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Agricultural Landscape Change in Ireland*

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# The Emerald or Yellow Isle? Estimating the Welfare Impacts of Agricultural Landscape Change in Ireland<sup>i</sup>

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## Abstract

In this paper we exploit a discrete choice modeling framework to estimate the potential non-market welfare impacts of alternative hypothetical rural Irish landscapes that could become real by the year 2030 depending both on future agricultural policy reform and changing land use demands. These hypothetical rural Irish landscapes were developed, based on a study by Flanagan et al. (2007) entitled *2030 Foresight Report for Irish Agriculture* where 5 different possible 'Irish farming futures' that may arise in 2030 were described. The results of a Random Parameters Logit model demonstrate significant preference heterogeneity amongst the Irish population for the attributes of agricultural landscapes. The largest welfare gain for the population is found to be from the 'agri-environmental landscape' that protects traditional farm landscape features and enhances biodiversity.

**Keywords:** Environmental Preferences, choice experiments, future farm landscapes, random parameter logit.

**JEL Classification:** Q51, Q58

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<sup>i</sup> Internationally Ireland is often referred to as the Emerald Isle due to the dominance of permanent grassland in the landscape. If bio-fuel crops such as the brightly coloured yellow rapeseed were to become more popular then Ireland's title might change to "the Yellow Isle".

## 1. Introduction

In this paper we exploit a choice experiment modeling framework to estimate the potential non-market welfare impacts of a number of hypothetical rural Irish landscape types that could become real by the year 2030 depending both on future agricultural policy reform and changing land use demands. While Irish agriculture is primarily a grass-based industry there exist distinctive farming regions within the country<sup>1</sup>. These are undergoing different processes of change depending on their resource base, their responses to economic imperatives, and the policy environment (Hynes et al., 2009a). Also, the general public's demands for new functions from agriculture are continuously changing. While food security was the dominant concern for consumers at the onset of the Common Agricultural Policy (CAP), concerns relating to the many non-market goods associated with agriculture are just as important to citizens of the EU today.

The reform of Europe's agricultural policy started in the 1990s when support prices were lowered for commodities such as cereals and beef. In June 2003, the EU made further changes to the CAP when they agreed to decouple direct payments from production with a gradual introduction of such a system from 2005. Decoupling means that income support, through what is now referred to as the Single Farm Payment (SFP), is provided to farmers irrespective of their level and type of production (Dixon and Matthews, 2007 and Dillon et al., 2010). Since these latest reforms, the European Commission, in November 2007, published a Communication on the 'CAP Health Check'. It stated that it is the Commission's objective to "streamline the CAP" by making the SFP scheme simpler and more efficient and to increase modulation<sup>2</sup>. This sends an important signal to all stakeholders that future reforms will undoubtedly place a greater emphasis on supporting the multifunctional agenda (Burrell, 2004)<sup>3</sup>. The reforms of the CAP and the indication that there may be further increases in the rate of modulation allowed by member states is in recognition of the fact that at the same time as performing its traditional role as a food producer, agriculture also has an increasingly important role in the production of environmental goods as well as contributing to rural development and the maintenance of cultural heritage<sup>4</sup>.

Coupled with the changing attitudes of the public towards the type of activity that agricultural policy should be supporting in the future are other challenges that may have a significant impact in shaping the Irish and European agricultural landscape in 2030. Firstly, the most pressing challenge facing global agriculture is maintaining and increasing production of food and fibre from natural resources in the face of an increase in average temperatures as a result of climate change. While there is still considerable uncertainty as to how climate change will affect Irish agriculture, the general consensus at present is that Ireland will experience an increase in average annual rainfall during the winter period (up to 20% in the west of the country) and warmer drier summers (Irish Committee on Climate Change, 2008 and Hynes et al., 2009b). Adaptations required by Irish farmers may include earlier planting and harvesting dates, lower fertiliser application rates, and significant capital investment in irrigation equipment. However, as the Irish Committee on Climate Change (2008) point out, more adverse impacts of climate change on agricultural production elsewhere in the EU may create new market opportunities and increase agricultural output in Ireland.

Secondly, global demand for a range of agricultural products is forecast to continue to grow as world population continues to expand. Increasing per capita incomes in both developed and developing countries will also likely increase the demand for higher value food products and animal proteins (FAPRI, 2004). Indeed, according to Cribb (2008), global food output must rise by 110 per cent in the coming 40 years if it is to meet the forecasted increase in world demand. Elsewhere, it has been projected that total crop and livestock production will rise by approximately 40% between 2008 and 2030 (FAO, 2006) while the World Bank predicts a 50% rise in cereals demand compared with an 85% increase for meat between 2000 and 2030 (World Bank, 2008). This may result in the reorientation of agricultural policy in Europe towards a dramatic increase in the production of livestock and crops especially in suitable agricultural production countries such as Ireland.

Also, the continued interest in and increasing demand for renewable fuels, to reduce carbon emissions and increase energy security, could result in an agricultural landscape

dedicated to the production of rapeseed, willow and other bio-fuels. In 2003, under the Biofuels Use Directive the EC established a goal of deriving at least 2% of EU transportation fuel from biofuels by the end of 2005, then growing the biofuels share by 0.75% annually thereafter. To date this objective has not been achieved but if energy prices were to rise significantly it is not inconceivable that biofuel production could significantly increase.

These changes in the policy environment and the external challenges and incentives that farmers will face in the future imply that the Irish agricultural landscape of the future may be very different from what one sees today. Ultimately, the EU agricultural policy of the future that drives these changes will be paid for by European taxpayers. Therefore, a more thorough understanding of the preferences of EU citizens for alternative agricultural policy options and the valuation of the possible resulting future agricultural landscapes are required and should assist decision makers in further reforming the CAP. The objective of this paper is to provide an assessment of the public support for alternative agricultural policy targets in terms of the non-market landscape values associated with each possible policy scenario. This paper argues that the choice experiment (CE) modelling framework is a suitable one for such a task especially when the trade offs that need to be considered relate to agricultural policy aimed at fostering a multifunctional agricultural sector with environmental, energy and economic (productive) and even social attributes.

The hypothetical future agricultural landscape types that may exist in Ireland and which are examined in this paper are based on a study by Flanagan et al. (2007) entitled *2030 Foresight Report for Irish Agriculture*. Based upon expert judgment, the authors developed 5 different possible 'Irish farming futures' that may arise in 2030. These were entitled 1, the food island, 2, globally competitive farming, 3, energy squeeze fuels agriculture, 4, European agriculture and 5, the sustainable rural environment. Each of these hypothetical futures can in turn be associated with different agricultural landscape attributes and thus a valuation technique that is capable of accounting for different attributes and attribute levels across different scenarios is needed. Choice Experiment

(CE) is one such valuation technique and we employ this methodology in what follows to estimate the welfare impact of changes in agricultural policy that result in a particular type of agricultural landscape in the future.

