calculus, numerical methods must be used to estimate β because the first partial derivatives of the log likelihood function are highly non-linear functions of β and cannot be solved directly (Judge, et al., 1982).

Logit models assume the errors have a logistic distribution. The cumulative distribution function (c.d.f.) of the logistic random variable ε is given by:

$$(1.5) \quad F(t) = 1/[1+\exp(-t)]$$

This c.d.f. gives the probability of the independent variable $Y_i=1$ at $\mathbf{x}'_i\beta$, where β is the estimated vector of parameters resulting from the maximized log likelihood function when the logit model is specified as:

$$(1.6) \quad \mathbf{Y} = 1/[1+\exp(-\mathbf{x}_i'\beta)]$$

where \mathbf{Y} is the vector of predicted probabilities of the choice variable $Y_i=1$.

6. Empirical Analysis

The empirical results of the hypothesis tests, derived from the Maximum Likelihood estimates of the logit model (Table 3), are summarised in Table 4. Beta (β) coefficients for the factors are considered significant at the 0.1 level or lower ($p < 0.1$). The estimated coefficients for *Employee Involvement*, *Safe Use and Export*, *Experience*, *Health Ambivalence* and *Overconfidence* are all significant at the 0.1 level. 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 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.

Consistent with Rantanen (1981) and Slovic, Fischhoff and Lichtenstein (1984), the findings of the empirical analysis provide strong support for the negative influence consumer experience and overconfidence have on problem recognition. The empirical results however only provide limited support for the current situation and consumers' concern over the actual state of affairs as determinants of problem recognition. Only the *Employee Involvement*, *Safe Use and Export* and *Health Ambivalence* factors were found to be significant determinants of problem recognition, although in all three cases the directional influence on problem recognition was as hypothesised. Finally, the three factors that measured the effects of information sources and marketing effort on problem recognition were found to be not significantly associated with problem recognition.

7. 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. Growers' agrichemical experience and overconfidence 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 and desire to participate in an agrichemical training programme.

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.

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 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 SS 21, 22 and 23 of the Health and Safety in Employment Act 1992, or 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 the influence of their attitudes, information and behaviour on their assessment of problem recognition. These findings would have important implications for training programme provision and primary sector policy analysis. Developing more comprehensive measures which relate attitudinal, informational and behavioral 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.

Table 1: Descriptive Statistics of the Independent Variables

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
Local Council	0.01	0.70	0-1
Family	0.09	0.29	0-1
Ministry of Ag. & Fisheries	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	1-729
Export	0.62	0.49	0-1

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.

Table 2: Rotated Factor Matrix of Independent Variables

	Employee Involvement	Safe Use & Export	Experience	Efficient Use	Experience & Awareness	Size	Hazardous Use	Environmental Concern	Health Ambivalence
Responsibilities									
Application		.713	-.360						
Storage		.777							
Calibration		.576							
Transportation		.402							
Disposal (containers)	.695								
Chemical type	.572							-.359	
Decision making									
Employees									
Employee involvement	.833								
Employees untrained	.772								
Employee training need			.657						
Practices									
Protective Equip. Use									-.647
Locked chemical area			.427						
Records				.732					
Warning signs									
Information Sources									
On experience						.727			
Grower association						-.437			
Chemical industry									

Previous employer			
Reading agchem. information		-0.342	-0.367
Field days			-0.531
Product information (labels)			
Other chemical users	-0.430		
Neighbours/locals			0.571
Local council			
Family			
MAF			
Chemical Knowledge Evaluation			
Course awareness		0.547	
Agricultural Concerns			
Efficient use and timing		0.668	
Application		0.671	
Alternatives		0.519	
Insufficient knowledge	0.503		
Safety			
Storage			
Mixing			0.446
Consumer perceptions			0.752
Container disposal			
Chemical disposal			
Spray drift			
Environment			
Withholding period			

Pest resistance
 Health
 Chemical cost

Demographics

Age .764
 Chemical experience .779
 Growing area (size) .772
 Export .730

	Unsafe Practices	Handling Concern	Spray Drift Concern	Decision Making	Previous Employment	Immunity Concern	Disposal & Info.	Over- Confidence	Family Influence
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Responsibilities

Application
 Storage
 Calibration
 Transportation
 Disposal (containers)
 Chemical type
 Decision making

.565

Employees

Employee involvement
 Employees untrained
 Employee training need

Practices

Protective Equip. Use

Locked chemical area

Records -.329Warning signs -.787**Information Sources**

On experience

Grower association .338Chemical industry -.578Previous employer .728Reading agchem. information -.355

Field days

Product information (labels) .379Other chemical users -.420

Neighbours/locals

Local council .812Family .848MAF -.751**Chemical Knowledge Evaluation**Course awareness .513**Agrichemical Concerns**

Efficient use and timing

Application

Alternatives

Insufficient knowledge

Safety		.346		.474	
Storage			.834		
Mixing		.547			
Consumer perceptions					
Container disposal					.736
Chemical disposal		-.628			.316
Spray drift				.322	.389
Environment	.507				
Withholding period					-.795
Pest resistance					.837
Health	-.744				
Chemical cost				-.764	
Demographics					
Age					
Chemical experience					
Growing area (size)					
Export					

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

Table 4: Hypothesis Test Results

Hypothesis	Factor	Hypothesis Test Findings	
		Hypothesis Upheld	Hypothesis Rejected
1	Responsibility		–
2	Employee Involvement	–	
3	Safe Use and Export	–	
4	Efficient Use		–
5	Size		–
6	Hazardous Use		–
7	Environmental Concern		–
8	Health Ambivalence	–	
9	Unsafe Practices		–
10	Handling Concern		–
11	Spray Drift Concern		–
12	Decision Making		–
13	Immunity Concern		–
14	Disposal and Information		–
15	Experience	–	
16	Overconfidence	–	
17	Experience and Awareness	–	
18	Previous Employment	–	
19	Family Influence	–	

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