NATIONAL
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CONFERENCE
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10.30	Conference Opening: *Professor Gerry Boyle, Director of Teagasc*

Session One:

Chairman:	*John Spink, Teagasc, Crops Research, Oak Park*
10.45	Grain marketing – a farmer's approach *Mark Wood, Farm Manager UK*
11.30	The tillage better farms programme *Tim O'Donovan, Teagasc, Kildalton*
12.00	Machinery: controlling your largest costs *Dermot Forristal, Teagasc, Oak Park*
12.30	Nitrates & Nitrogen for cereals *Richie Hackett, Teagasc, Oak Park*
13.00	Lunch

Session Two:

Chairman:	*Andy Doyle, Irish Farmers Journal*
14.30	Septoria sensitivity and disease control *Steven Kildea, Teagasc, Oak Park*
15.00	Oilseed rape management and disease control *John Spink, Teagasc, Oak Park*
15.30	Winter barley: maximising yield *Michael Hennessy, Teagasc, Oak Park*
16.00	Close of Conference *Dr. Frank O'Mara, Director of Research, Teagasc*
16.15	Tea/Coffee

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Grain Marketing - a grower's view

Mark Wood
Farm Manager, JPF Clay Farms

SUMMARY

With world grain markets being so volatile, the individual grower needs to become a little smarter and make informed decisions as to how to grow and market their crop. Use needs to be made of risk management strategies to minimise the impact of price fluctuations as well as take advantage of peaks in price.

Growers need to start working together with each other and grain marketing companies to achieve better returns. Producing grain needs to be carried out as a business, not as a lifestyle. It is important to achieve the best average price.

INTRODUCTION

There is a lot of advice at conferences like this, as to how to grow a good crop and how many sprays of a certain product should be sprayed. All very good information, but growing a good crop is only part of the battle to achieve a profitable crop. How a crop is sold has a massive impact on overall crop profitability.

Ireland is moving towards a similar way of grain selling as the UK, with the use of forward selling, options, pools etc now being available. So how can the average farmer make best use of these tools to sell their grain in what is a global market driven by factors that are way out of his control?

In this report I have tried to give a growers perspective of how I sell our grain and some of the many factors that I consider while trying to make a decision on when and how to sell. I hope that I will pose some questions that will make you look at how you sell your crops and challenge what we are all doing.

BACKGROUND

I am not from a farming background, but have been involved in farming since an early age. I attended college, going to Harper Adams and studying HND Agriculture. After college, I had several different roles on farms before becoming assistant manager at the 3500 acre Cranborne Estate in Dorset. In 2003 I was appointed to my current role of Farm Manager responsible for all farming operations from planning through to selling.

As Farm Manager for J.P.F. Clay, I run the Brockhampton and Perrystone estates in South West Herefordshire. In total we farm approx 2500 acres, some in-hand, the rest is under contract farming and tenancy arrangements. About 1750 acres of the land is under arable cropping with the main crop being Winter Wheat, as this consistently produces the best Gross Margin. We also grow the break crops of Winter Oilseed Rape, Spring Beans, Spring Peas and Winter Oats. All of these provide a good average gross margin, but do tend to be boom or bust either due to growing conditions or Market supply and demand.

Most of the rest of the land is steep and not ploughable and is down to low input grassland supporting 400 head beef herd. Based around Suckler cows, we are currently finishing everything we produce due to the constraints of TB.

Being an estate farm we are heavily involved in supporting the other estate enterprises, including estate maintenance, forestry and 2 shoots. For our sins we plant 170 acres of game crops for the shoot, very time consuming!

For the arable part of the business, our average field size is just 12 acres. Being in Herefordshire, famous for it's woodland, nearly every field has a tree or 2 in. We unfortunately are unable to take advantage of the large pieces of equipment and tractors that our arable acreage might lead you to believe we have as we just can't turn it around and get the productivity needed.

Our soils are at worst sand, at best sandy loams. Easy working in respect that if cultivations are timed they "fall apart", but on the downside they are very abrasive and will not stand any sort of drought, we need some rain each week to achieve potential. We have moved away from a fully plough based system, using a sub-soiler and a "top-down" cultivator as well as the plough to prepare seedbeds. All drilling at the present time is carried out by a power harrow drill combination, slow but the end product is good.

