

Research Stimulus Fund

Final Report

The impact of climate change on Irish farming

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Principal Coordinator:

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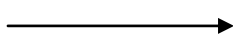
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Please tick below the appropriate area on the research continuum where you feel this project fits

BASIC/FUNDAMENTAL



APPLIED/PRE COMMERCIAL

	X	
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Key words: climate change, adaptation, farm level modelling, optimisation

1. Rationale for Undertaking the Research

Growing concern on agricultural productivity due to global warming has led many studies to determine the extent of effects of climate change on agriculture in many regions of the world. Extensive research has been conducted on the impact of climate change on crop production (Hakala, 1998; Brown and Rosenberg, 1999; Craigon et al., 2002; Chang, 2002; Peiris et al., 1996; Easterling et al., 1993; Rotter and Van de Geijn, 1999; Jones and Thornton, 2003). In the context of livestock production, climate change will affect production directly through animal health, reproduction and productivity. For example, a rise in temperature may induce heat stress in animals that can lower productivity by decreasing appetite and increase susceptibility to parasitic diseases (Adams et al., 1998; Sutherst et al., 1998; White et al., 2003). However, this direct effect of climate change on individual animals is expected to be minimal, especially under a temperate climate like in Ireland where the animals are expected to be capable of tolerating heat stress for the next fifty years (Parsons et al., 2001; Lynch, 2004). A more important issue for livestock production under climate change would be an indirect impact due to changes in grass production and conservation. Many studies suggest that due to CO₂-fertilization mechanism, increased levels of atmospheric CO₂ concentration can increase grass yield by 20-30% (Jones et al., 1996; Cannell and Thornley, 1998; Campbell and Smith, 2000). Similarly, a higher rainfall will be beneficial for grass growth in regions where water is currently a limiting factor, but it will have detrimental effects on grazing and grass conservation in areas with poor water drainage (Cooper and McGehan, 1996). Increase in precipitation would also render soil unsuitable for farm operations and grazing on farms with less drainage facility.

Many of these studies consider farm adaptation available to farmers to maximise their profits. It has been argued that farmers, especially profit-minded farmers, would always try to change their farming strategies to optimise production (Feder and Slade, 1984; Smithers and Blay-Palmer, 2001). Earlier researches show that economical studies to determine effects of climate change on agriculture without considering farm adaptations have an exaggerated effects of climate change, especially the adverse effects (Mendelsohn et al., 1996; Tan and Shibasaki, 2003). Hence inclusion of farmers' adaptation under a climate change is an important issue in these types of studies. In Ireland there are a growing number of studies on determining the effects of climate change on Irish farms in recent years (Brereton and O'Riordan, 2001; Holden, 2001; Sweeney, 2003). These studies provided information on possible adaptations to mitigate the effects of future climate change. However, not many of these studies identified farm level adaptations that are available on Irish farms under climate change. Keeping in mind that farm management would be different on different farms depending upon the types and location of a farm, we proceed in this study to examine the effects of climate change on Irish farms based on the types and location of the farms and identify optimal farm adaptations which are available for each of the farm types. The main focus of this study is on changes in crop and grass yields and field time availability under a changed climate.

2. Research Approach

The main objectives of the project can be broken down into two tasks and each task required a different research approach. The tasks and research approaches adopted were as follows;

(1) To determine crop and grass yields under climate change

The object was to project crop and grass yields under a climate change scenario for different Irish regions. For this purpose, growth models, DSSAT for crop production and Johnstown Grass Growth model for grass production were used. The growth models used the National Farm Survey data, 2007 (NFS) and weather data to project the crop and grass yields. Farm survey data was separated for each of the 7 NUTS region. The weather data was 30-year averaged data for each of the region for a baseline scenario and a climate change scenario. A high emission climate was used for this study. Besides crop and grass yields, another parameter, field time availability, was also determined for the baseline and climate change scenario under this task by using a soil moisture deficit simulator (JSMD).

