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CROPQUEST: New crop choices for Irish growers.

Key external stakeholders:
Crop growers; Crop industry (seed, inputs, feed producers); Policy makers; Advisors; Researchers

Practical implications for stakeholders:

- The most likely crops for broad-acre adoption as break crops are Oilseed Rape and Beans with Forage Maize also playing a role where markets are available.
- As these break crops are grown on a relatively small area currently they will need sustained industry support in terms of policy, research, extension and the development of processing and market infrastructure.
- A range of other crops and crop products have potential in our climate but their success will require the development of viable markets for their output and/or end products.

Main results:

- A review of the benefits of growing break crops in rotations indicated considerable variation depending on climate, but in Ireland the yield benefit to subsequent cereal crops is significant at 10% and rotation is needed for sustainable production.
- Eight break-crops were studied in detail with other minor crops also considered. Of these, Oilseed rape, Beans and Forage Maize have the most potential for broad-acre crop production in our climate.
- Sustained support in terms of policy, research, advice/extension and the development of markets is critical to give growers confidence to consistently grow break crops.
- The potential for minor crops and/or more specialised crop products exists, but requires active development. Cold-pressed bottled and branded rapeseed oil is an example of this approach.

Opportunity / Benefit:

- There is scope and need for growers and the crops industry to adopt more break crops to enhance the sustainability of crop production. With increasing challenges from pathogen, pest and weed resistance, rotation benefits are likely to increase.
- For the larger industry, wider adoption of break crops reduces dependency on one or two cereal commodities and in the case of protein break crops, gives an option for indigenously produced animal feed protein which could add considerable value to produce sold to markets requiring specific provenance and traceability.
- The development of more niche market crops or crop products offers the opportunity for access to a higher value market with specific quality and provenance requirements that allow smaller producers and growers develop profitable and sustainable production models.

Collaborating Institutions:

Teagasc and UCD

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Teagasc project team: Dermot Forristal (PI), John Carroll, Faisal Zahoor, Fiona Thorne, Eimear Gallagher.

External collaborators: Jim Burke (UCD), Liam Brennan (UCD), Gary Gillespie (UCD) Industry steering committee.

1. Project background:

- Crop rotation can result in improved soil nutrient uptake and reduced pest and disease challenges, returning improved crop yields. In Ireland where traditional rotations included grass pastures until the 1970s, the practice of rotation with break crops was not universal and that legacy now results in only 10% of our arable area being sown to break-crops. This inadequate level of rotation is of particular concern today where low soil organic matters and challenging pest, disease and weed control make monoculture cereals less sustainable.
- Ireland and European animal feed markets are deficient in protein sources leaving production exposed to changes in world supply and demand. Similarly some food export markets are now looking for a level of animal feed traceability and provenance that imports may not meet. There is scope to develop indigenous feed protein supply based on break-crop production.
- Approximately 80% of Irish crop produce ends up on the feed grains market where returns are based on world commodity prices, and added value opportunities are limited. Options to broaden the crop base such as growing lower volume commodities where traceability may be valued (e.g proteins) or seeking high-value specialty markets which may be as diverse as cold-pressed bottled rape seed oil or nutraceuticals.

This project sought to address the lack of cropping diversity by studying the role of break-crops and considering crop and crop product options.

2. Questions addressed by the project:

- What benefits do break-crops bring to rotations internationally and in the Irish context? What is the value of this benefit and what contributes to this benefit (nutrition, disease and weed control etc)?
- What are the broad-acre crop options available for Irish growers considering markets, suitability for climate, research and extension support etc?
- What are the high-value crop or crop product options that might be available now or in the future as cropping options for Irish growers?

3. The experimental studies:

The research approach used was a desk study. The elements of the work included:

- A review of all literature relating to the performance of crops in rotations focusing in particular on the impact of break crops, such as legumes and oilseeds, on the performance of the following cereal. The impact on crop nutrition, disease, pest and weed control was studied along with the impact on crop production economics.
- For each of eight potential break crops (Beans,Peas, Lupins, Oilseed rape, Camelina, Forage maize, Fodder beet, Starch potatoes) the relevant literature and information sources were studied to effectively rank their potential for adoption in Ireland. Each crop was studied under the headings: quick facts; crop description; markets; suitability for Ireland; rotational benefits; R+D status; and crop production summary.
- For a further 14 ‘minor’ crops (Amaranth, Borage, Calendula, Camelina, Crambe, Echium, Flax / Linseed, Hemp, Hops, Lentils, Lupins, Oats, Poppy, Quinoa) a less detailed synopsis of their potential was developed.
- Studies on the potential use of bio-products from crop sources and on the supply of plant-based protein were also carried out.
- A website was developed as a repository for all of the reports produced from this work . https://www.teagasc.ie/crops/crops/research/research-programme/cropquest/

4. Main results:

- A review of the agronomic, environmental and economic benefits of break crops indicated the positive role of break crops in rotations. Considering the importance of rotations, there was relatively

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little relevant research on their benefits due to the long term nature of this research. While international research indicated huge variability in yields following break crops 0 to 30%+, Irish research suggests a typical yield benefit of about 10%.

