Department of Agriculture, Food and the Marine
An Roinn Talmhaíochta, Bia agus Mara

Research Stimulus Fund

Final Report

New Crop Choices for Irish Growers: CROPQUEST

DAFM Project Reference No: 11/S/119

Start date: 17/06/2013

End Date: 31/12/2015

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Collaborating Research Institutions and Researchers: UCD; J.I.Burke

Please place *one* "x" below in the appropriate area on the research continuum where you feel this project fits

Basic/Fundamental → Applied → Pre Commercial

1	2	3	4	5	6 X	7

Please specify priority area(s) of research this project relates to from the National Prioritisation Research Exercise* (NRPE) report;

Priority Area (s)	**I: Sustainable Food Production and Processing** **H: Food for health**

Key words: *(max 4) Desk-study, Break-crops, Economic analysis.*

1. Rationale for Undertaking the Research

This section should outline the rationale for carrying out the research and identify the need / problem to be addressed

Over the last 40 years, tillage crop production on Irish farms evolved from a mixed farming system, where grass and other forage crops were an integral part of rotations, to specialised tillage farms where there was limited crop rotation and indeed frequently cereals monoculture was practiced. This lack of rotation, which was exacerbated by the loss of the sugar beet crop, challenges the profitability and sustainability of the tillage sector. Recent CAP reform seeks to increase crop rotation.

Ireland and the European animal feed markets are particularly deficient in protein sources resulting in a significant dependency on non-EU protein rich feeds such as soya. This leaves feed compounders and the animal sector exposed to excessive price fluctuations caused by protein demand /supply mismatches. Also in a developing food market, where the provenance and traceability of feedstuffs is becoming more important, there is a need to be able to source traceable, native produced crops to bolster marketing campaigns based on provenance.

Irish tillage crop producers are uniquely exposed to the vagaries of the commodity cereal market with a limited number of crops. There is a need to broaden the crop base by combinations of: growing more crop types; growing for lower volume commodity markets (proteins and oilseeds); seeking more speciality food/beverage markets; or developing more speciality food and speciality uses for existing or alternative crops.

Key knowledge gaps at the start of the project included:

- The value of crop rotation in climates similar to Ireland in terms of: impact on crop performance, costs and rotation profitability.
- Broad acre crop options for rotation and their potential in the Irish market with particular emphasis on protein crops.
- The potential for higher value crop and/or crop product options

2. Research Approach

Specify the research methodologies employed, emphasising novel techniques and also outline any modifications from the original approved project proposal

The approach applied was a desk study which included:

- A literature review of potential broad acre and minor crops focusing on their potential for adoption in Ireland specifically: Crop Description; Markets; Suitability for Ireland; Rotation benefits and Research and Development Status. This focused on a limited number of crops with potential for broad acre deployment including: Oilseed Rape; Beans; Camelina; Lupins; Starch Potatoes; Maize; Peas and Cover crops.
- A literature review of the potential of crops and crop products for high value markets and as a feedstock for industrial or pharmaceutical products. This included a crop-specific approach and an approach where the potential of crops to be processed (biorefinery approach) to produce a range of products that are of use in food, industrial and the pharmaceutical industry was assessed.
- A review of the benefits of crop rotation in Irish type climates. Relevant research in this area proved quite limited as rotation research tends to be long-term in nature. A wider spectrum of

rotation research data beyond the original climatic regions was included; however the limited relevance of this research to the Irish situation needs to be carefully considered in its interpretation.

- Grower/farm survey, primarily using the Teagasc National Farm Survey (NFS) to determine the impact of rotations on profitability. The NFS data was limited by the relatively small number of growers who grow rotation crops in the survey. A separate survey of farmers who attended the Oak Park Crops open day queried their use of break crops and factors influencing them.

- Industry consultation: The scope and opportunities for crop/product/market development was assessed in structured interviews with appropriate leaders in: food, feed and pharmaceutical industry. This research method proved difficult in practice due to the participants concern about confidentiality limiting both their willingness to contribute openly, and the potential to publish the results.

  Given these limitations with this industry cohort, it was decided to add an end of project workshop with the feed industry to discuss the incorporation of more break-crops into feed rations.

3. Research Achievements/Results

Outline main results achieved

As the project was a desk study, the research achievements were largely the production of synopsised information from existing research or data sources.

A comprehensive literature review of the effect of rotations on crop performance was completed and forms the basis of a scientific publication. It shows the benefits of break crops on: disease in the following crop; soil fertility; weed control and other effects, and their combined effects on crop yields in complete rotations.

A review of a range of potential break crops for Irish conditions was completed which indicated the potential of these as break crops in Irish conditions. The review included an assessment of: the crop types; their markets; their suitability for Ireland; their rotational benefits and research and development status. The crops: Oilseed Rape, Beans and Maize have the most potential for expansion as broad-acre break crops for Ireland. Other crops also have potential, but with broad- acre crops, there is merit in concentrating on one or two crops to ensure critical mass would be built in all areas from research, to production, to processing.

