FEED-A-GENE

Adapting the feed, the animal and the feeding techniques to improve the efficiency and sustainability of monogastric livestock production systems

Deliverable D6.4

Farmer and Consumer Attitudes to Proposed Production Systems

Due date of deliverable: M48

Actual submission date: M50

Start date of the project: March 1st, 2015 **Duration:** 60 months

Organisation name of lead contractor: UNEW

Revision: V1

Dissemination level	
Public - PU	**X**
Confidential, only for members of the consortium (including Commission Services) - CO	
Classified, as referred to in Commission Decision 2001/844/EC - Cl	

Funded by European Union
Horizon 2020
Grant Agreement No 633531

Table of contents

Funded by European Union
Horizon 2020
Grant Agreement No 633531

1. Summary

Objectives

(i) To design and implement a questionnaire survey to explore consumer attitudes relevant to livestock management issues being explored in Feed-a-Gene;
(ii) To use a choice experiment to investigate public preferences for enhanced welfare and environmental benefits associated with livestock production;
(iii) To investigate consumer attitudes and preferences for a range of production attributes associated with the technologies explored in the project; and
(iv) To investigate the attitudes of a small sample of farmers and farmer representatives in the UK and Spain, to the introduction, implementation and consequences of different aspects the novel management systems proposed in the project.

Rationale: A choice experiment approach was used to estimate values associated with selected externality attributes linked to livestock production. Choice experiments allowed us to test consumers' willingness to trade-off changes in the price of a commodity (in this case eggs) against varying levels of the positive and negative externalities associated with different production methods. Samples of 700 consumers from the UK and 1047 in Spain participated in a questionnaire survey that incorporated a range of choice questions designed to investigate preferences and values for the welfare benefits associated with different production systems and the carbon footprint associated with production methods. While the study did not have the scope to cover consumer preferences across the EU, the choice of a northern and a southern European sample was designed to reflect some of the differences in consumer attitudes, environmental priorities and production systems found across the EU. In the UK, qualitative questions based around a Likert scale were used to explore consumer attitudes and preferences for a range of production attributes associated with the technologies explored in the project. Qualitative approaches were also be used to investigate the attitudes of a small sample of farmers and their representatives in the UK and Spain to the introduction and implementation of the proposed novel management systems associated with the project. This is important in terms of identifying potential barriers to the uptake of new technologies and to identify approaches (e.g. education and incentives) that may be used to improve their acceptability and uptake. Semi-structured interviews investigated these issues for producers.

Teams involved: UNEW; CREDA-UPC-IRTA; AFZ

Species and production systems considered: Pigs and poultry across Europe

Funded by European Union
Horizon 2020
Grant Agreement No 633531

2. Approach

Feed-a-Gene aims to improve and adapt monogastric livestock production systems with the objective of improving their efficiency and reducing their environmental impacts. To achieve this, the project is developing alternative feed resources and feed technologies, while at the same time identifying robust animals that are better adapted to fluctuating conditions and optimizing feeding techniques to ensure the most efficient use of feeds. The successful achievement of these objectives will have economic, environmental and social implications. Task 6.4 of the project was designed to identify and evaluate some of these implications.

The main element of this Task was to design and implement a questionnaire survey to explore consumer attitudes to the livestock management systems being explored in Feed-a-Gene. The questionnaire survey incorporated a choice experiment (CE) to investigate public preferences for enhanced welfare and environmental benefits associated with livestock production. Different designs of the CE were used in the UK and Spain to allow different methodological and empirical questions to be explored. The UK questionnaire also included a sequence of qualitative questions that are used to investigate consumer attitudes and preferences for a range of production attributes associated with the technologies explored in the project.

The other element of this Task involved qualitative research with a small sample of livestock farmers in the UK and representatives of farmer groups in Spain, investigating their attitudes to the introduction, implementation and consequences of different technologies being developed by the project, in particular precision feeding mechanisms and novel feeds.

In order explore the preferences of the widest range of users of animal-based products relevant to the project, it was decided that the CE would focus on eggs. This had the advantage over choices involving pork and chicken meat of allowing vegetarians and members of some religious groups to participate in the survey. It also avoided potential problems over the selection of a particular cut of meat to use in the choice scenario. Eggs have been the subject of a number of successful CE applications over recent years, including Asselin (2005) exploring Canadian consumers' willingness to pay (WTP) for nutritional enhancement of eggs, Gracia et al. (2013) looking at Spanish consumers' preferences for production methods and origin and Gerini et al. (2016) examining Norwegian consumers' preferences for production methods and size.

In this application, respondents were asked to choose one of a number of boxes of six eggs on sale in a shop. Each box differed in terms of its price and a variety of other attributes (e.g. production method and environmental impacts) and it was assumed, as explained below, that an individual consumer's choice of box would reflect a trade-off between their preferences for these attributes and price. If none of the choices are attractive, then the respondent had the option to choose not to buy any of the boxes. Analysis of choices allows us to determine marginal WTP for changes particular attributes, e.g. for a 10g reduction in carbon footprint, or for a change from eggs produced by hens in cages to those produced using a free-range system.

Funded by European Union
Horizon 2020
Grant Agreement No 633531

2.1 Choice experiments

Stated choice modelling (Louviere *et al.,* 2000) is underpinned by consumer demand theory, particularly the theory of consumer behaviour following Lancaster (1966) and Rosen (1974). Consumer demand theory assumes that the utility that customers receive from a product (such as eggs) derives from the characteristics of this good (e.g. how it was produced, its size, environmental impact and price).

Figure 1 : Choice attributes used in the UK survey

Attribute	Levels shown on choice cards
Rearing	Cage, Barn, Free Range
Size	Small, Medium, Large, Mixed
Carbon Footprint	1150g, 1320g, 1440g, 1650g
Price	£0.80, £0.95, £1.20, £1.50

CEs are used by economists to reveal individuals' preferences and their willingness to pay (WTP) for particular attributes of goods and services (Garrod and Willis, 1999). In a CE, individuals participating in a questionnaire survey are typically shown a choice card (see Figure 1 for an example) depicting two to four alternative packages of product attributes (Adamowicz *et al.,* 1998). They are then asked to identify the alternative that they prefer. Each alternative is based on a number of product attributes (including price) that vary across the alternatives. Information on WTP and consumer preferences across different product attributes is determined by observing the trade-offs that people make across repeated choices based on different choice cards (Garrod and Willis, 1999). The attributes of interest in this study are egg size, rearing (i.e. production method), carbon footprint, water use and price (for six eggs) (see Figure 2 for the attributes used in the UK study). A baseline 'basic' choice was included in the UK study to allow consumers to benchmark their choices relative to an option offering basic levels of the attributes in question at a lower price; rather than making choices just between higher priced alternatives offering higher attribute levels. It is common practice in choice experiments to include a baseline or status quo option such as this, if the status quo (e.g. 6 'value' eggs) is an option that the consumer could choose (Garrod and Willis, 1999). In the Spanish study no baseline option was included but consumers had a greater number of alternatives to choose from in each choice.

Figure 2 : Example of a choice card from the UK survey

Attribute	**Box 1**	**Box 2**	**Box 3**
Rearing	Cage	Barn	Free Range
Size	Small	Medium	Mixed
Carbon Footprint	1440g	1650g	1150g
Price of 6 eggs	£0.80	£0.80	£0.95

In the CE, various combinations of egg attributes are traded-off against each other and against changes in the price of six eggs. In each case respondents were asked to choose the box of six eggs they most preferred from the various boxes offered. Repeated choices by customers reveal the trade-offs they are willing to make between attributes, their levels and price.

In a CE it is assumed that individuals know their own preferences and, are able to choose what offers them the highest utilty (an economic term referring to the total satisfaction individuals receive from consuming a good or service). Thus, if an individual *i* is assumed to choose alternative *j* over alternative *k,* then the utility derived from attribute bundle *j* is greater than the utility derived from attribute bundle *k*; i.e. if $U_{ij} > U_{ik}$, where U_{ij} is the total utility associated with alternative *j* and U_{ik} is the total utility associated with alternative *k*. The utility function for respondent *i* related to alternative *j* is specified as:

$$U_{ij} = V_{ij} + \varepsilon_{ij}$$

where V_{ij} is the systematic (non-stochastic) utility function observed by the analyst because it is linkable to the attribute levels of each alternative (e.g. environmental attributes, etc.) and ε_{ij} is a random component, which is known to the individual, but remains unobserved to the analyst. This random component (ε_{ij}) arises either because of randomness in the preferences of the individual, or the fact that the researcher does not have the complete set of information available to the individual.

2.2 UK questionnaire design

The UK questionnaire (see Annex 6.1) was designed to be implemented using Qualtrics (Qualtrics LLC, Provo, UT, USA), a powerful online survey platform used by many organisations worldwide and which also has been used successfully for many CE applications. The purpose of the questionnaire was framed to potential respondents as trying to better understand the preferences of the general public when buying hens' eggs. Respondents were also provided with a link to the project and told that the results of the research would be used only for the purposes of research. All respondents had to be aged over 18 and were asked to confirm that they were willing to take part in the survey. They were also told that they could end the survey at any time.

Figure 3: A Rough Guide to the carbon footprint of food

Many scientists believe that **global warming** is a serious environmental problem and that **greenhouse gases** contribute to global warming. Greenhouse gases are released into the atmosphere by many human activities - **including the production of food.**

The **carbon footprint** of a food tells us the amount of greenhouse gases that are released when producing and consuming the food. Carbon footprint is expressed in grams of carbon dioxide equivalents, or "g CO2e" for short.

When producing **eggs**, greenhouse gases (GHGs) are emitted at several stages, such as when:

Growing feed crops (e.g cultivating land; manufacturing fertiliser);

Processing crops into animal feed;

Heating and lighting the hen housing;

Transporting eggs and feed; and

From hen manure.

Respondents who decided to participate in the survey were first asked about how often they purchase eggs. The sample was then split and half of the respondents were then asked to watch a short (about one minute) BBC video about climate change (https://www.youtube.com/watch?v=97MCmfhcNlo). All respondents were presented with some written information providing a rough guide to the carbon footprint of food (see Figure 3). This would allow subsequent analysis to test the impact that an 'information treatment' on the importance of combatting global warming would have on consumer preferences for products with a lower carbon footprint.

One important issue around the use of stated preference CEs is the consistency between the hypothetical behaviour observed when respondents make choices and how they might behave in real life (i.e. the difference between the choices that a respondent would make in this study compared to the choices they would make in an actual supermarket). Practitioners attempt to manage such hypothetical bias by providing information in the questionnaire that makes respondents aware that such biases could exist. This information is generally referred to as 'cheap talk' (Cummings and Taylor, 1999). Here a 'cheap talk' script is provided to ensure that respondents are aware of the potential differences in their behaviour between this hypothetical exercise and their normal supermarket behaviour. In their study, Tonsor and Shupp (2011) find that the use of a 'cheap talk' script has an impact on WTP values (tending to make them more conservative in some cases) and leads to more reliable estimates. Figure 4 illustrates the 'cheap talk' script used in the UK questionnaire preamble to the choice experiment.

Figure 4 : UK Choice experiment preamble including 'cheap talk' script

On each of the next 4 pages we present you with 3 boxes of eggs which have different combinations of: production method; size of eggs; carbon footprint; and price. On each page, please compare the 3 boxes on offer and consider carefully how they differ from each other. Then select the box which you would buy if this was the choice available in a shop. All boxes contain 6 eggs. If you don't find any of the boxes attractive, you can choose to make no purchase and save the money for later.

It is important that you make each of your choices as you would if you were actually facing these specific choices in a store, i.e. noting that buying the eggs means you would have less money available for other purchases. If you select the most expensive box of eggs, then you must really want it! It will leave you with less cash to spend on anything else.

Following rigorous piloting, the questionnaire was implemented across a sample of individuals in the UK and Spain. In the UK, the survey was administered via an online internet panel managed by Qualtrix to a sample of 700 UK individuals in March 2019. The sample was stratified to ensure that it was representative of the UK population in terms of age and gender.

The choice sets for the UK were designed in Ngene (Choice Metrics Pty. Ltd.), using a D-efficient main effects design. The design included 36 choice scenarios divided into nine blocks of four choice questions each. Each respondent was randomly allocated one of the blocks. Each question had three unlabelled alternatives (Box 1, Box 2 and Box 3, see Figure 2 above).

As well as the choice experiments, the consumer questionnaire included a number of other sections designed to explore their preferences for the attributes of eggs (See Figure 4), their

attitudes to the innovations being explored in the project (i.e. precision feeding, use of novel feeds, use of livestock specially bred to improve feed conversion) (see Figure 5) and their attitudes to other relevant livestock management issues (i.e. indoor housing, automated monitoring of animal health and behaviour, larger flock size) (see Figure 6).

Figure 4 : Exploring consumer preferences for eggs

How important are the following factors when you buy eggs? Please click on the slider then move it along the scale to show how important/unimportant it is.

	Not at all important	Moderately important	Very important
Whether the price is low.			
Produced locally			
Higher animal welfare standard			
The 'Best before' or 'Use by' date			
Appearance			
Impact on the environment			
Usual brand			
Production system *e.g. cage, barn, free range*			
Whether they are the size that I prefer			

The questions used sliders which respondents can move to the left or right to demonstrate their preference or attitude. The use of sliders provide a continuous rather than an integer value in any subesquent data analysis and allows more discrimination in terms of measuring preferences. It is also argued to be more engaging format for respondents (Roster *et al.,* 2015). Previous research around whether or not the use of sliders in online surveys improves data quality or completion rates is inconclusive (Roster *et al.,* 2015), but there is some evidence that it yields slightly lower mean scores than the traditional 'radio button' format with a discrete response set (Couper *et al.,* 2006; Roster *et al.,* 2015).

Funded by European Union
Horizon 2020
Grant Agreement No 633531

Figure 5: Exploring consumer attitudes to technologies developed by Feed-a-Gene

Please tell us how acceptable or unacceptable you find each of the following approaches to poultry farming. ***Please click on the slider and move it along the scale to show how acceptable/unacceptable it is to you.***

	Totally unacceptable Totally acceptable
Using specially bred hens which convert more of their feed into eggs. *(This does NOT involve genetic modification.)*	
Using equipment that improves poultry feeding *(e.g. so food is always available when the hen wants it).*	
Replacing part of the diet with feed made from processed plant materials such as grass or clover. *This reduces the area of good agricultural land needed.*	
Replacing part of the diet with feed made from by-products of industrial processes. *This reduces the area of good agricultural land needed.*	

Figure 6: Exploring consumer attitudes to poultry farming

Please move the slider to show how acceptable/unacceptable each approach is to you.