In what follows we will first review the 5 different possible 'Irish farming futures' that may arise in 2030 as discussed by Flanagan et al. (2030), and briefly highlight where choice experiments have been previously used in the valuation of agricultural landscapes. This is followed in section 3 with a description of the survey design while the modelling approach used is discussed in section 4. Next, the estimation results are presented in section 5 and finally this paper concludes with a discussion of this paper's main findings and their implications for agricultural policy reform.

## **2. The Five Agricultural Futures and CEs in Agricultural Landscape Analysis**

### ***The Five Agricultural Futures***

The five scenarios presented in the paper by Flanagan et al. (2007) were designed to stimulate policy makers', agricultural researchers' and agricultural advisors' thinking and understanding of how both the agri-food and rural economy sectors in Ireland might proactively address different eventualities or 'futures' as they emerge. As the authors themselves point out; it is important to note that the scenarios developed for this Foresight exercise are not predictions of the future but possible fictional 'futures' that may arise, based upon expert judgment. The process involved elements of imagination and creativity but did draw on available forecasts and predictions at the time which were "grounded in reality".

It should be noted that while the five scenarios described in the paper did not explicitly concern themselves with describing what impact each might have on the rural landscape they did paint a picture that allowed us, in consultation with experts in the field, to decide on agricultural landscape attributes and levels for our choice experiment that could be used in describing the landscape that could possibly arise from each scenario. This in turn allowed us to estimate the welfare impacts, arising from landscape change, of pursuing each scenario option. The five future (2030) agricultural scenarios are described in

summary below along with what we perceive are their associated landscape characteristics.

### *The food island*

Global population growth and “westernization” of diets have driven the food industry. Ireland is a world leader in producing foods for health. The value of Ireland's dairy output has doubled and volume output has increased by 80%. Environmental issues and an energy crisis have had an impact, with policies on the implementation of efficient processing, water usage and eco-friendly packaging systems. There has been no significant change in the production of bio-fuel crops however. Food policy and regulation is designed to meet public health targets and consumer views. In terms of landscape change we would hypothesize that policy aimed at achieving this scenario might result in a moderate increase in livestock from current levels while at the same time a greater abundance of wild flora and fauna in the rural environment may be observed.

### *Globally competitive farming*

In 2030, commercial full-time farming in Ireland has expanded greatly. In 2030, we see a diversified sector that competitively produces milk, beef/sheep and tillage crops. Irish dairy farmers produce milk not only in Ireland but also abroad, and Ireland exports not only milk and milk products but management know-how and production skills. Ireland produces milk with clinical properties for specialist high value-added markets. Milk production has doubled and large tillage farms grow 500,000ha of crops for the food, pharmaceutical and other industries. Meeting environmental targets is seen as a major constraint. We hypothesize that a policy aimed at achieving this scenario might result in a moderate increase in livestock from current levels while at the same time the maintenance of field boundaries would deteriorate, with even their possible removal to make bigger field units for tillage expansion. This may also have the knock on effect of a decline in the presence of wild flora and fauna which often operates along the field margins.

### *Energy squeeze fuels agriculture*

In 2030, agriculture is now centre stage in terms of global food and energy security. The world has entered the post peak oil era with conventional oil production declining steadily. Oil prices fluctuate around \$300 per barrel. Agriculture has become an important source of renewable energy and of green-materials to replace petroleum based products such as plastics. The number of dairy farmers has declined substantially and tillage production has increased significantly to produce raw materials for the renewable energy sector. A policy aimed at achieving this scenario might result in a significant increase in the amount of land under rapeseed, willow and other bio-fuel crops, the quantity of cattle and sheep in the landscape would decrease, the maintenance of field boundaries would deteriorate and there would be a reduction in wild flora and fauna in the rural environment.

#### *European agriculture*

In 2030 the Irish agricultural sector is focused on the production of traceable, high quality food and energy for the European market. Repeated efforts to get agreement on liberalised world trade have failed in the previous 2 decades. Europe, the US and East Asian economies have, in response, reinstated significant agricultural policy intervention. European agricultural policy has refocused on the original objectives of the CAP in order to increase agricultural productivity, ensure a fair standard of living for the agricultural community, stabilize markets, provide certainty of food supplies; and ensure that those supplies reach consumers at reasonable prices and without detrimental effects on the rural environment. In terms of landscape change we would hypothesis that policy aimed at achieving this scenario might result in a moderate increase in livestock from current levels and a moderate increase in the amount of land under bio-fuel crops. Field margins would be maintained at current levels and there would be no change on the present levels of wild flora and fauna in the rural environment.

#### *Sustainable rural environment*

In 2030 the agricultural sector is concerned with the achievement of environmental sustainability as well as the competitive production of food. In this scenario environmental issues such as climate change, biodiversity loss and environmental



security take precedence as they are important political and economic driving forces at both an Irish and global level. The 2030 bio-economy significantly delivers a competitive range of agri-environmental produce using knowledge supported innovation over the previous 20 years. These range from species conservation to landscape protection. In terms of landscape change we would hypothesise that policy aimed at achieving this final scenario might result in a significant improvement in terms of field boundary upkeep and hedgerow planting. There would be no significant change in livestock or bio-fuel crops from current levels. However we would expect a noticeable increase in the levels of wild flora and fauna in the rural environment.

### ***The use of Choice Experiments in Agricultural Landscape Analysis***

The use of CE for agricultural policy and landscape valuation has increased significantly in recent years. While the use of CE to examine the preferences of respondents for landscape features (such as those described in the scenarios previously) associated with more intensive agriculture is rare, a number of studies have used CE to model the landscape that might be associated with the last scenario described above. Hanley et al. (2001) report on choice experiments carried out in Cambridgeshire, Devon and Shropshire that considered public preferences for ancient hedgerows, new hedgerows, arable field margins and heather moorland, as landscape features. Although preferences varied across the three study areas, in each case the authors found preferences for increased provision above the status quo. In a more recent example Colombo et al. (2009) examine a number of alternative modelling strategies that can be used in conjunction with a CE dataset on the preferences of respondents for conserving upland hill farming in the North West region of England. The authors conclude that the way the analysts treat preference heterogeneity in the random utility theoretical framework has an impact on the estimates of value measures for a public good, the impact being more important for the marginal WTP estimates than for the compensating surplus estimates. They highlight the use of models that incorporate preference heterogeneity as being vital in order to provide more reliable welfare measures for use in cost–benefit analysis and policy appraisal.

