## Introduction

Genetically modified (GM) foods are defined as foods derived from organisms (plants, animals or microorganisms) whose genetic material (DNA) has been modified in a way that does not occur naturally, e.g. through the introduction of a gene from a different organism (World Health Organisation 2014).

The foundation of modern agriculture is based on the genetic modification of plants and animals (Paarlberg 2001), which was previously achieved through the slow and imprecise method of selective breeding (Gasser and Fraley 2011). However, in 1973, scientists began recombining DNA molecules by moving individual genes carrying desired traits from one organism to another (Paarlberg 2001). These changes resulted in the expression of traits and characteristics not found in the original organism, providing a faster, more powerful, and potentially more precise method of genetic modification.

Since the 1990s, GM foods have been available for commercial purchase (Wunderlich & Gatto 2015), and today, the use of genetic engineering in food production is widespread. Examples of foods that have undergone genetic modification include tomatoes with delayed ripening, pest resistant crops and vitamin A infused rice (Schneider, Schneider & Richardson 2015). The crops most frequently involved in genetic modification are soybean, maize, canola and cotton (Chondie & Kebede 2015).

GM foods provide many advantages to modern day agriculture. Firstly, genetically modifying crops can produce higher yields by reducing losses from insect damage or weed competition (Carpenter 2010). For example, altering the DNA of a maize crop to increase insect and pathogen resistance improves yields by decreasing the number of crops destroyed by insects or disease (Wisniewski et al. 2002). Other benefits of GM agriculture include productivity improvements resulting in cheaper foods (van Meijl & van Tongeren 2003), greater drought resistance (Chondie & Kebede 2015) and the reduction of chemical use through the creation of herbicide and pesticide resistant crops.

In addition to these advantages, GM foods have a potential application in alleviating world hunger. In developing countries, GM foods provide farmers with a crop to grow

and sell, that without genetic modification, was previously unable to grow in local conditions (Pinstrub-Andersen & Schioler 2001)**.** Furthermore, genetic modification can be used to decrease malnutrition by increasing nutrition availability in crops. Vitamin A infused ‘golden rice’ was developed to decrease vitamin A deficiency in areas such as South Asia, where people suffer from a shortage in their diets (Beyer et al. 2002). In the Philippines, it is estimated that vitamin A infused rice can avert between 136 and 789 child deaths per year, depending on the success of the harvest (Zimmermann & Qaim 2004).

However, there are also disadvantages associated with the use of GM foods. These include the possible creation of allergenic crops (Malarkey 2003), issues regarding the patenting of the seeds (Kotch 1998), religious, cultural and ethical concerns, and the unknown long-term impacts (Kotch 1998). In addition, antibiotic resistant genes are commonly used as marker genes in the DNA of GM crops (Midtvedt 2014). This creates the risk of antibiotic resistant genes transferring from the GM crop to the surrounding organisms, unintentionally creating antibiotic resistant organisms throughout the environment (Midtvedt 2014). However, the major concern over the use of antibiotic resistant marker genes is that they may decrease antibiotic efficiency in humans and animals if consumed by them (Caplan 2002).

GM foods can also have harmful impacts on the environment, such as unintentional gene transfer. Genes from GM crops expressing herbicide, pest and disease resistance can be transferred to weeds and unwanted crops, resulting in their enhanced fitness, survival and spread (Conner, Glare & Nap 2003). Furthermore, GM crops may be toxic to non-target audiences such as pollinators, and have detrimental effects on their numbers, causing a cascade of problems throughout the ecosystem (Malone & Burgess 2009). GM crops also create the risk of severely decreasing biodiversity (Azadi & Ho 2009), as they increase the intensification of agriculture (Altieri 2005) and encourage monoculture, causing less varieties of seeds to be grown.

There has been extensive debate throughout the scientific community, governments, advocacy groups and consumers on the positive and negative consequences of GM foods (Öz, Unsal & Movassaghi 2017). As a result, due to the controversy over their safety, public attitudes towards GM foods continue to be uncertain (Sheldon et al.

2009; Honkanen & Verplaken 2004; Valente & Chaves 2018). Furthermore, the future development and use of GM foods is believed to be majorly influenced by public attitudes (Sparks, Shepherd & Frewer 1995). Without the support of the public, the development of GM foods is futile, as the public are the target market for their use and sale.

In order to explore public attitudes further, numerous studies investigating public attitudes towards GM foods have been conducted. In 2010, the European Commission, which measures changing attitudes across Europe, found that 61% of Europeans agree that GM food makes them feel uneasy (European Commission 2010(a)). Additionally, 61% disagree that the development of GM food should be encouraged, displaying the public's lack of confidence towards GM as a practice.

Former research has identified demographics such as age, gender and education level as key influences in shaping attitudes towards GM foods. Previously, males have shown more positive attitudes towards GM foods than females (Magnusson & Hursti 2002; Hoban 1996; Öz et al., 2017; Hudson et al., 2015). Both Siegrist (2000) and Baker and Burman (2001) explain this relationship as a result of women commonly having higher levels of concern regarding food safety and being more risk averse than men.

Within the existing literature, individuals with higher levels of formal education have expressed more positive attitudes towards GM foods than those with lower levels of education (Magnusson and Hursti, 2002; Öz, Unsal & Movassaghi 2017; Huson et al., 2015). However, research from Koivisto Hursti et al. (2002) found no educational differences in attitudes towards GM foods, with other studies reporting the same result (Schlapfer, 2008). Findings have been contradictory regarding the influence of age on attitudes towards GM foods, with several studies reporting younger subjects to hold more positive attitudes towards GM foods than older individuals (Koivisto Hursti et al., 2002; Magnusson and Hursti, 2002; Hudson, Caplanova & Novak 2015). Conversely, research from Cook, Kerr and Moore (2002) reported the opposite result. These contradictions highlight the need for further research.

Strong variations in attitudes towards GM foods are displayed throughout the literature, with contradictory research outcomes. These variations suggest further

research is required into what influences attitudes towards GM foods, as it may be a different factor that is the most significant stimulus.

An idea that is yet to be investigated in the literature, is whether an individual's level of environmental concern plays a role in determining their attitude towards GM foods. Environmental concern is a concept that explains the value the individual places on the environment, and the extent to which they consider the consequences of their own behaviour and that of others on the environment (Fransson & Garling 1999). Since the beginning of the environmental movement 30 years ago, research into what factors lead to and influence levels of environmental concern has been conducted (Schultz & Zeleny 1999). Van Liere and Dunlap (1980) suggest that many factors, such as age, gender and education level, affect levels of environmental concern. This has been supported in recent studies throughout the literature, such as the findings of Vicente-Molina, Fernandez-Sainz and Izagirre-Olaizola (2018), where women reported stronger pro environmental attitudes than men. Education has also been found to be positively correlated with environmental concern (Van Liere & Dunlap 1980; Roberts 1995; Zimmer, Stafford and Stafford 1994), and younger individuals have commonly been found to have higher levels of environmental concern (Honnold 2010; Buttel1979; Klineberg, McKeever & Rothenbach 1998; Arcury, Scollay & Johnson 1987).

An individual's level of environmental concern may influence their attitude towards GM foods, as GM foods can have negative impacts on the environment. If an individual has high levels of environmental concern, they may be more likely to be against GM foods, as they are unlikely to support a concept with such harmful impacts on the environment. This forms the research question; is there a connection between people who are concerned about the environment and their attitudes towards GM foods? This addresses a gap in the literature regarding the role of environmental concern in relation to attitudes towards GM foods, rendering this research innovative. In this paper, the determinants of attitudes towards GM foods are examined in more depth, focusing on the extent to which they are linked to levels of environmental concern, as well as previously studied factors such as age, gender and education level.

This study will investigate the hypothesis: people who are concerned about the environment are less likely to favour GM foods.

The specific aims are:

- To conduct an investigation into the attitudes of a sample population towards GM foods and determine how environmentally concerned they are using questionnaires.
- To investigate whether age, gender and education level influence attitudes towards GM foods.
- To investigate whether age, gender and education level influence environmental concern.

## Methods

Data was collected and tested via an online questionnaire, aiming to obtain information on the extent to which an individual is concerned about the environment and their attitude towards GM foods. The questionnaire was distributed by email and social media.

An online questionnaire provides both financial and time benefits, as no manual distribution is required, and data collection can take place while simultaneously working on other tasks (Llieva, Baron & Healey 2002). Online questionnaires allow for fast and honest responses to sensitive issues (Fricker & Schonlau 2002), as they allow anonymity (Newing 2011). Manual transcription of data is not required when using online questionnaires, resulting in no data entry errors (Llieva, Baron & Healey 2002).

Online questionnaires can be received by a wide variety of people (Garton, Haythornthwaite & Wellman 1999), including those who it may not be possible to reach through post (Wright 2005). In addition, using an online questionnaire allows ease of distribution and collection of responses (Wright 2005), and enables the questionnaire to be easily forwarded to multiple other people (Garton, Haythornthwaite & Wellman 1999).

## Questionnaire Design

A definition of GM foods was provided at the start of the questionnaire to avoid confusion regarding its meaning. Technical jargon was avoided throughout to minimise the risk of deterring respondents who may feel challenged by the questions (Brace 2000). The aims of the study were stated at the beginning of the questionnaire to provide background information, reassuring individuals and consequently encouraging participation (Denscombe 2010). Information was also included regarding the duration of the questionnaire, the anonymity of the individual and their results, and the participant's right to withdraw. The use of multiple-choice questions made the questionnaire quick and easy to answer, and the questionnaire was not restricted in length, as research shows that short email questionnaires do not yield a higher response rate than long questionnaires (Witmer, Colman & Katzman 1998).