	Totally unacceptable Totally acceptable
Using indoor production systems that offer the hens no access to outdoor areas. *Some* evidence suggests this can reduce greenhouse gas emissions and increase feed efficiency.	
Using conventional concentrated animal feeds that contain up to 30% of grains or oil meals derived from genetically modified plants.	
Automated monitoring of animal health and feeding behaviour using sensitive remote detectors (machines). This may reduce human contact but detect some problems earlier.	
Keeping hens in large flocks. *Some evidence indicates this may reduce global warming potential.*	

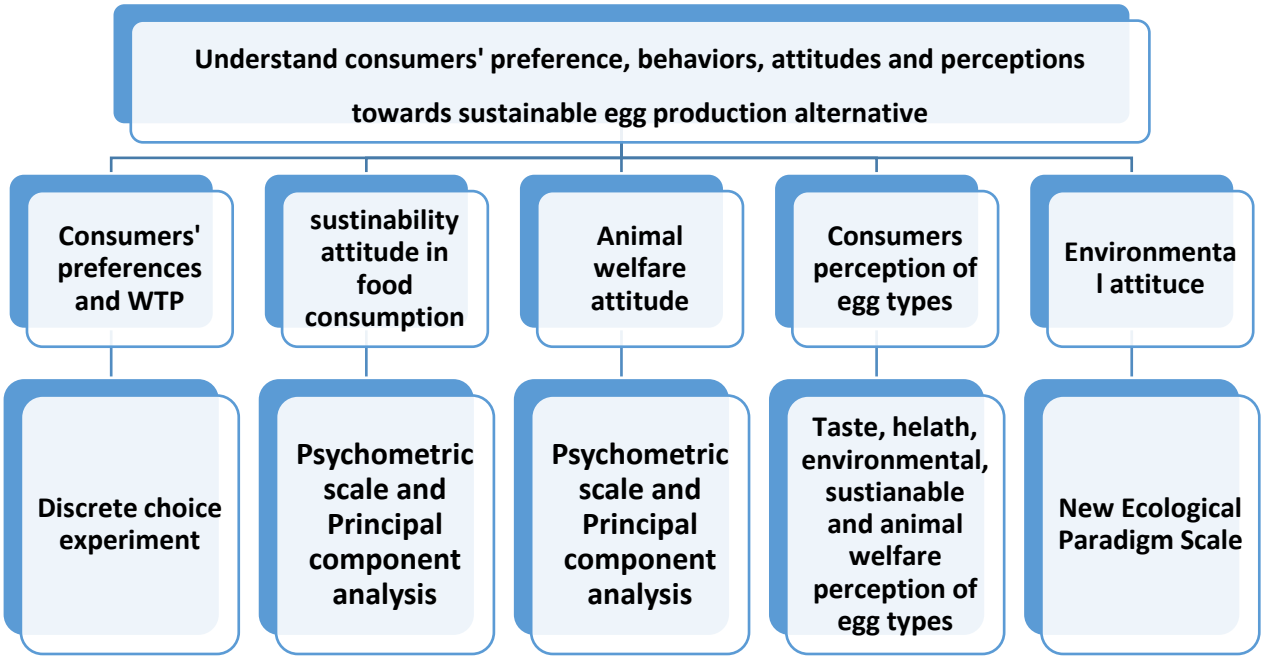
As well as this attitudinal data other questions elicited information on the gender, age, education and income of respondents.

2.3 Spanish questionnaire design

Like the UK questionnaire, the Spanish questionnaire (see Annex 6.2) was designed to collect information on consumers' preferences, perceptions, consumption behaviours and attitudes. While the UK questionnaire explored the most important factors considered by respondents

when buying eggs and attitude towards the application of new technological innovations to egg production, this questionnaire focused more on respondents' perceptions and attitudes. Perceptions on the qualities of eggs were collected following Malone and Lusk (2017), using an 11 points scale from -5 to +5. Respondents were asked about their perceptions for different types of egg regarding taste, health, environmental impacts, animal welfare and sustainability. Consumption behaviour was explored by obtaining information on consumer behaviour including, types of egg consumed, attributes and price of the most purchased egg and frequency of consumption. Attitudes were measured across three main topics: environment and nature, sustainability in food consumption and animal welfare in farming production systems. The questionnaire also assessed respondents' trust in egg producers with respect to maintaining animal welfare standards. Figure 7 shows a summary of the methodological framework.

Figure 7: Methodological framework for Spanish questionnaire



Data were collected from questionnaires completed by a sample of 1047 adult (over 18) consumers in Spain. While the UK study targeted the general public, the individuals selected for this study were consumers who had purchased and consumed eggs in the last seven days. A quota sampling procedure was used in terms of gender, age and income. As in the UK, the survey process and the consumers' panel were contracted to the specialized market company Qualtrics and carried out in April 2019. As in the UK questionnaire, a CE was used to investigate consumers' preferences and willingness to pay for different attributes of eggs.

Unlike the UK study, the Spanish CE was based on a labelled choice design similar to the design used by Lusk and Schroeder (2004) in which several different products were repeated in all choice scenarios (i.e. choice sets) with only the prices of the products varying across the scenarios. The Spanish study used a labelled rather than an unlabelled design (as used in the UK study) because in Spain egg prices are specific to the type of egg (i.e. the price attribute is

alternative-specific). Moreover, a labelled CE design allows as to use egg specific constants to estimate the real market share of each type of egg.

The choice sets were constructed by jointly presenting four egg products commonly available in the market place (caged, barn, free range egg and organic eggs), alongside two additional environmental attributes that refer to a reduction in carbon emissions and a reduction in water use during egg production. The four systems of egg production that are explored in the questionnaire are:

- Caged: eggs from hens that live in cages. Since January 2012, the European Union has required that these cages should be bigger and more spacious, aiming to improve of animal welfare. These hens do not have outdoor access.
- Barn: eggs from hens that live on the ground inside a barn. These hens do not have outdoor access.
- Free-range: eggs from hens that can move freely both inside and outside of a barn but where space may be limited.
- Organic: eggs from hens that can move freely both inside and outside of a barn and which typically have access to more space than free range hens. These hens are fed on organic feed.

The labels used to denote the different alternatives in the choice sets are the four types of egg shown above, which could be a proxy for the different animal welfare conditions associated with each production system.

Table 1: Price vectors of the different egg types in Spain

Egg types	Price levels (€/6 eggs)			
Caged	0.70	0.85	1.00	1.15
Barn	1.20	1.35	1.50	1.65
Free	1.70	1.85	2.00	2.15
Organic	2.45	2.60	2.75	2.90

Four price levels were identified for the different egg types. Price levels and product size were identified using market information regarding the price and the available format of all products. While the UK study varied the size of eggs, in the Spanish study it was fixed at the medium-large size (between 53-73 grams) and 6 egg package format because free-range eggs and organic eggs are only available in this format at the majority of purchase points. The price to buy six fresh eggs varied based on the egg type: the price vectors are shown in Table 1.

Another attribute that was considered in the CE was the reduction of greenhouse gas emissions (cf. carbon footprint in the UK study) during egg production. The following levels of greenhouse gas emission reductions were used in the CE:

- 0% reduction in greenhouse gas emissions
- 10% reduction in greenhouse gas emissions
- 20% reduction in greenhouse gas emissions
- 30% reduction in greenhouse gas emissions

In Spain, the reduction of water use during egg production is an important consideration and this was included in the CE as an additional attribute that was not explored in the UK study. The production of eggs requires water at various stages, such as feed production and for cleaning barns and equipment. Currently, there are various technologies available to help reduce water use, particularly the introduction of efficient irrigation technologies. The following levels of water reduction were used in the CE:

- 0% reduction of water used
- 10% reduction of water used
- 20% reduction of water used
- 30% reduction of water used

Figure 8: Example of a choice set in the Spanish questionnaire

	Eggs from hens raised in cages	***Eggs from hens reared in barns***	***Free-range eggs***	***Organic eggs***	***None of the options***
Price for half a dozen (€/6 eggs)	***0.85€***	***1.65€***	***2.00€***	***2.90€***	***I would not buy any of the four options***
Reduction of greenhouse gases (%)	***10%***	***30%***	***0%***	***20%***	
Reduction of water use (%)	***10%***	***30%***	***20%***	***0%***	

An optimal and efficient experimental design was then applied to create labelled alternative using *Ngene* (ChoiceMetrics, 2016). Accordingly, 8 choice sets were designed by ensuring balanced design that ensured a similar frequency of occurrence of all attributes across the different egg types. The option “none of the products presented” was also included to be consistent with the demand theory and to make the choice task more realistic as this option is available when shopping. The video treatment used in the UK was not used in this part of the study and all respondents received the same information and answered the same questionnaire. Respondents were each provided with a detailed description of the different egg production systems and the other choice attributes. Each respondent received a total of 8 choice sets, compared to 4 in the UK study. In each choice set, respondents were presented with 5 labelled options (caged, barn, free range, organic box or no choice), while respondents faced 4 unlabelled options in the UK study (which could be caged, barn or free range). Figure 8 shows an example of a choice set.

2.4 Econometric modelling

As explained previously, in a CE individuals choose among the various alternatives in a choice set according to a utility function with two main components: a systematic (observable) component and a random error term (non-observable):

$$U_{jn} = V_{jn} + \varepsilon_{jn} \qquad (1)$$

where U_{jn} is the utility of alternative j to subject n, V_{jn} is the systematic component of the utility and ε_{jn} is a stochastic term. Assuming linearity, the utility function for alternative j can be expressed as:

$$V_{jn} = \beta_j.ASC_{jn} + \delta_j.X_{jn} + \alpha_j.P_{jn} \qquad (2)$$

Where j are caged, barn, free-range or organic eggs. X_{jn} are the environmental attributes (i.e. reduction of greenhouse gas emissions and water use) selected by the consumer n, P_{jn} is the price of alternative j, β_j are the coefficients of the Alternative Specific Constant (ASC) for each alternative *j* relative to the "none" option which represents the marginal utility of alternative *j*. δ_j are the coefficients representing the effect of the $j\text{th}$ product attributes on the utility for the $j\,\text{th}$ product and α_j are the coefficients representing the effect of the $j\text{th}$ product price on the utility for the $j\,\text{th}$ product.

To predict subjects' preferences for an alternative, it is necessary to define the probability that individual *n* chooses the alternative *i* rather than the alternative j (for any i and j within choice sets T). McFadden (1974) developed the base model for the DCE often referred to as the multinomial logit (MNL) model. According to this model, the probability that a consumer *n* chooses product j is:

$$\text{Prob}\{j \text{ is chosen}\} = \frac{e^{\mu V_{jn}}}{\sum_{k=1}^{J} e^{\mu V_{jn}}} \qquad \forall k \in T \qquad (3)$$

Where μ is a scale parameter that is inversely related to the variance of the error term. For the MNL, the scale parameter is fixed to one for estimation reasons. Furthermore, in this model specification, the condition for an Independent and Identically Distributed (IID) error term must be met according to a Gumbel distribution. Such a distribution in the error term allows for the verification of a restrictive property within the MNL which is the Independence of Irrelevant Alternatives (IIA) property. This restriction implies that the ratio of the probabilities of choosing any pair of alternatives i and j $\left[P(i/T)/P(j/T)\right]$ is not dependent on the systematic utility of any other alternative within the set of alternatives which is seldom ensured. As a consequence,

the MNL impose a very strict structure on cross-price elasticities avoiding the possibility to analyze substitutability between the products (Hensher *et al*., 2005).

In this context, the universal or "mother" logit model can be estimated (McFadden *et al*., 1977). In this model, the utility of each product is specified as a function of the attributes of the other products. In our specific case studies, the utility of each egg type is a function of an Alternative Specific Constant (ASC), environmental attributes and the prices of all the other products. For instance, the utility of a caged egg is a function of an ASC for caged eggs, the environmental attributes and the prices of caged eggs, barn eggs, free-range eggs and organic eggs. In this case, the utility function for product j in the universal logit model is:

$$V_{jn} = \beta_j . ASC_j + \delta_j . X_{jn} + \sum_{k=1}^{J} \alpha_{jk} . P_{kn} \qquad (4)$$

Where j = caged egg, barn egg, free-range egg and organic egg, k is from 1 to 4 (i.e. the four egg types presented; X_{jn} are the environmental selected by the consumer n, δ_j are the coefficients representing the effect of the $j\text{th}$ product attributes on the utility for the $j\text{th}$ product. P_{kn} is the $k\text{th}$ product's price for consumer n, and α_{jk} represents the effect of the $k\text{th}$ product's price on the utility for the $j\text{th}$ product. To estimate the universal Logit model, the equation (4) is placed into equation (3).

However, the estimation of a universal logit model for labelled choices following equation (3), may violate the IIA assumption. Thus, in the Spanish study Mixed logit models (MIXL) (referred as Random Parameter Logit model, RPL) that relax the IIA assumption were used. The RPL model extends the MNL model by allowing for unobserved heterogeneity through random coefficients on attributes (Ben-Akiva *et al*., 1997). In this study, the random parameters were assigned on the Alternative Specific Constant (ASC) since this estimate encompasses all attributes of the product not accounted for in a holistic way. According to this model, the coefficient vectors for person n is $\beta_j + \delta_j = \bar{\beta} + \bar{\delta} + \sigma\lambda_n$ and where $\bar{\beta}$ and $\bar{\delta}$ are the estimated mean and σ is the standard deviation of the marginal distribution of β and δ. λ_n is a random term assumed normally distributed with mean zero and unit standard deviation. Thus, the term $\sigma\lambda_n$ is the vector of person *n* specific deviations from the mean value of the β_s and δ_s and the term λ_n is described by an underlying continuous distribution for the attributes and the ASC. In most applications the multivariate normal distribution is the most used, MVN (0, Σ). In this study, the egg specific constants (ASC) were considered independently normally distributed in the population because people can like or dislike a type of egg. However, we assumed log-normal distributions for the parameters associated with the two environmental attributes because we expected that all respondents have positive preferences for these environmental improvements (reductions of GHG emissions and water use). The price coefficients were considered fixed (i.e. non-random) to ensure that the estimated total Willingness to Pay (WTP) have a finite distribution moment.

This is because the total WTP for a product j versus the baseline alternative (none of the presented products) is calculated as the negative ratio of the ASC coefficient and the

coefficient of the base level of the environmental attributes (i.e. 0% reduction of the greenhouse gas emission and 0% reduction in water use) to the price coefficient of the same product *j* (Lusk and Schroeder, 2004):

$$WTP_{\text{egg j Vs. No-option}} = -\left(\frac{\frac{d}{dACS_j}\beta_j.ASC_j + \frac{d}{dX_j}\delta_j.X_j}{\frac{d}{dP_{kn}}\alpha_{jk}.P_{kn}}\right) \quad (5)$$

$$= -\left(\frac{\beta_j + \delta j}{\alpha_{jk}}\right) = -\left(\frac{\beta_{\text{egg j}} + \delta_{\text{base level of the environmental attributes j}}}{\alpha_{\text{price j}}}\right)$$

This calculation relies on the estimation of the Marginal Rate of Substitution (MRS) of any two coefficients. Since one of the coefficients is a monetary one (i.e. the price), it is possible to determine WTP.