Likewise, Campbell et al. (2008) report the findings from a discrete-choice experiment designed to estimate the economic benefits associated with rural landscape improvements in Ireland. Results from this work indicated that the landscape benefits alone associated with the Rural Environmental Protection Scheme in Ireland were almost enough to equal the total cost of provision of the scheme. Rambonilaza and Dachary-Bernard (2007) also valued landscape attributes (hedgerows, moorland, farm buildings) of the Monts d'Arée area in Brittany, France. The authors conclude that there exists a divergence of preferences between the users on the one hand and the policy makers (landscape managers) on the other.

A small number of studies have also used CE for the evaluation of future land-use alternatives. For example, Hunziker et al. (2008) evaluated how different societal groups perceive past and possible future Swiss landscape changes in the Alps. Their results show a rather broad consensus among different social groups regarding major landscape developments. However, they also report significant differences between groups such as people living inside and outside the Alps, and between lay people and experts. In another study, Schmitz et al. (2003) implemented the choice experiment method to non-market outputs of agriculture in a rural part of Germany. The survey included four attributes with five levels each: Water quality, richness in species, landscape characteristics and a hypothetical price per household. The authors report the WTP for selected scenarios combining different attribute levels. A scenario with no financial support and forest instead of agricultural land-use was found to result in negative WTP. However, a scenario with balanced land-use (crop and grassland) and an increase in species diversity resulted in a positive WTP.

Away from a CE framework, but relevant to the analysis presented here are two earlier studies that also examined the preferences of society for alternative agricultural policy and landscapes. In a study by Variyam et al. (1990), data from a nationwide survey on public attitudes toward agriculture was used to examine the structure of citizens' preferences for government involvement in agriculture and especially for policies to protect family farms. Estimates of the influence of economic and socio-demographic variables on policy preferences were computed using a multiple-indicator model. The authors concluded that altruistic motives on the part of society may not be strong enough to justify redistributory agricultural policies but rather the results lend support to the self-

interest theory of voter behaviour. Finally, Willis and Garrod (1993) examined the preferences for and the values of different landscapes which could possibly arise in the future in the Yorkshire Dales National Park in England using the Contingent Valuation framework. The landscapes assessed by respondents comprised of artists impressions of a range of possible future agricultural landscapes: today's landscape; abandoned; semi-intensive agricultural; intensive agricultural; planned; conserved; sporting; and wild landscapes. The authors found that a majority of both visitors to and residents of the Dales preferred the status quo landscape, although the conserved landscape was also valued highly.

We add to this literature by examining the non-market value of possible agricultural landscapes that may exist in Ireland in 2030 under different policy options. We do so using a random parameter logit (RPL) model that allows us to take account of the fact that there may be a wide variety of tastes in terms of the preferences of the population for alternative rural landscape attributes. Our study is also a national level study whereas most studies that attempt to value particular landscapes or agro-ecosystems are usually defined at local or regional scales. Attempts to generate value estimates at a national level are scarce (Drake, 1992 being an exception). Finally, the analysis in this paper facilitates a discussion on whether the ideas being presently discussed by members of the European Commission and agricultural policymakers, in relation to the future direction of the CAP, are meeting the aspirations of European citizens in terms of the future rural landscapes that are likely to be supported with the aid of their tax contributions.

### **3. Survey Design**

In order to obtain information relating to the Irish publics' attitudes towards different features of the Irish rural landscape and, in particular, to estimate the welfare impacts resulting from possible future changes to this landscape, a survey of 1005 individuals living in Ireland was conducted between November 2008 and January 2009. A quota controlled sampling procedure was followed to ensure that the survey was nationally representative for the population aged 18 years and above. The quotas used were based

on known population distribution figures for age, sex and region of residence taken from the Irish National Census of Population, 2006.

In the CE part of the survey each respondent was asked to identify a preferred farming landscape choice among a given set of alternatives. As discussed by Adamowicz et al. (1998), attribute selection in a CE can be based on either primary research (e.g. focus groups) that is tailored to a particular project, secondary research (e.g. literature sources, previous experience with the same or similar products or consultation with experts), or on a hybrid approach that uses both secondary and primary research. In this study the last approach was followed and in particular, the attributes in the choice sets were selected following three steps. First a short literature review of related studies was conducted. Previous studies by Willis and Garrod (1993), Campbell (2006 and 2008) and Hanley et al. (2007) were particularly informative. This was then followed up with consultation with experts and the completion of two focus groups. A number of one to one discussions with Professor Nick Hanley of Stirling University, in relation to a number of similar type CE studies conducted by him on aspects of the British countryside (see for example Hanley et al. (1998) and Hanley et al. (2007)) were also extremely useful in informing our CE design.

The selection of attribute levels was more difficult due to the need to make quantitative predictions of the impacts of future agricultural policy changes on the attributes chosen but through the focus groups and further discussions with specialists in the Irish Agricultural Research organization, Teagasc, we identified the attributes associated with "Irish farm landscapes" that the general Irish population wants to see supported under future reforms of the CAP and which were also compatible with describing the 5 possible future farm landscape scenarios<sup>5</sup>. Pilot testing of the survey instrument was also carried out prior to the main survey. The pilot survey was conducted during September 2008 with a sample of 50 respondents to test the coverage, wording, length, and the design of the survey. Along with the expert judgment and observations from earlier focus group discussions, the results from the pilot were used to refine the questions asked in the main

survey. Both the pilot and the main survey itself were conducted by a survey company using face-to-face, door-to-door personal interviews.

The final attribute list was comprised of the presence of wild flora and fauna on farm, the utilisable agricultural land under rapeseed, willow and other bio fuels, the condition of field boundaries (stone walls and hedges) and the quantity of cattle and/or sheep in the landscape. The changes in the utilisable agricultural land under rapeseed, willow and other bio fuels, and the quantity of cattle and/or sheep in the landscape attributes were described in percentage terms. The payment vehicle (the cost attribute) used in the choice experiment was an increase in general taxation. The reasons for using this payment vehicle include the fact that agricultural policy and programmes are generally paid for through taxation. Participants in the focus groups also indicated that taxation was their preferred payment option. The tax levels were €10, €20, €40, €80, with a baseline of no increase. The attributes and their levels are further described in table 1.