National farm survey analysis indicated a link between break-crop production and the productivity of other crops on the farm. While the survey data on its own was too limited for a sensitive economic analysis, using the literature review results on the benefits of crop rotation as the basis of an economic analysis clearly indicated that crop rotation can impact positively on overall farm profit. Separate additional surveys also indicated growers desire to adopt break crops and the combined importance of the profitability of the break crop and the rotation were key factors in determining whether they would adopt break crops.

A review of high-value crop and crop product options indicated a range of possibilities such as healthier food options which are now offering scope for development such as gluten-free oats and cold pressed vegetable oils with healthy fatty acid profiles. Also the potential use of crops or crop products as a base for developing food additives and/or industrial or pharmaceutical products was illustrated. However

developing these bio-refinery type derivatives would in many cases require substantial investment and commitment from industry. In some of these cases, it is unclear as to whether we have any competitive advantage in the production of the feedstock crops for these applications.

4. Impact of the Research

A summary of the tangible impact of the research project should be provided under the outcomes' and 'outputs' heading below. In addition, please provide a short narrative synopsis of the benefits / improvements the research has made to the area under investigation particularly as regards end users, e.g. industry, consumers, regulatory authorities, policymakers, the scientific community, etc

The CROPQUEST project has provided valuable information to underpin a change in cropping systems that is necessary to ensure sustainable crop production in the future.

For growers and processors, it has in the short and medium term indicated the potential for broad-acre break crops such as beans, oilseed rape and maize to improve diversity, sustainability and profitability at grower level, while providing native produced protein sources (beans and oilseed rape) with traceability and provenance credentials for the feed industry.

In the medium term it has identified a range of other crop and crop product options which offer scope in the 'healthier' food area of higher value products, where traceability and provenance are of particular concern. In the longer term the potential to produce crops for use as substrate for pharmaceutical or other industrial uses was also identified.

For consumers, a shift in production from commodity markets to more specialised markets where traceability and provenance are valued will add to assurances about Irish food quality. The availability of 'healthy' food options such as vegetable oils with unique fatty acid profiles or food products produced form healthier cereals, will also benefit consumers.

For policy makers and regulatory authorities, the work indicates that targeted support at a number of levels may be needed to kick start some of the options being presented. Research support will certainly be required , but short term processing and production supports may also be necessary to generate the necessary critical mass needed in some of these crop areas.

For the scientific community, this desk study pulls together information on rotations and break crops, but also indicates the need for research in many areas if they are to develop.

4(a) Summary of Research Outcomes

(i) Collaborative links developed during this research

- Collaborative links were developed with the feed processing industry and seed suppliers through interactions with members of the Tillage crop stakeholders group of Teagasc both during the project and at the final workshop.

- Linkage with growers was strengthened during this project and it provided further impetus to establishing the grower funded (IFA) break crop research programme at Teagasc Oak Park which is now led by one of the researchers that worked on CROPQUEST.
- Industry links were also developed with those involved in higher value options.

(ii) Outcomes where new products, technologies and processes were developed and/or adopted

- The project, as a desk study, indicated the scope for development of a number of new crop products in the medium to longer term.
- In particular higher value food crop options such as 'healthy' oils from oilseed rape and camelina and also options from oats such as gluten –free products, but also other health promoting products, were identified.
- In the longer term, the potential to use crops and crop products as a source of unique raw materials for pharmaceutical and other industrial products was illustrated. However these later options would require considerable development. Discussions with industry showed that there was interest in some of these options, but commercial sensitivity prevented this being developed in an open forum.

(iii) Outcomes with economic potential

- The identification of viable break crops will improve the economic sustainability of crop production in Ireland where continual cereal monoculture will result in uncompetitive production in the longer term. This outcome was developed with growers and the feed industry as part of the final CROPQUEST workshop.
- The identification of a range of potential higher value crop options will also impact on grower profitability as there is a need to move away from a non-contracted commodity market to higher value quality markets.
- The substitution of native imported protein for imports should impact positively on economics in volatile markets and should improve the marketing of meat and dairy products based on provenance and traceability.

(iv) Outcomes with national/ policy/social/environmental potential

- The identified need to diversify our cropping system to improve the long term sustainability of tillage crop production has implication s for national policy both from a production, sustainability and environmental perspective.
- To successfully transition farmers from cereal monoculture and production of lower value commodity market crops, to the production of break crop s and higher value crop options, will require support in the form of national development strategies that will ensure that all actors (growers, processors, research etc) can work in a cohesive fashion to ensure that critical mass can be built in all areas where opportunities arise.
- As the project was running, the outputs of this project were informally used by the Teagasc tillage stakeholder group industry members who were inputting into the 'High level Implementation committee' of Harvest 2020 and more recently contributing to Foodwise 2025. Both of these processes have recognised the importance of break crops and indeed influenced the provision of a protein crop support instrument for growers.

4 (b) Summary of Research Outputs

(i) Peer-reviewed publications, International Journal/Book chapters.

Carroll, J., Thorne, F., Zahoor, F. Forristal, P.D. (Prepared) A Review of the Agronomic, Environmental and Economic Benefits of Break Crops: An Irish Case Study. Irish Journal of Agriculture and Food Research; special crops edition 2017.

