Extended Abstract
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Paper/Poster Title	**Paper Title: The role of perceptions, attitudes and farming motivations for adopting low-emission practices in Ireland.**

Abstract prepared for presentation at the 97th Annual Conference of the Agricultural Economics Society, The University of Warwick, United Kingdom

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Abstract	***200 words max***
Livestock production systems are primarily responsible (99.4%) for ammonia emission in Ireland. Recent research findings link atmospheric ammonia concentrations to human respiratory health issues and damage to sensitive ecosystems. The European Union National Emission Ceiling Directive (NEC) provides a legal framework in terms of ammonia emissions limits for Ireland. As Ireland has been exceeding NEC Directive limits for the last number of years, policymakers have been promoting the uptake of low-emission farming technologies in Ireland. This research explores the Irish farmers' awareness and perceptions of agricultural ammonia emissions, the motivating factors for uptaking of new farming technologies that can mitigate ammonia, as well as the socio-economic characteristics of the early adopters. The Teagasc National Farm Survey (2021) data, factor reduction methods and econometric modelling are this research study's core materials and methods. The results show that there is minimal awareness and perceived importance among farmers about ammonia. This could be a severe barrier to achieving the emission reduction targets in Ireland. Farmers are motivated by "user friendliness" and "moral values" when adopting new farming technologies. Several demographic and structural variables such as age, contact with extension services, farming under nitrates derogation scheme and cattle rearing were found to be significantly related to the probability of adopting low-emission farming technologies examined. This analysis highlights important considerations for targeting farmer cohorts for emission reduction planning in Ireland.	

Keywords	Ammonia emission, Low emission technologies, farmer attitude, perception, motivation factors, Principle Component Analysis, Poison regression
JEL Code	Q16 see: www.aeaweb.org/jel/guide/jel.php?class=Q)

Introduction	***100 – 250 words***

Manure management, animal manure stored and applied to soil, and nitrogen from grazing animals' urine and dung deposition collectively account for approximately 89% of the national ammonia emission in the Republic of Ireland (called Ireland from here on) (2018) (EPA, 2020). Meanwhile, Ireland is non-compliant with the EU National Emission Ceiling Directive (Directive 2001/81/E.C.) which set down ammonia emission limits for Ireland. The Marginal Abatement Cost Curve (MACC) is the practical strategy to achieve emission reduction targets and achieve emission ceiling compliance in 2030 (Buckley et al., 2020). The current study

examines farmers' perceptions, attitudes and the role of motivating factors when adopting the main low-emission technologies recommended by Buckley et al., (2020).

Methodology

100 – 250 words

Methods

Data

The data used in this study are from the Teagasc 2021 National Farm Survey, operated as part of the EU Farm Accountancy Data Network. A random, nationally representative sample of farms is selected annually in conjunction with the Central Statistics Office (CSO). Each farm is assigned a weighting factor so that the results of the survey are representative of the national population of farms in Ireland. In 2021 the NFS contains 887 farmers represesting 83,771 population. The Teagasc collects data across a range of economic, environmental and social dimensions of farming. In this context of this research some additional questions were asked of these farmers in 2021 around their knowledge and perecpetions of ammonia emissions from farming.

In this context farmers were asked to rank the level of self-awareness and perceived importance of abating ammonia in agriculture in comparison to 4 other environmental issues, namely, GHG Emission, Loss of Biodiversity, Soil Quality, and Water Pollution. Farmers were also given a list of motivating factors and were asked to rank them from 1 to 5 based on what was most important to them.

Principle Component Analysis was used to reduce the above factors, and computed factors were used for further analysis. Principle Component Analysis (PCA) is a statistical technique for dimension reduction of the dataset by estimating components that can explain the maximum variance in the data. PCA find linear combinations of the variables by maximising variance in a sample (Das, 2019).

