New Zealand Agricultural and Resource Economics Society (Inc.)

Values of Ecosystem Services on Arable Land and the Role of Organic Farming

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Paper presented at the 2005 NZARES Conference
Tahuna Conference Centre – Nelson, New Zealand. August 26-27, 2005.

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Abstract:

Nationwide mail surveys implemented in November 2004 report New Zealand residents' willingness to pay for improvement in ecosystem services and support for organic farming on arable land. The surveys were split into two subsets: Canterbury, which is the region with most arable farming in the nation, and the other New Zealand regions. Analysis of the data reveals that Canterbury residents' willingness to pay for reduction in greenhouse gas emissions from arable farming is greater than their willingness to pay for improvement in water quality, while it is the opposite for residents in other regions. In addition, residents' willingness to fund an organic farming project that enhances certain ecosystem services is analyzed. The results provide insights for management of arable lands to deliver selected ecosystem services in New Zealand.

Keywords:
Ecosystem Management, Organic Farming, Arable Farming, Choice Modeling.

1. Introduction

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Farmers use a variety of inputs including human and manufactured capital to produce food, fibre or raw materials. As well as these inputs, they also make use of natural capital inputs such as soil fertility, pollination, bio-protection, and groundwater. These latter inputs are examples of ecosystem services (ES). Some ecologists and biologists have classified ecosystem services into four categories: regulating, supporting, provisioning, and cultural services [12]. Food, fibre and raw materials are examples of provisioning ES. Several authors have noted that ecosystem services play major roles supporting or contributing directly to economic output including output from agriculture [3, 4, 7]. It is clear that agriculture both benefits from and produces ES.

Income generation is a key objective for the majority of New Zealand farmers. Production of food, fibre and raw material generates revenue for landowners because most of these outputs can be sold in the market place. However, many ecosystem services delivered by arable farms have public good characteristics, there are no markets for them and hence no prices to users or revenue for producers of those ES. The absence of property rights for ES can result in their importance being overlooked by decision makers. When that occurs, profit maximizing behaviour may not lead to welfare maximization. Under these conditions, farmers may apply high amounts of external inputs such as synthetic fertilizer, pesticides, irrigated water and other inputs if they focus on food or fibre production to achieve short term profit maximization. This focus on profit maximization may have harmful consequences for natural capital stocks such as soil fertility, soil quality, and future productivity of the land. Little attention may be focused by landowners on aesthetic qualities of the landscape, or recreation possibilities if these ES are not readily marketed.

In many high income countries, agriculture has become more intensive in the last few decades [15]. In New Zealand the intensification of agriculture has raised concerns about some of the harmful effects it can have including high nitrate levels in groundwater, degradation of lowland streams and lakes, effects on fish availability and effects on greenhouse gas emissions [9, 14]. These concerns have focused particularly upon dairy farming but other types of farming including arable farming have come in for attention. Arable farming in New Zealand has made increased use of nitrogenous fertilizers during the past decade and this external input intensification has lead to increased greenhouse gas emissions and leaching of nitrates into the groundwater. Moreover, conventional arable farming practices lead to losses of soil through wind and water erosion and tends to mine soil organic matter. There are few recreation opportunities on conventional arable farms and arable farming landscapes may provide little aesthetic interest if they are dominated by treeless monocultures.

Researchers have estimated the total economic value of ecosystem services (ES) provided globally by 16 biomes [3]. Average, but not marginal values per hectare, of each ecosystem service have been estimated in these studies and the average values per hectare are applied irrespective of location. Patterson and Cole [16, 17] replicated the Constanza et al. [3] study and estimated values for Waikato and New Zealand ecosystem services. The land cover classes used in the Waikato and New Zealand studies include horticulture, agriculture and cropping land. Patterson and Cole [16, 17] report that on arable land only five ecosystem services have positive economic values.

We contend that arable farming can provide a range of ecosystem services and benefits to society as New Zealand farmers seek to maximize commercial gain from food, fibre and fuel production. Finding ways to more accurately measure the value of non-marketed ecosystem services associated with arable farming is a challenge addressed in this paper. We report how we have used discrete choice modeling to estimate the welfare value of selected ecosystem services provided on New Zealand arable land. Our paper estimates the welfare values associated with four key ecosystem services: climate regulation, water regulation, soil retention and scenic views associated with New Zealand arable farming. Based on data collected in a nationwide mail survey, our study reveals New Zealand resident's willingness to pay for improvements in these ecosystem services. Furthermore respondents' social characteristics are analyzed to identify correlates with support for organic farming as an alternative way to deliver the four ecosystem services. This study reports willingness to support organic farming and comments on the benefit of improving ecosystem services associated with arable land for a variety of social groups in New Zealand.

2. Choice Modeling Theory

In this study, our primary aim is to assess marginal economic values of ecosystem services; hence we employ two stated preference techniques - CVM and choice modeling. CVM and choice modeling are increasingly being formulated in a random utility framework, which allows measurement of the values of non-market goods and services. The utility function (U) is composed of an observable component (indirect utility function) and an unobservable error component,

$$U = V + \varepsilon \qquad (1)$$

where V is the indirect utility function and ε is the stochastic error term. We assume that the indirect utility is a linear form,

$$V_i = \beta_t X_{ki} + \alpha y = \beta_1 + \beta_2 x_{2i} + \beta_3 x_{3i} + ... + \beta_k x_{ki} + \alpha_i y_i \qquad (2)$$

where X_{ki} (= {x_1, $x_{2, \ldots,}$ x_k}) is a vector of k attributes associated with alternative i, β is a coefficient vector, y_i is income for a respondent choosing the alternative i bundle, and a is the coefficient vector of income. If the stochastic error term is logistically Gumbel distributed (Type I extreme value distributed), the choice probability for alternative i is given by,

$$\Pr(i) = \frac{\exp(\rho V_i)}{\Sigma_{j \in C}^{J} \exp(\rho V_i)} \qquad (3)$$

where ρ is a positive scale parameter, and C is the choice set for an individual. For convenience we generally make the assumption ρ =1 [1].