The WTP for the reduction of greenhouse gas emissions and water use can be also estimated for each type of egg j:

$$WTP_{\text{environmental attributes j}} = -\left(\frac{\frac{d}{dX_j}\delta_j.X_j}{\frac{d}{dP_{kn}}\alpha_{jk}.P_{kn}}\right) = -\left(\frac{\delta j}{\alpha_{jk}}\right) = -\left(\frac{\delta_{\text{environmental attributes j}}}{\alpha_{\text{price j}}}\right) \quad (6)$$

Because the reduction of greenhouse gas emissions and water use were effects coding, the associated parameters were multiplied by 2. For The marginal WTP of any product *j* versus any other product *i* is simply obtained by subtracting both total WTP values (Lusk and Schroeder, 2004). Finally, the Krinsky and Robb parametric bootstrapping method was applied to calculate the confidence intervals of the WTPs with 1,000 random repetitions (Krinsky and Robb, 1986). The Spanish study used the NLOGIT 5.0 software and 1000 random draws to estimate the coefficients, the WTP and their confidence intervals.

2.5 Farmer Interviews

A small number of interviews with farmers in the UK and Spain were used to explore attitudes and preferences around some of the technological innovations that could be delivered by the Feed-a-Gene project. Data collection for this phase of the study took place from late March to early April 2019 when series of exploratory semi-structured interviews were conducted with monogastric livestock farmers in the North and East of England and North East Spain. The purpose of these exploratory interviews is to develop a deeper understanding of how respondents think and react to particular topics and issues. A semi-structured interview permits the interviewer greater flexibility in asking questions, allowing the sequence of questions to be altered, so that interviewers may probe for more information or explore new avenues that have been introduced in previous answers (Bryman, 2012).This approach is highly flexible and permits respondents to define the world in their own unique ways (Merriam, 2013). This qualitative approach was intended to provide an in-depth understanding of key informants'

perceptions regarding livestock feeding practices which will help inform the design of future engagement activities in this project.

In qualitative research, developing the interview guide is always considered an important process (Bryman, 2012). Merriam (2013) refers to this as a list of questions that the researcher intends to ask in the interview. Creswell (2007) proposed that the interview guide for semi-structured interviews need not exceed five or six general questions. Bryman (2012) further emphasised that it is important for the interviewer to consider the questions that relate to participants' social worlds, since there is flexibility in conducting the interviews. The interview guide in this phase can be divided into five main sections (see Appendix 2). Table 1 summarises the topics covered in the farmer interviews.

Table 2 : Topics covered in UK farmer interviews

Section	
1. Identification	Enterprise type; land area; tenure
2. Contextual questions	Number of animals; production system; feed use; markets; decision making; recent changes to production system; key strategic areas
3. Precision feeding (including presentation pack)	Reactions to precision feeding technology; pros and cons of precision feeding; barriers to use; drivers for uptake; interest in Feed-a-Gene innovations
4. Novel feeds (including presentation pack)	Importance of European self-sufficiency in animal feed; reaction to novel feeds; knowledge of novel feeds; pros and cons of using novel feeds; barriers to use; drivers for uptake; interest in Feed-a-Gene innovations
5. Breeding solutions	Reactions to breeding solutions; pros and cons of breeding solutions; barriers to use; drivers for uptake; interest in Feed-a-Gene innovations

At the beginning of the interview, participants are told that they will be asked about the new technologies that are being developed in the project with the objective of improving feed efficiency. They are also told that this will help with the problems of the EU's dependence on imported protein feed and will help to reduce future transfers of land from human food to animal feed production. Following this, information on the specific innovations being developed by Feed-a-Gene are presented to farmers or, in Spain, representatives of institutions that represent farmers' interests (at the beginning of Sections 3, 4 and 5 respectively). This information comprises specially designed presentation packs about the technologies being developed by the project. The first presentation pack covers the rationale behind precision feeding and how it can be used in practice, while the second discusses the use of novel feeds based on EU-grown rapeseeds, soybeans, grass and legumes. The third introduces approaches for improving animal breeding to improve feed efficiency. Work package leaders were asked to provide further explanation and clarification of specific points in these presentations in order to ensure that interviewers were fully briefed about their meaning and importance and able to answer specific questions on these issues from farmers.

A purposive sampling procedure was used to select participants. This approach is generally associated with small, in-depth studies with research designs that are focused on the exploration and interpretation of experiences and perceptions of groups with particular characteristics (Matthews and Ross, 2010). As Matthews and Ross (2010) point out, a

purposive sample is selected on the basis of characteristics or experiences that are directly related to the research question and allow the researcher to study area topic in more detail. A pilot interview with an experienced livestock farm manager in the North of England was carried out to check that the questions and question wordings were appropriate and to estimate the likely duration of the interviews. This led to several minor amendments to questions, including asking about any current (as well as future) plans to change livestock systems and reflecting the fact that outdoor production systems (as well as indoor ones) can be intensive.

3. Results

3.1 UK Consumer questionnaire survey results

Table 3 reports the results from the question asking UK respondents about the importance of different factors when buying eggs. Differences in responses between those who had viewed the video on global warming and those who had not were tested and found to be minor (none were significant at the 0.01 significance level). Predictably, factors relating to welfare standards and freshness are rated as most important, with branding by far the least important factor (most eggs sold in the UK are supermarket own-brand). The environmental impact of eggs seems to be rated as a little higher than 'moderately important' to respondents (with a mean value 0.58 compared to 0.5 as the benchmark for 'moderately important') and is slightly more important to respondents than the size or price of the eggs purchased. Respondents are less concerned about whether or not eggs are produced locally. This may be due to a perception that in the UK most eggs are produced relatively close to point of sale anyway, rather than a failure to link local production with potentially lower environmentally impacts due to the reduced transport costs linked to shorter supply chains.

Table 3: Important factors for UK respondents when buying eggs (100=Very Important, 0=Not at all important)

Question	Mean (n=728)	Std. Dev.
High animal welfare standards	74.2940	24.9666
Production system e.g. cage, barn, free range	73.7033	26.9550
The 'Best before' or 'Use by' date	70.3091	24.5389
Impact on the environment	59.2418	27.8283
The size of the egg	58.8256	24.4566
Whether the price is low.	58.2610	25.3923
The egg is produced locally	53.2857	28.5362
A specific brand	32.8764	27.6130

Table 4 reports UK respondent attitudes to the adoption of some of the technologies being investigated in the Feed-a-Gene project, alongside other potential practices such as increasing flock size or using feeds with a higher concentration of inputs derived from genetically-modified (GM) sources. Encouragingly, respondents find the use of precision feeding mechanisms to improve poultry feeding the most acceptable of the technologies being addresses, followed by breeding solutions that improve feed conversion and the use of processed plant materials, such as grass and clover, as protein sources in poultry feed. Replacing part of the diet with feed made from by-products of industrial processes was found to be moderately acceptable overall, though less acceptable than the use of plant materials. The least acceptable practices

relate to concerns over animal welfare. Automated monitoring of animal health and feeding behaviour as an alternative to human contact is found to be unacceptable, as are large flock sizes, despite their potential to reduce the impacts of poultry farming on global warming. Use of feeds with up to 30% GM content and indoor production systems with no access to outdoor areas were also found to be largely unacceptable to respondents.

Table 4: UK Consumer attitudes to poultry farming (100= Totally acceptable, 0= Totally unacceptable)

Question	Mean (n=735)	Std. Dev.
Using equipment that improves poultry feeding *(e.g. so food is always available when the hen wants it).*	74.4054	21.0437
Using specially bred hens which convert more of their feed into eggs. *(This does NOT involve genetic modification).*	63.5225	24.3540
Replacing part of the diet with feed made from processed plant materials such as grass or clover. *This reduces the area of good agricultural land needed.*	63.2286	24.6233
Replacing part of the diet with feed made from by-products of industrial processes.*This reduces the area of good agricultural land needed.*	52.1456	27.1194
Using indoor production systems that offer the hens no access to outdoor areas. *Some evidence suggests this can reduce greenhouse gas emissions and increase feed efficiency.*	29.5986	40.1338
Using conventional concentrated animal feeds that contain up to 30% of grains or oil meals derived from genetically modified plants.	25.9810	37.7237
Keeping hens in large flocks. *Some evidence indicates this may reduce global warming potential.*	22.6027	34.8745
Automated monitoring of animal health and feeding behaviour using sensitive remote detectors (machines). This may reduce human contact but detect some problems earlier	21.9959	34.3697

Overall, the attitudinal questions suggest that respondents in the UK are more concerned about the welfare implications of egg production than the impact that it may have on global warming. That is not to say that respondents are indifferent to reducing the carbon footprint of egg production and results from both the choice experiments and the attitudinal questions suggest that respondents have a positive preference for producing eggs in a more environmentally-friendly way.

Table 5 reports the result of the UK choice experiment. The Table is divided into two sections to reflect the influence of the treatment (global warming video) on preferences and WTP.

Both models conform to *a priori* expectations around the sign and significance of the different attribute coefficients. Price and production method (a proxy for animal welfare) are important determinants of choice, with consumers more likely to buy free range eggs but less likely to buy boxes if they are more expensive. Consumers also prefer larger eggs and eggs with a smaller carbon footprint (especially in the sub-sample that watched the global warming video). Consumers also have a small and significant negative preference for the basic option (the baseline option in each choice) but only in the with-video treatment sample.

Table 5: Results of UK choice experiment

	With video treatment			Without video treatment		
	Coeff.	**Std. Err.**	**Pr > [z]**	**Coeff.**	**Std. Err.**	**Pr > [z]**
Price	-1.3979	0.2290	0.0000	-2.3660	0.2651	0.0000
Basic Option	-0.0139	0.1709	0.9350	-0.6482	0.1711	0.0000
Size (g)	0.0738	0.0070	0.0000	0.0707	0.0068	0.0000
Barn	1.7581	0.2213	0.0000	1.8307	0.2135	0.0000
Free Range	3.2156	0.3008	0.0000	3.3402	0.3380	0.0000
CO_2 (kg)	-1.1564	0.3190	0.0000	-0.5908	0.3036	0.0520
	WTP Estimates			**WTP Estimates**		
	Coeff.	**Std. Err.**	**Pr > [z]**	**Coeff.**	**Std. Err.**	**Pr > [z]**
Size (g)	0.0528	0.0091	0.0000	0.0299	0.0036	0.0000
Free Range	2.3003	0.4039	0.0000	1.4118	0.1763	0.0000
Barn	1.2576	0.2446	0.0000	0.7737	0.1085	0.0000
CO_2 (kg)	-0.8273	0.2982	0.0060	-0.2497	0.1389	0.0720
Observations	5,888			5,872		
Respondents	368			367		
Wald Chi^2 (6)	259.58		0.0000	256.24		0.0000
Log Likelihood	-1311.53			-1268.65		

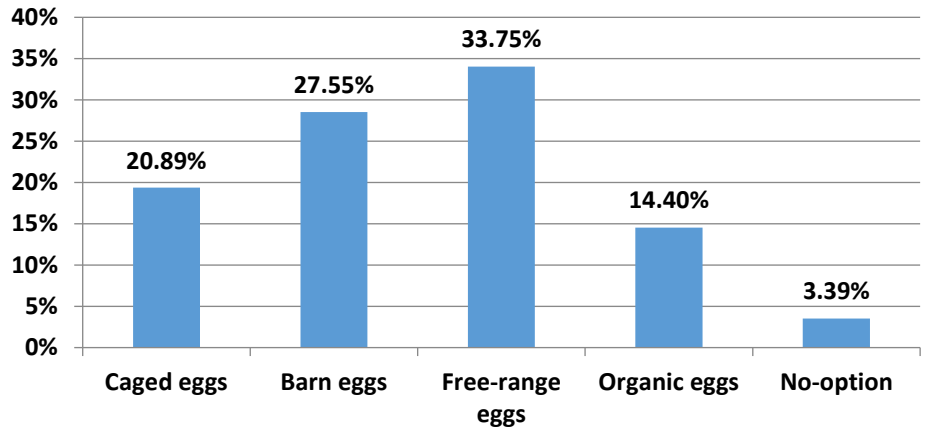
In terms of the impact that this has on consumers' WTP for six eggs, across the sample consumers are willing to pay a large premium for free range eggs compared to barn eggs (£1.04 for the with treatment sample and £0.64 for the without treatment sample). In terms of reduced carbon footprint, respondents in the with treatment sample would be willing to pay £0.83 to buy eggs that have a 1kg lower carbon footprint (or £0.083 for every 100g reduction in associated carbon emissions). Respondents who had not viewed the video on global warming before completing the experiment would be willing to pay around £0.25 more to buy eggs that have a 1kg lower carbon footprint (or £0.025 for every 100g reduction in associated carbon emissions). Both samples were willing to pay more for larger eggs (£0.053 per additional gram and £0.030 per additional gram in the respective samples).

3.2 Spanish consumer survey results

Table 6 shows the proportion of respondents in the Spanish survey choosing different egg types in the eight choice sets. As can be seen, the choice results were highly heterogeneous depending on the egg type, the price, the percentage of reduction of the greenhouse gas emission and water use. These results suggest the presence of clear trade-offs between egg type and the different attribute included, confirming the suitability of the design.

To better understand these aggregate results, total percentages for each egg type were also calculated independently of their price and the level of the environmental attributes. Results are shown in Figure 9. As can be seen, the free-range egg was the most frequently chosen type followed by the barn eggs, caged and organic in last position. The no-choice option was selected in less than 5% of cases.

Figure 9: Total percentage of choice of each type of egg in all choice sets



Results of the RPL model (Table 7) show that at 99% confidence level, we can reject the null hypothesis that all coefficients are jointly equal to zero with a Log-Likelihood ratio test highly significant. The goodness of fit, as assessed through the McFadden's pseudo-R^2, is highly acceptable. According to Hensher *et al*. (2005) a pseudo-R^2 of 0.3 represents an acceptable model fit for a discrete choice model. Indeed, a pseudo-R^2 of 0.3 represents an R^2 of approximately 0.6 for the equivalent R^2 of a linear regression model. Values between the range of 0.3 and 0.4 can be translated as an R^2 of between 0.6 and 0.8 for the linear model equivalent.