Consider equation 1 below:

$$z_i = Ay_i$$

Where

$$(y_i)\ is\ the\ vector\ of\ p\ variables = y_1, y_2, y_3, \ldots\ldots y_p$$

$$A = orthogonal\ matrix$$

The axes can be rotated by multiplying each y_i each by an orthogonal matrix A, and thus principal components are the transformed variables that can be given by;

$$z_i = a_i' y$$

The first principal component explains the maximum variance in a sample and is given by

$$z_1 = a_{11}y_1 + a_{12}y_2 + \ldots . a_{1p}y_p$$

A few components are sufficient to explain most of the variation in data; hence, PCA can be used to reduce the dimension of the dataset.

Results

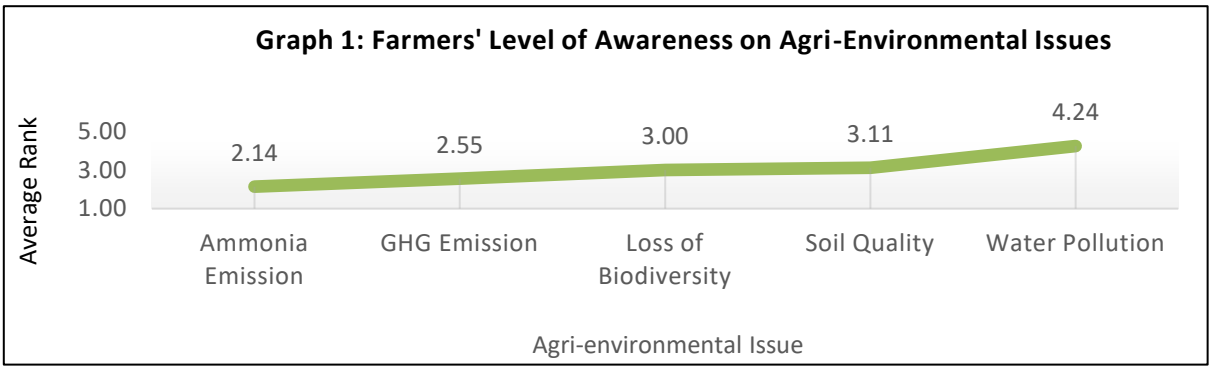
100 – 250 words

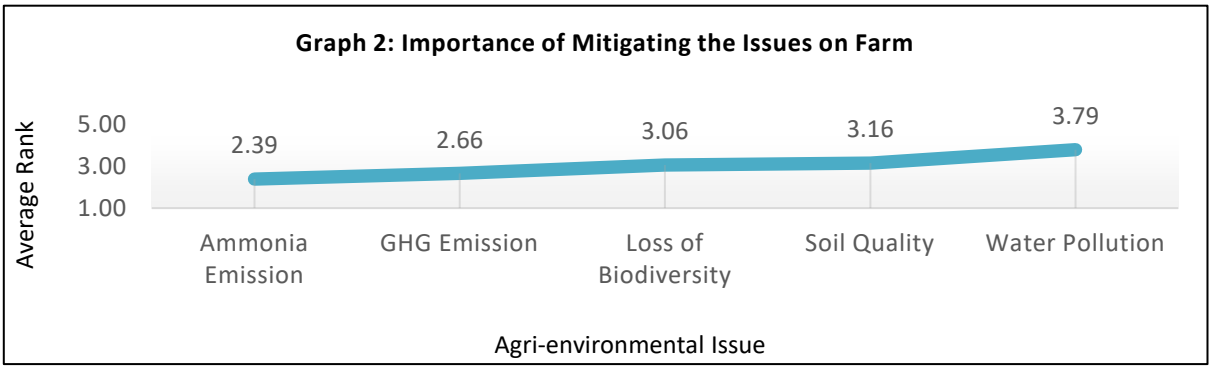
Results

Irish Farmers' Perception and Awareness of abating ammonia in agriculture

Farmers ranked their level of awareness on ammonia emission compared to the broad environmental issues such as water pollution, soil quality deterioration and loss of biodiversity

(Graph 1). And they ranked the level of importance of managing ammonia emission on their farms compared to the broad environmental issues (Graph 2).