To estimate the welfare impacts, i.e., willingness-to-pay, for a change from the status quo state of the world to the chosen state, the following formula is used:

$$V_i(X_i, y) + \varepsilon_i = V_j(X_j, y - CV) + \varepsilon_j \quad (4)$$

where V_i and V_j represent utility before and after the change and CV is compensating variation, the amount of money that makes the respondent indifferent between the status quo and the proposed scenario.

A multinomial logit model or conditional logit model can be applied to estimate the welfare measure in equation (4). With the multinomial logit model, the effects of the attribute variables are allowed to differ for each outcome. Equation (4) can be restated as:

$$\beta_\iota X_{ki} + \alpha_\iota y + \varepsilon_\iota = \beta_j X_{kj} + \alpha_j (y - CV) + \varepsilon_j \quad (5)$$

α_ι and α_j are assumed to be equal [6] if marginal utility of income for a respondent is constant. The welfare change is estimated by:

$$CV = -\frac{1}{a}\left[\left(\beta_\iota X_{ki} - \beta_j X_{kj}\right) + \left(\varepsilon_\iota - \varepsilon_j\right)\right] \quad (6)$$

For the multinomial logit model, the coefficient vector of k attribute variables differ for each alternative, and $\beta_\iota \neq \beta_j$. Alternatively, in the conditional logit model, coefficients of k attributes across the all alternatives are the same [5], and $\beta_\iota = \beta_j$; only the attribute levels differ across the alternatives. Under this condition, welfare change is estimated by the following:

$$CV = -\frac{1}{a}\left[\beta\left(X_{ki} - X_{kj}\right) + \left(\varepsilon_\iota - \varepsilon_j\right)\right] \quad (7)$$

In this paper, the conditional logit model (equation 7) is used to estimate welfare changes in ecosystem services, since the impact of the attributes of ecosystem services is assumed to remain the same across all choice alternatives.

3. Survey Experiment Methodology

In September 2004, pilot surveys were tested on students at Lincoln University and on randomly selected residents in both the South and North Island. In November 2004 a pre-survey card, survey booklet and cover letter, and a reminder post-survey card were sent to 2052 individuals selected from the New Zealand electoral roll using a random stratified sampling design. The sample was divided into two strata: 1026 persons were randomly selected from the Canterbury region (which contains the largest area of arable farming in New Zealand) and 1026 from the rest of New Zealand.

The response rates for the surveys are shown in Table 1. The overall effective response rate for the survey experiment was 36%. The response rate to the survey in Canterbury was 39%. For the rest of New Zealand it was 34%.

Both the CVM and choice modeling surveys contained four sections: (1) general questions about the environment in New Zealand; (2) general questions about New Zealand farming; (3) specific questions about alternative management scenarios for cropping farming and additional specific questions about organic farming; and (4) questions about respondent's social characteristics and backgrounds. Except for the section on alternative scenarios for cropping faming, all questions were held constant between the two formats. Social characteristic questions asked respondents about their age (AGE), education (EDU), income (INC), residence in rural or urban area (UEB), the number of people in household (NHH), the number of children (NCHI), and occupation. The questions relating to the environment and farming are summarised in Table 2 with the relevant variable names.

ES characteristics and attributes

The attributes of selected ES provided by cropping farming in New Zealand were explained to all survey respondents at the beginning of the section on alternative scenarios. Attributes discussed were greenhouse gas emissions, nitrate leaching, soil retention, and scenic views of cropping farms. Each attribute was presented to respondents as several discrete levels of delivery (see Table 3). For example, the attribute of greenhouse gas emissions from cropping farms was presented as having three discrete levels: 'big reduction' (50% reduction from the current emission level); 'small reduction' (20% reduction from the current emission level); and 'no change' from current emission levels. For the nitrate leaching from cropping farms, there were three levels presented to respondents: 'big reduction' (50% reduction in nitrate leaching to streams); 'small reduction' (20% reduction in nitrate leaching to streams); and 'no change' from current level of nitrate leaching to streams. The attribute of soil quality of cropping farms was limited to two levels: 'small change' (soils retain their organic matter and structure over 25 years) and 'no change' (continuation of the current slow rate of soil degradation). The fourth attribute, scenic views of cropping farms was also limited to two levels; 'more variety' (more trees, hedgerows and birds and a greater variety of crops on cropping farms) and 'no change' (maintain the current cropping farming landscape).

Choice modeling formats

The choice modeling surveys were designed to contain multiple choice questions (choice sets) about alternative policies for improving four ecosystem services on cropping land. In the surveys, before the choice set questions, respondents were briefed about the four attributes of ecosystem services and associated cost to the household. The cost to the household, the payment vehicle, was defined as an additional annual payment to the regional council responsible for management of the environment over the next five years. The discrete range of cost alternatives given to respondents was NZ$10, $30, $60, and $100. In the choice questions, respondents were asked to select an option they favored the most out of the three alternatives provided (See Appendix 2). Each option contained the four attributes and the cost to the household with various levels of attribute combinations. The cost to the household in option A was designed higher than in option B, and option C was set as the status quo across all choice sets. Respondents were asked to answer similar types of choice questions sets multiple times. As there are three levels for the greenhouse gas emission and nitrate leaching attributes, two levels in the soil and scenic view attributes, and four levels in the cost to household, there are 2^2x3^2x4 factorial designs

[11]. For statistically efficient choice designs, a D-efficient design excluding unrealistic cases was adapted to each of the choice questions [8, 20].