For this presentation I am going to concentrate on Wheat as the crop is commonly grown in both countries, so a few facts as to our Wheat crop. Average yield is 9.25 tons per hectare. We grow 4 different varieties, Alchemy, Panorama, Viscount and Einstein. I decide upon varieties by end market, disease profile and development type, (decides drilling date). I apply 200kg N per ha along with 3 fungicide applications. As in Ireland, our main disease pressure is Septoria.

My approach to selling

I am strong believer in trying to do everything I can so as to not produce a crop that I sell at a loss. Selling grain over the last few years has become a lot more difficult with massive fluctuations in price over a selling period. I liken selling grain to a game of poker; there are massive risks involved. There can be gains as well as large losses if gambles are taken. I, along with most other growers cannot afford to take these sorts of gambles with the business's future, so I take a position of trying to manage the risks involved. Due to not having a crystal ball I may not hit the market highs with all my grain but I don't end up at market lows, my average is what matters and over the past 7 years I have been in the top half of the market average and able to reinvest in my business. I do this by managing the risks involved as much as a single farmer can. I do take advice from traders and advisors to help me reach decisions but at the end of the day the buck stops here.

Key Decisions

Before thinking about growing any crop, a few key decisions need to be made. Some might seem very basic, but how many of us actually think these things through? The best way to take these decisions is in consultation with advisors and traders.

What crop does the market want?

There are a large amount of growers that grow the same crops year after year without any consideration to what the market actually wants. A prime example is one of my neighbours has stuck with feed barley, because his father had grown it. The barley market around us has been over-supplied for many years. Marketing a crop that is not wanted is always going to be an uphill struggle. Why grow what you can't sell at a profit? I strongly believe in talking to the end users to discuss what the market requires. There are situations when a lower gross margin crop is sensible to grow, such as a disease break etc, but it must be taken into account at the planning stage and in conjunction with the end user. This is the first point at which a grower has a choice to have to a profitable crop.

What variety and spec does the market want?

This is an extension of above, grow what can be sold. An example of this is when I took over at Brockhampton they concentrated on milling wheat; the nearest mill is a £14/t haul away. For a premium of only £10/t on average, is it worth it? Coupled with the increased risk of rejection, I decided to drop going for the milling premium and concentrate on feed wheat. This was reinforced by the fact that 8 miles away is a large feed mill producing chicken feed, which pulls in wheat from a large part of the surrounding area and from all traders. There are other feed mills in the locality, which I can deal with directly, and this adds another dimension to the market around us. Again at this point growers have a choice to make as to how profitable they can be.

There are many reasons that might force a grower into selling their crop in a certain period. Number one has to be cash-flow. It is fine trying to achieve the better prices in December, but if your business has a cash-flow that dictates you need to sell off the combine then your hands are tied. Secondly, have you any storage? If there is nowhere to store and condition your crop then again selling is enforced.

This is not the end to marketing, as selling at harvest does not mean having to accept spot prices. By use of forward marketing you can have a price that meets your needs. Also different companies and co-ops in the UK offer storage deals, or ultimately a case could be made for storage facilities to be built.

In our own situation, I have added to the storage facilities so we do not have to sell off the combine. In the past 7 years I have added 8000t of storage, half for us and half for third party customers. We have received encouragement from the EU for this, but it has offered ourselves and other farmer's flexibility to supply what the market requires. We benefit from an average £20/t increase in prices from harvest to November.

I do have to sell some grain by November to aid the cash flow so as I can pay for my fertiliser. This tends to be the position I do most forward sales into.

Cost of Production

One of the most important things before selling or even growing a crop is to know your cost of production. We are probably the only industry that produces a product to market and do not know what it has cost us to produce it. Why? Are we frightened to admit to ourselves our costs?

It does not have to be a complicated calculation, the back of an envelope will do, but it must be honest. If we are not honest the only one we are kidding is ourselves. When working out a cost, include everything from the obvious seeds, fert etc to storage costs and finance etc. For the actual farmers among us, include your labour, otherwise you will not get a true figure. The ultimate aim should be to not include any European subsidies in the calculation. Once this figure is known, growers then have the information to make a choice about marketing.