Graph 1 illustrates that ammonia emission was frequently ranked as the environmental issue the farmers were least aware of compared to the broad environmental issues. Graph 2 shows that ammonia emission was most commonly identified as the least essential environmental problem to manage on their farms.

Following a PCA, two factors emerged and were chosen for further analysis. The statements with high loadings for factor 1 were strongly associated with the characteristics of the technology, such as availability of financial support for the adoption, potential improvements in farm profitability, Cost of the technology and Ease of use of the specific technology. It was labelled 'User friendliness."

The statements with high loadings for factor 2 were strongly associated with the characteristics of individuals' values such as environmental benefits, human health-related benefits, opinions of family and peers and recommendations by farm adviser. It was labelled as "Moral values."

Modelling the intensity of technologies adoption

A count data model was used to assess intensity of practice adoption. A count data model predicts the number of times an event occurs given that the dependent variable is a non-negative integer. The Poisson regression model is commonly used in previous research studies for assessing the technology adoption intensity example, Buckley et al., 2015. In this study the dependent variable is measured by the number of low-emission technologies undertaken by a farmer in the survey year, which is a discrete non-negative integer value count. Table 1 shows the technologies that were assed in this analysis and the frequency of adopting them in the studied sample.

Table 1: Low emission technologies studied in this analysis.

Low emission farming technologies	Frequency of adopting (n=587)	Poison Regression model
1. Using dribble bar, trailing shoe, trailing horse (Low Emission Slurry Spreading Equipment) for slurry spreading	187	This variable takes a value of 1 if a farmer used LESS equipment for spreading at least 60% of slurry during the survey year.
2. Covered slurry storage tanks	433	This variable takes a value of 1 if a farmer has stored 100% of slurry in covered tanks during the survey year.
3. Protected urea	95	This variable takes a value of 1 if a farmer has incorporated protected urea during the survey year.
4. Lime application	202	This variable takes a value of 1 if a farmer has spread lime during the survey year.
5. Establishment of clover	110	This variable takes a value of 1 if a farmer has established clover in fields during the survey year.

Results of the poison regression model is presented in the table 2.

Table 2: Results of the poison regression model

Explanatory variable	**Coefficient**	**Adjusted p-value**
(Intercept)	0.83	<0.001
Income/(HA000)	0.069	0.126
Adjusted Size of Farm (Ha)	1.158	0.152
Age Farm Manager	-0.007	**0.008**
User Friendliness Factor	0.02	0.511
Moral Values Factor	0.03	0.305
Soil Group 1	0.213	0.144
Soil Group 2	0.179	0.221
Dairy Farmers under the derogation scheme (SO1)	0.176	**0.021**
Dry stock Cattle Rearing (SO2)	-0.223	**0.007**
Sheep (SO3)	-0.159	0.137
Discussion Group Member	0.211	**<0.001**
Off Farm Employment	0.16	0.827
Highest formal agricultural training	0.006	0.838

Table 2 shows that the number of low-emission technologies adopted was statistically significantly lower on cattle-rearing farms and among older farmers' farms. Dairy farms

farming under nitrates derogation and farmers engaged in discussion groups are more likely to practise a higher number of low-emission technologies explored.

Discussion and Conclusion

100 – 250 words

In keeping with the substantive body of previous work on technology adoption, several socio-economic characteristics and farm structural variables in this study were found to affect the number of low-emission technologies adopted by farmers. Age appeared to be a constraint for adopting more practices. More research is required to understand why the intensity of adoption is low in Irish cattle-rearing farms. Participating in a scheme and discussion group increases the likelihood of adopting a higher number of low-emission practices. Furthermore, motivating factors could be sensitive to the type of technologies. Findings from this study do not show a statistically significant relationship between the intensity of adoption of low emission technologies and farmer motivation factors.

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