Following the choice set questions, respondents were asked about their ideal policies, which are ideal levels of each attribute, and the ideal cost to their households for their ideal combinations. In addition, there were questions about organic farming associated with cropping land. Respondents were asked whether they would like to support organic farming for improving the ecosystem services and their willingness to pay for supporting organic farming if quality of the ecosystem services rose to their ideal level which they answered in the previous question. If respondents answered that they would like to contribute all their ideal cost of improving ecosystem services via organic farming, they were categorized as fully organic supporters. If they answered that they would like to contribute part of the cost, they were defined as partially organic supporters. If they chose not to support organic farming at all, they were classified as non-organic supporters.

4. Survey Analysis and Results

4.1 General Analysis

The descriptive statistics of the three sample strata (Canterbury, the rest of New Zealand, and the pooled data) are presented in Table 4. Chi-square tests indicate there are no significant differences in the social characteristics across the three samples.

Choice modeling results were analyzed with the conditional logit model using effect codes [11] rather than dummy variables for the four ecosystem service attributes. Definitions of the effect codes for attribute variables are presented in Table 5. The advantage of using effect codes over dummy variables is the ability to observe a respondent's comparison of one level with other levels in an attribute [19].

For simplicity of analysis, no social characteristic variables were included in the first model (Model 1). This model did not include an alternative specific constant which represents unobserved factor on respondent's choice between option A, B and C [13] because our interest was to estimate individual choice differences between option C and other options, not between option A and B. In the result of both sample strata, coefficients of COST are negative, which suggests that people are likely to accept the policy with lower cost to households.

The results of choice modeling for both areas are shown under columns of Model 1 in Table 6. All variables are significant at the 0.05 level. Coefficients of large reductions in greenhouse gas emissions and nitrate leaching show relatively large magnitudes in both Canterbury and the rest of New Zealand. On the other hand for both sample strata, the coefficients of scenic views are relatively lower than for the other variables.

Mean welfare values for the various policy alternatives described in the survey are estimated by using equation (7) and the results are shown in rows of Model 1, "for all respondents", in each strata in Table 7. The choice modeling results, on the other hand, elicit economic values for six policy alternatives, since the model is capable of estimating multiple policies simultaneously from multiple choice sets.

Mean welfare values of improvements in all four ecosystem services (ALL) are similar between Canterbury and the rest of New Zealand, which are around $250 per household. However, people in the two regions weight values of each attribute differently. In the results for Canterbury respondents, the value of large reductions of greenhouse gas emissions is greater than it is for reduction in nitrate leaching. For Canterbury respondents, willingness to pay for six alternative polices are ordered from the highest to lowest:

1. Large reductions of greenhouse gas emissions from cropping farms
2. Large reductions of nitrate leaching from cropping farms
3. Small reduction of greenhouse gas emissions from farms
4. Small reduction of nitrate leaching from farms
5. Soil quality change on cropping farms
6. Scenic view change of cropping farms

In the rest of New Zealand, willingness to pay for these policies are ordered as follow:

1. Large reductions of nitrate leaching from cropping farms
2. Large reductions of greenhouse gas emissions from cropping farms
3. Small reduction of nitrate leaching from cropping farms
4. Small reduction of greenhouse gas emissions from cropping farms
5. Soil quality change on cropping farms
6. Scenic view change of cropping farms

This result indicates that for residents in Canterbury reduction of greenhouse gas emissions is more important than improvement in water quality, but vice versa for residents in the rest of New Zealand. Attributes of soil and scenic view are also considered as valuable ecosystem services in both regions although those values are lower compared to greenhouse gas emissions and water attributes.

4.2 Analysis Using Support for Organic Farming and Social Characteristics

Individuals' willingness to pay for improvements in ecosystem services are examined depending on their social characteristics and support for organic farming. In Canterbury, 31, 36, and 34 % of the respondents are categorized as fully, partially, or non organic supporters, respectively. Similarly 31, 41, and 29 % of respondents in the rest of New Zealand are categorized as fully, partially, or non organic supporters. To determine the characteristic of each organic/non-organic group, the following logit models were regressed separately for Canterbury, the rest of NZ, and pooled data:

[Fully, Partially, or Non-Organic supporter]
=f [AGE, EDU, INC, URG, NHH, NCHI, RESO, MANUO, EDUCO, LEIO, GOVO, COMO]

The results are shown in Table 8. In both Canterbury and other regions, people who have larger numbers in their household but fewer children, or work in education, manufacturing, or leisure sector are more likely to be a fully organic supporter. A difference between the two regions is that in Canterbury a person working in a resource based sector is less likely to be an organic supporter, but the correlation is insignificant in the rest of New Zealand. Moreover, people working in the human health or government sectors are more likely to be fully organic supporters in the rest of New Zealand region, but the same tendency cannot be seen in Canterbury respondents. Analysis of non-organic supporters also can be completed. In both regions, the larger number of children in a household increases likelihood of being a non-organic supporter. In the rest of New Zealand region, people working in the communication sector are likely to be in the non-organic supporter.