My cost of production is £77 per tonne before rent and £104 including rent. This includes everything and is the point at which I break even, the point at which my business will stand still. I aim for at least £10/t above this to allow for reinvestment

Actual Marketing and Selling

I find the calculation of my costs is key, as without it how do I know at which point to agree to sell for a profit? With this in mind you can then decide which strategy to use to market your grain. There are many tools that can be used for selling, all of which have been explained to you before by people more intelligent than I. You may choose to use pools, options or storage deals etc. They are great ways to help manage risk and achieve a good average price, but like any insurance policy there is a premium to pay but they do provide a choice to growers as too how to manage the risk.

Teagasc advisors will probably shoot me for saying this, but I don't use any of the above. I do all selling off my own back. I have tried pools before for a part of my crop but always felt disappointed with returns, especially once the commission had been taken off. I usually use forward contracts with some of the large grain trading companies, or recently some of the local mills are doing the same.

Key to this is having a basic understanding of the grain market. I get this by keeping up with 3-4 grain reports. I pay particular attention to independent reports such as HGCA and Defra as some of the grain company reports can be offset by their buying needs. I have also built up a rapport with several grain traders. In the UK most traders give honest advice, as they want a long-term relationship and a days shooting at the end of the season.

I also try to use the full marketing period, I find it is amazing that the trading period for each year's crop is open for nearly 3 years but nearly all grain is traded in the final year once the crop is harvested. I have a policy for selling:

¼ of the anticipated harvest before it is planted once my cost of production has been reached. Sometimes I will sell several small amounts to help minimise risk if the market dictates

¼ around the time of planting when areas are confirmed. This is again done once cost of production is passed. This is the final chance to change what I grow if the market is not right.
¼ is sold through the growing season, up to and including harvest.

The final ¼ is sold once it is safely in the barn and exact quantities are known. Sometimes I will keep this longer term, if prices are disappointing.

If at any stage prices are particularly strong I will sometimes sell a higher proportion if grain reports lead me to believe the market might slip. The opposite will happen if the market is weaker than needed.

For harvest 2011, I have already sold 50% of my wheat and 40% of my OSR. Average price on the wheat is £141/t, OSR is £312. These are my bankers, I have made money to reinvest and even if the market falls strongly I will still average a profit. Conversely if the market continues to move on I am making a margin that I am happy with and my average will improve with future sales

CONCLUSIONS

I view grain marketing as an absolute key part of our business; it is no use growing the best crop in the world if it is poorly sold. Most important is to grow what the market wants and to know your cost of production so as you can make informed decisions as to when selling will improve your business.

Managing the risk of marketing, whether using pools etc or by selling to a plan is essential. We are all on a world market and nobody knows for certain where the grain price will be in 12 months, so having a policy and sticking to it is essential to achieving good average selling prices every year. Your bank manager will not thank you for a boom and bust cash flow like our governments are doing. Average price for the season is most important, it is nice to be able to go down the pub and boast about selling a load of grain for a fantastic price, but it is the average price that will result in overall profitability.

One final point, don’t be greedy. If the price is above your cost of production and allows you to reinvest then sell some to set a base level in your budgets. The grain markets are so volatile now that they can drop over night and none of us like to sell on a falling market.

Once all the facts are known, informed decisions can be made. If some of the parameters do not suit, think around them. For example, if cash flow is an issue and you wish to sell later look at different financing options or deferring expenditure. If storage is a problem, look at the options, if you can’t afford to develop your own store, look at collaboration or a storage deal. It pays to think outside the box.

The Tillage Better Farm Programme

(Business, Environment and Technology through Training Extension and Research)

Tim O Donovan, Ciaran Collins, Dermot Forristal, Michael Hennessy, John Pettit, Shay Phelan

SUMMARY

The Teagasc Crops BETTER farm programme is a major programme in Teagasc aimed at developing stronger links between research, advice and farmers. Its main goals are to improve technology transfer to Irish growers through benchmarking and demonstrating best practise at farm level and also by having appropriate research trials on farms. Each of the three participating farms is working to a business plan which has been written to suit their own particular situation. The participating farmers work closely with their local Teagasc tillage advisors and avail of the Teagasc planning tools to help them make management decisions on their farms. The Crops BETTER farms host local and national farm walks as well as selected Teagasc and Department of Agriculture research trials.

INTRODUCTION

The Crops Better Farm programme is a major programme in Teagasc aimed at developing stronger links between research, advice and farmers. The programme aims to achieve effective technology transfer of the latest information from research and advisory at a local and regional level.

Teagasc advisors, specialists and researchers are working with selected farmers to look at all areas of their production systems and by implementing the latest technologies and research findings, ensure maximum efficiency is achieved. These farms will become a benchmark for efficient production and for transferring knowledge to other farmers.