- Simple modelling of the economic benefits of including break crops in rotations in Irish production systems indicates that rotations using broad-acre break crops like beans or oilseed rape increased annual margins in rotations by between €101 and €118/ha compared to monoculture.
- Field Beans were considered to be one of the break crops with most potential due primarily to: the potential market for native protein in animal feeds; its yield potential and suitability for Irish conditions; common machinery requirement but different working windows to cereals; partial research programme in place; current protein crop subsidy and N-fixing capability (legume). However the challenges in developing the market for feed (against simply imported ingredients) along with the need to develop breeding and agronomy were also highlighted.
- Oilseed rape was also considered to have potential in the Irish production system, being well adopted to our climate and also being compatible with cereal production equipment, while having different sowing and harvesting dates. While there is a certain amount of research supporting agronomy in our climate, the need to ensure that management systems are optimised for our mild climate, where excess growth and fungal disease can be problematic, was identified. While there is significant potential to displace food oils for human consumption, there is no large scale oil crushing facility in Ireland so the only food market is the small scale but high-value cold-pressed bottled oil product. The remainder is used either as whole seed protein and energy source in feed rations or is exported for crushing.
- Both Maize and Fodder beet were both considered as forage break crops that have a potential market with direct sales to livestock farms, but that market is currently poorly developed with potential buyers reluctant to participate in properly structured contracts. As a consequence demand and price vary excessively with the season. Fodder beet is very well adapted to our climate and yields well, but there are a limited number of buyers for the product. Maize performs much more variably, but there is a steady demand, fuelled in part by individual dairy farm expansion and the need to purchase in forage where the land base is limiting.
- Lupins and Peas were considered to be legume crops with limited expansion potential. They have different amino acid profiles to beans and consequently suit specific feed rations (pigs, poultry, calves etc). Their agronomy is less well developed than beans but there is a potential for these crops as an additional legume to beans.
- Camelina is an oilseed crop with a different, potentially healthier fatty acid profile than rape seed oil, which may make it attractive as a human food oil source and in rations for poultry. There is limited plant breeding and Irish agronomy research is also restricted, but it may be considered as a speciality alternative to rape seed oil for some markets.
- Starch potatoes were considered but, Irish production costs were considered too high for this relatively low value product.
- Sugar beet was not considered as part of CROPQUEST as other feasibility studies were in process for this crop.
- A total of 14 minor crops were also briefly reviewed and reported on, which is available at https://www.teagasc.ie/crops/crops/research/research-programme/cropquest/A detailed report on the full range of bio-products which could potentially be developed from existing or new crops through crop fractionation, was produced. The product categories included biopolymers, chemicals, modified starches, amino acids and vitamins. These options all require the establishment of processing facilities and are consequently for consideration by the industry in the long or medium term.
- A literature review of high-value protein products was generated to underpin and support the potential future development of an indigenous Irish plant protein sector.

5. Opportunity/Benefit:

- There is scope for growers and the crops industry to adopt more break-crops and to be proactive about putting in place the necessary supports to allow these alternative options to develop. The benefits of break crops in rotations are clear with yield increases in the succeeding crops of approximately 10% being recorded. This benefit from rotation is likely to increase as reduced efficacy of all plant protection products increases due to reduced sensitivity and development of resistance in the target pests. Decreasing soil carbon will also reduce the sustainability of cereal monoculture.
- A protein deficit across Europe in feed and food, indicates the opportunity for producing indigenous protein, which may help stabilise price, but would provide an indigenous traceable protein source

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that may enhance the provenance of the resulting animal product. This report clearly shows the potential for legume and oilseed crops to address the protein deficit.
- High-value crop options are more challenging to develop but may offer greater rewards. The existing cold-pressed bottled oil market for example offers scope for further development, where the development of unique quality standards in terms of fatty acid profiles and production standards could underpin future growth. Of the minor crops, Quinoa may offer some scope for development in Ireland.
- Fractionation of crops at an industrial scale may offer scope for developing alternative products, however considerable investment may be required to develop processing facilities and relatively inexpensive feedstock may be required resulting in limited returns for growers.

Overall there are many benefits to broadening the crop base, for growers and the wider industry. However these opportunities will not be realized unless there is a concerted approach to developing these opportunities by all stakeholders including growers, crop users, research/technology transfer suppliers and policy makers.

6. Dissemination:

The main dissemination tools for this project were the production of a website which acts as a repository for the reports generated, the publication of a peer reviewed paper and presentation of the results at an industry workshop and a number of conferences.

Main publications:

- Carroll, J., Thorne, F., Zahoor, F., Forristal, P.D. (Submitted). A review of the agronomic, environmental and economic benefits of break crops: an Irish case study. Irish journal of Agriculture and Food Research.
- 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/

Popular publications:

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

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