The initial three questions asked for the respondent's age, gender and education level, so correlations between these variables could be investigated during the analysis. Section one of the questionnaire included 12 questions aiming to measure an individual's level of environmental concern (Table 1). Existing literature was used to develop the questions, which increased the validity of the research, as only studies producing consistent results were used.

| **Question used in the Questionnaire** | **Sources the questions were adapted from** |
|---|---|
| **5.** Humans are severely abusing the environment.<br>**7**. The so-called "ecological crisis" facing humankind has been greatly exaggerated.<br>**9.** Humans have the right to modify the natural environment to suit their needs. | Dunlap scale (Dunlap et al. 2000) |
| **4**. I am worried about the country being too dependent on using energy generated by fossil fuels such as oil, gas and coal**.**<br>**6**. The world's climate is changing.<br>**11**. I feel a personal responsibility to try to reduce climate change. | European Social Survey (2017)<br><br>Schwartz 'Basic Human Values' questionnaire (Schwartz 2012) |
| **8.** Plants and animals exist primarily to be used by humans.<br>**9**. Humans have the right to modify the natural environment to suit their needs. | (Straughan and Roberts 1999) |
| **12.** Natural resources must be preserved even if people must do without some products.<br>**13**. Much more fuss is being made about air and water pollution than is really justified.<br>**14.** I am interested in the environmental consequences of the products I purchase.<br>**15**. Environmental issues are overrated and do not concern me. | (Mintona & Roseb 1997) |
| **10.** Ending world hunger is more important than environmental issues. | Created for the purpose of this study. |

Table 1: The questions used in section one of the questionnaire and the sources from which they were adapted.

Section two of the questionnaire included ten questions designed to measure the respondent's attitudes towards GM foods (Table 2). These were also influenced by existing literature, but some questions were created for the purpose of this study.

| **Questions used in the Questionnaire** | **Research the questions were adapted from** |
|---|---|
| **16.** Have you ever heard of GM food before today?<br>**17**. I am uncomfortable with the concept of GM food.<br>**18**. GM food helps people in developing countries.<br>**19**. GM food does no harm to the environment.<br>**21.** GM food is unsafe for future generations.<br>**22**. The development of GM foods should be encouraged. | Eurobarometer Survey on Biotechnology (European Commission 2010(b)) |
| **20**. Genetically modifying foods is like 'playing God'.<br>**23**. GM foods pose a risk to human health.<br>**24**. I am willing to consume foods produced with GM ingredients.<br>**25.** GM foods are unethical. | Created for the purpose of this study. |

Table 2: The questions used in section two of the questionnaire and the sources from which they were adapted.

All questions were adapted into statements to fit the Likert scale (Allen & Seaman 2007) in order to be consistent throughout, making them easier to analyse and correlate.

A pilot questionnaire was distributed to 20 individuals ranging in age, gender and education level. This was to ensure that all respondents could easily understand the

questions and to check for any errors. It also established if the aims and objectives of the project were achieved, and gave an indication of how long the questionnaire would take to complete (Brace 2008). The questionnaire was considered complete once it was returned by 15 people without any mistakes or issues being identified.

The pilot study identified several areas of improvement; firstly, the definition of GM was changed. To further elaborate on the meaning of the word ‘modified’, ‘altered’ was added in brackets afterwards, as some respondents said the meaning was unclear. Question 17 was changed from ‘GM food makes me feel uneasy’ to ‘I am uncomfortable with the concept of GM food’, as the word ‘uneasy’ was reported to be too vague. In addition, an optional question was added at the end of the questionnaire, asking respondents if they had any further comments on their attitudes towards GM foods, as participants from the pilot sample conveyed that they had additional opinions they would have liked to express.

**Data Collection**

Distribution through social media prevented the collection of a stratified sample, so a random sample was obtained. The sample was made more systematic by targeting certain age groups and genders. This was achieved by distributing the questionnaire on social media platforms or pages where there was a particular age or gender demographic. Through email distribution, different age categories were targeted by using the contacts of individuals within that age group, such as family members. Respondents were asked to forward the questionnaire on to their contacts to increase involvement. The contact information of the researcher was included with the questionnaire when distributed, so any queries from respondents could be answered. This enhanced the credibility of the study, consequently reassuring respondents (Wright 2005). The questionnaire was open for four months to allow a sufficient data set to be collected.

Despite online questionnaires being an effective method of data collection, there are limitations associated with their use. For example, computer illiterate individuals may find responding to an online questionnaire challenging, and therefore cease responding (Fricker & Schonlau 2002). Additionally, certain demographics may not have internet access (Gjestland 1996), so may not be included in this study, causing

the sample to be unrepresentative of the population. Also, no clarification can be provided if there is confusion over the meaning of a question, so some responses may not be genuine (Newing 2011).

### Data Analysis

Each answer was assigned a value so that a total GM score (how much an individual approves or disapproves of GM foods) and a total green score (how environmentally concerned an individual is) could be calculated. Total green value scores were calculated by adding all the answers from questions 4-15 and total GM attitude scores were calculated by adding the answers from questions 17-25. A higher total green score indicates an individual has strong green values (more environmentally concerned) and a high total GM score indicates an individual has a positive attitude towards GM foods.

Statistical analysis of the results was completed on IBM SPSS Statistics 24 to establish if attitudes towards GM foods and environmental concern had a significant relationship with each other and other contributing factors (age, gender, and education level). The tests used were one way ANOVA (analysis of variance), Tukey and Spearman's Rank Correlation.

Age, gender and education level were tested using a one way ANOVA to see if they had an effect on GM score or green score. A Tukey post hoc test was conducted when a significant difference was shown. The data for age, gender and education level were designated an index to make analysis easier and more accurate. Spearman's Rank Correlation was used to compare GM score and green score, as it tests the significance of the correlation between two variables (Sedgewick 2014).

## Results

**Analysis of Questionnaire Results**

The questionnaire returned 236 responses in total. Before analysing the results, the data from participants who did not fully complete the questionnaire and anyone who had not heard of GM before today was removed, as their responses to the questions on GM would be based on guesses.

An equal distribution of individuals within each age, gender and education category was desired, but was not reflected in the results. A disproportionate number of respondents (54.21%) were aged between 18 and 25 (Figure 1), and an equal distribution of genders was not achieved, as the majority of respondents were female (59.81%) (Figure 2). A mixture of respondents with different education levels was achieved, but again these were not equally distributed (Figure 3).

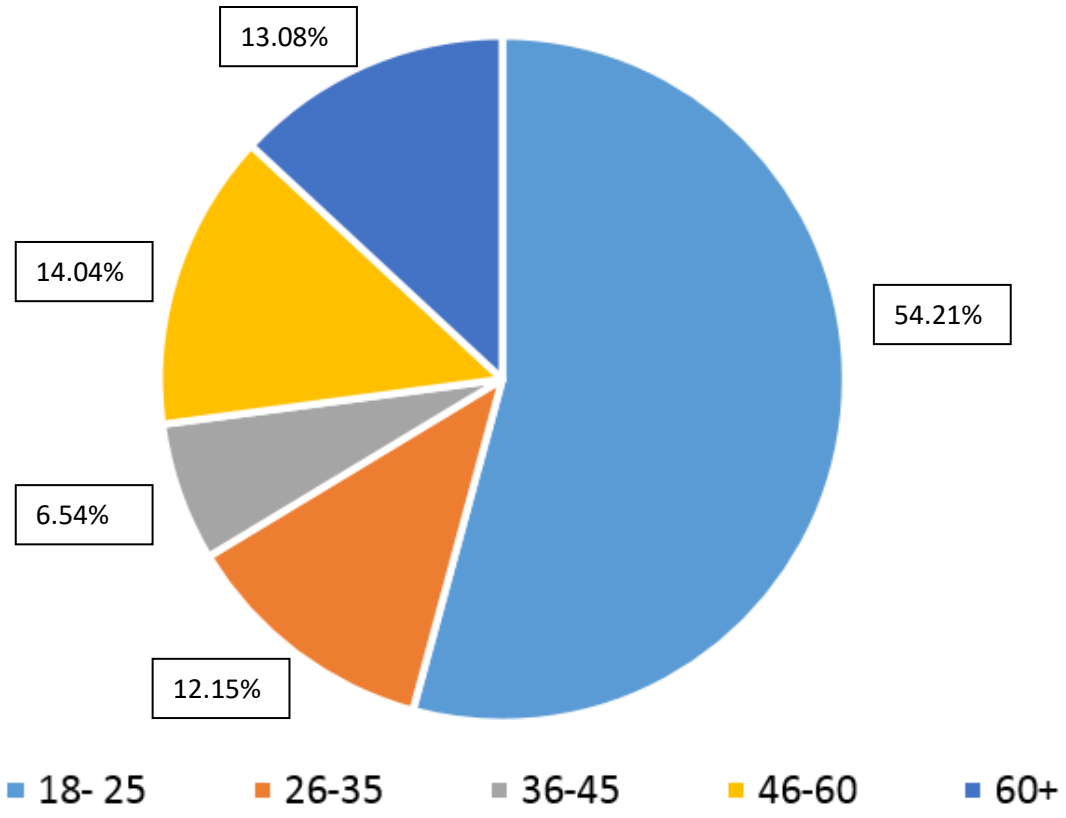


Figure 1: The percentage of questionnaire respondents from each age category.