Objectives

The overall goals of the Crops BETTER Farm Programme are to:

- Improve knowledge transfer to growers/industry at a local level by:
    - Improving the adoption of new technology
    - Up-skilling growers on existing methods and practices

- Improve the Crops BETTER farmer's circumstances, measured by:
    - Income
    - Net worth
    - Standard of living (work/life balance, etc.)

The Farms

Three tillage crops farms were asked to participate in the programme with the following criteria in mind:

- Representative of the local farming area
- Farmer maintains good farm physical and financial records and willing to share this information (in a sensitive manor) with the public
- Willingness to change current practices or try new methods
- Open to hosting trials or demonstrations

The selection process began in June /July 2009 and farms were selected in August. Planning decisions on the farm regarding cropping and rotations were amended for the 2010 season to accommodate demonstrations and replicated trials.

The three farms selected are as follows:

Table 1: Crops Better Farm Names and Location

Area	Farmer	Teagasc Advisor
South	John and Denis Crowley, Crowley Farm, Carigoon, Mallow	Ciaran Collins
South East	George and Ken Williamson, Ambrosetown, Duncormick, Co Wexford	John Pettit
North East	Joe O Donohue, Glassmerry house, Herbertstown, Stamullen, Co Meath	Shay Phelan

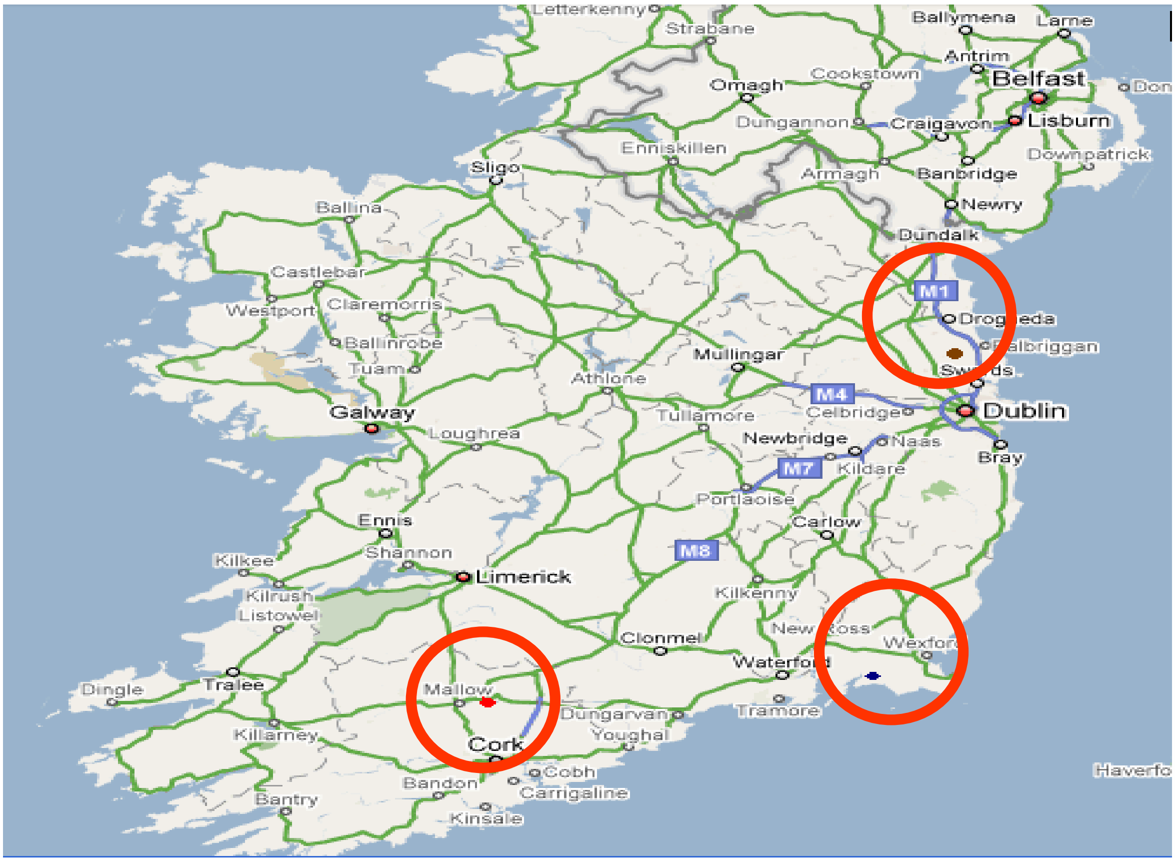

Figure 1: Crops BETTER Farms Location

During the programme these farms will be working closely with their advisor on key decisions including physical and financial planning, agronomy and other management decisions.