The positive/negative sign of the coefficients imply higher/lower levels of utility associated with the products, and therefore their characteristics. In this context, the model estimates show that all coefficients are statistically significant with the exception of the utility and prices associated with organic eggs. Finally, all of the estimated standard deviations of the random coefficients (ASCs) were highly significant with the exception of the two first levels of water reduction and the first level of GHG reduction (confirming the presence of non-observed heterogeneity around the mean) and thus the suitability of the used model specification.

Table 6: Descriptive analysis of the discrete choice experiment

	Choice set #1			Choice set #2			Choice set #3			Choice set #4			Choice set #5			Choice set #6			Choice set #7			Choice set #8		
	€/6 eggs	GHG %	WAT %	€/6 eggs	GHG %	WAT %	€/6 eggs	GHG %	WAT %	€/6 eggs	GHG %	WAT %	€/6 eggs	GHG %	WAT %	€/6 eggs	GHG %	WAT %	€/6 eggs	GHG %	WAT %	€/6 eggs	GHG %	WAT %
CAGE	€0.7	0%	30%	€0.8	10%	10%	€1.1	30%	0%	€1.1	30%	10%	€0.8	10%	20%	€1.0	20%	20%	€1.0	20%	30%	€0.7	0%	0%
% selected	**17.64%**			**17.43%**			**14.82%**			**20.04%**			**20.98%**			**16.18%**			**30.17%**			**17.64%**		
BARN	€1.5	10%	0%	€1.6	30%	30%	€1.5	20%	20%	€1.3	20%	0%	€1.2	0%	30%	€1.2	30%	10%	€1.6	0%	10%	€1.3	10%	20%
% selected	**22.4%**			**37.68%**			**33.09%**			**29.33%**			**29.02%**			**36.74%**			**18.79%**			**21.29%**		
FREE RANGE	€1.8	30%	20%	€2.0	0%	20%	€1.7	10%	10%	€2.1	10%	30%	€2.1	20%	10%	€1.8	0%	0%	€2.0	30%	0%	€1.7	20%	30%
% selected	**44.36%**			**29.02%**			**34.13%**			**27.97%**			**30.9%**			**26.62%**			**31.73%**			**47.6%**		
ORGANIC	€2.4	20%	10%	€2.9	20%	0%	€2.6	0%	30%	€2.7	30%	20%	€2.4	30%	0%	€2.7	10%	30%	€2.6	10%	20%	€2.9	0%	10%
% selected	**13.26%**			**12.53%**			**13.67%**			**17.64%**			**15.87%**			**16.81%**			**15.55%**			**10.86%**		
NONE	-			-			-			-			-			-			-			-		
% selected	**2.3%**			**3.34%**			**4.28%**			**5.01%**			**3.24%**			**3.65%**			**3.76%**			**2.61%**		

GHG: Percentage of reduction of the greenhouse gas emissions. WAT: percentage of reduction of water use.

Funded by European Union
Horizon 2020
Grant Agreement No 633531

WTP was estimated using equations 5 and 6 and is presented in Table 7. First, focusing on the egg types without any improvement of the environmental attributes (i.e. with the base level 0%" GHG and water use reduction), the WTP showed non-significant values for the barn and organic eggs. The former indicates that for consumers the small improvement of animal welfare does not compensate the difference in price with respect to caged eggs, while the latter confirms consumers' low consumption of organic eggs. WTP for caged eggs is very small and coincides with the minimum market price for this type of egg. This result indicates that Spanish consumers have a low preference for caged eggs. In the last year most major submarkets in Spain have decided to no longer sell caged eggs. Lidl stopped selling caged eggs in 2017, Carrefour announced they too will no longer sell them after 2020, while Mercadona (the supermarket with the highest market share in Spain) will stop selling them by 2022. However, Spanish consumers are willingness to pay a high price premium for free range eggs, which confirms their high consumption of free range eggs. This result indicates that higher animal welfare in free range eggs is more important to consumers than it is in organic eggs.

For reductions in GHG and water use, WTP was estimated for each type of egg. This peculiarity is inherent in the experimental design adopted by the Spanish study. Accordingly, results showed that in all types of eggs WTP for a 10% reduction of GHG or water use were not statistically significant. Consumers may consider that the costs of a 10% reduction in GHG or water use should be borne by producer and not by the consumer. However, for GHG or water use reductions, consumers exhibited a positive and significant WTP for a 20% or 30% reduction in both caged and free-range eggs (results for barn and organic eggs were not significant). These results demonstrated that consumers' WTP for the reduction of GHG emission in egg product is highly related to the egg type and the interval of reduction.

Table 7: Results of the Spanish choice experiment

Random parameters in utility functions			
	Coeff.	**Std. Err.**	**Pr > [z]**
GHG reduction 10%	0.1951	0.1328	0.1418
GHG reduction 20%	0.2913	0.0331	0.0000
GHG reduction 30%	0.3833	0.0351	0.0000
Water reduction 10%	0.1089	0.1220	0.3722
Water reduction 20%	0.2383	0.0316	0.0000
Water reduction 30%	0.3598	0.0352	0.0000
ASC - Caged	1.9560	0.3098	0.0000
ASC - Barn	3.6662	0.3457	0.0000
ASC - Free Range	7.4646	0.4030	0.0000
ASC - Organic	0.1329	0.9244	0.8856
Non-random parameters in utility functions			
	Coeff.	**Std. Err.**	**Pr > [z]**
Price - Caged	-1.4773	0.2796	0.0000
Price - Barn	-0.7402	0.2315	0.0014
Price - Free Range	-2.3841	0.2007	0.0000
Price - Organic	-0.2357	0.3403	0.4885

Standard deviations of random parameters			
	Coeff.	**Std. Err.**	**Pr > [z]**
S.D. GHG reduction 10%	0.5344	0.5421	0.3243
S.D. GHG reduction 20%	0.3675	0.0819	0.0000
S.D. GHG reduction 30%	0.4820	0.0822	0.0000
S.D. Water reduction 10%	0.2197	0.3762	0.8856
S.D. Water reduction 20%	1.4528	0.8139	0.0743
S.D. Water reduction 30%	0.2010	0.0735	0.0063
S.D. Caged	3.7258	0.1722	0.0000
S.D. Barn	2.1608	0.1221	0.0000
S.D. Free Range	3.7398	0.1480	0.0000
S.D. Organic	4.2379	0.1903	0.0000
WTP Estimates (€/6 eggs)			
	Coeff.	**Std. Err.**	**Pr > [z]**
Caged without any reduction	0.4624	0,1715	0.0070
Barn without any reduction	3.2330	2.0122	0.1081
Free Range without any reduction	2.5970	0.0762	0.0000
Organic without any reduction	-4.8355	330.93	0.9883
10% reduction of GHG in Caged	0.2641	0.2932	0.3677
10% reduction of GHG in Barn	0.5271	0.6876	0.4433
10% reduction of GHG in Free Range	0.1636	0.1610	0.3094
10% reduction of GHG in Organic	1.6552	234.74	0.9944
20% reduction of GHG in Caged	0.3944	0.1026	0.0001
20% reduction of GHG in Barn	0.7872	0.6769	0.2448
20% reduction of GHG in Free Range	0.2444	0.0337	0.0000
20% reduction of GHG in Organic	2.4721	86.342	0.9772
30% reduction of GHG in Caged	0.5189	0.1239	0.0000
30% reduction of GHG in Barn	1.0356	0.9185	0.2595
30% reduction of GHG in Free Range	0.3215	0.0441	0.0000
30% reduction of GHG in Organic	3.2521	23.915	0.8918
10% reduction of water use in Caged	0.1474	0.8804	0.8670
10% reduction of water use in Barn	0.2943	3.1136	0.9247
10% reduction of water use in Free Range	0.0913	1.8425	0.9604
10% reduction of water use in Organic	0.9241	140.58	0.9948
20% reduction of water use in Caged	0.3227	0.0886	0.0003
20% reduction of water use in Barn	0.6440	0.9697	0.5066
20% reduction of water use in Free Range	0.1999	0.0338	0.0000
20% reduction of water use in Organic	2.0223	38.532	0.9581
30% reduction of water use in Caged	0.4870	0.1233	0.0001
30% reduction of water use in Barn	0.9720	0.5573	0.0811
30% reduction of water use in Free Range	0.3018	0.0395	0.0000
30% reduction of water use in Organic	3.0525	71.0562	0.9657
Observations	8360		
Respondents	1045		
Wald Chi^2 (24)	11,442.33		0.0000
Log Likelihood	-7,733.73		
Restricted log likelihood	-13,454.90		
McFadden Pseudo R-squared	0.4252		
Akaike information criterion (AIC)	15,515.5		

ASC = Alternative Specific Constant

3.3 Results of UK and Spanish farmer surveys

Table 8 summarises the characteristics of farmers and farmer representatives (Spain only) recruited into the survey.

Table 8: Characteristics of interviewees

Farmer	Location and size	Pig Enterprise/ Sector	Poultry Enterprise/ Sector	Feed origin[(1)]	Market
1	East Yorkshire 615ha mostly rented	50 sows and pigs taken through from birth to slaughter weight - mostly indoors	24,000 free-range laying hens	100% bought in feed	Most pigs go to a local buying group and eggs are sold on contract
2	North Yorkshire 83ha owned	120 sows and 800 weaned and fattening pigs from birth to slaughter weight - all indoors	-	Mostly self-sufficient in feed with 3-4% bought in (creep feed, plus some protein & oils)	Member of a marketing group and also sells some direct to local bacon factory
3	Northumberland 800ha on long lease	130 sows with 980 pigs (3500 per year) taken from birth to slaughter weight – all indoors	-	90% bought in concentrate – 10% own-produced rolled barley	Output sold through marketing agents
4	Eastern England *	Multiple sites. Breeding and production for meat. 60% indoor and 40% outdoor	-	60% bought in; mixed with 40% own feed (own mill)	Pigs to abattoir; semen and gilts to farms
5	East Yorkshire 142ha owned	240 sows and 2,500 pigs weaned and fattening pigs from birth to slaughter weight - all indoors	-	Mostly self-sufficient in feed with 15% bought in (creep feed and lactating sow pellets)	Member of a marketing group and also sells some direct to local bacon factory
6	East Yorkshire 1,500ha nearly all owned	8,000 breeding sows 100,000 fattening pigs	Laying hens	All feed bought in but mixed to their own specification under a nutritionist's guidance	All output sold to major supermarket
7	Barcelona province	-	Poultry lobby Director	95% of the raw feed is imported	-

				(The feed is produced in Catalonia)	
8	Barcelona province	Pig lobby Director and Farmer	-	70% of the raw feed is imported**	-
9	Barcelona province	Pig lobby technician	-	80% of the raw feed is imported**	-
10	Tarragona province	Pig researcher and consultant	-	90% of the raw feed is imported	-
11	Tarragona province	-	Poultry Health organization Director	-	-
12	Lleida province	Pig farm and feed user	-	-	-

* Suppressed to avoid disclosure of interviewee's identity

** When the interviewee is a sector representative the data is provided is their estimate for the relevant sector

UK Results

General

Six UK pig producers were interviewed, two of whom also had poultry businesses. Interviewees' farms covered the whole pig production cycle from breeding (all using artificial insemination) to finishing. All had a great deal autonomy over production decisions (e.g. type of housing, feed, livestock management, breed, etc.) and would be able to adopt any new technologies if they wished to. Farms contracted for particular stages (e.g. fattening and/or finishing) might not have this freedom, or could be influenced by their customers (e.g. supermarkets). Likewise poultry sector producers working to tight specifications (e.g. for breed and feed) may not be able to make such changes independently.

Interviewees were asked what they need to do to survive or expand in the short to medium term. Maintaining a healthy herd and efficient production are paramount. Pig farmers work to very tight margins so small changes in input or output prices or in feed conversion rates (FCR) can make the difference between profitability and loss. In the short term, farmers constantly monitored prices and possibilities to improve efficiency and made frequent adjustments to their management to remain in profit. In the medium term they looked to make investments, for example to comply with legislation, improve production efficiency or to sell into different markets (such as higher welfare or higher kill weight). Not surprisingly then, all farmers appeared to be fairly open to adapting their systems within their operational constraints.

Having clarified their current production arrangements farmers were shown the stimulus materials. Though lacking detail farmers were able to think about the concepts and provide their first reactions.

Precision feeding

Interviewees reacted with enthusiasm to the concept of precision feeding and the resultant improvement in feed conversion efficiency and improved animal welfare (from reducing under-feeding and bullying). The larger farms in the survey were already using remote monitoring for things like air temperature and water consumption in the pig houses. As well as feed, two farmers mentioned the importance of upgrading water systems and the benefits of ensuring that pigs drank more to improve weight gain. One farmer mentioned the possibility of a reduced environmental footprint as an incentive for introducing this sort of system but this was not a common concern.

Several farmers suggested that the investment required for implementation was expected to be very high and there was considerable scepticism among respondents about whether the gains in feed efficiency necessary to justify the investment would be realised. This would particularly apply if existing buildings, infrastructure and feeding systems could not be simply adapted as most farmers believed to be the case. Production systems and size had generally made best use of existing buildings and the available site, although at least one respondent (an owner occupier) was currently upgrading buildings to give pigs more space because they are now fattening pigs to a higher weight.

Questions were raised about the necessary skill level of the farm workforce and the continuing need for good animal husbandry skills. It appeared to interviewees that operating such precision feeding systems would require skilled labour, which is expensive and could increase labour costs. Some were also concerned about animal welfare issues resulting from a possible reduction in human contact if a highly automated feeding system were adopted. Currently, staff might observe pigs three times per day during feeding, and behavioural problems, non-feeding and signs of disease (as well as problems with buildings and equipment) can be spotted at an early stage.

Any precision feeding equipment must be reliable and able to function continuously. One farmer mentioned the failure of printed circuit boards to operate properly in the atmosphere of piggeries. Clarity is needed as to how easy it would be for staff to obtain and interpret the data. Data might need to be downloaded to off-site specialists (for production analysis and equipment diagnostics) which will require a good broadband connection. Equipment suppliers must have the capacity to provide a fast and reliable on-farm repair service, which requires enough skilled staff. Broadband connection was also mentioned as a possible issue for monitoring in areas where internet and mobile communications reception were unreliable.

To justify such major investment, convincing evidence regarding future improved financial performance (for calculating return on capital and payback period) was required for which large and authoritative trials are required. These should determine the farm sizes and systems where a positive return on investment could be expected. Such investment was perceived as risky as returns will be sensitive to volatile input costs and market prices and repayments would be made over many years. The issue of scale is relevant and whether small producers can benefit. One farmer suggested that banks were unlikley to lend the money required to buy this equipment, as it would prove difficult to repossess if loans were not repaid. Tenant farmers are unlikely to be able to obtain finance (unsecured loans); family life-cycle is also relevant and older farmers may not want to invest if the payback period extends beyond their exit from

farming. In some cases the availability of low-cost loans or grants would alter the expected return on investment from negative to positive.

