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## Crop production systems



### Key external stakeholders:

Cereal and crop growers; Crop production industry; Other research teams.

### Practical implications for stakeholders:

- Increased use of break-crops will increase the yields of cereal crops in rotations and offer scope for input reduction, making tillage production more sustainable.
- The response to rotation adoption is site-specific requiring careful selection of the individual crops within a rotation.
- To make rotations viable, the industry needs to grow the market for break-crops such as oilseeds and legumes.

### Main results:

- Growing break-crops in rotations increases the yield of cereals in the rotation and allows input levels to be reduced offering scope to improve the profitability of cereal production.
- The overall effect of adopting rotations in place of monoculture depends on grain and input prices, and particularly on the relative yields of the rotation component crops on the specific soil and site.

### Opportunity / Benefit:

There is considerable scope to capitalise on the benefit from the incorporation of break-crops in rotations. Yields and margins from the following cereal crops can be increased and input levels can be reduced. This can result in more sustainable production. This profitability and sustainability potential indicates the potential for the development of break crop production, giving more diverse cropping opportunities for growers; more native produced protein for feed compounders, and more diversity for all involved in the crop sector.

### Collaborating Institutions:

IT Carlow and Cork IT

**Teagasc project team:** Dermot Forristal, Brendan Burke.  
**External collaborators:**

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### 1. Project background:

Crop rotation has played a lesser role in Ireland's crop production systems, than in other countries, as Irish growers have tended to produce proportionally large amounts of continuous cereals, either spring barley or winter wheat, in the absence of significant break-crop markets. For many years, crop yields in this monoculture system were sustained by relatively high levels of soil nutrients; a beneficial legacy from the mixed farming systems which predominated until the late 1970s. However as fertility and soil organic matter reduce, input levels have risen in an attempt to retain the high yielding capacity of these soils. While this relatively simple model of production has performed reasonably well, production costs are high and cereal yields have plateaued or declined with successive cereal cropping. In this context, the role of crop rotation needed to be addressed. A previous project (RMIS 5249) had established a complex long-term field trial to evaluate input levels and rotations. While the earlier phase of the trials covered by the previous project focused on the role of input levels in crop production, the long trial history allowed more meaningful comparisons of rotations to be carried out. This was the focus of the project reported here. The main objectives of this work were to:

- 1) Determine the role of rotations in crop production in terms of impact on individual crop yields and on the crop production and economic performance of the entire rotation.
- 2) Assess the effect of input levels on crop performance in the main cereals and to assess whether there was any interaction between input level and rotation

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### 2. Questions addressed by the project:

- What impact do break-crops have on subsequent crop yields?
- How do cereal and break-crop rotations compare with monoculture spring barley and winter wheat in terms of crop yields and particularly profit margin?
- Do the levels of inputs used impact on the response achieved when rotations are used?
- Where high levels of inputs give improved performance with spring barley, is it the crop nutrition or disease control element which is more important?
- Which are the key inputs which produce a yield response in winter wheat (seedrate, N level and fungicide use) and do they interact with one another?

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### 3. The experimental studies:

Two rotations were compared with monocultures (i.e. continuous cereals) in a long term systems field trial, which also evaluated input levels. The individual plots were relatively large (30m x 12m) located on a moderately heavy textured soil at Knockbeg, adjacent to the Teagasc Oak Park research centre, and the experimental design included four replications. A five-course break-crop rotation had a cropping sequence of: field beans; winter wheat; spring barley; spring oilseed rape; and winter barley. A cereal rotation where oats was used as a disease break for 'take-all' had a cropping sequence of winter oats; winter wheat and winter barley. Production in these rotations was compared with both winter wheat and spring barley grown in monoculture. As winter wheat was grown in monoculture and both rotations, the trial facilitated detailed analysis of this crop. Similarly winter barley was grown following a break-crop, and following a cereal, allowing useful comparisons. Production input levels (fertilizer, fungicides, herbicides etc) were also examined in this trial in combination with the rotation treatments. Two levels of inputs: high and low, were applied to all the cereal crops grown in monoculture or rotations. The 'high' level of inputs were similar to that used by commercial growers which included the maximum recommended rates of fertilizer, and recommended rates of plant protection products, for weed and disease control. The 'low' level of inputs used 80% of the fertilizer nitrogen applied to the high-input crops and 50% of all plant protection products applied at the same timing as in the 'high' strategy. Sowing date and variety was also varied with winter wheat where a later sowing date and more disease resistant variety were used. Crop performance and financial margin were assessed in these trials. A separate multi-factor trial focused on the interaction between seed rate, nitrogen use and fungicide use using a conventional small plot design.