The farms selected are quite different in their size, land ownership and land fragmentation. All farms are specialised tillage enterprises however all the farms have a minor livestock enterprise.

All farms are currently farming to a good standard and using the most current cultivars, cultivation practices and agronomy inputs. Average yields on the farm are good and these farms can be ranked in the top third of growers in the country.

Farm Details: Cork Crops BETTER Farm

The Crowley farm is run on a full time basis by John and Denis (brothers) with the help of their father Denis senior. John and Denis are the two main labour units on the farm with some additional help at harvest and planting. Therefore efficiency of operation is key to completing the necessary farm operations in a timely manner.

Machinery on the farm is maintained to a high standard with a relatively new fleet and ample capacity for the farm operation. A hire tractor is used during the peek workload for cultivations during the autumn.

In order to keep up-to-date with technical issues John completed the Teagasc Advanced Tillage course over the last few years and is currently a member of the Castletownroche Tillage Discussion Group.

The Crowley's holding extends across North Cork within 50 miles from their base in Mallow. The farm is 384 hectares in total of which 336ha is owned and 48ha rented or leased. Soil type varies with location across the different farms from medium to heavy. Current land use is cereals only.

Table 2: Breakdown of 2010 land use on Crowley farm

Cropping	Approx area 2010	Av. yields 2006-08
Winter wheat	202 ha	10 t/ha
Winter barley	121 ha	8.6 t/ha
Spring barley	61 ha	7.5 t/ha

All grain is stored and dried before sale to maximise returns. Traditionally the farm was heavily involved in sugar beet production and the loss of this crop brought about substantial change in the farming system. As well as the inevitable financial loss, farm rotation also suffered and winter cereals are now the main focus.
The decision to confine the rotation to cereals, without a break crop, was influenced by factors such as:

- Soil type (medium to heavy)
- Fragmentation
- Farm size
- Labour availability
- Ease of management
- Local markets (especially for winter barley straw)

Challenges

Because of the loss of sugar beet and enforced change in cropping the farm has changed substantially over the past five years and agronomic issues such as Take-all and maintaining yields are becoming increasingly important. The following concerns are to the fore on the farm

- Maintain yields given there is no break crop and little imported organic manures coming onto the farm.
- Continuous wheat and continuous barley will be a feature on a number of their out farms and Take-all control will become an issue in the near future.

Wexford Crops BETTER Farm

The Wexford Crops BETTER farm is run by George and Ken Williamson. This father and son operation, in South Wexford, is typical of farming operations in the area, and they farm a combination of winter and spring crops with some contracting as part of their business. The soil type is mainly heavy to medium.

Table 3: Breakdown of 2010 land use on Williamson's farm

Cropping	Approx area 2010	Av. yields 2006-08
Spring barley	49 ha	6.8 t/ha
Spring Wheat	15 ha	7.5 t/ha
Winter cereals	18 ha	New enterprise
Other	50 ha	

The Williamson's rent approximately 75% of the 131 ha farmed. The farm was traditionally involved in sugar beet production and the loss of this crop was a blow to farm income. And now, like many other tillage farms in the region, the Williamson's grow a wide range of crops. Winter crops include wheat and oats along with spring-sown barley, oats and maize with some Miscanthus. The majority of the barley is grown for feed. The farm uses break crops (e.g. oats, fodder beet and maize) as much as possible and these are followed by spring or winter wheat. A number of fields are in continuous spring barley.

Currently grain is marketed at harvest each year but the Williamsons have built a new storage shed/workshop which can be used to store and aerate grain. The maize and all the straw are typically traded to local farmers (on a repeat basis). The Williamsons have an interest the energy company Wexgen who began to process the miscanthus into briquettes in 2010.

Machinery contracting to farmers in the local area is used to supplement farm income hence the number of machines on the farm is higher than typically found on a farm of its size. The contracting service ranges from ploughing and sowing cereals, to beet harvesting.