Novel feeds

Again, all farmers expressed interest in the three novel feeds which were presented to them especially the most unfamiliar, green protein. Due to the need to integrate crops into their own arable rotation, interviewees commented on the prospects for UK-grown crops. Supply of UK-grown soya were thought to be problematic and farmers knew of UK trials which, due to climate, were commercially unsuccessful. It would therefore be a question of waiting for plant breeders to produce suitable strains. Some farmers expressed uncertainty about the stability of supply of UK-grown oil seed rape (OSR). Following the EU's 2013 ban on neonicotinoid pesticide use on OSR, establishment has sometimes proved very difficult in the UK (and possibly elsewhere) and since 2012 there have been modest year-on-year decreases in OSR crop area in the UK. Furthermore OSR feed may be a by-product of the ethanol production process, so OSR feed supply is also driven by government policy towards the biofuel industry and the market price of ethanol, which determine the level of demand by refineries for OSR. One farmer expressed concerns about whether adopting these feeds could tie the business into a particular external organisation producing or distributing the feed.

Green protein might be useful as a break crop in an arable rotation but it would otherwise be a strange use of good arable land. It would be interesting if grass from poorer land could be used. The on-farm operation of a such a closed system that also produce cattle feed and bioenergy caught the imagination of interviewees but it was a very radical departure from current methods and seemed speculative.

Palatability to pigs is obviously crucial, but otherwise the cost of novel feeds, their protein content and animal performance relative to other feeds were the principal determinants of whether interviewees would use them. For example, EU-produced soya was only of interest if it matched imported soya for protein content delivered per unit price.

Another important factor mentioned by several farmers was the handling and storage of the feed: whether it could be stored in existing facilities, transported easily, its stability, whether or not it requires mixing on-farm, its form (dry, liquid, pellets, etc.) or is suitable for the current feed delivery system. This has implications for both investment and labour requirement, for example if there is a change from simply transferring feed from lorry to store to having to mix feed. It may be that some feeds are not suitable for mixing in small quantities (on-farm) but can only be handled in advanced facilities in large feed mills. If substitute EU (or UK) crops are to be used then pig farmers must feel confident of an adequate and consistent supply of them, and arable farmers must be convinced that there is a good market for them to encourage their participation.

The adoption of these feeds will be mediated by animal nutritionists, especially those working at large feed producers. Farmers expect them to investigate the feeds and provide professional advise them on how to incorporate them into a ration. One interviewee suggested that almost all soya used was genetically-modified (GM) and a non-GM soya feed might be more appealing to European consumers.

One farmer, who sells all of his production to a major retailer, suggested that consumer pressure or retailer interest in these foods would be an important consideration. He questioned

the extent to which consumers were likely to care where the protein in animal feeds came from.

Breeding solutions – feed efficiency

Farmers were aware of the issues raised in Feed-a-Gene and already addressed them during routine stock husbandry. Great attention is paid to developing gut microbiota by means of stock management (e.g. by ensuring that all new-borns have access to colostrum and having appropriately formulated feed at each development stage). Likewise farmers were aware of the significance of social behaviour among pigs and its effect on welfare and feed intake. They already tackle aggressive behaviour through handling, separate feeding etc and might provide an environment in pens which supports 'good behaviour' such as enriched pens, and more space per animal. One commented that it should be the conditions that are changed and not the genetic make-up of the pig.

Nevertheless there was considerable enthusiasm at the prospect of better technology helping to improve stock along these dimensions. One commented that is what farmers are always trying to do when they select breeding stock. Three farmers recognised that improving gut microbiota (by means of selection of sows with a favourable trait) could be a key driver of future productivity gains. Another suggested gene-editing to improve disease resistance. Biomarkers for nitrogen and for detecting pre-clinical disease would be big gains.

To use biomarkers it will be necessary to conduct tests of samples (blood, urine, faeces). This raises practical issues of taking samples, especially blood which must be done by veterinary scientists. Vets routinely visit farms every three months so this might set a timetable for taking samples. Pigs have a short life-span so it will be necessary to identify the best stages at which to do the testing and preferably to relate it to feed and growth data. The onerousness of any testing regime will be important and the availability of inexpensive testing equipment on farm would be advantageous. Cost, ease of operation and the ability to implement results to improve production will be important in determining take-up.

Commercialisation

Farmers repeatedly mentioned the need for detailed evaluation of all the novel technologies in a commercial setting and the provision of accurate and complete information to farmers. Several interviewees commented that company representatives frequently exaggerated the benefits of any new product and its suitability for a particular farm's scale or system. Buyers (e.g. supermarket chains) might be influential in encouraging uptake by farmers if they can sell the meat as an 'improved product' (e.g. lower carbon footprint) or to drive efficiency improvements in the supply chain.

Variation in pig production systems between different EU member states is to be expected. UK interviewees remarked on the higher animal welfare standards that exist on UK farms compared to some other countries. Consequently technology designed for very large herds with high stocking density indoor systems would not be relevant to the needs of smaller producers with (say) freedom farrowing and straw floored systems. One interviewee thought this resulted in lower returns to many UK producers and as a consequence less capital available for investment.

Spanish results

General

Most respondents in the Spanish survey were representatives of groups operating in the poultry and pig sectors that work in in close contact with producers and have deep insights into those sectors. This approach provided a broad picture of both sectors and avoided some of the problems linked to the under-representation of certain groups in a small sample. One pig farmer, a user of the precision feeding technology, was included in the sample.

It is noticeable that both sectors have a high degree of concentration in the region of Catalonia. The pig sector, however, seems to be moving towards the west and inner regions of Spain, such as Castile and León, towards areas were the population is scarce.

Poultry sector

The poultry sector in Catalonia is highly intensified and the lock-in system covers practically all farms. This structure prevails for broilers and for laying hens. The integration level of individual farms, however, varies greatly and this determines the degree of autonomy that the farmer has over farm-level decisions. However, when it comes to choice of feed, farmers generally have little autonomy.

As the integrating companies innovate at a high rate, the structure of the sector leads to a high level of technology transfer to farms. In this context, the breeding systems are highly professionalised and follow up production protocols established by the integrating companies.

Innovation in the poultry sector, thus, relies to a great extent on the developments produced by breeding and feed companies. Each genetic line is provided with recommendations that the farmer needs to follow at each stage, determining, in the case of laying hens, hours of light, the amount and type of feed and the amount of water among other things. The specifications also foresee the starting of the lay, its peak and its reduction.

The main short to medium term challenges for the Spanish poultry industry were identified as:

- a reduction in antibiotic use,
- a reduction of the pollution loads of the poultry litter,
- to communicate that intensive production systems are more sustainable than extensive systems, which is the contrary to what consumers' believe; and
- a reduction in the incidence of campylobacteriosis.

Pig sector

The structure of the pig sector in Catalonia is very similar to that of the poultry sector. However, in the pig sector there are several strong cooperatives. These cooperatives possess a feed mill as their main core business and provide farms with all the services required. Their representation is important but lower than that of the vertical integrating companies, while organic breeding is practically non-existent.

The reduction of production costs is of paramount importance for the sector as margins are currently low. In this sense, as the cost of the feed represents a high proportion of total costs, anything that leads to a reduction in these is highly desirable. Costs have to be kept down to remain competitive on the international markets and to remain economically sustainable. It

should be noted that Spain is one of the biggest producers and exporters of pork meat in the world.

The main short to medium term challenges for the Spanish pig industry were identified as:

- a reduction in antibiotic use;
- stopping the African swine fever virus (ASFV) entering the country;
- reducing greenhouse gas emissions;
- adapting the industry to consumers' demand and to communicate the good practices that the sector follows while increasing transparency over animal welfare, environmental & health issues; and
- contributing towards food security.

For both sectors, feeds are provided from feed mill plants located in the region which import a high proportion of raw materials (>70%).

Having clarified these topics, the stimulus materials were shown. The material was provided by the Dissemination, training and technology transfer team (WP7). Although these did not contain detail about specific solutions, the interviewees were able to think about the technologies explored by Feed-a-Gene and provide their initial reactions.

Precision feeding

The reactions of the poultry sector were largely unenthusiastic. Large poultry farms deal with a huge volume of birds in an all-in-all-out system that, according to one interviewee, makes it very difficult to monitor. More specific information about precision feeding systems for poultry would be required for a more detailed judgement to be made about their potential usefulness.

On the other hand, reactions from the pig sector were more positive, though interviews were cautious about the costs involved. For the installation of the system on farms fattening pig, the costs were estimated as ranging from 75 to 100€ per animal, this would include automatic precision feeders, weighing devices, control and decision support software. Interviewees were happy about this level of costs, especially as they would be expected to fall once the system is introduced and becomes more common. Nevertheless, interviewees stressed the need to be clear about the potential benefits of such systems. Questions were raised about the benefits for breeding pigs, though the benefits seemed clearer for gestating sows. For breeding pigs in an *ad libitum* system, multiphase feeding (within a precision feeding regime) would be highly valued, especially when two or more feeds could be mixed.

The possibility of working with large animal groups (at least 400 animals) was found to be attractive. However, this is only possible for larger farms are. Larger herd sizes create certain practical challenges, such as loading and locating specific animals. On the other hand, larger groups dilute the hierarchies that are generated in smaller groups.

Other possible advantages mentioned by interviewees included gains in space by removing passageways and walls, retaining young people in rural areas, as they might find careers in pig husbandry more attractive, and a reduction in the environmental footprint of pig farming.

Some other questions were also raised. If the installation of one system would cover 20 animals, in a 5,000 animal farm 250 such machines would be required. This would require

more skilled labour, which in turn would increase labour costs. On the other hand, the monitoring of farm systems from a distance would be a great advantage, which could lead to a reduction in labour costs. One option to reduce costs would be to have teams of skilled technical staff operating across a group farms rather than being based at a single farm. This would, however, provide challenges for biosecurity.

New technologies in most areas of agriculture are now widely accepted and interviewees agreed that it will be the same for the livestock sector in the near future. However, solutions would need to be simple and cheap if adoption was to be swift. Appropriate training and good after-sales services were also a must.

Novel feeds

Overall, the reactions to the novel feeds were positive or neutral but the most important factor in terms of their successful adoption would be price. Feed costs in the intensive livestock sector are high and margins are very tight, so anything that reduced feed costs would be popular. Protein digestibility and nutritional value would also be important. However, their introduction would only be possible if they were available at a competitive price. The adoption of these feeds should be mediated by animal nutritionists, especially those from the integrating companies.

The novel feed found most interesting was the extraction of green protein from fodder crops, as this would allow the exploitation of several harvests. It was thought that most soya and rape seed would probably remain imported as the climatic conditions do not allow yields that would make it competitive in the market. Again, new feed would only be accepted when available at a competitive price.

Related to feed, it was argued that the pollution caused by poultry litter has been reduced in recent years because of the use of protein sources based on essential amino acids. This being the case, if the novel feeds would lead to a reduction of these essential amino acids, this could lead the sector returning to higher pollution levels. Therefore, the results of the novel feeds on the pollution of the litter and the slurry should be also taken into account.

Palatability of the green protein concentrate for poultry was also questioned by respondents. The use of GMO-free soya was considered a European issue rather than a sectoral issue.

Breeding solutions – Feed Efficiency

Respondents were aware of some of the issues raised in Feed-a-Gene. Specially, animal welfare was directly related to feed efficiency. Respondents' opinions about this issue were enthusiastic, especially when bearing in mind that these solutions would help to increase feed efficiency and therefore reduce production costs. Nevertheless, respondents did not feel well enough informed to have an opinion about their potential on-farm effectiveness. Therefore, more accurate and complete information about future breeding solutions would be needed for a more accurate evaluation.

4. Conclusions

Overall, this research provides some encouraging findings with relation to the Feed-a-Gene project, while providing a few notes of caution around the potential for the adoption of new monogastric livestock feeding technologies by farmers. The attitudinal questions in the UK consumer questionnaire suggest that the precision feeding technologies and novel plant-based feeds being developed in the project are broadly acceptable to consumers, while farmers are also open to the use of these technologies in the right circumstances.

Consumers in the UK considered welfare standards and freshness more important considerations when buying eggs than their impact on the environment. Nevertheless, the choice experiments demonstrate that many consumers in the UK and Spain are willing to pay a premium for eggs with a lower carbon footprint though, again, higher premiums are associated with production methods linked to higher welfare standards. In the UK, premiums were found to be higher for consumers who had recently been reminded of the consequences of global warming, suggesting that if public concerns grow around global warming, farmers should be able to attract substantially better prices for eggs with a lower carbon footprint (part of which could come from improved feed and feeding technologies such as those being developed in Feed-a-Gene). Results from the Spanish study suggested that in Spain consumers are willing to pay a premium for a reduction in greenhouse gas emissions and water use associated with free-range and caged egg production, but only when these reductions are relatively high (at least 20%). This may suggest that Spanish consumers feel that the costs of achieving modest environmental improvements should be borne by producers and that they are only willing to pay to achieve higher levels of improvement.

In the UK, consumers seem very supportive of the use of technologies that improve the efficiency of poultry feeding (though this could derive from a combination of welfare and environmental motives). Most respondents in the UK and Spain were enthusiastic about the concept of precision feeding and the likely improvements in feed conversion efficiency, especially where this could have a positive impact on margins. Their main reservations were around the reliability of this equipment, the potentially high costs of adopting these technologies and the likely payback time in terms of savings from reduced feed use. Costs would be higher for farmers where existing infrastructure (e.g. older farm buildings) could not be adapted simply and this technology is likely to be more suited to larger and more modern operations, as the costs of installing the necessary equipment may prove prohibitive for many smaller producers. Interviewees in Spain stressed the need to be clear about the potential benefits of such systems in different circumstances, e.g. for breeding or fattening pigs compared to gestating sows. Representatives of the poultry industry in Spain had less enthusiasm for this technology, suggesting that the very high numbers of birds in some commercial operations would make the technology hard to implement. More detailed information on the costs and benefits of these systems is needed to inform decision making.

By contrast, many consumers in the UK find automated monitoring of animal health and feeding behaviour using remote sensors to be unacceptable, possibly because of the loss of human contact

UK consumers were more supportive of using protein from green biomass as a substitute for more conventional livestock feeds. Farmers were also interested in the use of green protein, especially if grass from poorer land could be used. On-farm systems producing cattle feed and

bioenergy were also attractive but thought to be rather speculative. Palatability to livestock, costs, protein content and performance would all be major considerations for farmers thinking about adopting novel feeds, which would need to at least match existing feeds in terms of the protein content delivered per unit price. This suggested an important role for animal nutritionists in assisting the adoption of such feeds. Handling and storage of novel feeds would also be an important consideration.