(2) To determine the impact of climate change on farms and farmers responses to the change

An optimising linear programming model was developed for this study. The model is a farm level model which maximises farm profits within restricting farm resources. The model consists of all possible farm activities which mean that farms are allowed to change their enterprise if profitable. The major component of the model is three livestock enterprise; dairy, beef and sheep production as well as tillage production system. These systems are constrained over land, feed and labour. Land is fixed on a farm however feed and labour can be brought in if required and profitable. There are two major data inputs for the model; i. farm level data, which comes from the national farm survey, 2007 and ii. climate data taken from growth models and JSMD simulator used in the first task of the study. The data which were not available in these two sources such as livestock coefficients and costs and prices of some of the farm variables are taken from published figure (Teagasc, 2008).

3. Research Achievements

The main research results or achievements can be summarised under the three objectives outlined above.

(1) Summary results from the growth models

Cereal production was affected substantially under the study climate change scenario in all regions of the country. The yields reduce significantly with the yields for winter wheat decreasing up to -11 % yield in the South East region whereas yields for spring barley decreases by up to -10% in both East and South East regions. This means tillage farms in the country would suffer a loss under the climate change scenario unless they change their farm activities. Maize silage however, had a substantial increase in yields in all of the regions. The highest increase in the yield (+98%) was projected in the Border region. Grass yield also benefitted under the climate change scenario with an increase of yield ranged from a maximum (+56%) in the South East region to a minimum (+49%) in the South West region. There is also an increase in field time availability especially during summer time when grass is conserved. The soil moisture deficit level during these months allow more days available for farms in all regions to allow

machineries on farms. Availability of grass land for grazing is also increased by at least one in all regions except in the Border region where grazing period remained the same under the climate change.

(2) Summary results from the farm level model

There is a large variation in farm types in different regions. The effect of climate change is differs from farm types to farm types between regions. However the major adaptation for all farm types is to exploit the increase in grass production. On all farms the use of concentrate feed is reduced to zero and grazing and grass silage feed increased. Dairy farms in all regions did not have a large variation under the climate change except on intensive dairy farms in the South East region. Farms in this group has a substantial decrease in farm margins as the increase in grass yields is not sufficient enough to decrease the production costs on farms. The other dairy farm groups either benefit a little or lose a little in all regions. Beef farms especially the small extensive beef farms in the East and Western regions would benefit from increase in grass production. Tillage farms suffer under climate change because of the decrease in cereal yields in all regions. However, tillage farms in the East region have a possibility to increase beef and sheep production to improve farm margins. All of the farms benefit if they increase stocking rate. However, there would be a threshold to that when increasing animal numbers cannot be beneficial any more due to poaching or increase in grass yield alone could not sustain increased number of animals. A decrease in farm margins for instance intensive dairy farms in the South East region would improve farm margins with an addition of 0.5 lu/ha but lose out when stocking rate is increased by an addition of 1 lu/ha. Most of the farm groups in all regions do not benefit from early stock turning out (by one month). This is because the grass yield on extra month is not sufficient enough to be beneficial. However, large dairy farms in the South West region benefitted a lot by turning the animal out a month early for grazing. Miscanthus as an alternative crop has not been adopted by most of the farms. However, intensive dairy farms in the South East region improved their farm margins by shifting from cereal production to miscanthus production. The reason for that is entirely because of the fact that cereal is used as animal feed on these farms. With increased grass availability these farms used more grass based feed on farm and moved arable land to produce miscanthus which they can sell to the market. The main conclusion from this study there is no big difference in farm adaptations adopted by farms in different regions. Farms in all regions would benefit under climate change if they exploit the increase in grass yield under climate change. Generally dairy farms are capable of minimising losses in farm margins by changing their feed regime alone. Small beef farms would benefit more adopting under climate change in most of the regions where as tillage farms in all regions lose out.

4. Impact of the Research

The objective of this research project was to determine the impact of climate change on Irish farms and to identify possible farm level adaptations to maximise benefits on farms. Acknowledging that projecting effects of a future climate is very difficult, this study used the high emission climate change scenario so that the largest possible impact of the climate change would be examined. This provided a guideline for the stakeholders (farmers, policy makers and academia) to understand the nature of changes on agriculture production and farm adaptation available to farmers to benefit under those changes.