An efficient Bayesian experimental design (Louviere et al., 2000), based on the minimisation of the Db error criterion was used to vary attributes and levels. D-efficiency has been the most common approach for measuring the efficiency of experimental designs used in the literature (Ferrini and Scarpa, 2007). For the pilot version, the experimental design was based on a priori knowledge of the sign and magnitude of the parameters gained from focus group discussions, relevant literature and stakeholder opinions. The main survey employed a Bayesian design based on the multinomial logit parameter estimates obtained from the pilot study data. This created 16 initial profiles that were used to generate the choice cards, thus following the approach of Campbell (2008); Ferrini and Scarpa (2007) and Rose et al. (2008)<sup>6</sup>. An example of a choice card used is shown in Figure 1.

The initial 16 landscape profiles were blocked into 2 versions of 8 choice cards, each containing three landscape alternatives: option A, option B and a status quo. The status quo alternative represented a continuation of current levels in all the landscape attributes and therefore a zero additional tax (price) was associated with the status quo alternative.

Generic alternatives A and B contained variations in the attribute levels, but with a positive tax price, representing modification to current policy support. Since choice scenarios involving both large increases to livestock and bio-fuel crops were deemed unfeasible, a level constraint was also added to the experimental design process

#### 4. Methodology

In a CE framework, the agricultural landscape is broken down into its component attributes, which are presented to respondents normally as a set combination of the attributes. Respondents are then presented with a sequence of these choice sets, each containing alternative descriptions of the rural landscape, differentiated by their attributes and levels. Respondents are then asked to state their preferred alternative within the choice set (Hensher et al., 2005). More formally, each respondent  $n$  is asked to identify his or her preferred landscape choice  $i$  among a given set of alternatives  $J$ . Data from the CE are analyzed by employing the theoretical framework of random utility models (McFadden, 1974). It is assumed that the observed choice is the one associated with the highest obtained utility ( $U_{ni}$ ).  $U_{ni}$  is assumed to consist of a systematic part,  $V_{ni}$ , and a stochastic part,  $\varepsilon_{ni}$ :

$$U_{ni} = V_{ni} + \varepsilon_{ni}. \quad (1)$$

The probability that respondent  $n$  chooses alternative  $i$  from the set of  $J$  alternatives is given by:

$$P_{ni} = \text{Prob}(V_{ni} + \varepsilon_{ni} > V_{nj} + \varepsilon_{nj} \forall j \neq i). \quad (2)$$

The observed utility  $V_{ni}$  is usually assumed to be linear in the parameters so that  $V_{ni} = \beta' x_{ni}$ , where  $x_{ni}$  is a vector of observed variables relating to alternative  $i$ . If  $\varepsilon_{nj}$  is assumed to be an independently and identically distributed extreme value, this probability will have a closed form expression, leading to the conditional logit model:

$$P_{ni} = \frac{e^{\beta'x_{ni}}}{\sum_j e^{\beta'x_{nj}}} . \quad (3)$$

By observing and modelling how respondents change their preferred option in response to the changes in the levels of the attributes, it is possible to determine how people trade-off between the agricultural landscape attributes (Bennett and Adamowicz, 2001). Frequently, researchers employ the basic conditional logit model to analyse such choice data. However, the standard conditional logit model has some noted limitations. These include the fact that it generally fails to meet the assumption implied by the independence from irrelevant alternatives property (IIA), it can not handle situations where the unobserved part of the utility function is correlated over time and finally it represents only systematic taste variation rather than random taste variation across respondents (Train, 2003). To handle these limitations other more flexible models are needed. McFadden and Train (2000) showed that mixed logit models provide a flexible and computationally practical econometric method for any discrete choice model derived from the random utility maximization framework.

The mixed logit model overcomes the limitations of the standard logit model by facilitating random taste variation, flexible substitution patterns and correlation among unobserved factors. Additionally with the use of a mixed logit model it is possible to account for dependence across repeated choices made by the same respondent by specifying a panel version of the model. In mixed logit models, the probabilities are integrals of the standard logit probabilities over a density of parameters. In the mixed logit model referred to as the random parameters logit (RPL) (Train, 1998), the unconditional choice probability is the integral of logit formulas over all possible variables of  $\beta_n$  such that:

$$P_{ni} = \int \prod_{t=1}^T \left[ \frac{e^{\beta_n'x_{nit}}}{\sum_j e^{\beta_n'x_{njt}}} \right] f(\beta) d(\beta) . \quad (4)$$

The integral in equation (4) cannot be evaluated analytically, and we have to rely on a simulation method for calculating the probabilities. As Columbo et al. (2009) points out, in order to estimate the RPL model one must make assumptions about how the  $\beta$  coefficients are distributed over the population  $f(\beta)$ ; take a set of  $R$  draws from  $f(\beta)$  and then calculate the logit probability for each draw. Therefore, as demonstrated by Train (2003) and reproduced in equation 5 below the simulated probability  $\hat{P}_{ni}$  is an unbiased estimator of  $P_{ni}$  whose variance decreases as  $R$  increases:

$$\hat{P}_{ni} = \frac{1}{R} \sum_{r=1}^R \left( \prod_{t=1}^T \left[ \frac{e^{\beta'_{nr} x_{ni}}}{\sum_j e^{\beta'_{nr} x_{nj}}} \right] f(\beta) d(\beta) \right). \quad (5)$$

The subscript  $nr$  on  $\beta$  indicates that the probability is calculated for each respondent using  $R$  different sets of  $\beta$  vectors. When employing the RPL model the researcher must also decide on the parameterization of the covariance matrix. In this paper we assume preference parameters are independent so that the  $r$ th draw of  $\beta_{nr}$  is taken using the diagonal of the variance–covariance matrix. In this application we will use a simulated maximum likelihood estimator with Halton draws. In the final estimation of the model 200 Halton draws were used.

By including price/cost as one of the attributes of each landscape option, the monetary welfare impact of moving from the status quo agricultural landscape today to an alternative landscape with attribute levels set to be representative of what could result under alternative agricultural policy options can be calculated. The marginal willingness to pay for the different landscape attributes in our model (often referred to in the literature as the implicit prices) and the welfare impact from a move from  $x^0$  to  $x^1$  and conditional on individual taste  $\beta_n$  are logit and can be derived using the standard compensating variation (CV) log-sum formula (Hanemann, 1984):



$$CV = -1/\beta_m \left[ \ln \left[ \sum \exp(\beta' x_n^1) \right] - \ln \left[ \sum \exp(\beta' x_n^0) \right] \right]. \quad (6)$$

The expected measure however needs integration over the taste distribution in the population so that:

$$CV = \int \left\{ -1/\beta_m \left[ \ln \left[ \sum \exp(\beta' x_n^1) \right] - \ln \left[ \sum \exp(\beta' x_n^0) \right] \right] \right\} f(\beta) d(\beta). \quad (7)$$

This integral is also approximated by simulation from draws of the estimated distributions for the random parameters in our chosen model (Hynes et al., 2008). Using this formula, the welfare impact of a change in the landscape attributes from the status quo scenario to a landscape associated with each of the 5 possible future Irish agricultural scenarios, along with model results, will be presented and discussed in the following sections.