Respondents in the UK farmer survey had some reservations around the potential future supply of home-grown OSR and soya, the latter based on previous unsuccessful trials in the UK and the former reflecting concerns around crop protection following the ban on neonicotinoid pesticides and uncertainties around the future of bioethanol production. Respondents in Spain cited climatic conditions as preventing increased cultivation of soya and OSR in Mediterranean countries. European soya would, however, have its attractions as a GM-free alternative to most imported soya.

Consumers favoured using specially bred birds that convert more of their feed into eggs. Respondents in both countries were well aware of the potential benefits of breeding animals with desirable traits but also pointed out that better husbandry or conditions could deliver some of the same benefits as improved livestock breeds. Nevertheless, farmers in the UK survey exhibited considerable enthusiasm for scientists generating some of these improvements through improved breeding or gene editing. Routine testing for disease and other problems using biomarkers is also attractive but the uptake of such technologies would depend on cost, ease of implementation and the potential to use results in a meaningful way that improved productivity. Some respondents did not feel well enough informed to have an opinion and wanted more complete information about future breeding solutions before making a judgement..

Interviewees in both the UK and Spain stressed the importance of the provision of accurate and complete information to farmers and the need for a detailed evaluation of novel technologies in a commercial setting before more widespread adoption. Other actors, such as supermarket buyers, may be influential in supporting the spread of new technology if this leads to a premium product (e.g. more environmentally or welfare friendly) or reduces costs. Significantly improved prices for environmentally or welfare-friendly products would require consumer attitudes to change, with more consumers willing to pay a higher premium for products with lower environmental or welfare impacts.

To conclude, while the innovations being explored by Feed-a-Gene offer many potential benefits to both the livestock industry and society as a whole, much more work needs to be done to ensure that these benefits can be fully realised following the adoption of these new technologies by the industry. Precision feeding systems and novel protein sources that can offer improved returns and reduced environmental impacts can find favour with both producers and consumers. The industry must, however, remain aware that while consumers remain highly price sensitive, many continue to prioritise animal welfare over other considerations, including the environmental impacts of livestock farming.

5. References

Adamowicz, W. L., Boxall, P. and Louviere, J. (1998). Stated preference approaches for measuring passive use values: Choice experiments and contingent valuation. American Journal of Agricultural Economics, 80, 64-75.

Asselin, A.M. (2005). Eggcentric behavior—consumer characteristics that demonstrate greater willingness to pay for functionality. American Journal of Agricultural Economics 87, 1339–1344.

Ben-Akiva, M., McFadden, D., Abe, M., Böckenholt, U., Bolduc, D., Gopinath, D. and Morikawa, T. (1997). Modelling methods for discrete choice analysis. Marketing Letters 8, 273-286.

Bryman, A. (2012). Social Research Methods (4th edition). Oxford University Press, Oxford.

ChoiceMetrics (2016). Ngene 1.1.2 User Manual & Reference Guide. ChoiceMetrics, Australia.

Couper, M.P., Tourangeau, R., Conrad, F.G., and Singer, E. (2006). Evaluating the effectiveness of visual analog scales: A web experiment. Social Science Computer Review 24, 227-245.

Creswell, J. W. (2014). Research Design Qualitative, Quantitative and Mixed Methods. Approaches (4th edition). Sage, Thousand Oaks, CA.

Cummings, R.G. and Taylor L.O. (1999). Unbiased Value Estimates for Environmental Goods: A Cheap Talk Design for the Contingent Valuation Method. American Economic Review 89, 649-665.

Garrod, G.D. and Willis, K.G. (1999). Economic Valuation of the Environment : Methods and Case Studies. Edward Elgar, Cheltenham.

Gerini, F., Alfnes, F. and Schjoll, A. (2016). Organic- and animal welfare-labelled eggs: competing for the same consumers? Journal of Agricultural Economics 67, 471-590.

Gracia, A., Barreiro-Hurlé, J. and López-Galán, B. (2013). Are local and organic claims complements or substitutes? A consumer preferences study for eggs. Journal of Agricultural Economics 65, 49-57.

Hensher, D. A., Rose, J. M., and Greene, W. H. (2005). Applied choice analysis: a primer. Cambridge University Press in choice experiments". Economics Letters, 89,147–152.

Krinsky, I. and Robb, L. (1986). On approximating the statistical properties of elasticities. The Review of Economics and Statistics, 68, 715-719.

Lancaster, K. (1966). A new approach to consumer theory. Journal of Political Economy 74, 132-157.

Louviere, J.J., Henscher, D.A. and Swait, J.D. (2000). Stated Choice Methods: Analysis and Applications. Cambridge University Press, Cambridge.

Lusk, J. L., and Schroeder, T. C. (2004). Are choice experiments incentive compatible? A test with quality differentiated beef steaks. American Journal of Agricultural Economics, 86, 467-482.

Malone, T. and Lusk, J.L. (2017). Taste trumps health and safety: Incorporating consumer perceptions into a discrete choice experiment for meat. Journal of Agricultural and Applied Economics 49, 139-157.

McFadden, D., Tye, W. B. and Train, K. (1974). An application of diagnostic tests for the independence from irrelevant alternatives property of the multinomial logit model. Institute of Transportation Studies, University of California.

Matthews, B. and Ross, L. (2010). Research Methods. Pearson Longman, New York.

Merriam, S.B. (2013). Qualitative Research A Guide to Design and Implementation. Jossey-Bass, San Francisco, CA.

Rosen, S. (1974). Hedonic prices and implicit markets : product differentiation in pure competition. Journal of Political Economy 82, 34-55.

Roster, C. A., Lucianetti, L., and Albaum, G. (2015). Exploring slider vs. categorical response formats in web-based surveys. Journal of Research Practice 11(1) Article D1. Retrieved from http://jrp.icaap.org/index.php/jrp/article/view/509/413

Tonsor, G.T. and Shupp, R.S. (2011). Cheap Talk Scripts and Online Choice Experiments: "Looking Beyond the Mean". American Journal of Agricultural Economics, 93, 1015–1031.

6. Annexes

Annex 6.1 : UK Consumer Questionnaire

Start of Block: Intro

Q1 **Welcome to our EGG survey!** Thank you for your interest in this survey. This research, carried out by **Newcastle University** (UK) and **Institut de Recerca i Tecnologia Agroalimentaàries** (IRTA, Spain), tries to better understand the preferences of the general public when buying hens' eggs. This research is part of a project called Feed a Gene funded by The European Union. *(The Feed-a-Gene Project has received funding from the European Union's H2020 Programme (agreement no. 633531.)* You can find more information on this project by visiting https://www.feed-a-gene.eu/.

This survey will take approximately 12-15 minutes to complete.

Participation in this survey is voluntary and you have the right to decline the invitation or to withdraw from the study at any time. Your answers will be recorded and analyzed. Responses will be treated confidentially and reported so that individual respondents cannot be identified. The results will be used for research purposes only including written reports and academic papers. Any questions? Please e-mail marian.raley@ncl.ac.uk With many thanks for your time and support. Marian Raley and Guy Garrod, Centre for Rural Economy, Newcastle University.

Q3 **Please tick the box to confirm that you agree to participate in this survey.** Your participation is voluntary, and you may discontinue the survey at any point.

- ○ I agree to participate in the survey. (1)

Page Break

End of Block: Intro

Start of Block: Exclude under 18s

Q4 Are you aged 18 years or older?

- Yes (5)
- No (6)

Page Break

End of Block: Exclude under 18s

Start of Block: Purchasing frequency

Q5 How often do you buy eggs?

- ○ At least once a week (1)
- ○ At least once every 2 weeks (2)
- ○ At least once every month (3)
- ○ Less than once a month (4)
- ○ Never (5)

End of Block: Purchasing frequency

Start of Block: Device type

Q6 How are you viewing this survey? *This is so we show it in the correct format.*

- ○ PC, laptop or tablet (1)
- ○ Phone (2)

End of Block: Device type

Start of Block: Allocate treatment and label

Start of Block: Group=video PC and laptop

Q9 Timing

First Click (1)
Last Click (2)
Page Submit (3)
Click Count (4)

Q10 **Please watch this video (It's about 1 minute long.) PC / laptop version**

Page Break

End of Block: Group=video PC and laptop

Start of Block: Group=video, Phone version

Q13 Timing

First Click (1)
Last Click (2)
Page Submit (3)
Click Count (4)

Q14 Please watch this short video (PHONE VERSION)

Page Break

End of Block: Group=video, Phone version

Start of Block: Global warming Rough Guide

Q57 Timing

First Click (1)
Last Click (2)
Page Submit (3)
Click Count (4)

Q78 **A Rough Guide to the Carbon Footprint of food** Many scientists believe that **global warming** is a serious environmental problem and that **greenhouse gases** contribute to global warming. Greenhouse gases are released into the atmosphere by many human activities - **including the production of food.**

The **carbon footprint** of a food tells us the amount of greenhouse gases that are released when producing and consuming the food. Carbon footprint is expressed in grams of carbon dioxide equivalents, or "g CO2e" for short.

When producing **eggs**, greenhouse gases (GHGs) are emitted at several stages, such as when: Growing feed crops (e.g cultivating land; manufacturing fertiliser); Processing crops into animal feed; Heating and lighting the hen housing; Transporting eggs and feed; and From hen manure.

End of Block: Global warming Rough Guide

Start of Block: choice set allocation

Q16 **Buying Eggs**
On each of the next 4 pages we present you with 3 boxes of eggs which have different combinations of: production method; size of eggs; carbon footprint; and price. On each page, please compare the 3 boxes on offer and consider carefully how they differ from each other. Then select the box which you would buy if this was the choice available in a shop. All boxes contain 6 eggs. If you don't find any of the boxes attractive, you can choose to make no purchase and save the money for later.

It is important that you make each of your choices as you would if you were actually facing these specific choices in a store, i.e. noting that buying the eggs means you would have less money

available for other purchases. If you select the most expensive box of eggs, then you must really want it! It will leave you with less cash to spend on anything else.

End of Block: choice set allocation

Start of Block: CExp Block1

Bk1.1 **Scenario 1** **Which box of eggs would you buy?** ***All boxes contain 6 eggs.***

- Box 1 Rearing: **Cage** Egg size: **Small** Carbon footprint: **1440g** Price: **£0.80p** (1)
- Box 2 Rearing: **Barn** Egg size: **Medium** Carbon footprint*:* **1650g** Price: **£ 0.80p** (2)
- Box 3 Rearing: **Free range** Egg size: **Mixed** Carbon footprint*:* **1150g** Price: **£0.95p** (3)
- None of these (4)

Page Break

Bk1.2 **Scenario 2** **Which box of eggs would you buy?** ***All boxes contain 6 eggs.***

- ○ Box 1 Rearing: **Cage** Egg size: **Small** Carbon footprint: **1440g** Price: **£0.80p** (1)
- ○ Box 2 Rearing: **Free range** Egg size: **Medium** Carbon footprint*:* **1150g** Price: **£ 0.80p** (2)
- ○ Box 3 Rearing: **Cage** Egg size: **Mixed** Carbon footprint*:* **1320g** Price: **£0.95p** (3)
- ○ None of these (4)

Page Break

Bk1.3 **Scenario 3** **Which box of eggs would you buy?**

All boxes contain 6 eggs.

- ○ Box 1 Rearing: **Cage** Egg size: **Small** Carbon footprint: **1440g** Price: **£0.80p** (1)
- ○ Box 2 Rearing: **Barn** Egg size: **Medium** Carbon footprint: **1320g** Price: **£ 1.20p** (2)
- ○ Box 3 Rearing: **Free range** Egg size: **Mixed** Carbon footprint*:* **1440g** Price: **£1.50p** (3)
- ○ None of these (4)

Page Break

Bk1.4 **Scenario 4** **Which box of eggs would you buy?** ***All boxes contain 6 eggs.***

- ○ Box 1 Rearing: **Cage** Egg size: **Small** Carbon footprint **1440g** Price: **£0.80p** (1)
- ○ Box 2 Rearing: **Barn** Size: **Mixed** Carbon footprint*:* **1320g** Price: **£ 0.80p** (2)
- ○ Box 3 Rearing: **Free range** Egg size: **Large** Carbon footprint*:* **1440g** Price: **£0.95p** (3)
- ○ None of these (4)

Page Break

THE OTHER 8 BLOCKS OF CHOICES USED IN THE CHOICE EXPERIMENT ARE OMITTED FOR BREVITY BUT ARE AVAILABLE ON REQUEST FROM THE AUTHORS

End of Block: CExp Block1

Start of Block: Socio-demographic Qs

Q17 Now we ask a few questions about you. This is so we can check that a wide range of different people have completed the questionnaire. Remember, the data we collect are for research purposes only and will be anonymised.

What is your gender?

- ○ Female (1)
- ○ Male (2)
- ○ Prefer not to say / Other (3)

Page Break

Q18 **At what stage did you finish your formal education?**

- ○ Lower secondary stage *e.g. GCSEs, 'O' levels* (1)
- ○ Upper secondary stage *e.g. 'A' levels, Highers, NVQ3, IB* (2)
- ○ Certificate or diploma in Higher Ed or equivalent *e.g. Level 4 or 5 NVQ; HNC; HND* (3)
- ○ Bachelor's degree or equivalent *e.g. NVQ6; level 6 certificate* (4)
- ○ Postgraduate degree or equivalent *e.g. NVQ 7; level 7 or 8 certificate* (5)
- ○ Professional qualifications only (6)

Page Break

Q19 What is your age?

_____

Q20 What is your household's annual pre-tax income (approximately)? *Include all income sources such as salary, pensions, benefits.*

- Less than £15,000 (1)
- £15,000 to £19,999 (2)
- £20,000 to £29,999 (3)
- £30,000 to £39,999 (4)
- £40,000 to £49,000 (5)
- £50,000 to £59,999 (6)
- £60,000 to £69,999 (7)
- £70,000 to £99,999 (8)
- £100,000 to £149,999 (9)
- £150,000 or more (10)
- I'd prefer not to say (11)

Page Break

End of Block: Socio-demographic Qs

Start of Block: Purchasing behaviour

Q21 **How important are the following factors when you buy eggs?** Please click on the slider then move it along the scale to show how important/unimportant it is.