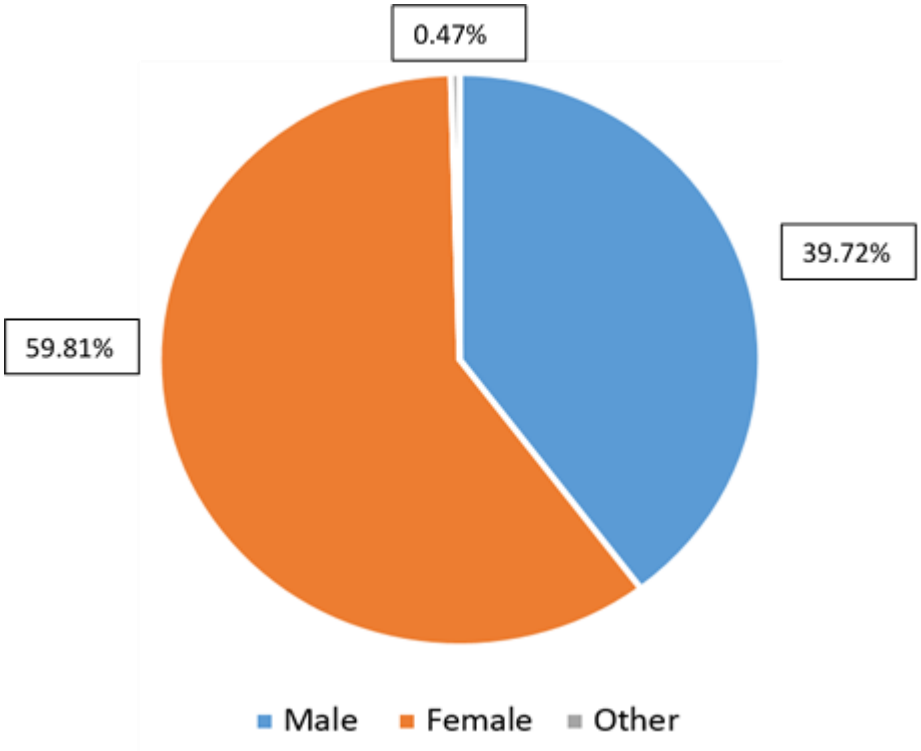


Figure 2: The percentage of questionnaire respondents from each gender.

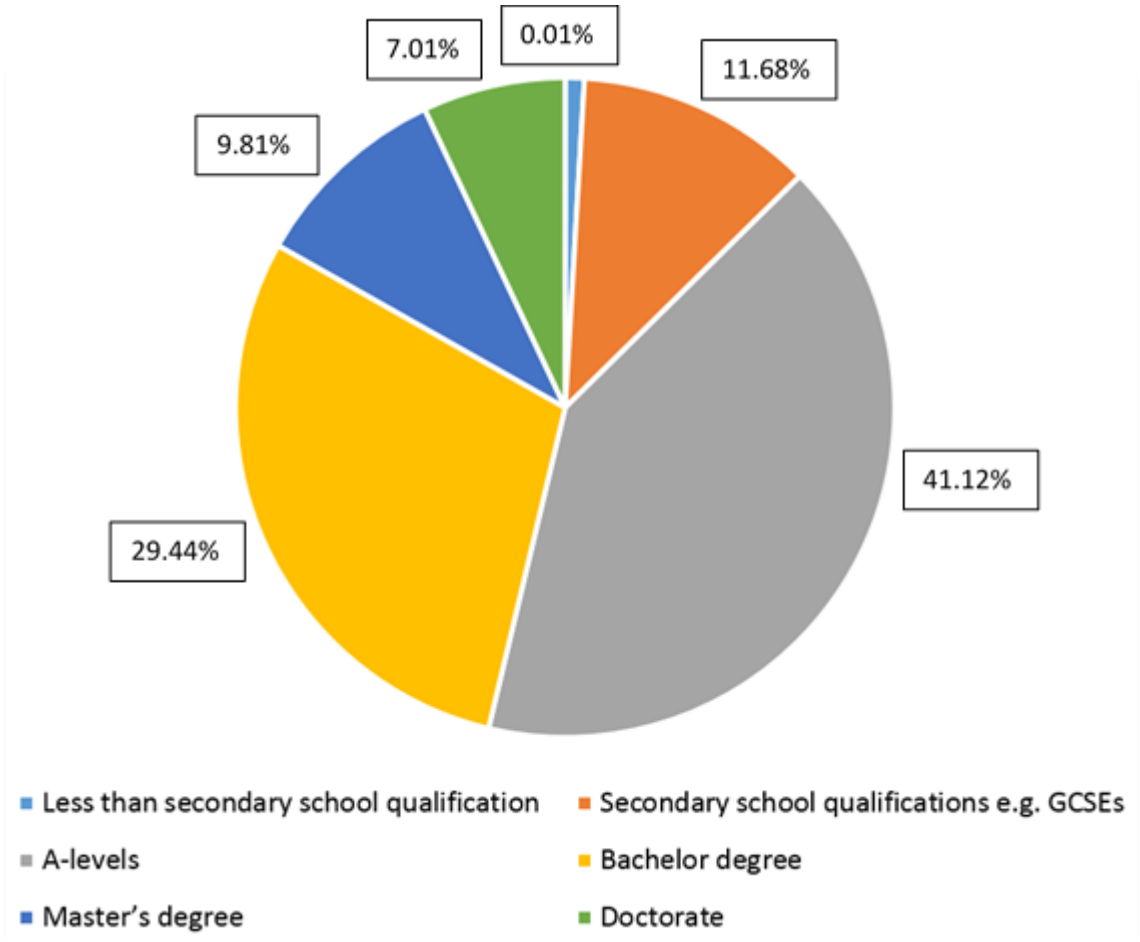


Figure 3: The percentage of questionnaire respondents from each education level.

Age, gender and education level were tested using a one way ANOVA to see if they had an effect on GM score (Table 3). There was a statistically significant difference between age categories (F= 4.822, p= 0.001), and a Tukey post hoc test revealed that individuals aged 46-60 produced significantly lower GM scores than the other age categories. There was no statistically significant difference between gender categories (F= 2.576, p= 0.078), and no statistically significant difference between education level categories (F= 1.953, p= 0.087).

| **Factor** | **Significance** | **Description** |
|---|---|---|
| Age | Yes (p= 0.001) | Individuals aged 46-60 are more likely to be against GM foods (Figure 4). |
| Gender | No (p= 0.078) | There is no significant difference between gender and attitude towards GM foods. |
| Education Level | No (p= 0.087) | There is no significant difference between the level of formal education a respondent has and attitude towards GM foods. |

Table 3: The significance of age, gender and education level on an individual's attitude towards GM foods. If the p value is less than 0.05 then there is a significant correlation between two factors (Dytham 2011).

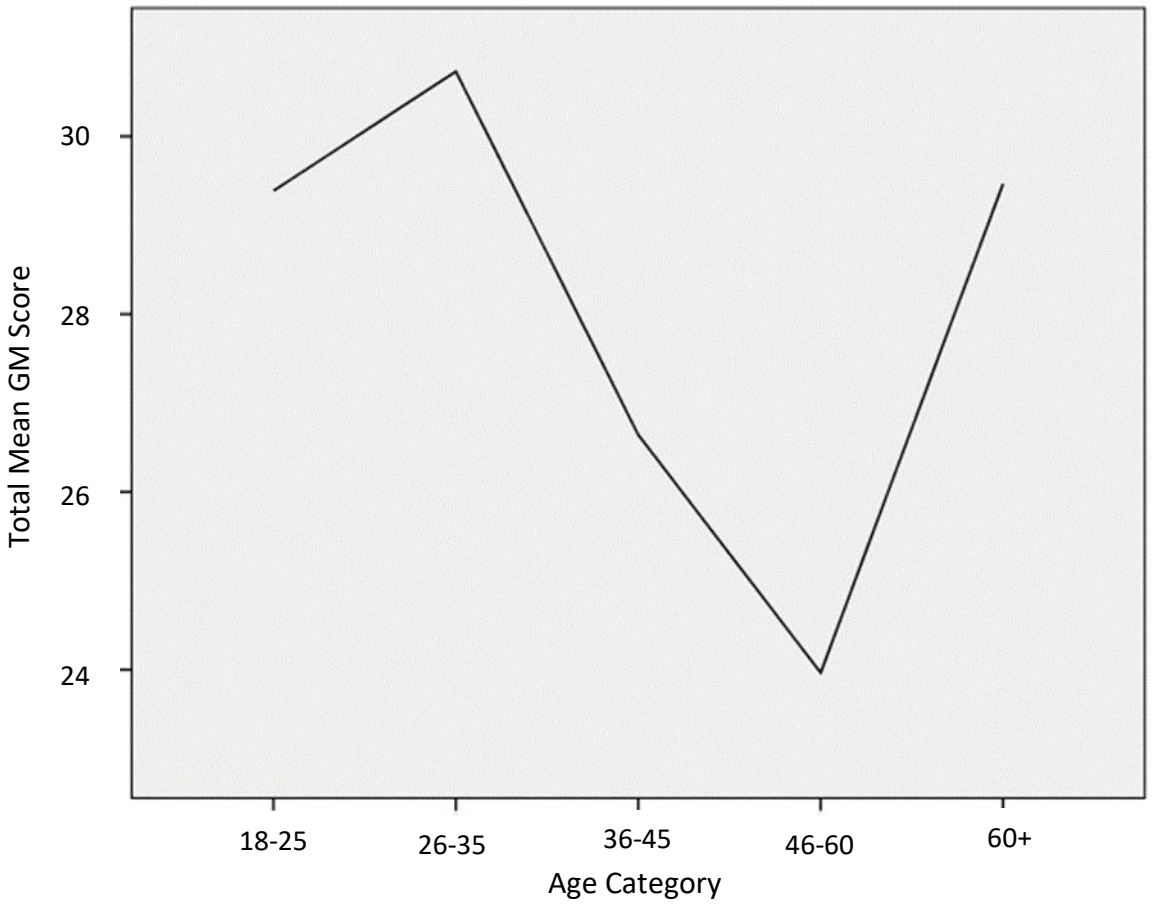


Figure 4: The relationship between age and total mean GM score, showing that individuals aged 46-60 displayed significantly lower GM scores, so are more likely to be against GM foods.

