

Project number: 5249
Funding source: Teagasc

Date: September, 2012
Project dates: Jan 04 – May 07

Cereal production systems



Key external stakeholders:

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

Practical implications for stakeholders:

- Growers need to consider their level of input application carefully and should challenge the notion of fixed levels of inputs. There is scope to save costs and improve profits, but decisions need to be crop, site, and season specific.
- Rotations offer benefits to growers but their overall adoption will require significant development in production technology and particularly in the provision of stable markets.

Main results:

Profit margin can be increased by optimising input levels rather than adopting an inflexible, high-input strategy. Low-input approaches in winter wheat production can be more profitable whereas spring barley profit may be reduced by lowering the spend on inputs.

Crops grown in beneficial parts of a rotation yield better than those grown in monoculture; due mainly to disease reduction. However the relatively poor performance of the break crops can result in the profitability of the entire rotation being no better than continuous production of a cereal crop.

Opportunity / Benefit:

There is scope for growers to improve their profit margins by attempting to tailor their inputs to crop needs and by managing their crops in an integrated manner including varietal choice, sowing date and disease control strategy. The work highlights the need for continuing research to more accurately guide growers decisions about input levels in particular crop situations. While crop rotation can benefit crop yield there is a need to develop markets and production technologies for specific break crops to facilitate the profitable uptake of this research.

Collaborating Institutions:

IT Carlow and Cork IT (separate studies using this trial site)

Teagasc project team: Dermot Forristal, Brendan Burke.
External collaborators: N/A

1. Project background:

The production of cereals in Ireland has largely been based on relatively high inputs of fertilisers, herbicides and fungicides, as growers have sought to exploit the high crop-yield potential of our climate. Variation in weather conditions has steered growers towards strategies of input application where high and relatively fixed levels of inputs are used to ensure that near maximum yields can be achieved in any given season. This may not be the optimum approach as the response to inputs in a single crop type will vary with site and seasonal weather effects. There may also be a relationship or interaction between levels of different inputs. If for example early autumn sowing of a winter cereal is coupled with high fertiliser nitrogen rates and the use of a disease-prone variety, then it's possible that the response to a high input disease control programme will be much greater than with a later sown, more disease resistant variety, grown with less fertilizer nitrogen.

The role of rotations in modern cropping systems also needs to be addressed. As crop production has become more specialised, the practice of monoculture has increased with many growers prepared to accept reduced yield potential for simplified cropping systems, and the less variable crop performance and market opportunities than that associated with many rotation break-crops. However, the impact of crop rotation on crop performance in high-input crop production systems is not fully known. The possible interaction between rotation and input level i.e. the potential reduced need for high input levels with crops grown in rotation, has not been addressed.

2. Questions addressed by the project:

- What is the impact of level of inputs (fertiliser, herbicides, fungicides etc) on the performance of the main cereal crops grown in Ireland?
- Where high levels of inputs give greater yields, is this the economic optimum for crop producers?
- Do rotations benefit crop production; specifically what is the effect of a break-crop on the subsequent cereal crop performance?
- Can an exclusively cereal rotation deliver benefits comparable to a traditional break-crop rotation?
- How do complete rotation systems compare economically with cereals produced in monoculture?

3. The experimental studies:

The research questions were addressed in a large-plot (30m x 12m) field trial on a moderately heavy textured soil at Knockbeg, adjacent to the Teagasc Oak Park research centre. Two levels of inputs: high and low, were applied to a range of cereal crops (winter wheat, spring barley, winter barley and winter oats) over the duration of the trial. 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. For winter wheat, a high yielding variety was sown in the beginning of October. 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. For winter wheat, a later sowing date (mid-October) and more disease resistant variety were used.

Two rotations were compared with monoculture (i.e. continuous cereal) in the same trial. A five course break-crop rotation had a: winter bean; winter wheat; spring barley; spring oilseed rape; winter barley cropping sequence. A cereal rotation was also included (winter oats; winter wheat; 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. The input levels and rotations were combined in a field trial design that allowed the combined impact of these factors to be assessed. The impact of input level and rotation was measured by assessing crop performance including plant establishment, disease development and harvest grain yield and quality. Also as both input level and the crop type used in a rotation can impact on production costs, a financial analysis of crop performance was carried out to produce individual crop, and entire rotation, production margins.