The Williamson's use a plough-based establishment system combined with one pass planting. All machinery operations are carried out by the Williamson's but some of the machinery cost is shared by their contracting business.

Challenges

- The main short to medium term challenge for the farm business is to work towards predominately a one-man labour unit system, from the current two-man labour unit system, whilst maintaining farm income.
- It is envisaged that a rotation focusing more strongly on winter cropping will increase current margins and will better match labour availability.
- Like many other farm businesses, the Williamsons have left important day to day planning decisions run close to the day of action. This can and does affect production systems and cost. A major challenge is to put in place a system for planning input strategies and pricing all inputs before purchase. This strategy will be strongly adhered to in the future and this farm has already seen the benefits of this in 2010.

Meath Crops BETTER Farm

Joe O'Donoghue and his brother, Colm, are full time farmers in the Meath/Dublin catchment. Approximately 60% of their land is rented with most of the land in smaller parcels spread upto 15 miles from their base in Stamullen, Co Meath. The soil type is prominently heavy or very heavy soil.

Table 4: Breakdown of 2010 land use on the O' Donoghue farm

Cropping (approx 2010)	Approx area 2010	Av. yields 2006-08
Winter wheat	109 ha	9.9 t/ha
Spring barley	125 ha	7.2 t/ha
Other	27 ha	

Access to a stable and affordable land bank has proven a challenge year in year out in this highly competitive tillage area. Fragmentation of and distances between farm parcels reduce efficiency, increase costs and interrupt timeliness of operations. These factors adversely influence profits and, consequently the O'Donoghue's are exploring all avenues to minimise this fragmentation including; Share Farming, long term leases and rental of larger parcels.

The home farm in Stamullen has a newly build farm yard with storage capacity for grain, machinery and a workshop. Grain is dried with a batch dryer and is marketed through the year while the straw is sold locally and to Northern Ireland buyers.

Winter wheat and spring barley have been the crops of choice due to soil type and land access, however, some winter barley was planted in 2010. Land which is acquired in springtime is usually planted to spring barley.

Despite the challenges, the O'Donoghues' have maintained a critical size while curtailing machinery spend to acceptable levels. Crop establishment costs are, however, high due to heavy soils and access to land in a timely fashion. Generally two powered cultivations are required to achieve an acceptable seedbed.

Joe O'Donoghue is a member of the 2% Discussion Group based in North Co. Dublin.

Challenges

The main challenges for the business are:

- Timely access to land on an annual basis. Late land acquisition prevents good planning, rotations and requires special management. These factors are influencing profitability and the O'Donoghues are exploring all avenues to minimise the problem. These include share farming, long term leasing and rental of larger parcels.
- The cost of crop establishment is higher on the O'Donoghue farm than average as a result of land access, soil types and previous management of soils. Access to a stable land base would enable more specific actions to be taken on difficult land and may also influence the replacement policy of current cultivation equipment.
- Input costs can be reduced through more aggressive planning and cost control. Advisory tools such as Nutrient Plans, chemical planner, etc. will be used to aid this process

- The next generation of O'Donoghues are now entering the farming business and this will provide new challenges and opportunities.
- It remains a challenge to increase the value of grain sales by exploring local markets.

Planning Process

One of the main aims of the Crops BETTER Farm programme is to improve the profitability of the three participating farms and by doing so demonstrate to other farmers the tools available to them to analyze their own businesses and make informed decisions based on fact.

Crop Analysis

Each of the three Crops BETTER farms has been completing the Teagasc Profit Monitor for a number of years. Data from the 2008 and 2009 harvests was taken to be the common baseline for the three farms for comparison and analysis purposes. In consultation with the farmers, the past farm performance was analyzed and appropriate recommendations and changes were discussed and agreed.

Both the Cork and Meath Crops BETTER farms have produced above average yields for winter wheat as shown in Table 5. High yields are being achieved in both farms but high input costs are resulting in lower gross margins than the 'top 10%' in the National Farm Survey (NFS).

Table 5: Financial Performance of winter wheat on Crops BETTER Farms

	Winter Wheat 2008 & 2009 Average			
	BETTER Farm		National Farm Survey	
	Cork	Meath	Average	Top 10 %
Grain Yield t/ha	9.6	10.2	8.9	9.2
	€/ha		€/ha	
Grain & Straw	1406	1431	1085	1437
Materials	645	749	589	445
Machinery	382	404	359	488
Gross Margin*	379	278	137	504

*Overhead fixed costs (car, phone, land maintenance, professional fees etc) and land rental must be deducted from Gross Margin to give Net Margin.