Next, age, gender or education level were tested using a one way ANOVA to see if they had an effect on green score (Table 4). There was a statistically significant difference between age categories ($F= 4.425$, $p= 0.002$), and a Tukey post hoc test revealed that individuals aged above 60 produced significantly lower green scores than individuals aged 46-60. However, neither group showed significantly different scores compared to the other age categories. There was no statistically significant difference between gender categories ($F= 1.846$, $p= 0.160$), and no statistically significant difference between education level categories ($F= 1.148$, $p= 0.336$).

| Factor | Significance | Description |
|---|---|---|
| Age | Yes (p= 0.002) | Individuals aged above 60 are more likely to have a lower level of environmental concern compared to individuals aged 46-60 (Figure 5). |
| Gender | No (p= 0.160) | There is no significant difference between gender and level of environmental concern. |
| Education Level | No (p= 0.336) | There is no significant difference between the level of formal education a respondent has and level of environmental concern. |

Table 4: The significance of age, gender and education level on an individual's level of environmental concern. If the p value is less than 0.05 then there is a significant correlation between two factors (Dytham 2011).

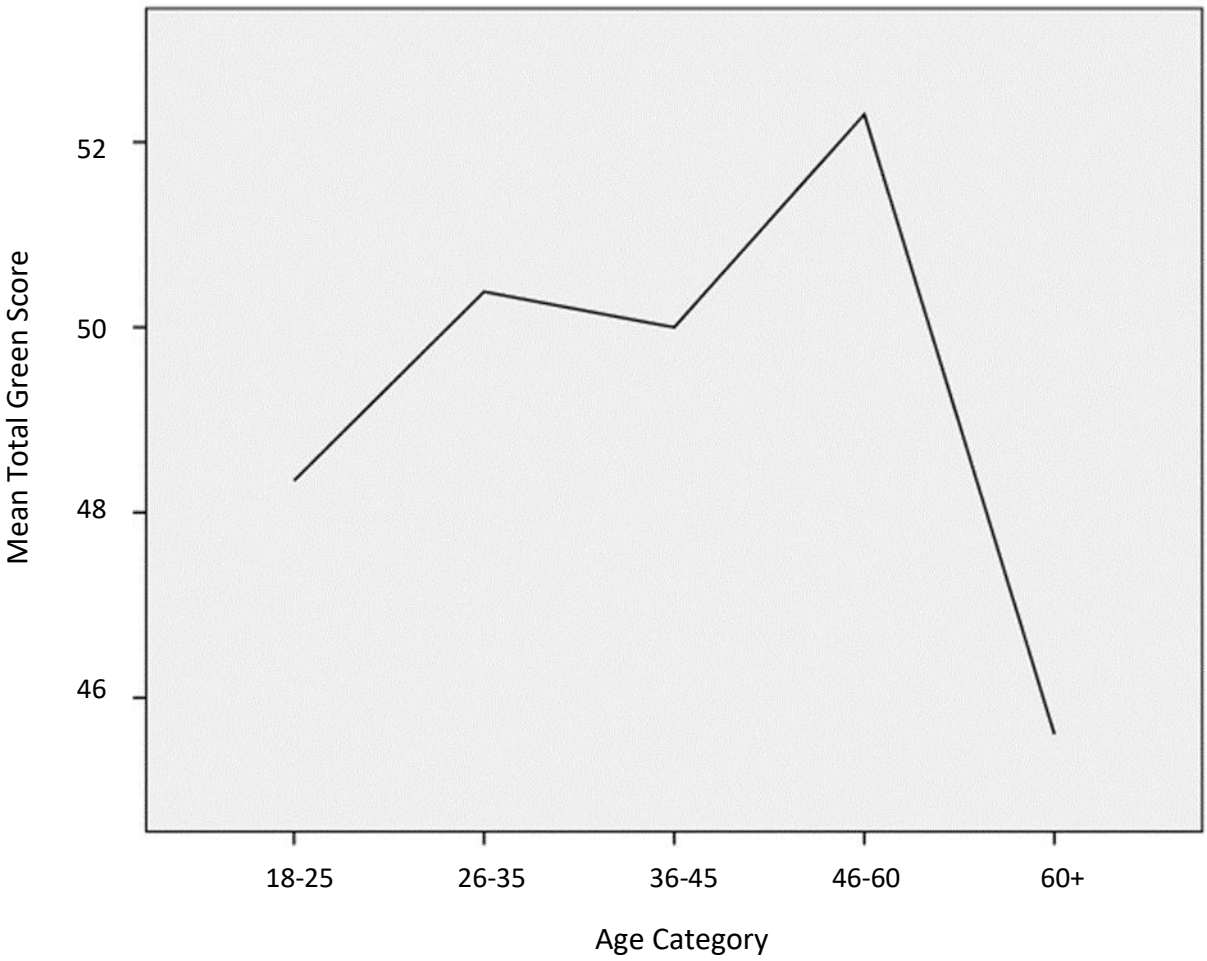


Figure 5: The relationship between age and total mean green score, showing that individuals aged 46-60 displayed the highest mean green score, and is significantly higher than the mean green score of individuals aged above 60.

Spearman's Rank Correlation (rho) was used to compare GM score and green score. The plot of green score against GM score showed a significant, but very weak correlation (Spearman Rank, rho = -0.145 , N = 214, p = 0.034 ). However, there was clear signs of heteroscedasticity in the data (Figure 6). To formally assess this, each green score was categorised by dividing itself by 10 and then rounding to the nearest integer. Using these numbers as categories, differences in GM score variability were found with the different categories (Levene's test, $p < 0.05$) with standard deviations increasing from green score 3 (GM score SD = 4.5) to green score 6 (GM score SD = 9.5) (Figure 7) (Table 5).

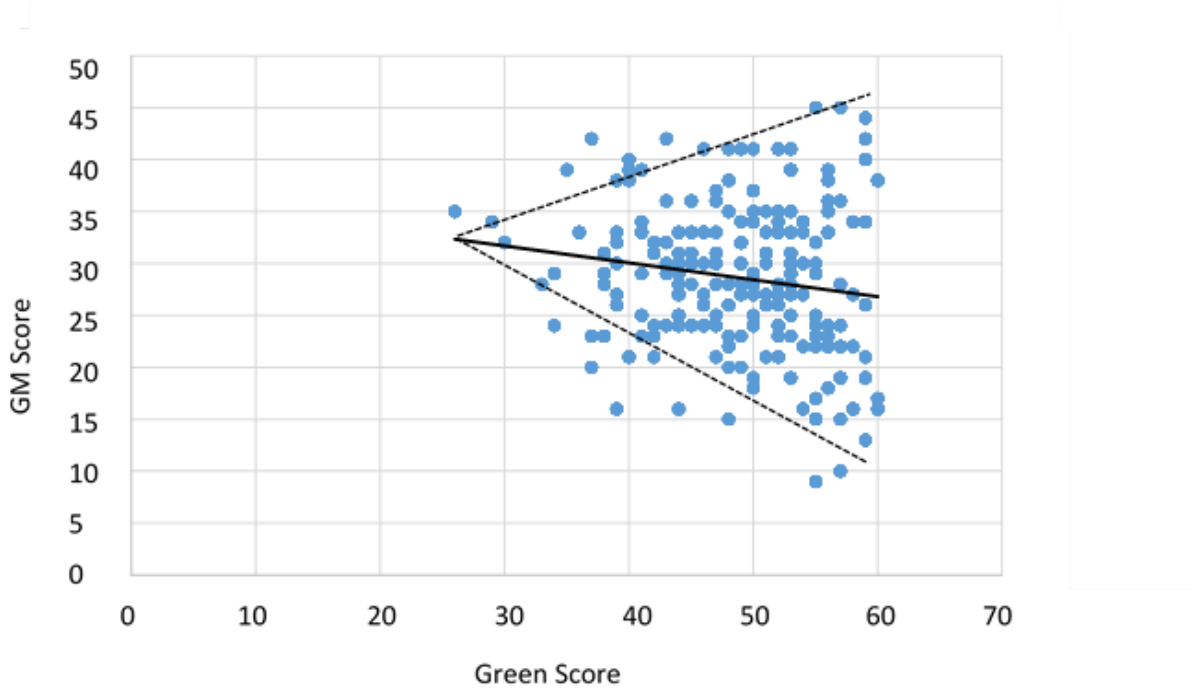


Figure 6: The relationship between green score and GM score. A higher total green score indicates an individual has strong green values (more environmentally concerned) and a high total GM score indicates an individual has a positive attitude towards GM foods. The line of best fit shows that as green score increases, GM score decreases, however this is a very weak relationship. The dashed lines show the heteroscedasticity in the data.