To estimate the values of each ecosystem service attribute for the organic/non-organic supporter groups, interaction terms of each organic group are included in the conditional logit model (Table 6). Model 2 contains an interaction term of non-partially organic group (NPO), which is comprised of the fully and non-organic group. This model allows us to easily and precisely estimate values of each ecosystem service for the partially organic group because the interaction term plays a role like a dummy variable. Model 3 and Model 4 are also constructed in the same manner. For estimation of values for the fully organic support group, an interaction term with partially and non organic support group (NFO) are contained in Model 3. For estimation of non-organic support group, interaction terms of fully and partially organic group (POR) are contained in Model 4. The three models are separately regressed for Canterbury, the rest of New Zealand, and the pooled data.

The results of the conditional logit model (Model 2, 3, and 4) are shown in Table 6. All coefficients of the attribute variables and interaction terms are significant at the 0.01 or 0.05 level across the three models except for small reduction of greenhouse gas emissions (GGS) and scenic view (SV) in Model 4.

Estimated mean willingness to pay for each attribute are presented in Table 7. In Canterbury the fully and partially organic group valued a large reduction of greenhouse gas emissions the highest among all attributes, at $139.84 and $142.13 per household per year respectively. However, non-organic supporters' willingness to pay for a large reduction of greenhouse gas emissions and willingness to pay for nitrate leaching are nearly equal, and the values are approximately $55, which is less than half of the willingness to pay for those attributes by organic support groups. Values of soil quality and scenic views for non-organic supporters are also much lower compared to their willingness to pay by organic supporters. Values of soil quality and scenic views are about one third and one fifth of the values for other groups.

In the rest of New Zealand, unlike Canterbury, a large reduction of nitrate leaching is valued the highest among the selected ecosystem services for all three organic/non-organic groups. However, the lowest value among all attributes for non-organic supporters was again scenic views. The values of change in greenhouse gas emissions, nitrate leaching, soil, or scenic views for the non-organic group were approximately 30, 50, 30, and 25 percent, respectively, of the values of other organic supporters.

Total WTP for these ecosystem service attributes can be calculated from the mean values. According to Statistics New Zealand [18], there are about 1.5 million households are in New Zealand, of which 0.184 million households are in Canterbury. Based on these numbers, the estimated mean WTP, and the ratio of the organic supporter groups, the total WTP for ecosystem services are estimated and shown in Table 9. The results show that for all New Zealand the value of controlling nitrate leaching is $173.24 million and in the highest among the four attributes. The value of reductions of greenhouse gas emissions is $159.13 million. Values of improved soil quality and scenic view qualities for New Zealand are approximately 45 and 20 percent of the value of controlling nitrate leaching respectively. The results also reveal that almost half of willingness to pay for enhancing each ecosystem service is attributable by partially organic supporters. More than 85 percent of the total values of improving ecosystem services are attributable by organic supporters when fully and partially organic supporters are grouped together.

Analysis has been conducted to determine what social characteristics in each organic/non-organic group are significantly related to individual willingness to pay for improving ecosystem services. Interaction terms which are combined social characteristics variables with the organic support groups were included in the conditional logit model (Model 5), as shown in Table 6. From the results, coefficients of interactions combining fully organic supporters and education or income are positive and significant in both Canterbury and rest of New Zealand regions. On the other hand, interactions combining partially organic supporters and number of children are negative and significant in the regions. This can be interpreted as people who are fully organic supporters and have higher education or income are more likely to pay for improving ecosystem services; however, people who are partially organic supporters and have more children are less likely to pay. These results are summarized in Table 10. There are three columns for fully, partially or non organic support groups. The vertical axis shows the degree of willingness to pay from low to high. It is noticeable that some people categorized as fully organic farming supporters are less willing to pay for enhancement of ecosystem services. They are people working in manufacturing, education, or resource based sectors in Canterbury or working in leisure or communication sectors in the rest of New Zealand. Another interesting fact is that non-organic supporters in the rest of New Zealand are more likely to pay for improvement in ecosystem services if they are young, have a large family, work in the communication sector, or live in urban areas.

5. Summary

The choice modeling study allows us to estimate welfare values for changes in levels of four ecosystem services (significant reductions of greenhouse gas emissions and nitrate leaching and improvement of soil quality and scenic views) associated with arable land for people living in Canterbury (the region with most cropping farming in New Zealand) and for people in the rest of the nation. Estimated mean willingness to pay for each attribute reveals that individuals' concern for greenhouse gas emissions is greater than their concern for water quality in Canterbury while it is the opposite in the rest of New Zealand. In addition, this study finds that the values of scenic views of arable farms are the lowest among the four studied ecosystem services. This ecosystem service, which is not directly related to ecosystem functioning and is a public good, is likely to be ignored in management decisions on cropping farms.

However the results show that on average people in New Zealand enjoy seeing cropping farm landscapes and consider that ecosystem service as a valuable service.

Mean willingness to pay for the ecosystem services varies depending on the level of support for organic farming. The mean values of each ecosystem service attribute for the fully organic supporter or partially organic supporter is respectively 43 or 34 percent higher than for the total nations' average. When fully and partially organic supporters are combined, these groups contain around 70 percent of the nation's population and share 87 percent of the nation's willingness to pay for improvement in the four ecosystem services.