#### 4. Results

For the purpose of modeling alternative agricultural policy preferences the indirect utility for any landscape option is assumed to depend on the levels of the attributes of that landscape. The same attributes are allowed to enter the utility function of all three generic landscape options with the levels varying in the first two. The third landscape has the same attributes as the first two but the levels are held constant across all choice sets in landscape 3 to represent the fact that this is the status quo situation representing the no policy change scenario. We also assume that the socio-economic characteristics of respondents may influence their preferences for alternative attributes and levels and therefore also include an ‘income’ and ‘family involved in farming’ variable in the model. Because these socio-economic variables do not vary between choices for any given respondent they are interacted with the status quo option. The estimated coefficients for the cost variable and the interacted socio-economic variables are specified as fixed to aid estimation.

A grouped alternative specific constant for the unlabeled landscape options 1 and 2 (the non-status quo options) was also included in the model specification. This variable indicates the utility respondents get from leaving the status quo that is unaccounted for by the attributes of the landscape choices. It may pick up on other unaccounted for features of the landscape that the respondent may associate with the given attribute levels in each option such as, for example, recreational opportunities. The attribute levels (apart from cost) are treated as dummies in the model specification with the status quo level of no change in attribute level being always taken as the base case. The final chosen model assumes that  $U = f(\text{Flora and Fauna, Bio Fuels, Field Boundaries, Cattle and Sheep, Family Member involved in Farming, Gross Income, dummy for the non-status quo options, Cost})$ . Further details on attributes and their levels are given in table 1. On completion of the choice sets respondents were asked if, in making their choices, they had ignored any of the landscape characteristics. Only those who indicated that they had not ignored any of the attributes and options were included in the final analysis. This resulted in 915 usable observations in the model (91% of the sample), each of whom was presented with 8 choice sets containing 3 landscape options. With each respondent completing eight choice tasks, the model was estimated using 7320 choice occasion observations.

For each landscape attribute parameter in the RPL (each estimated as having a Normal distribution<sup>7</sup>), parameters for the mean and standard deviation are estimated.<sup>8</sup> Associated with every estimate parameter is an estimate of the standard error, so one can draw inferences about the significance of the coefficient<sup>9</sup>. The results of the model (table 2) show that the means of the attributes associated with improving the presence of wild flora and fauna on the farm and for improved maintenance of field boundary walls and hedgerows are positive and statistically significant. The majority of respondents also appear to have a positive preference for a moderate reduction (-30%) of the quantity of sheep and cattle in the landscape. The results further show that the mean preferences for a decline in the presence of wild flora and fauna on the farm and reduced maintenance of field boundary walls and hedgerows are both negative, conforming to our prior expectations that the majority of respondents would dislike reductions in farmland biodiversity and maintained field boundaries. Furthermore, on average, a policy change that would increase the quantity of agricultural land under rapeseed or other bio-fuel crops would appear not to

be welcomed by respondents. The estimated mean values are nearly all estimated as being significantly different from zero, with 30% increases in bio-fuel crops (only significant at 10% level) and quantity of cattle and sheep in the landscape (insignificant at even the 10% level) the only exceptions.

Turning our attention to the estimated standard deviations for the landscape attributes we find that they are all significant at the 5% (or above) level. This indicates that the preferences for these attributes do indeed vary across the population. The relative magnitudes of the standard deviations are quite high, suggesting a considerable variation in taste-intensities across the sampled respondents - to the extent that all distributions have a high share in both the negative and positive domains. This supports our choice of using Normal distributions to represent the random taste variation. We note that the random taste variation remains even after the inclusion of observed sources of preference heterogeneity (i.e., respondent's income level and agricultural background) socio-economic characteristics of the population. This is in line with findings elsewhere (Brownstone and Train, 1999 and Hynes et al., 2008), and suggests that preferences vary considerably more than can be explained by the observed characteristics of respondents. As expected, a respondent's income level and having a family member involved in farming does have a significant impact on landscape preferences. Those on lower income are significantly more likely to choose the status quo option which obviously is associated with no change in taxation payable by the respondent while those with a family member involved in farming are less likely to choose the status quo option. This latter finding may be an indication that those respondents with more knowledge of farming in Ireland are unhappy with the current impact that agricultural policy is having on the rural landscape and with farmers ability to manipulate the land under the current policy regime.

The cost coefficient in our RPL model is specified as fixed and is found to be negative, as expected, and significant. The simulated log likelihood of -6016 compared to the standard log likelihood of -7184 for a basic conditional logit specification also indicates an improvement in the fit of the model. The implicit prices of the attribute (the marginal willingness to pay estimates) with associated 95% confidence intervals and the alternative agricultural landscape welfare estimates derived from the RPL model and

integrated over the taste distribution in the population are presented in tables 3 and 4 respectively. Respondents have positive WTP for increasing the presence of flora and fauna, for an improvement in the condition of field walls and hedgerows and for a 30% reduction in the quantity of cattle and sheep in the countryside. At €-67 per person per year, the poor maintenance of field walls and hedgerows yields the highest negative WTP value. A 60% increase in the quantity of bio-fuels or a 60% increase in cattle and sheep leads to a WTP value of approximately €-22 per person per year in each case.

The compensating surplus estimates and 95% confidence interval calculated using the Haneman log-sum formulae integrated over the taste distribution in the population, and shown in table 4, represent respondents' average WTP to move from the state of the world given in the baseline (the no change scenario) to the state of the world that results from the change in a number of the landscape attributes resulting from agricultural policy targeted at the achievement of the 5 future agricultural scenarios for 2030 outlined in section 2. The attribute levels that are assumed to correspond to each of these 5 agricultural future scenarios are described in table 4. The average welfare change that would result from the pursuit of the *Sustainable Rural Development* scenario was calculated to be €21.96 per person per year while the equivalent value for the Food Island scenario was €13.27. These were the only 2 future agricultural policy scenarios that yielded positive compensating surplus landscape value estimates.

The future agricultural landscape associated with bio-fuels and renewable energy production (*Energy squeezed Fuels Agriculture*) results in a loss of welfare to society of €92 per person per year. The intensive *Globally Competitive Farming* landscape scenario also would appear to result in a significant average welfare loss to society (€-77.87 per person per year). The welfare change per person per year for the *European Agriculture* landscape scenario are only marginally negative at €-9. The simulated distribution of these welfare estimates are also displayed in figure 2 in both a histogram format and using a kernel density function where the distribution is smoothed using a Gaussian kernel with optimal bandwidth. They indicate in all cases significant heterogeneity in preferences for the alternative future landscape options.