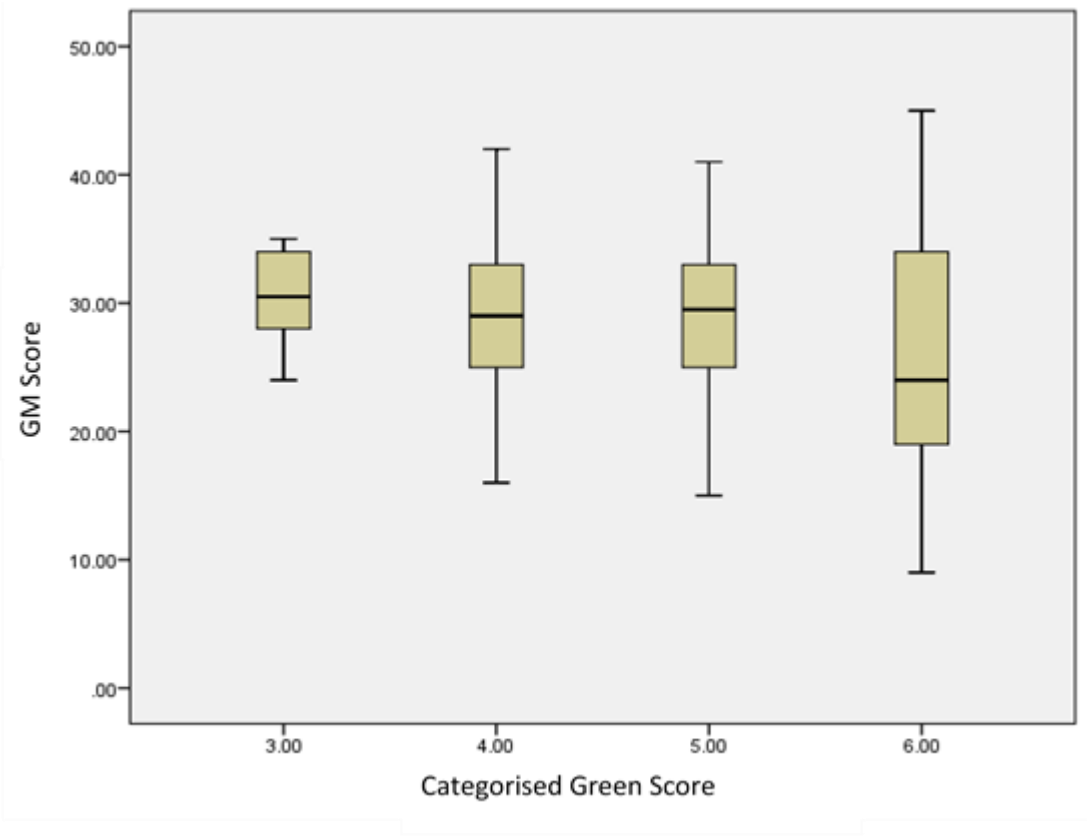


Figure 7: The relationship between categorised green score and GM score, showing that the higher categories of green score (most environmentally concerned individuals) show a greater variation in their attitude towards GM (GM score).

| **Green Score Category** | **Standard Deviation** |
|---|---|
| 3 (25-34) | 4.13 |
| 4 (35-44) | 6.34 |
| 5 (45-54) | 5.9 |
| 6 (55-60) | 9.59 |

Table 5: Standard deviations from GM scores compared with categorised green scores.

**Analysis of Comments**

61 respondents left comments for the optional question 26, ‘Do you have any further comments on your attitude towards GM foods?’. To analyse these, the comments were split into positive, negative and other categories depending on the viewpoint

expressed in the comment. Reoccurring themes of views expressed were identified, and the comments were categorised into these. Some comments expressed multiple opinions, both positive and negative, so were split when recorded in the table (Table 6). Comments not about GM were not included. Of the 58 comments regarding GM, 26 (44.82%) expressed a mix of positive and negative opinions, displaying the ambivalence towards GM as a practice.

| Positive | | Negative | | Other | |
|---|---|---|---|---|---|
| Using GM foods to end world hunger/help farmers in developing countries. | 14 | Companies may act unethically and use GM for financial gain. | 14 | Require more knowledge on GM. | 14 |
| GM foods are the next advancement in agriculture- produce higher yields, reduce pesticide use, cheaper foods. | 11 | Negative environmental/ecological impact of GM foods. | 10 | Development and use of GM foods needs to be carefully regulated. | 5 |
| GM foods do not pose a risk to human health. | 4 | Not enough known about the long-term effects of GM foods, future harms unknown. | 10 | Are fine with GM plants but GM animals would be unethical/inhumane. | 2 |
| No ethical implications of GM foods. | 4 | More focus should be aimed on reducing waste as a better approach to end world hunger. | 4 | | |
| GM foods do not harm the environment. | 3 | GM foods have negative impacts for farmers. | 3 | | |

Table 6: A summary of the main opinions expressed by respondents in the comments section of the questionnaire. The columns to the right of the opinion columns signify how many times that particular view was raised.

Overall, we can accept the hypothesis that people who are concerned about the environment are less likely to favour GM foods. Even though the correlation is very weak ($p=0.034$), there is still a slight correlation so the hypothesis can be accepted.

## Discussion

### Factors influencing attitudes towards GM foods and level of environmental concern

Gender did not influence attitudes towards GM foods in this study, with no significant difference shown between gender categories (p= 0.078). This result opposes those presented in the literature, where males have been found to hold more positive attitudes towards GM foods than females (Magnusson & Hursti 2002; Hoban 1996; Öz, Unsal and Movassaghi 2017; Hudson, Caplanova & Novak 2015). Cook, Kerr & Moore (2002) explain this relationship by reporting males to have a higher sense of self- identity; a quality found in people who intend to purchase GM foods. Other research has shown women to be more sceptical towards GM foods than men, explaining their more negative attitudes (Hoban 1996). It is likely that the contradiction of this study's results compared to previous research is due to the relatively small sample size and the lower male response rate.

No significant correlation was found between formal education level and attitudes towards GM foods (p=0.087). This is opposed by results from previous research, which has indicated that people with a higher level of education hold more positive attitudes towards GM foods (Magnusson & Hursti 2002; Öz, Unsal and Movassaghi 2017; Huson, Caplanova & Novak 2015). It has been argued that knowledge is an important determinant of support for science and technology (e.g. GM foods), however, knowledge on GM foods may not be provided by formal education, which this study was measuring, thus potentially explaining the lack of correlation. Contrariwise, research from Koivisto Hursti, Magnusson and Algers (2002) found no educational differences in attitudes towards GM foods.

Age differences were also suggested to influence attitudes towards GM foods, with previous research showing contradictory results. Some studies have shown older subjects to hold more positive attitudes towards GM foods (Cook, Kerr & Moore 2002), while others revealed the opposite (Koivisto Hursti, Magnusson & Algers 2002; Magnusson & Hursti 2002; Hudson, Caplanova & Novak 2015). Sparks, Shepherd and Frewer (1994) found that older subjects reported lower benefits of GM foods compared to younger subjects, explaining their more negative attitudes.

There was a statistically significant difference between age categories (p= 0.001), with individuals aged 46-60 being more likely to be against GM foods, and both the oldest and two youngest age categories showing positive attitudes towards GM foods (Figure 4). If we were to follow the belief that older individuals are more likely to be against GM foods, then the opposing results could be explained by the small sample size of individuals aged above 60. Making up only 13.08% of the total sample, this age category was not well represented. If only a few individuals in this age category had very positive attitudes towards GM foods, they may have skewed the sample, causing this age category to have a very high mean GM score. However, due to the lack of consistent literature, the results from this study should not be considered unusual. How age influences attitudes towards GM foods is a relationship that needs further investigation.

The results from this study found no difference between gender and level of environmental concern (p= 0.078), which is not supported by the existing literature. Previous studies show women reporting stronger pro-environmental attitudes and behaviours than men (Dietz, Kalof & Stern 2003; Zelezny, Chua & Aldrich 2002; Dietz, Stern & Guagnano 1998; Vicente-Molina, Fernandez-Sainz & Izagirre-Olaizola 2018). Research from Dietz, Kalof and Stern (2003) suggests that this is because women value altruism higher than men, and altruism is the value most closely related to environmentalism in both theoretical and empirical work. Reasons for this lack of concordance with the literature may be due to the uneven distribution of respondents, as 59.81% of respondents were female, creating an unbalanced sample (Figure 2).

No difference was found between the level of formal education a respondent has and their level of environmental concern (p= 0.336), a trend which is not often observed in the literature. Level of education is often linked to environmental attitudes, with studies showing education positively correlated with environmental concerns and behaviour (Van Liere & Dunlap 1980; Roberts 1995; Zimmer, Stafford & Stafford 1994). However, a study by Kinnear, Taylor and Sadrudin (1974) found no significant relationship between education level and environmental concern, supporting these results. An explanation for this study's inconsistency with certain literature may be the lack of current research into the influence of education level on environmental concern, with the majority of studies investigating this relationship being conducted

over a decade ago. Over this time, education level may have become a less important factor in determining level of environmental concern, explaining the difference in results.

The oldest age category (individuals aged above 60) showed significantly lower levels of environmental concern compared to those in the previous age category (individuals aged 46-60) ($p=0.002$), following the trend of previous studies that reveal older individuals to have lower levels of environmental concern (Honnold 2010; Buttel 1979; Klineberg, McKeever & Rothenbach 1998; Arcury, Scollay & Johnson 1987). Due to this correlation, a study by Pillemer et al. (2017) suggests creating programmes to increase environmental volunteering among older people, to raise their levels of interest and concern for the environment. However, given that environmental concern is quite variable among older adults, concluding that all older people are unconcerned about the environment would be incorrect (Wright, Caserta and Lund 2003). Conversely, neither group (individuals aged above 60 and 46-60) showed significantly different scores compared to the other age categories, and environmental concern did not decrease continuously with age. Individuals aged 46-60 had the highest levels of environmental concern (Figure 5), so the results do not follow exactly the same pattern as previous studies, which have suggested that environmental concern decreases with age.

The literature shows that younger individuals have higher levels of environmental concern (Honnold 2010; Buttel1979; Klineberg, McKeever & Rothenbach 1998; Arcury, Scollay & Johnson 1987), commonly explained by them growing up in a time period in which environmental concerns were a salient matter, so are more likely to be more sensitive to these issues (Straughan & Roberts 1999). However, the results from this study contradict this, as the lowest age category (18 to 25) had the second lowest mean score for environmental concern (48.34). This could be explained by an ‘era effect’, which is where the overall political-social climate is growing more conservative, so everyone may be less concerned about the environment than they previously were (Gifford & Nilsson 2014). However, this would suggest that environmental concern scores were low for all age categories, which was not the case. Another explanation for younger individuals having lower levels of environmental concern could be the “issue-attention cycle” (Downs 2016), where an issue, such as the environment, varies in levels of public attention and interest over

time. At the time of the study, public attention of younger individuals towards the environment may have been low, so younger individuals showed lower levels of environmental concern.