	Not at all important	**Moderately important**	**Very important**
Whether the price is low. ()			
Produced locally ()			
Higher animal welfare standard ()			
The 'Best before' or 'Use by' date ()			
Appearance ()			
Impact on the environment ()			
Usual brand ()			
Production system *e.g. cage, barn, free range* ()			
Whether they are the size that I prefer ()			

Page Break

End of Block: Purchasing behaviour

Start of Block: Preferences for production technology

Q23 **Final questions - Your opinion on the future of egg production**

Another aim of this project is to develop technological innovations for *farmers w*ho keep *poultry or pigs* to produce *meat and eggs*. The objective of these innovations is to produce more protein from each kilogram of animal feed and from each hectare of land without increasing environmental problems or reducing animal welfare.

Carefully designed new technology can allow farmers to meet the world population's increasing demand for protein products.

Q24 Some examples of new technologies: • *Improved breeding programmes* for hens so they can convert more of the feed into eggs or meat. • *Adding enzymes to animal feed* to make it easier for hens to digest, so more is absorbed and less wasted. • *Better feeding equipment* to ensure hens always get the right food, when they need it. • Improved ways of *monitoring the health and welfare* of hens, both for the wellbeing of the hens and to minimise production losses.
• *Ways of using new feed sources* such as processed grass and by-products from industries. This would reduce the requirement for good agricultural land for growing feed crops such as soya.

Page Break

Q25 **Please tell us how acceptable or unacceptable you find each of the following approaches to poultry farming.** ***Please click on the slider and move it along the scale to show how acceptable/unacceptable it is to you.***

	Totally unacceptable **Totally acceptable**
Using specially bred hens which convert more of their feed into eggs. *(This does NOT involve genetic modification.)* ()	
Using equipment that improves poultry feeding *(e.g. so food is always available when the hen wants it).* ()	
Replacing part of the diet with feed made from processed plant materials such as grass or clover. *This reduces the area of good agricultural land needed.* ()	
Replacing part of the diet with feed made from by-products of industrial processes.*This reduces the area of good agricultural land needed.* ()	

Page Break

Q26 ***Please move the slider to show how acceptable/unacceptable each approach is to you.***

	Totally unacceptable **Totally acceptable**
Using indoor production systems that offer the hens no access to outdoor areas. *Some* evidence suggests this can reduce greenhouse gas emissions and increase feed efficiency. ()	
Using conventional concentrated animal feeds that contain up to 30% of grains or oil meals derived from genetically modified plants. ()	
Automated monitoring of animal health and feeding behaviour using sensitive remote detectors (machines). This may reduce human contact but detect some problems earlier ()	
Keeping hens in large flocks. *Some evidence indicates this may reduce global warming potential.* ()	

End of Block: Preferences for production technology

Annex 6.3 : Spanish Consumer Survey (English Translation)

Q1. Do you usually consume hens' eggs?

- Yes
- No

Q2. Have you bought hens' eggs at least once in the last three months?

- Yes
- No

Q3. Sex?

- Male
- Female

Q4. Year of Birth?

Q5. Where do you think is your monthly household net income classified in relation to the mean?

- Far below the average
- Below the average
- Equal to mean
- Above the mean
- Far above the mean
- I do not know

This questionnaire is part of a research project which is related to OPINIONS and PREFERENCES of consumers regarding egg products and is being carried out by The Center for Agro-food Economy and Development (CREDA-UPC-IRTA) of Catalonia Polytechnic University.

The results of this survey, which is currently being carried out in entire Spain, are characterized as a public RESEARCH and in NO CASE are going to be used for INDIVIDUAL/PROPRIETARY and/or COMMERCIAL purposes. On the contrary, they are going to be used in scientific research with the purpose of HELP in a better understanding of the different aspects and points of view regarding the PURCHASE and CONSUMPTION of EGG PRODUCTS.

All the acquired information in this survey will be CONFIDENTIAL and strictly ANONYMOUS as well as the individual responses will NEVER be provided to others.

Throughout this questionnaire THERE IS NO such thing as a CORRECT or INCORRECT response, we just like to know your OPINION. Please, take into account

the fact that, if you CANNOT, OR DO NOT WANT to give an answer in all of the questions included in the survey, you can immediately quit answering it. Remember that you can return ANSWERING THE QUESTIONNAIRE whenever and wherever you left it off.

Q6. Which types of fresh eggs de hens do you USUALLY PURCHASE for the household consumption?

- Eggs from caged hens
- Eggs from hens in barns
- Free-range eggs
- Organic eggs
- Eggs enriched with Omega 3
- I do not know
- Others

Q7. How often do you consume fresh eggs of hens?

- Every day
- 2 to 3 times per week
- Once per week
- 2 times per month
- Once per month
- Less than once per month
- Never

Q8. Which material the packaging of eggs that you usually purchase is made off?

- Only of carton
- Of carton and plastic
- Only of plastic

Q9. Do you remember the approximate price of fresh hens eggs that you purchased last time?

- Yes, I remember
- No, I do not remember

Q10. Which was the format and the price of the format that you last purchased? Give an answer depended only on the format that you usually purchase.

	Price in Euros
For 6 eggs (in euros).	☐ For 6 eggs (in euros).
For 12 eggs (in euros).	☐ For 6 eggs (in euros).
For 30 eggs (in euros).	☐ For 6 eggs (in euros).
or _____ € for any other format (Specify): _____	☐ For 6 eggs (in euros).

Next, we will present you one series of EIGHT PURCHASING SITUATIONS of 6 fresh chicken medium sized eggs per pack (M-L). In each of these eight purchasing situations, we would like to know which product you would purchase, taking into account your purchasing behavior relating to fresh chicken eggs. We do not ask you to ACTUALLY PURCHASE ANY of the selected products, we are simply interested in your decisions.

The following fresh chicken eggs that we are going to show you in the next eight purchase situations are differentiated based on a series of characteristics (attributes), which we are going to explain to you below.

According to the applicable regulation, there are FOUR systems of egg production:

EGGS FROM HENS RAISED IN CAGES: Are eggs from hens that live in cages. Since January 2012, the European Union required that these cages should be bigger /more spacious and appropriately conditioned, aiming to the improvement of animal welfare. These hens do not have outdoor access.

EGGS FROM HENS RAISED IN BARNS: Are eggs from chickens that live on the ground inside a barn where they do not have outdoor access.

FREE-RANGE EGGS: Are eggs from hens that can move freely both inside and outside of a barn but where space may be limited.

ORGANIC EGGS: The organic eggs have been produced from hens that can freely move and have access to the inside of a barn in a context of a bigger space than that of the free range eggs, and, also, their feed comes from Organic Farming.

Therefore, one attribute of fresh chicken eggs which could be taken into account by their consumers during the purchase could be the **conditions of animal welfare of each production system**.

Another attribute that we are going to consider is the **REDUCTION OF GREENHOUSE GAS EMISSIONS** released during the production of fresh chicken eggs. In order to produce eggs, the gases of the greenhouse effect released in various stages of the production chain. BIG PART of these emissions are generated from hens FEED PRODUCTION coming from the FARMING (for example, land cultivation; making of fertilizers) and its processing. Additionally, these emissions can also be produced from other sources like the barns' Heating and illumination of the hens, egg Transportation, feed and fertilizers of hens.

Nowadays, there are technologies for the REDUCTION OF EMISSIONS as far as farming is concerned (reduction in the use phosphorus, nitrogen, and potassium, reuse of the organic waste and improved practices on agricultural land among other technologies).

We distinguish eggs according to the following POSSIBLE REDUCTIONS OF GREENHOUSE GAS EMISSIONS:

- 0% REDUCTION OF GREENHOUSE GAS EMISSIONS
- 10% REDUCTION OF GREENHOUSE GAS EMISSIONS
- 20% REDUCTION OF GREENHOUSE GAS EMISSIONS
- 30% REDUCTION OF GREENHOUSE GAS EMISSIONS

Also, the production of fresh chicken eggs is an IMPORTANT USE of natural resources like WATER. To produce eggs, water is used in various stages during the production process, like in the water needed for farming, for feeding the hens and maintaining cleanliness in the barns and the facilities that are inside them.

Currently, there are various technologies for the **REDUCTION OF WATER USE** mainly around farming practices and the cleanliness of the facilities concerned. This way, we can distinguish eggs according to the following POSSIBLE REDUCTIONS OF WATER USE

- 0% REDUCTION OF WATER USE
- 10% REDUCTION OF WATER USE
- 20% REDUCTION OF WATER USE
- 30% REDUCTION OF WATER USE

The price for six fresh chicken eggs can vary BASED ON THE EGG TYPE, the level of emissions' reduction and the water use. Thus the price for a pack of six eggs:

- For eggs produced in cages can be: 0.70€/ six eggs, 0.85*€/six eggs, 1.00€/six eggs, 1.15€/six eggs.*
- *For eggs produced in barns can be: 1.20€/ six eggs, 1.35€/six eggs, 1.50€/six eggs, 1.65€/six eggs.*
- *For free-range eggs can be: 1.70€/ six eggs, 1.85€/six eggs, 2.00€/six eggs, 2.15€/six eggs.*
- *For organic eggs can be: 2.45€/ six eggs, 2.60€/six eggs, 2.75/six eggs, 2.90€/six eggs.*

Accordingly, we present you the EIGHT PURCHASE SCENARIOS for six fresh chicken eggs. In each purchasing situation, we will ask you to choose, between four TYPES OF EGGS, the one you would purchase taking into account your normal behaviour as a consumer.

Please, compare all of the characteristics of the EGGS IN EACH PURCHASE SCENARIO including their price. If none of the given EGG TYPES is quite to your liking, always can choose the option of not buying none of them.

Similar studies previously conducted have shown that in purchasing cases like those which we are about to show you, quite frequently what people finally CHOOSE TO BUY IS DIFFERENT from what they actually end up buying in real life. By not having to pay for the product they choose (as in the previous study) people tend to overestimate their individual preferences and willingness to pay for the chosen product, which means the product they like most is not necessarily the one they really buy.

One possible explanation for this behaviour lies in the observation that people do not really realise the great impact of the extra cost of the choice in the family budget. It's easy to be generous when you do not really have to pay for it. In a shop, people tend to think differently: the amount of money spent on a product cannot be spent on other things.

So, please, in each purchase situation, we ask you to behave supposing that you were actually in the store and had to pay for your choice.

Q11. PURCHASING SITUATION 1: Which of the following six eggs would you buy?

	Eggs created from caged hens	*Range eggs in soil*	*Free-range eggs*	*Organic eggs*	*None*
Price for 6 eggs (€)					*I would not buy any of the four options.*
Reduction of greenhouse gas emissions (%)					
Reduced use of water (%)					
Type of packaging					
I would buy	☐	☐	☐	☐	☐

- Eggs created from caged hens
- Range eggs in soil
- Free-range eggs
- Organic eggs
- None of the above

Q12. PURCHASING SITUATION 2: Which of the following six eggs would you buy?

	Eggs created from caged hens	*Range eggs in soil*	*Free-range eggs*	*Organic eggs*	*None*
Price for 6 eggs (€)					*I would not buy any of the four options.*
Reduction of greenhouse gas emissions (%)					
Reduced use of water (%)					
Type of packaging					
I would buy	☐	☐	☐	☐	☐

- Eggs created from caged hens
- Range eggs in soil
- Free-range eggs
- Organic eggs
- None of the above

Q13. PURCHASING SITUATION 3: Which of the following six eggs would you buy?

	Eggs created from caged hens	*Range eggs in soil*	*Free-range eggs*	*Organic eggs*	*None*
Price for 6 eggs (€)					*I would not buy any of the four options.*
Reduction of greenhouse gas emissions (%)					
Reduced use of water (%)					
Type of packaging					
I would buy	☐	☐	☐	☐	☐

- Eggs created from caged hens
- Range eggs in soil
- Free-range eggs
- Organic eggs
- None of the above

Q14. PURCHASING SITUATION 4: Which of the following six eggs would you buy?

	Eggs created from caged hens	*Range eggs in soil*	*Free-range eggs*	*Organic eggs*	*None*
Price for 6 eggs (€)					*I would not buy any of the four options.*
Reduction of greenhouse gas emissions (%)					
Reduced use of water (%)					
Type of packaging					
I would buy	☐	☐	☐	☐	☐

- Eggs created from caged hens
- Range eggs in soil
- Free-range eggs
- Organic eggs
- None of the above

Q15. PURCHASING SITUATION 5: Which of the following six eggs would you buy?

	Eggs created from caged hens	*Range eggs in soil*	*Free-range eggs*	*Organic eggs*	*None*
Price for 6 eggs (€)					*I would not buy any of the four options.*
Reduction of greenhouse gas emissions (%)					
Reduced use of water (%)					
Type of packaging					
I would buy	☐	☐	☐	☐	☐

- Eggs created from caged hens
- Range eggs in soil
- Free-range eggs
- Organic eggs
- None of the above

Q16. PURCHASING SITUATION 6: Which of the following six eggs would you buy?

	Eggs created from caged hens	*Range eggs in soil*	*Free-range eggs*	*Organic eggs*	*None*
Price for 6 eggs (€)					*I would not buy any of the four options.*
Reduction of greenhouse gas emissions (%)					
Reduced use of water (%)					
Type of packaging					
I would buy	☐	☐	☐	☐	☐

- Eggs created from caged eggs
- Range eggs in soil
- Free-range eggs
- Organic eggs
- None of them

Q17. PURCHASING SITUATION 7: Which of the following six eggs would you buy?

	Eggs created from caged hens	*Range eggs in soil*	*Free-range eggs*	*Organic eggs*	*None*
Price for 6 eggs (€)					*I would not buy any of the four options.*
Reduction of greenhouse gas emissions (%)					
Reduced use of water (%)					
Type of packaging					
I would buy	☐	☐	☐	☐	☐

- Eggs created from caged hens
- Range eggs in soil
- Free-range eggs
- Organic eggs
- None of the above

Q18. PURCHASING SITUATION 8: Which of the following six eggs would you buy?

	Eggs created from caged hens	*Range eggs in soil*	*Free-range eggs*	*Organic eggs*	*None*
Price for 6 eggs (€)					*I would not buy any of the four options.*
Reduction of greenhouse gas emissions (%)					
Reduced use of water (%)					
Type of packaging					
I would buy	☐	☐	☐	☐	☐

- Eggs from caged eggs
- Range eggs in soil
- Free-range eggs
- Organic eggs
- None of the above

Q19. Punctuate, by sliding the circle, which of the following egg type do you think is LESS RESPECTFUL OF ANIMAL WELFARE, according to what you understand by the term RESPECTFUL OF ANIMAL WELFARE.