## 5. Discussion and Conclusions

In this paper we have attempted to examine the non-market value of possible agricultural landscapes that may exist in Ireland in 2030 under different policy options. The fact that the *Sustainable Rural Environment* was found to be the highest valued of all the future agricultural landscape scenarios could be an indication that the Irish public wants something more from agriculture than just a sector that produces food and fibre for human consumption. They would also appear to be aware of, and value, the range of other agri-environmental products and services that Irish farming delivers such as the biodiversity services from species conservation and the protection of traditional landscapes. This preference not to return to the type of policy that supports extremely intensive agricultural production with little regard for environmental consequences is further reflected in the negative welfare impact shown for the *Globally Competitive Farming* scenario. This scenario reflected a landscape where there was a 30% increase in cattle and sheep in the landscape, a deterioration in the aesthetic appearance of boundary walls and hedgerows and a significant decline in biodiversity on the farm. Alternatively, a policy option that both allows for an increase in drystock production and an improvement in biodiversity would be supported by the public accounting to the positive welfare associated with *the Food Island* scenario.

It should be kept in mind that the preferences shown for the different farm attributes in the choice options and the welfare impacts resulting from the agricultural landscapes being changed are dependent on the current set of endogenous and exogenous influences on the utility of the respondents. If for example oil prices were to suddenly rise to €300 a barrel, the preferences shown for bio-fuel crops such as rapeseed and willow in the Irish landscape might dramatically alter given the impact such a change would have on the spending power of many Irish citizens. This could result in the *Energy Squeeze Fuels Agriculture* scenario changing from the least preferred landscape type to the most preferred. It should also be noted that of all the scenarios examined, this landscape type would also be the most alien to the Irish public since approximately 80% of utilizable agricultural land in Ireland is currently under permanent grassland with only

approximately 6000 hectares of rapeseed been sown each year. Furthermore, while individuals may display a negative preference towards the effect on the landscape accruing from certain scenarios there may be other positive benefits that this study does not capture. These may include lower food prices, a more viable rural economy, increased employment, lower dependency on oil, etc. Respondents were only asked to consider the effect on the visual amenity of the landscape so this study does not capture the total welfare loss/gain to society associated with these scenarios. Finally, the analysis presented here only reflects the non-market values from each of the landscape scenarios. Inclusion of direct use values such as the value of agricultural commodities and bio-fuel would likely lead to a different ranking of each landscape in terms of total economic value.

It is difficult to compare welfare estimates for agricultural landscapes across studies due to differences in the attributes used and differences in the assumed changes in attributes under different policy scenarios. The value estimates presented in this paper are however broadly comparable to other similar studies in the literature. In particular the estimate for the conserved extensive landscape under the *Sustainable Rural Environment* yields a similar value to that found by Colombo et al. (2009), who estimated values for an agri-environmental scenario resulting in the conserving of upland hill farming in the North West region of England. In that study the authors found that the public were more willing to support such an option than an alternative scenario option where all support payments were removed (€12.11 per household per year compared to €-0.10 respectively)<sup>10</sup>. Although few other studies have attempted to value a range of possible future agricultural landscapes, one such attempt by Willis and Garrod (1993) found that the willingness-to-pay to achieve an alternative future landscapes in the Yorkshire Dales of England was highest for a ‘conserved farm landscape’ that maintained traditional farm landscape features. Also similar to the results of our study, Willis and Garrod (1993) found that the lowest WTP values were associated with an ‘intensive landscape’, geared towards food production and with negative repercussions for the rural environment.

As has been found in many other environmental economic valuation studies (Willis et al., 1995; Hynes et al., 2008 and Columbo et al., 2009) our results also demonstrated preference heterogeneity amongst the Irish population for the attributes of agricultural landscapes. This heterogeneity was incorporated into the random utility modelling framework with the use of the RPL specification. Although the welfare estimates are discussed in terms of respondents' average WTP to move from the state of the world given in the baseline (the no change scenario) to the state of the world that results from the change in a number of the landscape attributes, the welfare estimates were calculated using the Haneman log-sum formulae integrated over the taste distribution in the population. Furthermore, the distributions in the welfare estimates were shown in figure 2 to vary significantly across the population.

The Mid Term Review of the CAP is currently on the European Commission's agenda and the European Union is facing some important choices in terms of direct agricultural support and the role and structure of rural development policy after 2013. Many commentators are already of the opinion that budgetary pressures may result in a substantial reduction of expenditure on traditional forms of income support under Pillar I of the CAP with the possible complete elimination of the single farm payment itself and a greatly expanded role for rural development policy under Pillar II (Blandford and Hill, 2010). As highlighted by the Commission of the European Communities (2009) and Skerratt and Slee (2010) it is likely that the issues of climate change, renewable energies, water management and biodiversity will strengthen the argument in favour of the EU radically reforming the CAP and for EU member states to adapt their rural development policies accordingly.

Within this policy environment better understanding of the preferences of EU citizens for alternative agricultural policy options and the valuation of the possible resulting future agricultural landscapes should assist decision makers in further reforming the CAP. Accounting for the differences in the welfare impacts of moving from the status quo to agricultural scenarios under alternative policy regimes should also ensure that tax payers money is used in a manner that results in the public getting both the non-market goods and the agricultural commodities in quantities that at least attempt to equate the publics

attitudes towards the environment, rural quality of life, social capital, cultural heritage, etc. to the challenges of an expanding world population, decreasing amounts of utilisable agricultural land and a changing climate.

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<sup>1</sup> According to statistics from the Irish Department of Agriculture, Fisheries and Food (DAFF, 2009), the total land area of Ireland is 7 million hectares of which 4.2 million ha is used for agriculture. There are approximately 128,200 family farms in Ireland of which 63% are less than 30 hectares. Close to 80% of Ireland's farmland is in pasture, hay and grass/silage (grassland), 11% (0.45 m ha) is rough grazing and 10% (0.42 m ha) is in crop production. The average farm size is 32.3 hectares and beef and milk production account for approximately 60% of total agricultural output at producer prices.

<sup>2</sup> It was agreed under the Agenda 2000 reforms of the CAP that Member States could reduce compensation payments to farmers by up to 20% under new arrangements termed "modulation". This would allow the equivalent amount of public resources being freed up for addressing other concerns such as rural development and agri-environmental management under Pillar two of the CAP.