### The relationship between level of environmental concern and attitudes towards GM foods

The relationship between attitudes towards GM foods and environmental concern was significant ($p=0.034$), but only marginally, indicating that with further research into this relationship, a more significant difference may become apparent. One reason for the weak correlation may be the small sample size, as if a larger volume of data was collected, a more significant relationship may have been identified. The relationship between these two factors has not yet been explored in the literature, thus there was a lack of existing data for comparison.

However, the data did show clear signs of heteroscedasticity (Figure 6), with individuals in the higher categories of green score (most environmentally concerned individuals) showing a greater variation in their attitude towards GM foods. An explanation for this could be that individuals with high levels of environmental concern and in support of GM foods may not know about the harmful effects of GM foods on the environment, so do not have a negative opinion of them. Data from this study showed that many individuals lacked sufficient knowledge on GM foods (Table 6). This could explain why some individuals with high levels of environmental concern had positive attitudes towards GM foods, as they lacked knowledge on their harmful impacts on the environment. Nonetheless, the associated benefits of GM foods, such as ending world hunger, may outweigh the costs of environmental harm to some more environmentally concerned individuals. Even though they have high levels of concern for the environment, the perceived benefits may still outweigh the costs for them. Further research into this relationship is required to confirm if these results can be repeated, or if they are an anomaly, appearing only for this select sample.

Interestingly, individuals aged 46-60 showed significantly both the most negative attitudes towards GM foods and the highest levels of environmental concern. This age category perfectly corroborates the hypothesis; demonstrating individuals with

high levels of environmental concern are less likely to favour GM foods. An explanation for this age category having the most negative attitudes towards GM foods may be that the individuals within this age group grew up with the development of GM foods. Being aged between 1 and 15 when GM first appeared (1973) (Paarlberg 2001), these individuals grew up at the same time GM foods were being developed. Original attitudes towards GM foods may have been sceptical, as they were a new and controversial concept, so the scepticism towards GM foods may have remained with them throughout their lives. Similarly, a major negative event or issue regarding GM foods may have occurred at an influential age for them, so they may have retained negative attitudes towards them. In addition, these individuals are at the age where they are likely to have children, so may be more concerned over food safety. However, research from Miles et al. (2004) found no effect of having children under 19 on concern over technological food safety issues. Individuals within this age category having the highest levels of environmental concern may be unique to this sample, so repeats of this study are required to confirm whether this result is an abnormality.

**Examination of comments, limitations and recommendations for further research**

11 participants left positive comments regarding GM foods, reporting that they are the next clear advancement in agriculture, with benefits such as producing higher yields, reducing pesticide use and decreasing food prices. On a global scale, GM technology has helped reduce pesticide use, and it is estimated that the use of GM on many varieties of crops has reduced pesticide use by a total of 22.3 million kilograms of formulated product in the year 2000 (Phipps & Park 2002). Using GM crops has also provided farmers with higher yields by modifying the crops to be herbicide or pesticide resistant (Carpenter 2010). GM foods can provide many benefits, and these can be a strong influence in shaping attitudes.

However, 14 respondents commented that they had concerns over the patenting of GM food products, and were worried that larger companies may act unethically and use GM foods for financial gain. An investigation from the Food Standards Agency (Sheldon at al. 2009) found that many people had suspicions over the motivations of

the producers and regulators of GM foods, and were sceptical to trust them. Large corporations, such as Monsanto, have caused some of the mistrust towards the large-scale production of GM crops, and have previously been found to bribe Indonesia's environmental ministry to bypass an environmental study into the use of their GM crops (Ferrell & Ferrell 2014).

Two respondents commented that they were okay with GM methods being used on plants, but when used on animals (for food production), it was seen as unethical or inhumane. In previous studies, the same opinion has been identified, with respondents agreeing that the genetic modification of plants and microorganisms is more acceptable than the genetic modification of animals (Honkanen & Verplanken 2004; Magnusson & Hursti 2002, Ribeiro, Barone & Behrens 2016). This may be useful information for livestock farmers, as using GM on their animals may deter people from consuming their products.

Another subject commonly identified throughout the comments was concerns regarding the unknown (potentially harmful) long-term effects of GM foods and their negative impact on the environment (Table 6). This finding is in accordance with previous research, where uncertainty over the future safety of GM foods and their impact on the environment has been found to cause hesitation in their support (Bredahl 1999; Sheldon et al. 2009, Magnusson & Husti, 2002; Ribeiro, Barone & Behrens 2016). GM agriculture does have negative impacts on the environment, such as through creating herbicide resistant crops (Jank & Gaugitsch 2001). Herbicides do not harm the GM resistant crops, but may decrease the surrounding weed and invertebrate populations. This is detrimental, as other organisms rely on these species for their own survival (Hails 2000). This will have a negative effect on these species and eventually decrease biodiversity. Overcoming the negative impacts of GM crops on the environment may influence people to have more positive attitudes towards GM foods.

With 14 individuals mentioning their lack of knowledge on GM foods in the comments, it can be concluded that it is not a subject on which all people have sufficient knowledge. This may cause suspicion and unease towards their use, affecting an individual's ability to make an informed decision on the matter. In a recent study on GM foods by Ribeiro, Barone and Behrens (2016), individuals were found to ask for

more information on the topic. By providing the public with more, honest information on GM foods, it will allow them to make informed decisions regarding their attitude towards them. This may aid agricultural companies growing GM crops, as Öz, Unsal and Movassaghi (2017) found that individuals who were more knowledgeable about biotechnology were more willing to purchase GM foods.

The ambivalence of opinions displayed in the comments is a common theme throughout the literature. Many studies have found opinions on GM as a practice to be sceptical or undecided (Sheldon et al. 2009; Honkanen & Verplaken 2004). Valente and Chaves (2018) provide an explanation for this, saying that GM foods are a highly controversial topic, so public opinion is not likely to be definite.

One of the most commonly mentioned concepts in the comments was the justification of GM foods if used to aid in ending world hunger and to help farmers in developing counties. By providing farmers in developing countries with GM crops to grow and sell, production can increase, which consequently decreases malnutrition and provides them with a source of income (Pinstrub-Andersen & Schioler 2001). Toenniessen, O'Toole and DeVries (2003) claim that developing countries are benefiting from advances in plant technology, and should continue to benefit significantly. Unfortunately, developing countries are not always the primary focus of most GM agricultural projects. In 2011, 77% ($10.3 billion) of the global GM crop market belonged to industrialised companies, with only 23% ($3 billion) belonging to developing countries (James 2011). More investment from governments and companies into small-scale farmers is required if GM foods are to solve the world hunger crisis.

The most notable limitation of this study was the sampling: the small sample size and use of random sampling. This limited the data and affected the external validity of the results, as trends identified in a large amount of literature were not present in the results collected. The inconsistency with the literature caused some data to be externally invalid. This is likely due to a lack of data, with only 214 questionnaires completed and a limited range of distribution. In addition, random sampling prevented the collection of an equal distribution of individuals from each age, gender and education level category. Repeats of this study should aim to collect a larger sample to ensure external validity. In addition, if repeated, stratified sampling should

be used, as it allows a more statistically representative sample to be collected compared to random sampling (Trost 1986).

Future research could investigate if an individual's level of knowledge on GM foods effects their attitude towards them. This study's participants and those from previous studies displayed a lack of knowledge on GM foods, which may have influenced their attitudes towards them. Attitudes towards GM foods could be measured before and after providing information on the impacts, uses and safety of GM foods. This would reveal if knowledge on GM foods influences attitudes towards them. By conducting this study, companies and policy makers would know if effectively informing the public would improve their attitudes towards GM foods.

Despite the limitations of this study, the results clearly indicate a significant education campaign is required to educate the public honestly on the basics of GM foods, and their impacts on both humans and the environment. This may include more positive research featured in the media, such as educational documentaries or TV shows on GM foods, or more education within schools and universities on GM foods.

From a policy perspective, these findings are important. If the government believes that GM foods present no risk to individuals or the environment, but their development is prevented as a result of public hostility, then these results will highlight which groups of people are most opposed to GM foods. This will allow the government to identify the target audience for initiatives regarding the promotion of GM foods. This study identifies individuals aged 46-60 are most opposed to GM foods, indicating that individuals within this age group are whom campaigns should be targeted towards.

The results from this research are limited, so only make a small contribution to an area where further research is required. However, it is important to gain an in-depth understanding of the factors that contribute to public resistance, and this study brings forward a novel concept of what may influence attitudes towards GM foods. Over time, results from this study, and larger-scale repeats of this study, may divulge new and reliable information on what factors influence attitudes towards GM foods.

## Conclusion

The findings of this study both support existing research and contribute new information regarding what factors influence attitudes towards GM foods, extending the existing knowledge of the area by reinforcing current thinking. However, some results differ from existing research, and so future research should aim to clarify these relationships.

This study has identified that there is a significant, but weak, negative relationship between an individual's level of environmental concern and their attitudes towards GM foods. The hypothesis that people who are concerned about the environment are less likely to favour GM foods is thus accepted. However, the data showed clear signs of heteroscedasticity, with the most environmentally concerned individuals showing a greater variation in their attitude towards GM foods, which contradicts the hypothesis. This may be due to some individuals having limited knowledge on GM foods and their negative environmental impacts, hence they do not have a negative opinion of them. This is supported by information provided in the comments section of the questionnaire, which revealed many individuals lacked adequate knowledge on GM foods. However, more investigation into this relationship is needed to confirm the association between environmental concern and attitudes towards GM foods, and to identify the underlying reasons behind it.