Analysis of the social characteristics of the organic supporter groups and their willingness to pay for improved ecosystem services presents some interesting insights. The results indicate that social values of improving ecosystem services associated with cropping land in New Zealand depends on respondents' social characteristics. One finding is that willingness to pay for enhancement of ecosystem services is significantly higher among fully or partially organic farming supporters. Currently New Zealand is targeting $1 billion sales from the organic farming sector by 2013, which is seven times more than the 2001/2002 level [14]. Switching from conventional to organic farming, which is one of methods to improve ecosystem services on arable land, may meet social demand and increase social utility. However, further analysis reveals that people working in manufacturing, education, or leisure sector who are fully organic supporters are less willing to pay for improvement in ecosystem services. Although fully organic supporters are generally considered to be people favoring better quality of environment and life, they are not always equivalent to people who obtain higher welfare values for improvements in these ecosystem services. On the other hand, the study also shows that some people in the non-organic group, such as people working in the communication sector or living in urban areas, have higher willingness to pay for selected ecosystem services. The values of improved ecosystem services for people working in resource based sectors in Canterbury or people living in rural areas in non-Canterbury regions, who may be engaging in farming, are relatively low.

Individuals in New Zealand are willing to pay significant amounts for improvement in selected ecosystem services associated with arable land. Nearly half of the estimated national willingness to pay for enhancements of ecosystem services from arable land is attributable to people who partially support organic farming. Further investigation is required to determine organic farming's ability to deliver improvements in ecosystem services. The information reported in this paper should be considered together with cost estimation to verify whether new policies or strategies of arable land management are efficient and capable of increasing social wellbeing in New Zealand.

Acknowledgement

This project is financially supported by the New Zealand Foundation for Research, Science & Technology (LINX0303).

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Appendix 1

Table 1. Response Rates

	Canterbury	Rest of NZ	Total
Surveys	1026	1026	2052
Undelivered	20	31	51
Responded	391	334	725
Response Rate	0.39	0.34	**0.36**

Table 2. Definitions of Variables

Variables	Definition
AGE	Age
EDU	1 if primary school; 2 if high school without qualifications; 3 if high school wit qualifications; 4 trade/technical qualification; 5 undergraduate diploma; 6 bachelors degree; 7 postgraduate
INC	5 if less than $10,001; 15 if $10,001 to $20,000; 25 if $20,001 to $30,000; 35 if $30,001 to $40,000; 45 if $40,001 to $50,000; 55 if $50,001 to $60,000; 65 if $60,001 to $70,000
URB	1 if residence in urban area; otherwise 0
NHH	Number of household
NCHI	Number of children
RESO	1 if work in resource based industry; otherwise 0
MANUO	1 if work in manufacturing and transport industry; otherwise 0
EDUCO	1 if work in education sector; otherwise 0
HSO	1 if work in health service industry; otherwise 0
LEIO	1 if accommodation, retail, and leisure service industry; otherwise 0
GOVO	1 if work in government sector; otherwise 0
COMO	1 if work in communication and financial service industry; otherwise 0
ICOST	Ideal cost for respondent's ideal policy program
ORGCOST	Ideal cost for supporting organic farming
FORG	1 if fully organic supporter; otherwise 0
LPORG	1 if partially organic supporter; otherwise 0
NONOR	1 if non-organic supporter; otherwise 0
NFOR	1 if non-fully organic supporter; otherwise 0
NPOR	if non-partially organic supporter; otherwise 0

Table 3. Definitions of Selected Ecosystem Service Attributes on Arable Farms

Attributes	Levels	Definitions
Greenhouse Gas Emissions	Big Reduction	50% reduction from the current emission level
	Small Reduction	20% reduction from the current emission level
	No Change	Maintain current emission level
Nitrate Leaching	Big Reduction	50% reduction in nitrate leaching to streams
	Small Reduction	20% reduction in nitrate leaching to streams
	No Change	Maintain current nitrate leaching to streams
Soil Quality	Small Change	Soil organic matter and structure are retained over 25 years
	No Change	Maintain current slow rate of soil degradation
Scenic Views	More Variety	More trees, hedgerows and birds and a greater variety of crops on cropping farms
	No change	Maintain the current cropping farm landscape
Cost to Household	10; 30; 60; 100	Annual payment to a regional council for the next 5 years (NZ$)

Table 4. Descriptive Statistics

	Canterbury		Rest of NZ		Pooled	
	Mean	Std.Dev.	Mean	Std.Dev.	Mean	Std.Dev.
AGE	52.02	15.85	53.69	15.59	52.79	15.75
EDU	4.00	1.57	3.97	1.64	3.99	1.60
INC	55.81	33.09	60.51	35.20	58.02	34.18
URB	0.74	0.44	0.68	0.47	0.71	0.45
NHH	2.78	1.34	2.70	1.35	2.74	1.34
NCHI	0.59	1.01	0.53	0.95	0.56	0.98
RESO	0.11	0.32	0.12	0.33	0.12	0.32
MANUO	0.21	0.41	0.17	0.37	0.19	0.39
EDUCO	0.15	0.36	0.15	0.36	0.15	0.36
HSO	0.11	0.32	0.10	0.30	0.11	0.31
LEIO	0.13	0.34	0.10	0.29	0.11	0.32
GOVO	0.05	0.21	0.06	0.24	0.05	0.23
COMO	0.09	0.29	0.13	0.33	0.11	0.31
ICOST	55.25	59.71	63.04	101.15	59.42	84.55
ORGCOST	31.08	60.65	35.07	80.91	33.18	72.06
FORG	0.31	0.46	0.31	0.46	0.31	0.46
LPORG2	0.36	0.48	0.41	0.49	0.39	0.49
NONOR	0.34	0.47	0.29	0.45	0.31	0.46