5. Exploitation of the Research

The objective of this research project was to determine the impact of climate change on Irish farms and to identify possible farm level adaptations to maximise benefits on farms. The results of this research were presented at academic conferences and specialist workshops within Teagasc and contributed to the wider understanding of the effects of climate change.

6. Summary of Research Outputs

- (a) Intellectual Property applications/licences/patents
N/A
- (b) Innovations adopted by industry
N/A
- (c) Number of companies in receipt of information
N/A
- (d) Outcomes with economic potential
N/A
- (e) Outcomes with national/ policy/social/environmental potential
N/A
- (f) Peer-reviewed publications, International Journal/Book chapters.

M. Abdalla, D. Forristal and M. Jones, (2011). Climate change and Irish agriculture: impacts on selected major crops. Global Environmental Change. Under review.

Shrestha, S., Hennessy, T. Abdalla, M. and M. Jones (2010). Irish farms under climate change - identifying optimal farm level adaptations. Climate Policy. Under Review.

- (g) Scientific abstracts or articles including those presented at conferences

Shrestha, S. (2010). Optimising Irish Farms Under Climate Change: A Farm-Level Study. Paper presented at the Seminar on Climate Change, Stuttgart-Hohenheim, Germany . June 2010

Dillon, E. and Hennessy, T. (2010). Modelling Farm-level Sustainability. Paper presented at the annual Agricultural Economics Society Conference, Edinburgh, Scotland. March 2010.

Abdalla, M., Kumar, S., Jones, M., Burke, J., Williams, M., (2009) Testing DNDC model for simulating soil respiration and assessing the impacts of climate change on CO₂ effects from Irish Agricultural soils. Working Paper, School of Botany, Trinity College Dublin.

M. Abdalla and M. Jones, (2010). The impact of climate change on Irish farming. An end of the project report. TCD.

(h) National Report

(i) Popular non-scientific publications

Shrestha, S. and Hennessy, T. (2010) The Impact of Climate Change on Irish Farming. Technology Update Series, Teagasc.

(j) Workshops/seminars/ open days at which results were presented (excluding those in (g))

M. Abdalla and M. Jones, (2011). Modeling the Impacts of Climate Change on Irish Farming. A poster presented at the Irish Met Society Weather and Climate Conference on 26th of March 2011 at Maynooth University.

Shrestha, S. (2009) The Impact of Climate Change on Irish Farming. Presentation at the Staff Seminar Research Series. Teagasc.

7. Permanent Researchers

Institution Name	Number of Permanent staff contributing to project	Total Time contribution (months)	Average time contribution per permanent staff member
Teagasc RERC	1	.92	.92
TCD	1	1.38	1.38
Total	2	2.30	2.30

8. Researchers Funded by RSF

Type of Researcher	Number	Total Time contribution (months)	Average time
Post Doctorates	1	11.88	11.88
Contract Researchers	1	18.27	18.27
PhD postgraduates			
Masters postgraduates			
Temporary researcher			
Other			
Total	2	30.15	

9. Postgraduate Research

Total Number of PhD theses: _____

Please include authors, institutions and titles of theses and submission dates. If not submitted please give the anticipated submission date

Total Number of Masters theses: _____

Please include authors, institutions and titles of theses and submission dates. If not submitted please give the anticipated submission date

10. Project Expenditure

Total expenditure of the project: €198, 691.12

Total Award by RSF €214, 632.24

Other sources of funding (specify) N/A

1.

2.

Breakdown of Total Expenditure

Category	Name Teagasc	Name TCD	Total
Contract staff	495.55	90,107.43	90,602.98
Temporary staff			
Post doctorates		58,420.91	58,420.91
Post graduates			
Consumables			
Travel and subsistence	2415.97	6,829.74	9,245.71
Sub total	2911.52	155,358.08	158,269.60
Durable equipment		854.12	854.12
Other			
Overheads	727.88	38,839.52	39,567.40
Total	3639.40	195,051.72	198691.12

11. Future Strategies

Work is still ongoing on the preparation of papers for submission to peer reviewed journals.

12. Industry Collaboration

N/A