<sup>3</sup> In launching the current debate on the CAP beyond 2013, the EU Commission underlined the need for the revamped policy to take into account the diversity of EU agriculture and its different levels of competitiveness (global, regional, local) among the 27 member states. The Commission also highlighted the fact that any reform needed to focus on the future economic, social and environmental challenges of the CAP, and on innovation, thus contributing to the objectives of Europe 2020, the Union's strategy for smart, sustainable and inclusive growth. Given that the share of the EU budget devoted to agricultural and rural development will still account for over a third of the total EU budget by 2013 the debate on CAP reform post-2013 is also inextricably linked with the negotiations on the next EU multi-annual financial

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framework which defines the framework for the Community's budget priorities over a period of several years (Harvey, 2010).

<sup>4</sup> There is substantial evidence that the general public across a wide range of countries appreciate and are willing to pay to support the protection of particular features of the rural landscape and the rural environment (Campbell, 2008; Raymond and Brown, 2006; Hanley et al., 1998; Colombo et al., 2009; Buckley et al., 2009). It has however been pointed out by Harvey (2010) that the vast majority of the professional literature analysing the CAP considers that the continuation of direct payments will need considerable redesign and much more careful planning to specific objectives. Indeed, according to Swinnen (2009) "CAP as a policy instrument is no longer effective in any dimensional level".

<sup>5</sup> All attributes apart from cost were expressed in terms of percentage change away from current levels. The current levels of each attribute were assumed to represent what has resulted in the rural environment under the current agricultural policy approach. Respondents were also presented with figures for what the average taxpayer already spends through taxation on CAP support and on the Irish Rural Environmental Protections scheme and reminded that the costs associated with each choice would be on top of these current payments.

<sup>6</sup> For a general overview of efficient experimental design see Scarpa and Rose (2008).

<sup>7</sup> In this application we consider that it is feasible that some respondents may have positive taste-intensities for the landscape attributes whilst others may have negative taste-intensities. Hence, the landscape attributes are specified with Normal distributions. Moreover, Normal distributions are less prone to problems with 'fat-tails', which are an artifact with Log-Normal distributions.

<sup>8</sup> We also estimated a model which overlay an error component specification on the RPL thus allowing for correlations between the utilities for different alternatives as illustrated by Brownstone and Train (1999) and Train (2003). In our case, we allowed for correlation between the two non-status quo agricultural landscape options in the choice sets. The error component proved to be insignificant however with no improvement in the fit of the model. We therefore dropped the error component specification and present the results of the RPL in the following section.

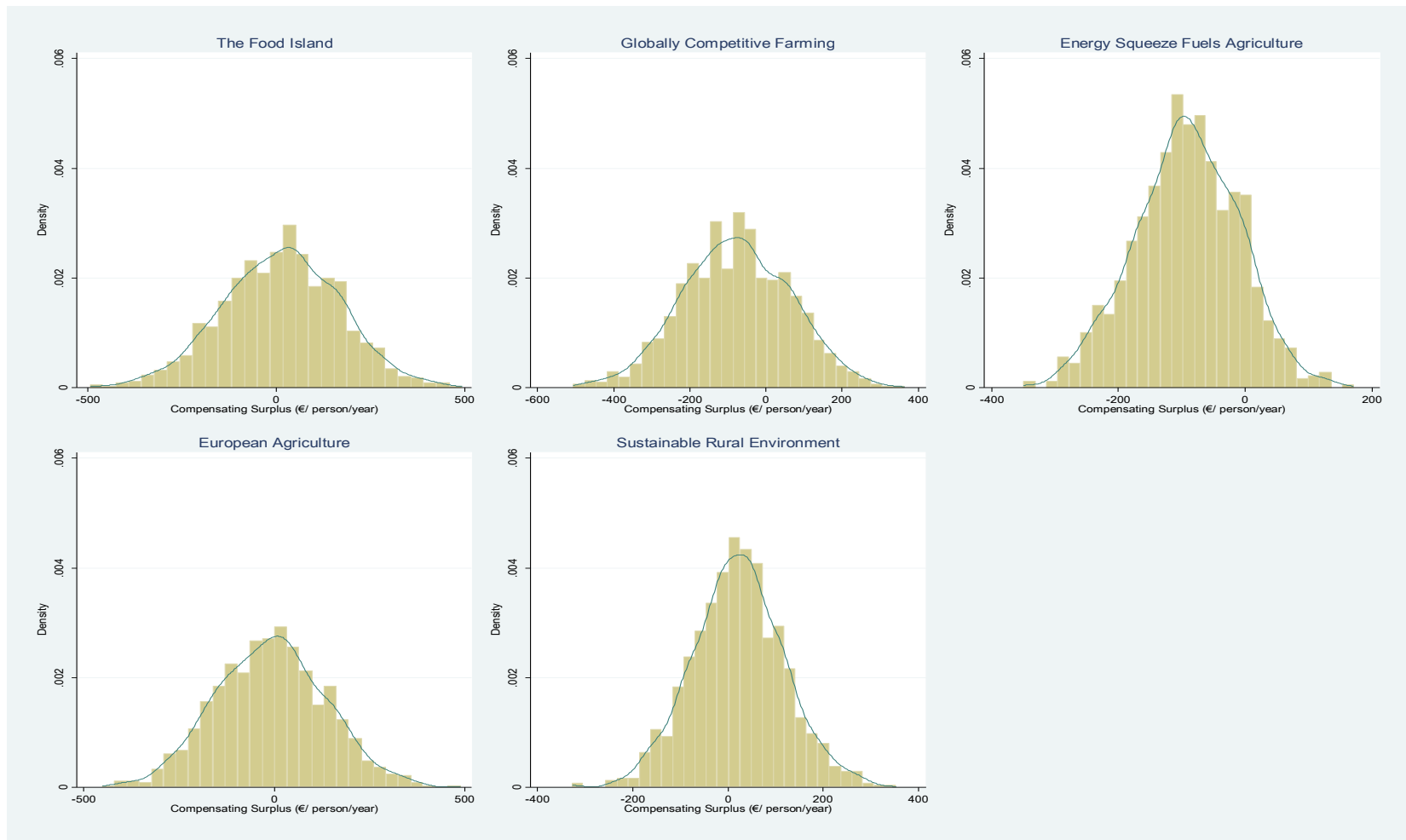
<sup>9</sup> If the estimate of the standard deviation is not statistically different from zero, but the mean coefficient is, then one can infer that the preference parameter is constant across the population. If the mean coefficient is zero, but the standard deviation estimate is significant one cannot infer that the attribute does not affect choice: but rather that there is a diversity of preferences, both positive and negative. Ultimately, however, and as Rigby and Burton (2003) point out, for an attribute to be declared as having no impact on choices, both the estimate of the mean and the standard deviation would have to be insignificantly different from zero.