Type of eggs	*-5: Less Respectful to Animal Welfare* *+5: More respectful to Animal Welfare*										
Caged eggs	**-5**	**-4**	**-3**	**-2**	**-1**	**0**	**+1**	**+2**	**+3**	**+4**	**+5**
Barn eggs	**-5**	**-4**	**-3**	**-2**	**-1**	**0**	**+1**	**+2**	**+3**	**+4**	**+5**
Free-range eggs	**-5**	**-4**	**-3**	**-2**	**-1**	**0**	**+1**	**+2**	**+3**	**+4**	**+5**
Organic eggs	**-5**	**-4**	**-3**	**-2**	**-1**	**0**	**+1**	**+2**	**+3**	**+4**	**+5**

Q20. Punctuate, by sliding the circle, the following egg types from LESS TO MORE SUSTAINABLE, according to what you understand by the term a SUSTAINABLE EGG.

Type of eggs	*-5: Less sustainable* *+5: More sustainable*										
Caged eggs	**-5**	**-4**	**-3**	**-2**	**-1**	**0**	**+1**	**+2**	**+3**	**+4**	**+5**
Barn eggs	**-5**	**-4**	**-3**	**-2**	**-1**	**0**	**+1**	**+2**	**+3**	**+4**	**+5**
Free-range eggs	**-5**	**-4**	**-3**	**-2**	**-1**	**0**	**+1**	**+2**	**+3**	**+4**	**+5**
Organic eggs	**-5**	**-4**	**-3**	**-2**	**-1**	**0**	**+1**	**+2**	**+3**	**+4**	**+5**

Q21. Punctuate, by sliding the circle, the following egg types from LESS TO MORE HEALTHY, according to what you understand by the term a HEALTHY EGG.

Type of eggs	*-5: Less Healthy* *+5: More Healthy*										
Caged eggs	**-5**	**-4**	**-3**	**-2**	**-1**	**0**	**+1**	**+2**	**+3**	**+4**	**+5**
Barn eggs	**-5**	**-4**	**-3**	**-2**	**-1**	**0**	**+1**	**+2**	**+3**	**+4**	**+5**
Free-range eggs	**-5**	**-4**	**-3**	**-2**	**-1**	**0**	**+1**	**+2**	**+3**	**+4**	**+5**
Organic eggs	**-5**	**-4**	**-3**	**-2**	**-1**	**0**	**+1**	**+2**	**+3**	**+4**	**+5**

Q22. Punctuate, by sliding the circle, which of the following egg type do you think is LESS RESPECTFUL TO THE ENVIRONMENT, according to what you understand by the term RESPECTFUL TO THE ENVIRONMENT.

Type of eggs	*-5: Less Respectful to the environment* *+5: More respectful to the environment*										
Caged eggs	**-5**	**-4**	**-3**	**-2**	**-1**	**0**	**+1**	**+2**	**+3**	**+4**	**+5**
Barn eggs	**-5**	**-4**	**-3**	**-2**	**-1**	**0**	**+1**	**+2**	**+3**	**+4**	**+5**
Free-range eggs	**-5**	**-4**	**-3**	**-2**	**-1**	**0**	**+1**	**+2**	**+3**	**+4**	**+5**
Organic eggs	**-5**	**-4**	**-3**	**-2**	**-1**	**0**	**+1**	**+2**	**+3**	**+4**	**+5**

Q23. Punctuate, by sliding the circle, the following egg types from LESS TO MORE TASTY.

Type of eggs	*-5: Less tasty* *+5: More tasty*										
Caged eggs	**-5**	**-4**	**-3**	**-2**	**-1**	**0**	**+1**	**+2**	**+3**	**+4**	**+5**
Barn eggs	**-5**	**-4**	**-3**	**-2**	**-1**	**0**	**+1**	**+2**	**+3**	**+4**	**+5**
Free-range eggs	**-5**	**-4**	**-3**	**-2**	**-1**	**0**	**+1**	**+2**	**+3**	**+4**	**+5**
Organic eggs	**-5**	**-4**	**-3**	**-2**	**-1**	**0**	**+1**	**+2**	**+3**	**+4**	**+5**

Q24. The egg has a code consisted of numbers and letters. The first number of the code corresponds to the different egg production systems. Please indicate which number corresponds to each type of egg production system.

	First number of the code					
	code 0	code 1	code 2	code 3	I do not know	I do not remember
Eggs from caged hens	○	○	○	○	○	○
Free-range eggs	○	○	○	○	○	○

	First number of the code					
	code 0	code 1	code 2	code 3	I do not know	I do not remember
Barn eggs	○	○	○	○	○	○
Organic eggs	○	○	○	○	○	○

Q25. On a scale of 1 to 7, how much do you agree or disagree with the following statements?

Completely Disagree	*Mostly Disagree*	*Slightly Disagree*	*indifferent*	*Slightly agree*	*Mostly agree*	*Completely agree*
1	*2*	*3*	*4*	*5*	*6*	*7*

Always choose to buy food products that I like, regardless of the material are made of their packages.	
Always choose to buy food products that I like, regardless of their production origin.	
Always choose to buy local and seasonal food products because they pollute less.	
I have always considered that all food packaging are unnecessary.	
Always choose to buy food products, knowing that I am helping to prevent rural depopulation.	
Always choose to buy food products that I like, regardless if they are produced by a social cooperative or a multinational one.	
Always choose to buy food products, whose production has been done under fair working conditions.	
Always choose to buy food products, no matter the working conditions of its production.	
Mainly buy the food needed so as to avoid having to throw it out or overspending.	
Always choose to buy food products that do not have any visual imperfections although their cost is elevated.	

Always choose to buy food products that I like, regardless their price. ☐

Always choose to buy food products that are about to expire ☐

Q26. On a scale of 1 to 7, how much do you agree or disagree with the following statements?

Completely Disagree	*Mostly Disagree*	*Slightly Disagree*	*indifferent*	*Slightly agree*	*Mostly agree*	*Completely agree*
1	*2*	*3*	*4*	*5*	*6*	*7*

Human ingenuity will ensure that we do not make the earth a place uninhabitable. ☐

We are approaching the maximum number of people that earth can tolerate. ☐

Earth has natural resources in abundance. We just have to learn how to exploit them. ☐

Earth is like a spatial nave, with limited resources and space. ☐

Despite our special skills, human beings are still subject to nature's laws. ☐

Plants and animals have as much right as human beings to exist. ☐

Human beings have the right to modify the environment so as to suit their needs. ☐

Eventually, humans will learn how nature works, in order to be able to control it. ☐

Humans severely abuse the environment. ☐

When humans interfere on nature's balance, the consequences are usually disastrous. ☐

Humans were created to dominate the rest of nature. ☐

If nothing changes, we are soon going to experience a severe ecological disaster. ☐

Nature's balance is very delicate and easily alterable.	
The idea of humanity facing a global ecological crisis has been greatly exaggerated.	
Nature's balance can tolerate the impact of industrialized countries.	
In order to achieve sustainable development, a more balanced economy is required, accompanied by a more controlled industrial growth in it.	

Q27. On a scale of 1 to 7, how much do you agree or disagree with the following statements?

In Spain, people show respect for animal welfare in farms.	
In Spain, people show respect for animal welfare during transport.	
In Spain, people show respect for animal welfare in slaughterhouses.	
In Spain, the authorities conduct frequent inspections to ensure compliance with the requirements regarding the protection of animals in the farm, during transport and slaughterhouses.	
In Spain, the companies conduct frequent inspections to ensure compliance with the requirements regarding the protection of animals in the farm, during transport and slaughterhouses.	
To achieve a more sustainable development, it is required a balanced economic situation in which industrial growth is controlled.	

Q28. On a scale of 1 to 7, how much do you agree or disagree with the following statements?

It is totally wrong to hunt wild animals just for sport.	
I do not think there is anything wrong with using animals in medical research.	
I think it is perfectly acceptable that the cattle and pigs are raised for human consumption.	

Basically, humans have the right to treat animals in which manner they consider convenient.	
Sometimes I get upset when I see animals in cages at zoos.	
Breeding animals for fur is a legitimate use of animals.	
Some aspects of animals can only be learned through dissecting preserved animals like cats.	
It does not seem right that animals used in cultural festivals.	
The use of animals like rabbits in testing the safety of cosmetics and household products is unnecessary and it has to be stopped.	
I agree with the use of animals for work.	
I do not agree to improve animal health or resistance to disease through genetic changes.	

Q29. How many people live at your house (including you)?

Q30. How do you rate your average monthly spending on food, consumed inside your household, belongs compared to the mean? (excluding restaurants)

- Far below the average
- Below the average
- Equal to average
- Above average
- Far above the average
- I do not know

Q31. In which of the following groups would you include yourself?

- Independent adults
- Independent young
- Single-parent households
- Adult parents without children
- Young parents without children
- Couples with middle-aged children
- Couples with older children
- Couples with young children

- Retired
- Other:

Q32. What is your level of education?

- Primary education not completed
- Elementary education
- Secondary education (vocational education, …)
- Tertiary education (University)

Q33. What is your current employment situation?

- Student
- Wage earner (third party account)
- Entrepreneur/Self-employed
- Retired
- Household work
- Unemployed
- Other:

Q34. Do you own a pet?

- Yes
- No

Q35. Postal Code

Annex 6.3 : UK Interview Schedule

Name of Firm /farm: _____

Location: _____

Interviewee name and position: _____

Interest *(circle option):*
Pigs / broilers / layers/ rabbits

Does the farm specialise in Pigs / broilers / layers/ rabbits? YES /NO

If NO, which other major enterprise(s) exist?

Area of land (hectares): _____

Land tenure *(circle option):*
Owner-occupier / Rented / Other

Section 2 – Contextual questions

2.1. Number of animals:

Pig farms	**Broiler farms**	**Layer farms**
Sows ……	Total birds	Total birds
Weaned /fattening pigs ……		

2.2 Production system:

Pig farms	**Broilers**	**Layers**
All indoors	Enriched cage	Enriched cage
Mostly indoors	Barn	Barn
Mostly outdoors	Free range	Free range
Organic	Organic	Organic
Other – please explain	Other – please explain	Other – please explain

2.3 How intensive/extensive do you consider this system to be?

Scale of 1 to 10, where 1 is very extensive and 10 is very intensive.

2.4 Why this choice of system?

2.5 a. What feed do you use?

100% bought-in concentrated /compound feed YES /NO

IF NO

b. Approximately what percentage is bought in?

c. Do you mix your own feed? (% of total)

d. Do you grow your own feed? (% of total)

2.6 Who do you sell your output to?

2.7 Could you tell me about the **degree of autonomy** which the farm manager here has in decisions about production? *Do you have the freedom to make strategic changes such as to feed, housing, market outlet, or introduce new technology etc?*

2.8 a) Have you made any changes to your production system or management in the last 5 years?

b) If yes, why did you make these changes?

2.9 What aspects or improvements are considered KEY in the short-medium term for the survival and / or growth of pork/poultry/ production companies like yours?

2.10 Can modern technology help with making these improvements?

Section 3

Now I'll show you some slides about the new technologies that are being developed in our project. (Still at prototype stage.) The purpose of the technologies is to **improve feed efficiency** – more output from the same level of input, or maintaining current output level but using less inputs.

This approach helps with the problems of the EU's dependence on imported protein feed, and to reduce future transfers of land from human food to animal feed production.

Section 3 – Precision feeding (Pigs and broilers only)

Summary of presentation for interviewers

- Individual animals are different from each other
- Precision feeding allows you to account for individual variability which can improve nutrient efficiency and reduce feed costs
- Example uses lysine (amino acid) which causes problems if given in excess (expensive; N-excretion and ammonia emissions) or insufficiently (lower growth and production).
- It works through using sensors to collect information which is used to control the amount and type of food that stock are given. Apply to individual animal (pigs) or group feeding (pigs/poultry).Example - Mix of 2 feeds – one lycine rich and one lycine-poor.
- There is potential to improve the underlying mathematical models and apply the approach to a greater range of nutrients, and reaction to perturbations such as stress, heat, disease).
- On farm will employ feeders, measurements and +decision support tools (feed consumption and animal weight)

3.1 In your experience, have you observed different levels of performance in livestock in terms of feed intake and feed utilisation? Do you see this as a problem and if so why?

3.2 What is your initial reaction to precision feeding technology?

- Did you already know about it, and where from (e.g. trade literature, other farmers)?

Do you already use it?

What is attractive about the idea?

What is unattractive?

3.3a *If no precision feeder:*

What benefits (pros) would you expect from using this type of precision feeding?

3.3b. I*f already uses a precision feeder:*

What benefits do you obtain from your current use of precision feeding?

What extra benefits would you like that your current precision feeding system does not provide? Does the Feed a Gene ‘solution’ deliver anything extra compared to your current system?

3.4 What do you expect the cons (disadvantages) to be of using precision feeding equipment?

3.5 What barriers might make it difficult to introduce it and use it on your farm?

3.6 What would encourage you to adopt the technology?

3.7 On balance, are precision feeding techniques developed Feed a Gene something you would be interested in using on your farm?

Section 4 - Novel feeds

Summary of presentation for interviewers

- The vast majority of plant protein in the EU is consumed by livestock and 70% of this is imported.
- Here, novel feeds are based on EU-grown rapeseeds, soybeans, grass and legumes.
- In the project, three approaches to improving processing techniques: producing novel green proteins; producing GM-free soybean meals; and improving the nutritional status of rapeseed meals.
- *Green protein is most divergent from current practice. Uses grass and not arable land. Less N/P leakage to the environment. Processing could take place centrally or on-farm (local benefits of green energy). No need to buy in feed and lower transport costs (hence organic farmers could be 1st movers)*
- Rapeseed meal (fine fraction) is better than current standard feed.
- Not clear to us if soya feeds offer better nutrition than current feeds (and greater feed efficiency) or if the main attraction is EU self-sufficency.

4.1 Do you think it is important for Europe to become more self-sufficient in plant proteins by using sources such as green protein and European grown soybeans?

4.2 What is your reaction to these technologies (first thoughts)? What is attractive? What is unattractive?)

a.) green protein

b.) European soybeans. *Is 'European' enough incentive to adopt, or is 'better nutrition' the only determinant.*

c.) Upgraded rapeseed meal

Did you already know about any of them, and if so where from (e.g. trade literature, other farmers)?

4.3 If you adopted feeds using these new sources and techniques, what benefits would you expect?

4.4 What do you expect the cons (disadvantages) to be of using these new sources and techniques?

4.5 Can you imagine using these new feeds on your farm?

4.6 What would stop you using these feeds on your farm?

4.7 What would encourage you to use these feeds?

4.8 On balance, is this something you would be interested in?

Section 5 Breeding solutions

Ask interviewee to read presentation

Ask for their reactions (interest, relevance, issues) about 4 parameters (feeding behaviour, gut microbiota, social interactions/welfare, and biomarkers/nutrient metabolism)

Socio-economic

Age

Post-secondary education **End of survey**