Table 5. Effect Codes: Choice Modeling

Attributes	Variables	
Green House Gas Emissions	GGS	1 if small reduction ; 0 if big reduction ; -1 if no change
	GGB	1 if big reduction; 0 if small reduction; -1 if no change
Nitrate Leaching	NLS	1 if small reduction ; 0 if big reduction ; -1 if no change
	NLB	1 if big reduction; 0 if small reduction; -1 if no change
Soil Quality	SOIL	1 if small change; -1 if no change
Scenic Views	SV	1 if more variety; -1 if no change
Cost to Household	COST	NZ$10; $30; $60; $100

Table 6. Conditional Logit Model

	Model 1			Model 2			Model 3			Model 4			Model 5		
	No-Interaction			Interaction with non-partially organic supporter			Interaction with non-fully organic supporter			Interaction with organic supporter			Interaction with social characteristics		
	Canterbury	Rest of NZ	Pooled	Canterbury	Rest of NZ	Pooled	Canterbury	Rest of NZ	Pooled	Canterbury	Rest of NZ	Pooled	Canterbury	Rest of NZ	
	Coeff.	Coeff.	Coeff.	Coeff.	Coeff.	Coeff.	Coeff.	Coeff.	Coeff.	Coeff.	Coeff.	Coeff.	Coeff.	Coeff.	Coeff.
Attributes of ecosystem services															
COST	-0.011 **	-0.012 **	-0.011 **	-0.010 **	-0.009 **	-0.009 **	-0.009 **	-0.009 **	-0.010 **	-0.015 **	-0.016 **	-0.015 **	-0.014 **	-0.014 **	-0.014 **
GGS	0.088 **	0.194 **	0.137 **	0.103 **	0.201 **	0.146 **	0.097 **	0.209 **	0.152 **	0.072	0.165 **	0.116 **	0.102 **	0.180 **	0.139 **
GGL	0.513 **	0.421 **	0.470 **	0.602 **	0.499 **	0.524 **	0.549 **	0.461 **	0.537 **	0.360 **	0.269 **	0.317 **	0.492 **	0.442 **	0.453 **
NLS	0.250 **	0.193 **	0.224 **	0.304 **	0.232 **	0.247 **	0.260 **	0.200 **	0.257 **	0.150 **	0.099 *	0.127 **	0.212 **	0.130 **	0.167 **
NLL	0.370 **	0.498 **	0.429 **	0.411 **	0.529 **	0.453 **	0.388 **	0.519 **	0.461 **	0.325 **	0.446 **	0.380 **	0.400 **	0.531 **	0.458 **
SOILC	0.252 **	0.263 **	0.257 **	0.309 **	0.311 **	0.292 **	0.277 **	0.294 **	0.302 **	0.160 **	0.168 **	0.164 **	0.224 **	0.258 **	0.234 **
SVV	0.105 **	0.124 **	0.113 **	0.142 **	0.148 **	0.131 **	0.118 **	0.135 **	0.138 **	0.038	0.056 **	0.045 *	0.066 *	0.094 **	0.078 **
Interactions for varied organic group															
01xNPO1				-0.721 **	-0.726 **	-0.595 **									
02xNPO2				-0.547 **	-0.375 **	-0.279 **									
01xNFO1							-0.486 **	-0.595 **	-0.663 **						
02xNFO2							-0.199 *	-0.238 **	-0.403 **						
01xPOR1										1.466 **	1.898 **	1.648 **			
02xPOR2										1.090 **	1.421 **	1.225 **			
Interactions comvined by varied organic group and social variables															
FORG*AGE 1													0.013	-0.014	0.003
FORG*AGE 2													0.016 *	-0.003	0.011 *
LPORG*AGE 1													-0.014	0.002	-0.009
LPORG*AGE 2													-0.004	0.008	0.000
NONOR*AGE 1													0.000	-0.033 **	-0.019 **
NONOR*AGE 2													0.009	-0.024 **	-0.010 **
FORG*EDU 1													0.461 **	0.474 **	0.382 **
FORG*EDU 2													0.329 **	0.400 **	0.272 **
LPORG*EDU 1													0.010	0.056	-0.026
LPORG*EDU 2													-0.013	0.030	-0.040
NONOR*EDU 1													-0.142	0.264 **	0.056
NONOR*EDU 2													-0.255 **	0.058	-0.092
FORG*INC 1													0.019 **	0.019 **	0.020 **
FORG*INC 2													0.021 **	0.016 *	0.020 **
LPORG*INC 1													0.003	-0.007	0.001
LPORG*INC 2													0.000	-0.008	-0.002
NONOR*INC 1													0.006	0.005	0.003
NONOR*INC 2													0.000	0.005	0.002
FORG*URB 1													-0.718 *	0.160	-0.440
FORG*URB 2													-0.503	0.025	-0.422
LPORG*URB 1													0.052	0.563	0.440 *
LPORG*URB 2													0.235	0.677 *	0.560 **
NONOR*URB 1													-0.085	1.126 **	0.633 **
NONOR*URB 2													0.209	0.781 **	0.471 **
FORG*NHH 1													-0.207	-0.020	-0.088
FORG*NHH 2													-0.142	0.078	-0.038
LPOR*NHH 1													0.950 **	0.192	0.564 **
LPOR*NHH 2													0.794 **	0.139	0.442 **
NONOR*NHH 1													-0.124	-0.557 **	-0.318 **
NONOR*NHH 2													-0.212 **	-0.231 **	-0.189 **

Continue Table 6.