(ii) Popular non-scientific publications and abstracts including those presented at conferences

Forristal, P.D. (2014) : Crop rotations: practical considerations. In proceedings of the CAFRE crops conference, 21/01/14. Greenmount Ag College, N.I.

Forristal, P.D (2014): Crop rotations and the CROPQUEST project. Conference presentation, National Crops Forum 11/09/2014, Keadeen hotel, Kildare.

Carroll, J. (2015): Break-crop agronomy and the grower funded research programme: In Proceedings of the National Tillage conference, Teagasc, Carlow.

Forristal, P.D (2016): CROPQUEST: A study of rotations and break crops. In Proceedings of the National Tillage conference. Teagasc, Carlow.

(iii) National Report

Reports included in Website below at (iv)

(iii) Workshops/seminars at which results were presented

Forristal, P.D., Zahoor, F. CROPQUEST Workshop (growers, feed industry) on break crops. 28/01/2016, Teagasc Oak Park

(v) Intellectual Property applications/licences/patents

None

(vi) Other

Forristal P.D. Zahoor, F (2016) CROPQUEST website including direct information on 8 crops and 7 reports: https://www.teagasc.ie/crops/crops/research/research-programme/cropquest/

Carroll, J. (2015-2016) Presentations at Teagasc Spring crop meetings presentation on Beans and Cropquest. (6 of these between 2015 and 2016).

Carroll, J. (2013) Presentation at Teagasc stand at National Ploughing championships. 25/09/2015.

Zahoor, F (2015) Presentation on stand at Teagasc Open day 24/06/2015.

5. Scientists trained by Project

Total Number of PhD theses: None

Total Number of Masters theses: None

6. Permanent Researchers

Institution Name	Number of Permanent staff contributing to project	Total Time contribution (person years)
Teagasc	2	0.75
UCD	1	0.10
Total	**3**	**0.85**

7. Researchers Funded by DAFM

Type of Researcher	Number	Total Time contribution (person years)
Post Doctorates/Contract Researchers	2	2.97
PhD students		
Masters students		
Temporary researchers		
Other		
Total	**2**	**2.97**

Note: Each contract research position had 2 researchers as the first incumbent moved to other employment in each case during the term of the project.

8. Involvement in Agri Food Graduate Development Programme

Name of Postgraduate / contract researcher	Names and Dates of modules attended
None	

9. Project Expenditure

Total expenditure of the project:	€184,333
Total Award by DAFM:	€208,804
Other sources of funding including benefit in kind and/or cash contribution(specify):	None

Breakdown of Total Expenditure

Category	Teagasc Institution 1	UCD Institution 2	Name Institution 3	Name Institution 4	Total
Contract staff	€102,823.56	€37,323.59			€140,147.15
Temporary staff					
Post doctorates					
Post graduates					
Consumables					
Travel and subsistence	€401.79				€401.79
Sub total	€103,225.35	€37,323.59			€140,548.94
Durable equipment					
Other	€8,647.12				€8,647.12
Overheads	€25,806.34	€9,330.90			€35,137.24
Total	**€137,678.81**	**€46,654.49**			**€184,333.30**

10. Leveraging

Summarise any additional resources'/funding leveraged by this award from other sources e.g. Additional Staff, National/EU funding secured, EI Commercialisation Fund, etc.

None directly in this project, however during the time of the project the grower funded research on Break Crop Agronomy (Teagasc project 6471) was commenced.

11. Future Strategies

Outline development plans for the results of the research.

There are many potential development strategies for this work, many of them being actively progressed at the moment. These are as a result of research deficiencies recognised, and opportunities identified, in the CROPQUEST project.

The agronomy of break-crops and specifically beans is being pursued in the grower funded Break Crop Agronomy project (RMIS 6471), which is a five year project researching a range of bean agronomy factors in replicated trials. This project is led by J.Carroll who was the first contract researcher on the CROPQUEST project, with two PhD students associated with the work.

A Teagasc (Carroll and Forristal) led project OPTI-BC in collaboration with UCD and WIT has just been successful in the 2016 RSF call. This project will look at specific aspects of the agronomy of both oilseed rape and beans and includes a comprehensive survey of farmers' crops to determine specific challenges in our climate. The quality characteristics of oil from Irish grown rape will be studied as will opportunities to produce specific healthy fatty acid profiles for use in cold pressed products.
As a result of difficult markets and the emphasis on seeking higher value outputs, there is now a greater emphasis on producing quality crop specifications to more closely meet the needs of higher value markets. This will inform much of our future crop research, where targeted and more precise agronomy will aim to efficiently meet these quality targets.

The range of crops being grown is likely to expand and the research needed to support them will also develop. In this context there is a renewed interest in oats as a crop, particularly for human consumption and this is likely to increase.

Developing more minor crops with more specific end uses presents a greater challenge as the market is small and our competitive advantage in supplying the crops may not be certain. This requires much more careful consideration. Equally the development bio-refinery type industries, to feed either industrial or pharmaceutical type processes, although attractive from a national perspective, would require considerable research and development and a high level of industry commitment.