#### 4. Main results:

The main results of the trial were:

- Cereal crops grown following break crops in rotations had higher yields and greater profit margins than those grown in monoculture. Over 7 years, winter wheat following a break crop yielded 1.1t/ha or 11% more than continuous wheat, whilst winter barley yielded 0.73t/ha or 9% more than barley grown after a cereal. This translated into margin gains of €174/ ha and €111/ha respectively for winter wheat and winter barley grown following a break crop.
- The response following break crops was influenced by input level. Crops grown with low levels of inputs benefitted more from rotation than crops grown with high levels of inputs. This indicates also that rotation benefits would be greater when grain prices are lower.
- The yield benefit to a wheat crop following oats was similar to that following beans, indicating that take-all was the major factor influencing yields and profitability at this site.
- The translation of break-crop yield benefits to entire rotations depends on the performance of all crops in the rotation. In this trial in Knockbeg, the break crops (beans and spring oilseed rape) did not perform particularly well and coupled with the suitability of the site for winter wheat production, resulted in margins from the entire rotation being similar to continuous wheat. Spring barley grown continuously performed least well.
- Where the break-crop yield benefits are coupled with the national average yields of the component crops, rotations are however more profitable than continuous wheat or barley production.
- At Knockbeg, high input levels increased winter wheat grain yield by an average of 8.4% (0.9t/ha) but there was a substantial season effect. With winter barley, the use of high levels of inputs increased yield by an average of 14%. Spring barley had the biggest yield benefit from the application of high levels of inputs, with an average 18% grain yield increase at the Knockbeg site.
- On a more disease prone site (Kildalton), the response to input levels was more season dependent with higher disease pressure seasons favouring higher input levels on wheat as well as barley.
- Additional trials designed to determine the source of the yield response in spring barley showed that the response was primarily to the additional N applied (135kg/ha vs 105kg/ha) rather than to disease control.
- A two season evaluation of the potential interaction of seeding rate, applied N rate and fungicide rate indicated that lower seed rates can reduce the need for fungicides in wheat crops in a disease prone season

#### 5. Opportunity/Benefit:

- There is considerable scope to capitalise on the potential benefit from the incorporation of break-crops in rotations. Yields and margins from the following cereal crops can be increased.
- The use of rotations can also allow input levels to be reduced, thereby increasing margins. This can be particularly beneficial when grain prices are low.
- These benefits can make production more sustainable particularly on sites in continuous crop production for long periods, as monoculture on these sites can require high input levels and have limited yield potential.
- The response to rotations and input levels is site specific however; component crops and input levels need to be carefully selected to optimise performance.
- The profitability of rotations illustrates the potential for the development of break crop production, giving more diverse cropping opportunities for growers; more native produced protein for feed compounders and more diversity for all involved in the crop sector.
- The interaction between input levels (seed rate and fungicide response) indicates the scope for developing cultural aspects of disease control.

#### 6. Dissemination:

In addition to the publications highlighted here, this project provided a centre point for visiting groups (growers, advisors, industry including groups from other countries) to discuss systems of crop production for many years.

**Main publications:**

- Forristal, P.D., Grant J. (2011) The impact of break-crop and cereal rotations on crop performance and profit margins. Aspects of Applied Biology 113 p29-36.
- Forristal, PD., Burke, B, Grant J (2012). The effect of rotation and input level on winter wheat performance . In proceedings of the Ag research Forum 2012. p108.
- Forristal, PD., Burke, B (2008) The combined effect of seed, nitrogen and fungicide rates on disease levels and grain yield in winter wheat. In proceedings of the Ag research Forum 2008 p52.
- Forristal, PD., Burke, B (2007) The effect of input level on winter wheat and spring barley grain yield and profit margin on a disease prone site. In proceedings of the Ag research Forum 2007 p39.

**Popular publications:**

- Forristal, PD., Burke, B, Grant J (2012). Rotations for profit. T research Vol 7 p 30-31
- Forristal, P.D. (2009). Crops open day booklet and presentation, Teagasc Oak Park 2009
- Forristal, P.D. (2011). Crops open day booklet and presentation Teagasc Oak Park 2011
- Forristal, P.D. (2007). Can we reduce costs and increase profits. Proceedings of the National Tillage conference.

**7. Compiled by:** Dermot Forristal