FORG*NCHI 1													-0.009	0.496	-0.007
FORG*NCHI 2													-0.226	0.321	-0.122
LPORG*NCHI 1													-1.676 **	-0.734 **	-1.226 **
LPORG*NCHI 2													-1.279 **	-0.506 **	-0.878 **
NONOR*NCHI 1													0.170	0.164	0.244 **
NONOR*NCHI 2													0.288	0.085	0.184
FORG*RES 1													-1.715 **	-0.555	-1.078 **
FORG*RES 2													-2.555 **	-1.044	-1.718 **
LPOR*RES 1													0.421	1.343 **	1.149 **
LPOR*RES 2													-0.331	0.744	0.429
NONOR*RES 1													-0.913 **	0.874 **	0.372
NONOR*RES 2													0.263	0.197	0.308 **
FORG*MANUO 1													-1.454 **	1.442	-0.892 **
FORG*MANUO 2													-1.478 **	1.344	-0.982 **
PORG*MANUO 1													-0.391	0.895	0.280
PORG*MANUO 2													-0.450	0.794	0.145
NONOR*MANUO 1													-0.266	1.359 **	0.415 *
NONOR*MANUO 2													-0.023	0.932 **	0.332
FORG*EDUCO 1													-1.559 **	-1.654 **	-1.312 **
FORG*EDUCO 2													-2.052 **	-1.923 **	-1.646 **
LPORG*EDUCO 1													0.696	2.706 **	1.409 **
LPORG*EDUCO 2													0.188	1.898 **	0.757 **
NONOR*EDUCO 1													0.454	-1.067 **	0.177
NONOR*EDUCO 2													0.461	0.424	0.707 **
FORG*HSO 1													-0.531	0.680	0.549
FORG*HSO 2													-0.280	0.217	0.390
LPOR*HSO 1													0.154	0.652	0.596
LPOR*HSO 2													0.030	0.170	0.293
NONOR*HSO 1													1.005 *	1.147 **	1.100 **
NONOR*HSO 2													1.811 **	0.667	1.267 **
FORG*LEIO 1													-0.718	-1.370 **	-0.646
FORG*LEIO 2													-1.294 **	-1.361 **	-0.954 **
LPORG*LEIO 1													0.474	0.211	0.595
LPORG*LEIO 2													0.317	-0.041 **	0.384
NONOR*LEIO 1													0.002	-1.725 **	-0.377
NONOR*LEIO 2													0.464	-0.161	0.291
FORG*COMO 1													-0.202	-1.637 **	-0.863 **
FORG*COMO 2													-0.636	-3.106 **	-1.777 **
LPORG*COMO 1													-0.189	1.366 **	0.611 **
LPORG*COMO 2													-0.409	0.327	-0.053
NONOR*COMO 1													0.680	0.984 **	0.875 **
NONOR*COMO 2													1.230 **	1.486 **	1.340 **
Number of observation	2075	1089	3884	2075	1089	3884	2075	1809	3884	2075	1809	3884	1833	1572	3405
Log-likelihood	-2007.174	-1723.427	-3733.935	-1998.200	-1710.063	-3712.799	-1998.781	-1711.728	-3706.557	-1943.719	-1637.399	-3587.448	-1587.676	-1298.916	-2968.376
R-squared Adj.	0.043	0.040	0.042	0.052	0.047	0.047	0.047	0.046	0.049	0.073	0.088	0.079	0.117	0.146	0.116

* significant at the 0.10 level
** significant at the 0.05 level

Table 7. Mean WTP per household per year (NZ$)

Canterbury		GGL	GGS	NLL	NLS	SOIL	SV	ALL
Model 1	for all respondents	100.91	62.42	89.70	78.77	45.68	18.99	255.28
		0.40		*0.35*		*0.18*	*0.07*	*1.00*
Model 2	for fully organic	139.84	86.98	121.17	106.17	64.89	27.61	353.51
		0.40		*0.34*		*0.18*	*0.08*	*1.00*
Model 3	for partially organic	142.13	78.82	109.69	99.23	60.23	27.76	325.12
		0.44		*0.34*		*0.19*	*0.09*	*1.00*
Model 4	for non-organic	54.47	34.68	54.93	42.91	22.06	5.28	136.74
		0.40		*0.40*		*0.16*	*0.04*	*1.00*
Rest of NZ								
Model 1	for all respondents	87.09	67.98	99.99	74.32	44.17	20.91	252.15
		0.35		*0.40*		*0.18*	*0.08*	*1.00*
Model 2	for fully organic	131.84	99.10	142.03	109.32	68.33	32.53	374.74
		0.35		*0.38*		*0.18*	*0.09*	*1.00*
Model 3	for partially organic	124.70	96.93	136.56	101.40	64.80	29.70	355.75
		0.35		*0.38*		*0.18*	*0.08*	*1.00*
Model 4	for non-organic	43.21	36.85	60.84	39.57	20.63	6.83	131.52
		0.33		*0.46*		*0.16*	*0.05*	*1.00*
Pooled								
Model 1	for all respondents	94.28	65.20	94.67	76.75	45.02	19.81	253.79
		0.37		*0.37*		*0.18*	*0.08*	*1.00*
Model 2	for fully organic	135.97	92.93	131.13	107.72	66.57	29.86	363.53
		0.37		*0.36*		*0.18*	*0.08*	*1.00*
Model 3	for partially organic	126.01	86.49	121.28	100.36	62.11	28.42	337.82
		0.37		*0.36*		*0.18*	*0.08*	*1.00*
Model 4	for non-organic	48.85	35.81	57.75	41.25	21.31	5.93	133.85
		0.36	*0.27*	*0.43*	*0.31*	*0.16*	*0.04*	*1.00*

GGL - large reductions of greenhouse gas emissions
GGS - small reductions of greenhouse gas emissions
NLL - large reductions of nitrate leaching
NLS - small reductions of nitrate leaching
SOIL - improvement in soil quality
SV - improvement in scenic views
ALL - improvement in all four ecosystem service attributes
A figure in italic indicates percentage share of ALL value for each model in each strata.