4. Main results:

The main results of the trial were:

- 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 high inputs giving no increase in one year and a 23% yield increase in a season with high yield potential.
- With winter barley, the use of high levels of inputs increased yield by an average of 14% with a lesser level of variation than winter wheat (12 to 20%).
- Winter oats had an average of 11% increase in yield with little seasonal variation where a higher level of inputs was used.
- Surprisingly 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.
- With winter wheat, the low input strategy gave the highest production profit margin overall, as the savings in production costs were equivalent to 1.4t/ha in grain yield. However season had an effect with the high-input system being marginally more profitable in one year which had high yield potential.
- On this site, normal practice, in terms of input application, for spring barley, was close to optimal whereas normal practice for winter wheat was excessive, resulting in poorer profit in most years.
- Input level had little impact on winter barley profitability as the yield increase with the high-input strategy was cancelled out by the extra production costs.
- With winter oats, the relatively modest increase in costs associated with higher levels of inputs gave a small financial gain.
- Spring barley gave the biggest economic response to higher levels of inputs where the 1.2t/ha average yield benefit easily outweighed the equivalent 0.7t/ha additional cost of the strategy.
- Winter wheat grown after a break crop yielded between 6% and 8% more than monoculture wheat. Where low inputs were used, the benefit of the break crop was slightly greater. Winter barley also yielded more when grown in a favourable position in a crop rotation.
- The level of the root disease 'take-all' was halved in wheat grown after both a break crop and oats compared to monoculture; allowing wheat in the cereal rotation to perform as well as in the break-crop rotation.
- The profit margin from wheat produced within a rotation was between 20% and 31% greater than from monoculture wheat.
- When the profit margins of all the crops within the rotations were taken into account, the monoculture wheat was as profitable as either of the two rotations due to the poor financial performance of the other crops in the rotations. This result is influenced by the market prices used and by the favourable performance of wheat on the particular site.
- The impact of rotation type or input level on disease levels and grain quality was small.

5. Opportunity/Benefit:

- The low-input systems used in these trials generally reduced yields, but the level of yield response and the effect of this response on profit margin were determined by crop and season. There is scope with winter wheat to increase profit by reducing input levels. Conversely the spring barley results indicate that a universal input reduction approach cannot be justified.
- The concept of using easily-managed high-input systems with pre-determined rates of inputs should be challenged to promote the development and application of more appropriate systems that respond to crop needs and seasonal variations. This will ultimately involve the development of appropriate decision support systems based on, and/or validated by, Irish crop research data; a significant task that should not be underestimated.
- Crop rotation can bring yield and production margin benefits to individual crops within the rotation, however this work clearly shows the need to develop suitable markets and production methodology for break crops to improve their profitability.

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)

Main publications:

- Forristal, P.D., Hogan, J.J. Burke, B. (2005) 'Rotations: a new role in a new era' In Proceedings of the National Tillage Conference 2005, Teagasc, Oak Park, Carlow.
- Forristal, P.D., Burke, B. (2007) 'Can we reduce costs and increase profits' In Proceedings of the National Tillage Conference 2005, Teagasc, Oak Park, Carlow.
- Forristal, P.D. Forristal, P.D. (2007). The effect of input level on winter wheat and spring barley on grain yield and production margin on disease prone site. In: In Proceeding of the Agricultural Research forum 2007, Tullamore, 12-Mar-2007

Popular publications:

- Forristal, P.D. (2004). Crops open day booklet and presentation, Teagasc Oak Park 2004
- Forristal, P.D. (2007). Crops open day booklet and presentation Teagasc Oak Park 2007
- Forristal, P.D. (2007). Can we reduce costs and increase profits. Todays Farm 18 2 2 pp

7. Compiled by: Dermot Forristal