Age had a significant effect on levels of environmental concern and attitudes towards GM foods. Individuals aged above 60 had the lowest levels of environmental concern, confirming results from previous research where older individuals were found to have lower levels of environmental concern. However, level of environmental concern did not decrease continuously with age, with the youngest age category (individuals aged 18-25) showing the second lowest levels of environmental concern, opposing trends from existing research. The results from this research found individuals aged 46-60 were more likely to be against GM foods. The existing literature displays contrasting results, with some studies showing older subjects to have more positive attitudes towards GM foods, while others revealed the opposite. The influence of age on attitudes towards GM foods and level of environmental concern requires further investigation to elicit the nature of these relationships.

Gender and level of formal education had no significant effect on both levels of environmental concern and attitudes towards GM foods. These findings do not fit the literature norm, and can be explained by the uneven distribution of genders in the study sample and the small sample size.

Comments from the questionnaire suggested that many participants are ambivalent towards GM foods, with the majority of concerns relating to the unknown long-term effects, the negative environmental impacts and corporations using GM foods unethically. Individuals commonly expressed lacking sufficient knowledge on GM foods, explaining their unease towards their use. The perceived benefits of using GM foods to end world hunger facilitated their use to some respondents. This research concludes that if GM is to be used as part of the solution to sustainable food production, more emphasis is required on educating individuals on GM foods, their uses and future impact.

Although only age was shown to influence levels of environmental concern and attitudes towards GM foods, it is likely that a mixture of age, gender and education level ultimately decide how environmentally concerned an individual is and their attitudes towards GM foods. Age, gender and education level were all shown to influence attitudes towards GM foods and environmental concern in the existing literature, so it would be irresponsible to ignore them when drawing conclusions on the studied relationships and when planning future research.

In conclusion, the study confirms that an individual’s level of environmental concern does influence their attitude towards GM foods. In a context where the development of GM food is prevented due to public hostility, this research and results from similar research may be important for GM companies and for government policy making. The results identified which groups of people are more likely to oppose GM foods (individuals aged 46-60), and therefore might enable initiatives and advertisements to be planned to target specifically these groups.

Due to inconsistencies between the results of this study and the existing literature, future research should focus on investigating the importance of age on both attitudes towards GM foods and levels of environmental concern. In addition, further investigation into the link between attitudes towards GM foods and levels of

environmental concern is required, to confirm if the results from this study can be replicated, or if they are an anomaly.

## Ethics

This research followed the BU Research Ethics Code of Practice: Policy and Procedure (Bournemouth University 2018), for which an ethics checklist was completed and approved by the supervisor. No ethical concerns were raised so it was not necessary for the study to be approved by the Research Ethics Panel.

## Acknowledgements

I would like to formally thank my supervisor, Professor Chris Shiel, for her time, patience and guidance throughout the project. Also, I would like to thank all those who participated in the study, for helping provide valuable data. I would like to give a special thanks to my sister, Megan Dancer, for her advice and expertise; I could not have done it without you.

## References

**Altieri, A.** (2005) The Myth of Coexistence: Why Transgenic Crops Are Not Compatible With Agroecologically Based Systems of Production. *Bulletin of Science Technology Society,* 25 (4), 361-371. DOI: https://doi.org/10.1177/0270467605277291

**Arcury, T. A., Scollay, S. J. and Johnson, T. P.** (1987) Sex Diffeerences in Environmental Concern and Knowledge: The Case of Acid Rain. *Sex Roles*, 16 (9-10), 463-472. DOI: https://doi.org/10.1007/BF00292481

**Azadi, H. and Ho, P.** (2009) Genetically modified and organic crops in developing countries: A review of options for food security. *Biotechnology Advances*, 28 (1), 160-168. DOI: https://doi.org/10.1016/j.biotechadv.2009.11.003

**Baker, G. A. and Burnham, T. A.** (2001) Consumer Response to Genetically Nodified Foods: Market Segment Analysis and Implications for Producers and Policy Makers. *Journal of Agricultural and Resource Economics*, 26 (2), 387-403.

**Beyer, P., Al-Babili, S., Ye, X., Lucca, P., Schaub, P., Welsch, R. and Potrykus, I.** (2002) Golden Rice: Introducing the β-Carotene Biosynthesis Pathway into Rice Endosperm by Genetic Engineering to Defeat Vitamin A Deficiency. *The Journal of Nutrition*, 132 (3), 5065-5105. DOI: https://doi.org/10.1093/jn/132.3.506S

**Bournemouth University** (2018) Research Ethics @ BU. *Available from: https://blogs.bournemouth.ac.uk/research/research-ethics-bu/* [Accessed 25 February 2018].

**Brace, I.** (2008) *Questionnaire Design: How to Plan, Structure and Write Survey Material for Effective Market Research*. 2nd ed. London: Kogan Page Ltd.

**Bredahl, L.** (1999) Consumers>> Cognitions With Regard to Genetically Modified Foods. Results of a Qualitaative Study in Four Countries. *Appetite*], 33 (3), 343-360. DOI: https://doi.org/10.1006/appe.1999.0267

**Buttel, F. H.** (1979) Age and Environmental Concern: A Multivariate Analysis. *Youth & Society*, 10 (3). DOI: https://doi.org/10.1177/0044118X7901000302

**Caplan, R.** (2002) Antibiotic Resistance and Genetically Engineered Plants. *Institute for Agriculture and Trade Policy*, 1-14.

**Carpenter, J. E.** (2010) Peer-reviewed surveys indicate positive impact of commercialized GM crops. *Nature Biotechnology*, 28, 319-321. DOI: http://dx.doi.org/10.1038/nbt0410-319

**Chondie, Y. G. and Kebede, M.** (2015) Review Article: Genetically Modified Crops and Food Security. *Food Science and Quality Management*, 42. DOI: http://dx.doi.org/10.5897/AJB2015.15098

**Conner, A. J., Glare, T. R. and Nap, J.** (2003) The release of genetically modified crops into the environment. *The Plant Journal*, 33 (1), 19-46. DOI: https://doi.org/10.1046/j.0960-7412.2002.001607.x

**Cook, A. J., Kerr, G. N and Moore, K.** (2002) Attitudes and intentions towards purchasing GM food. *Journal of Economic Psychology*, 23, 557-572. DOI: https://doi.org/10.1016/S0167-4870(02)00117-4

**Denscombe, M.** (2010) *The Good Research Guide for Small-Scale Research Projects.* 4th . Maidenhead: Open University Press.

**Dietz, T., Kalof, L. and Stern, P. C.** (2003) Gender, Valure, and Environmentalism. *Social Science Quarterly*, 83 (1), 353-364. DOI: https://doi.org/10.1111/1540-6237.00088

**Dietz, T., Stern, P.C. and Guagnano, G. A.** (1998) Social Structural and Social Pshychologucal Bases of Environmental Concern. *Environment and Behaviour*, 30 (4), 540-471. DOI: https://doi.org/10.1177/001391659803000402

**Dunlap, R. E., Van Liere, K. D., Mertig, A. G. and Jones, R. E.** (2000) Measuring Endorsement of the New Ecological Paradigm: A Revised NEP Scale. *Journal of Social Issues*, 56 (3), 425-442. DOI: https://doi.org/10.1111/0022-4537.00176

**Dytham, C.** (2011) *Choosing and Using Statistics: A Biologist's Guide*. 3rd ed. West Sussex: John Wiley & Sons.

**European Commission** (2010 (a)) *Biotechnology*. Brussels: European Union.

**European Commission** (2010 (b)) *Europeans and Biotechnology in 2010*. Luxembourg: European Union.

**European Social Survey** (2017) *Source Questionnaire*. London: European Social Survey.

**Fransson, N. and Garling, T.** (1999) Environmental Concern: Conceptual Definitions, Measurement Methods, and Research Findings. *Journal of Environmental Psychology*, 19 (4), 369-382. DOI: https://doi.org/10.1006/jevp.1999.0141

**Fricker, R.D. and Schonlau, M.** (2002) Advantages and Disadvantages of Internet Research Surveys: Evidence from the Literature. *Field Methods*, 14 (4) 347-367. DOI: https://doi.org/10.1177/152582202237725

**Garton, L., Haythornthwaite, C., and Wellman, B.** (1999) Studying on-line social networks. IN: Jones, S. *Doing Internet Research: Critical Issues and Methods for Examining the Net*. California: Sage, 75-105.

**Gasser, C. S. and Fraley, R. T.** (2011) Genetically Engineering Plants for Crop Improvement. *Science*, 244 (4910), 1293-1299. DOI: 10.1126/science.244.4910.1293

**Gifford, R. and Nilsson, A.** (2014) Personal and social factors that influence pro-environmental concern and behaviour: A review. *International Journal of Psychology*, 49 (3), 141-157. DOI: https://doi.org/10.1002/ijop.12034

**Gjestland, L.** (1996) Net? Not yet. *Marketing Research* [online], 8 (1).

**Hails, R. S.** (2000) Genetically modified plants- the debate continues. *Trends in Ecology and Evolution*, 15 (1), 14-18. DOI: https://doi.org/10.1016/S0169-5347(99)01751-6

**Hoban, T. J.** (1996) Anticipating public reaction to the use of genetic engineering in infant nutrition. *The American Journal of Clinical Nutrition*, 63 (4), 657-662. DOI: https://doi.org/10.1093/ajcn/63.4.657

**Honkanen, P. and Verplaken, B.** (2004) Understanding Attitudes Towards Genetically Modified Food: The Role of Values and Attitudes Strength. *Journal of Consumer Policy*, 27(4), 401-420. DOI: https://doi.org/10.1007/s10603-004-2524-9

**Honnold, J. A.** (2010) Age and Environmental Concern some specification of effects. *The Journal of Environmental Education*, 16 (1), 4-9. DOI: https://doi.org/10.1080/00958964.1984.9942695

**Hudson, J., Caplanova, A. and Novak, M.** (2015) Public attitudes to GM foods. The balancing of risks and gains. *Appetite*, 92, 303-313. DOI: https://doi.org/10.1016/j.appet.2015.05.031

**James, C.** (2011) Global Status of Commercialized Biotech/GM Crops: 2011. *ISAAA Breifs*, 43, 225-230.

**Jank, B. and Gaugitsch, H.** (2001) Assessing the environmental impacts of transgenic plants. *Trends in Biotechnology*, 19 (9), 371-372.