<sup>10</sup> In the study by Colombo et al. (2009) however the assumed change in attribute levels and the attributes themselves were different. Field boundaries were the only common attribute across the two studies. Also the assumed changes in attribute levels were smaller than the ones examined here.

**Figure I. Example Choice Card.**

	<b>Landscape A</b>	<b>Landscape B</b>	<b>Landscape C</b>
Change in quantity of cattle and/or sheep in landscape	Moderate decrease on current levels (-30%)	Moderate Increase (+30%)	No change (+0%)
Change in utilisable agricultural land under rapeseed, willow and other bio fuels	Moderate Increase (+30%)	No change (+0%)	No change (+0%)
Condition of field boundaries (stone walls and hedges)	Poor: For every 1km, 50m is fully maintained	Good: For every 1km, 700m is fully maintained	No change: For every 1km, 400m is fully maintained
Presence of wild flora and fauna on farm	Rapid decline	Improved conservation	No change
Increase in tax payments by you each year	€40	€80	€0
<b>Which do you like best?</b>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

**Figure II. Distribution of Compensating Surplus Estimates for Alternative Landscape Scenarios**



The distribution of the conditional welfare estimates are also shown using a kernel density graph which is overlaid on the histograms above. The distribution is smoothed using a Gaussian kernel with optimal bandwidth. The figures 54, 29, 13.5, 48 and 60 represent the percentage of positive, as apposed to negative, compensating surplus estimates across the simulated distribution of estimates for the *Food Island*, *Globally Competitive Farming*, *Energy Squeeze Fuels Agriculture*, *European Agriculture* and the *Sustainable Rural*



## Tables

**Table 1. Landscape Attributes and Levels used to Describe Choice Alternatives**

<b>Attribute</b>	<b>Description</b>	<b>Levels</b>
Cattle and Sheep	Change in quantity of cattle and/or sheep in landscape	Moderate Decrease (-30%) <b>No change (0%)</b> Moderate Increase (30%) Large Increase (60%)
Bio-fuel Crops	Change in utilisable agricultural land under rapeseed, willow and other bio fuel crops	<b>No change (0%)</b> Moderate Increase (30%) Large Increase (60%)
Field Boundaries	Condition of field boundaries (stone walls and hedges)	Poor: For every 1km, 50m is fully maintained <b>No Change: For every 1km, 400m is fully maintained</b> Good: For every 1km, 700m is fully maintained
Flora and Fauna	Presence of wild flora and fauna on farm	Rapid decline <b>No change</b> Improved conservation
Cost	Amount paid per person per year through higher tax payments.	<b>€0, €10, €20, €40, €80</b>

Note. The status quo levels of these attributes are shown in BOLD text.

**Table 2. RPL Model Results**

<i>Random Parameters in Utility Functions</i>	Mean of coefficient	Standard Deviation of coefficient
Flora and Fauna Decline	-0.41 (0.08)***	0.26 (0.1)**
Flora and Fauna Improvement	0.33 (0.1)***	1.75 (0.1)***
Bio-fuel Crops (+30%)	-0.13 (0.074)*	1.31 (0.068)***
Bio-fuel Crops (+60%)	-0.32 (0.085)***	1.31 (0.07)***
Field Boundaries: Poor	-1.09 (0.108)***	1.04 (0.126)***
Field Boundaries: Good	0.16 (0.068)**	0.90 (0.065)***
Cattle and Sheep (-30%)	0.20 (0.076)***	0.58 (0.116)***
Cattle and Sheep (+30%)	-0.09 (0.13)	2.64 (0.126)***
Cattle and Sheep (+60%)	-0.37 (0.11)***	1.11 (0.163)***
<i>Non-Random Parameters in Utility Functions</i>		
Cost	-0.02 (0.001)***	
Family Member Involved in Farming	-0.59 (0.08)***	
Gross Income (€/1000)	-0.02 (0.002)***	
Non- Status Quo Landscape Option	1.34 (0.107)***	
Log-Likelihood	-6016.39	
Likelihood Ratio $\chi^2$ (22) statistic	4050.9	
McFadden Pseudo R-squared	0.252	

Notes: Figures in parenthesis indicate the values of the standard errors. \*\*\* indicates significant at 1%, \*\* indicates significant at 5%, \* indicates significant at 10%.

**Table 3. Attribute marginal willingness to pay and 95% confidence intervals (€ per person per year)**

Attribute	Mean WTP	95% Confidence Interval
Flora and Fauna Decline	-27.35	(-28.10, -26.60)
Flora and Fauna Improvement	20.39	(16.24, 24.54)
Bio-fuel Crops (+30%)	-9.82	(-13.24, -6.41)
Bio-fuel Crops (+60%)	-21.12	(-24.59, -17.65)
Field Boundaries: Poor	-66.84	(-69.83, -63.85)
Field Boundaries: Good	8.57	(6.09, 11.04)
Cattle and Sheep (-30%)	13.13	(11.32, 14.98)
Cattle and Sheep (+30%)	-2.34*	(-10.48, 5.79)
Cattle and Sheep (+60%)	-22.98	(-26.32, -19.63)

\* Even though the mean coefficient on this attribute was insignificant we still report the marginal willingness to pay and 95% confidence interval as the standard deviation parameter for this attribute level was highly significant indicating that there is a broad distribution in tastes for this attribute level and that it does influence the choice of landscape made by the respondents.

**Table 4. Attribute levels and compensating surplus value estimates for the five policy scenario landscapes (€ per person per year)**

<b>Attribute</b>	<b>The Food Island</b>	<b>Globally Competitive Farming,</b>	<b>Energy Squeeze Fuels Agriculture</b>	<b>European Agriculture</b>	<b>Sustainable Rural Environment</b>
Presence of wild flora and fauna on farm	Improved conservation	Decline	Decline	No change	Improved conservation
Change in utilisable agricultural land under bio fuels	No change	No change	60% increase	30% increase	No change
Condition of field boundaries (stone walls and hedges)	No change	Poor: For every 1km, 50m is fully maintained	Poor: For every 1km, 50m is fully maintained	No change	Good: For every 1km, 700m is fully maintained
Change in quantity of cattle and/or sheep in landscape	30% increase	30% increase	30% decrease	30% increase	No change
Compensating Surplus (€/person/year)*	13.27 (3.60, 22.94)	-77.89 (-86.71, -69.08)	-92.01 (-97.10, -86.91)	-9.02 (-17.97, -0.07)	21.96 (15.96, 28.01)

\* 95% confidence interval in brackets