Table 8. Logit Model: Analysis of Social Characteristics Depending on Support for Organic Farming

	Canterbury			Rest of NZ			Pooled		
	Full-Organic	Partly-Organic	Non-Organic	Full-Organic	Partly-Organic	Non-Organic	Full-Organic	Partly-Organic	Non-Organic
	Coeff.	Coeff.	Coeff.	Coeff.	Coeff.	Coeff.	Coeff.	Coeff.	Coeff.
ONE	-1.233 **	-0.822 **	0.032	-1.156 **	0.488 **	-0.468 **	-1.051 **	-0.552 **	-0.489 **
AGE	0.000 **	0.000 **	0.000	0.000 **	0.001 **	0.001 **	0.000 **	0.001 **	0.000 **
EDU	0.001 **	-0.001 **	0.000	-0.001 **	-0.003 **	-0.002 **	0.000	-0.001 **	0.001 **
INC	0.000 **	0.000 **	0.000 **	0.001 **	0.001 **	0.001 **	0.000	0.001 **	-0.001 **
URB	-0.001 **	0.000	-0.001 **	0.001 **	0.001 **	0.000	0.000	0.000	-0.001 **
NHH	0.121 **	0.068 **	-0.229 **	0.001 **	0.002 **	0.000	0.002 **	0.000	-0.002 **
NCHI	-0.121 **	0.006	0.228 **	-0.001 **	0.000	0.001 **	-0.002 **	0.002 **	0.001 **
RESO	-0.260 **	-0.083	0.238 **	0.020	-0.033	-0.086	-0.080	-0.041	0.079
MANUO	0.587 **	0.101	-0.778 **	0.346 **	-0.402 **	-0.859 **	0.508 **	-0.286 **	-0.214 **
EDUCO	0.291 **	0.541 **	-0.885 **	0.828 **	0.830 **	-0.009	0.528 **	0.265 **	-0.795 **
HSO	-0.227 **	0.621 **	-0.573 **	0.902 **	0.844 **	-0.160 **	0.275 **	0.300 **	-0.665 **
LEIO	0.329 **	0.242 **	-0.553 **	0.393 **	0.230 **	-0.182 **	0.352 **	0.065	-0.400 **
GOVO	-0.078	0.807 **	-0.950 **	0.581 **	1.373 **	0.466 **	0.253 **	0.632 **	-1.108 **
COMO	-0.178	0.539 **	-0.446 **	-0.397 **	0.120	0.362 **	-0.308 **	0.446 **	-0.222 **
Log likelihood	-3740.693	-4091.424	-3577.381	-3229.255	-3426.253	-3260.058	-7070.836	-7599.227	-6980.428
Restricted log likelihood	-3853.301	-4220.152	-3732.833	-3355.550	-3550.837	-3461.252	-7208.857	-7787.184	-7209.659
Chi squared	225.216	257.457	310.904	252.591	249.169	402.388	276.041	375.914	458.463
P-value	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
McFadden	0.029	0.031	0.042	0.038	0.035	0.058	0.019	0.024	0.032
Akaike I.C.	1.206	1.319	1.154	1.195	1.268	1.207	0.042	0.055	1.201

* significant at the 0.10 level
** significant at the 0.05 level

Table 9. Total WTP for New Zealand (million NZ$)

	GGL	GGS	NLL	NLS	SOIL	SV	ALL
for fully organic	61.91	45.50	65.01	50.78	31.65	14.88	173.46
	0.39	0.38	0.38	0.39	0.39	0.42	0.39
for partially organic	77.47	58.10	81.77	61.90	39.34	18.04	215.64
	0.49	0.49	0.47	0.47	0.49	0.50	0.48
for non organic	19.75	16.11	26.46	17.65	9.18	2.91	58.30
	0.12	0.13	0.15	0.14	0.11	0.08	0.13
Total	159.13	119.72	173.24	130.33	80.18	35.84	447.41

Table 10. Individual WTP for Organic Farming and Social Characteristics of Respondents

	NON-ORG	PARTIALLY-ORG	FULLY-ORG
HIGH ↑		Education Industry^	
	+No. of Household*^	**-No. of Children*^**	
	Communication Industry^		
	Urban^		
		+No. of Household*	
			+Education*^
WTP	-Age^		**+Income*^**
	+AGE^		**-Income*^**
			-Education*^
		-No. of Household*	
	Rural^		
			Leisure Industry^
	-No. of Household*^	**+No. of Children*^**	Manufacture Industry*
			Education Industry*
↓ LOW			Resource Base Occupation*
			Communication Industry^

* Canterbury

^ Rest of NZ

Bold letters indicate social characteristics related to both Canterbury and the rest of NZ.

Appendix 2

A sample question in a Choice Modeling Survey

Please tick the option that you most prefer:

	Option A	Option B	Option C
Greenhouse Gas Emission	Big reduction	No change	No change
Nitrate Leaching	Big reduction	Small reduction	No change
Soil	No change	No change	No change
Scenic Views	More variety	No change	No change
Cost to Household ($ per year for next 5 years)	$100	$10	$0

Option A ☐ Option B ☐ Option C ☐