**Kinnear, T. C., Taylor, J. R. and Sadrudin, A.** (1974) Ecologically Concerned Consumers: Who Are They? *Journal of Marketing*, 38 (2), 20-24. DOI: https://doi:10.2307/1250192

**Klineberg, S. L., McKeever, M. and Rothenbach, B.** (1998) Demograpgic Predictors of Environmental Concern: It Does Make a Difference How It's Measured. *Social Science Quarterly*, 79 (4), 734-753.

**Koivisto Hursti, U., Magnusson, M. K. and Algers, A.** (2002) Swedish consumers' opinions about gene technology. *British Food Journal*, 104 (11), 860-872. DOI: https://doi.org/10.1108/00070700210454596

**Kotch, K.** (1998) Food Safety battle: Organic vs. biotech. *CQ Researcher*, 8 (33) 761-784.

**Llieva, J., Baron, S., and Healey, N. M.** (2002) Online surveys in marketing research: Pros and cons. *International Journal of Market Research*, 44 (3), 361-367.

**Magnusson, M. K. and Hursti, U. K.** (2002) Consumer attitudes towards genetically modified foods. *Appetite*, 39, 9-24. DOI: https://doi.org/10.1006/appe.2002.0486

**Malarkey, T.** (2003) Human health concerns with GM crops. *Mutation Research/Reviews in Mutation Research*, 544 (2-3), 217-221. DOI: https://doi.org/10.1016/j.mrrev.2003.06.001

**Malone, L. A. and Burgess, E. P. J.** (2009) Impact of Genetically Modified Crops on Pollinators. IN: Ferry, N. and Gatehouse, A. M. R., *Environmental Impact of Genetically Modified Crops.* CABI International, 199-224.

**Midtvedt, T.** (2014) Antibiotic resistance and genetically modified plants. *Microbial Ecology in Health and Disease*.

**Mintona, A. P. and Rosed, R. L.** (1997) The Effects of Environmental Concern on Environmentally Friendly Consumer Behaviour: An Exploratory Study. *Journal of Business Research*, 40 (1), 37-48. DOI: https://doi.org/10.1016/S0148-2963(96)00209-3

**Newing, H.** (2011) *Conducting research in conservation: social science methods and practice*. London: Routledge.

**Öz, B., Unsal, F. and Movassaghi, H.** (2017) Consumer attitudes toward genetically modified food in the United States: Are Millennials different? *Journal of Transnational Management*, 23 (1), 3-21. DOI: https://doi.org/10.1080/15475778.2017.1373316

**Paarlberg, R. L.** (2001) *The Politics of Precaution: Genetically Modified Crops in Developing Countries*, 1, 1-5.

**Phipps, R. H. and Park, J. R.** (2002) Environmental Benefits of Genetically Modified Crops: Global and European Perspectives on Their Ability to Reduce Pesticide Use. *Journal of Animal and Feed Sciences*, 11, 1-18.

**Pillemer, K. Wells, N. M., Meador, R. H., Schultz, L., Henderson, C. R. and Cope, M. T.** (2017) Engaging Older Adults in Environmental Volunteerism: The Retirees in Service to the Environment Program. *The Gerontologist*, 57 (2), 367-375. DOI: https://doi.org/10.1093/geront/gnv693

**Pinstrub-Andersen, P. and Schioler, E.** (2001) Seeds of Contention, 86-106.

**Ribeiro, T. G., Barone, B. and Behrens, J. H.** (2016) Genetically modified foods and their social representation. *Food Research International*, 84, 120-127. DOI: https://doi.org/10.1016/j.foodres.2016.03.029

**Roberts, J. A.** (1995) Profiling Levels Of Socially Responsible Consumer Behaviour: A Cliuster Analytic Approach And Its Implications For Marketing. *Journal of Marketing and Theory Practice*, 3 (4), 97-117. DOI: https://doi.org/10.1080/10696679.1995.11501709

**Schlapfer, F.** (2008) Derteminants of Voter Support for a Five-Year Ban on the Cultivation of Genetically Modified Crops in Switzerland. *Journal of Agricultural Economics*, 59 (3), 421-435. DOI: https://doi.org/10.1111/j.1477-9552.2008.00167.x

**Schneider, K. R., Schneider, R. G. and Richardson, S.** (2014) Genetically Modified Food. *IFAS Extension*.

**Schultz, P. W., and Zelezny, L.** (1999) Values as predictors of environmental attitudes: Evidence for consistency across 14 countries. *Journal of Environmental Psychology*, 19 (3) 255-265. DOI: https://doi.org/10.1006/jevp.1999.0129

**Schwartz, S. H.** (2012) An overview of the Schwartz theory of basic values. *Online Readings in Psychology and Culture*, 2 (1). DOI: https://doi.org/10.9707/2307-0919.1116

**Sedgewick, P.** (2014) Spearman's rank correlation coefficient. *Statistical Questions*, 349. DOI: https://doi.org/10.1136/bmj.g7327

**Sheldon, R., Cleghorn, N., Penfold, C., Brown, A. and Newmark, T.** (2009) *Exploring attitudes to GM food*. Food Standards Agency.

**Siegrist, M.** (2000) The Influence of Trust and Perceptions of Risk and Benefits on the Acceptance of Gene Technology. *Risk Analysis*, 20 (2), 195-204. DOI:https://doi.org/10.1111/0272-4332.202020

**Sparks, P., Shepherd, R. and Frewer, L. J.** (1994) Gene technology, food production, and public opinion: A UK Study. *Agriculture and Human Values*, 11 (1), 19-28. DOI: https://doi.org/10.1007/BF01534445

**Sparks, P., Shepherd. R. and Frewer, L.** (1995) Assessing and Structuring Attitudes Toward the Use of Gene Technology in Food Production: The Role of Perceived Ethical Obligation. *Basic and Applied Social Psychology*, 16 (3), 267-285. DOI: https://doi.org/10.1207/s15324834basp1603_1

**Straughan, R. D. and Roberts, J. A.** 1999. Environmental segmentation alternatives: a look at green consumer behaviour in the new millennium. *Journal of Consumer Marketing*, 16 (6), 558-575.
DOI: https://doi.org/10.1108/07363769910297506

**Toenniessen, G. H., O'Toole, J. C. and DeVries, J.** (2003) Advances in plant biotechnology and its adoption in developing countries. *Current Opinion in Plant Biotechnology*, 6 (2), 191-198. DOI: https://doi.org/10.1016/S1369-5266(03)00002-5

**Valente, M and Chaves, C.** (2018) Perceptions and valuation of GM food: A study on the impact and importance of information provision. *Journal of Cleaner Production*, 172, 4110-4118. DOI: https://doi.org/10.1016/j.jclepro.2017.02.042

**Van Liere, K. D. and Dunlap, R. E.** (1980) The Social Bases of Environmental Concern: A Review of Hypotheses, Explanations and Empirical Evidence. *The Public Opinion Quarterly*, 44 (2), 181-197. DOI: https://doi.org/10.1086/268583

**Van Meijl, H. and Van Tongeren, F.** (2003) International diffusion of gains from biotechnology and the European Union's Common Agricultural Policy. *Agriculture Economics*, 31, 307-316.

**Vicente-Molina, M. A., Fernandez-Sainz, A. and Izagirre-Olaizola, J.** (2018) Does gender make a difference in pro-environmental behaviour? The case of the Basque County University students. *Journal of Cleaner Production*, 176, 89-98. DOI: https://doi.org/10.1016/j.jclepro.2017.12.079

**Wisniewski, J., Frangne, N., Massonneau, A. and Dumas, C.** (2002) Between myth and reality: genetically modified maize, an example of a sizeable scientific controversy. *Biochimie*, 84 (11), 1095-1103. DOI: https://doi.org/10.1016/S0300-9084(02)00014-7

**Witmer, D. F., Colman, R. W. and Katzman, S. L.** (1998) From Paper-and-Pencil to Screen-and-Keyboard. IN: Jones, S. *Doing Internet Research: Critical Issues and Methods for Examining the Net*. California: Sage, 145-158.

**Wright, K. B.** (2005) Researching Internet-based populations: Advantages and disadvantages of online survey research, online questionnaire authoring software packages, and web survey services. *Journal of Computer-Mediated 71 Communication*, 10 (3). DOI: https://doi.org/10.1111/j.1083-6101.2005.tb00259.x

**Wright, S. D., Caserta, M., & Lund, D. A.** (2003) Older adults' attitudes, concerns, and support for environmental issues in the 'new west'. *International Journal of Aging & Human Development*, 57, 151–179. DOI: https://doi.org/10.2190/Y73Y-0RK9-RP0J-E7HH

**Wunderlich, S. and Gatto, K. A.** (2015) Consumer Perception of Genetically Modified Organisms and Sources of Information. *Advances in Nutrition*, 6 (6), 842-851. DOI: https://doi.org/10.3945/an.115.008870

**Zelezny, L. C., Chua, P. and Aldrich, C.** (2002) New Ways of Thinking about Environmentalism: Elaborating on Gender Differences in Environmentalism. *Journal of Social Issues*, 56 (3), 443-457. DOI: https://doi.org/10.1111/0022-4537.00177

**Zimmer, M. R., Stafford, T. F. and Stafford, M. R.** (1994) Green issues: Dimensions of environmental concern. *Journal of Business Research*, 30 (1), 63-74. DOI: https://doi.org/10.1016/0148-2963(94)90069-8