The Wexford and Meath Crops BETTER farms have spring barley yield well above the NFS average as shown in Table 6. Whilst yields are as good as or better than being achieved the top 10% of farms in the NFS Higher materials and machinery costs are resulting in slightly lower gross margins

Table 6: Financial Performance of spring barley on Crops BETTER Farms

	Spring Barley 2008 & 2009 Average			
	BETTER Farms		National Farm Survey	
	Wexford	Meath	Average	Top 10%
Grain Yield t/ha	6.8	7.2	5.8	6.8
	€/ha		€/ha	
Grain & Straw	920	1037	661	912
Materials	422	451	420	375
Machinery	381	406	271	303
Gross Margin	117	180	-30	234

*Overhead fixed costs (car, phone, land maintenance, professional fees etc) and land rental must be deducted from Gross Margin to give Net Margin.

Machinery Analysis

In order to understand the above average machinery costs a detailed machinery analysis was carried out by Dermot Forristal, Teagasc to quantify the costs on the farms and identify the factors contributing to them. This further analysis from the Wexford farm is presented in Table 7 as an example. In this case the significant contracting business was the cause of their apparent higher machinery costs. When this is removed by reallocating the appropriate costs to the contracting business, the machinery costs associated with crop production appear much more competitive. This emphasisies the complexity of machinery cost analysis on individual farms and stresses the need to develop analysis methodology to deal with it.

Table 7: Machinery costs and capabilities for Wexford BETTER Farm

Machinery costs and capacities on the Wexford BETTER Farm		
Overall Costs:		€295/ha (€119/ac)*
Cultivation costs:		€167/ha (€68/ac)
Power available:		5 kW/ha (2.7hp/ac)
	Own cereals	all cereals (incl contracting)
Plough time:	55hrs	134hrs
Till/ Sow time:	60hrs	127 hrs
Spray time:	10.1hrs	16.7hrs
Combine:	60.7hrs	129 hrs
Excl: transport, straw etc		

Business Plans

A medium term (3-5 years) business plan was developed for each BETTER farm by their advisors. Detailed discussions took place on all aspects of the farm business and possible future scenarios. Considerations such as succession, land availability, labour requirements and lifestyle etc were also included in the business plans.

Implementing the business plans

Each BETTER farmer avails of intensive advice from their Teagasc advisors as part of the programme. Depending on the situation, certain advisory tools are used to help make decisions on the farm and help the farm prepare for the busier times of the season. These tools include fertilizer plans, chemical calculators and variety selection and drilling date. Each decision is made with the major 3-5 year business plan in mind, but of course, adjustments are made as conditions dictate throughout the season.

A sample of some of the 2010 advisory tools used on the Wexford BETTER Farm is presented in appendices 1-3.

On farm research trials and demo plots

Research and Advisory integration on the farms is a high priority of the programme and with this in mind a number of trials were conducted on the BETTER farms. These trials were designed so that maximum benefit could be derived from them at open day events. Other groups locally were encouraged to visit the farms, especially where individual trials were of interest. The farmers were also encouraged to change practice and try out (or demo) different techniques or cultivars on their farm. Table 8 outlines the replicated trials and demonstrations carried out on the farms through the 2010 growing season.

Table 8: List of Trials and Demos on Crops Better Farms

Description	Trial /Demo	Cork	Wexford	Meath
Variety Trials (DAFF)	Replicated trial	Early sown Winter Wheat	Spring Barley	Early sown Winter Wheat
Weed Control (Teagasc)	Replicated Trial	Winter Wheat	Spring Barley	Winter Wheat
Fungicide Trial (Teagasc)	Replicated Trial	Winter Barley		
Winter Wheat Nitrogen Response trial (Teagasc)	Replicated trial	Winter Wheat		Winter Wheat
Trace Element Response Trial (Teagasc)	Replicated Trial		Winter Wheat	
Potash Response Trial (Teagasc)	Replicated Trial		Winter Wheat	
Varieties (Seed supplied by Goldcrop and Seedtech)	Demo (strips or areas)	Winter barley (3 new varieties)	Winter wheat (one variety)	Winter Barley (one variety)
Seed Dressing	Demo area		Winter Oats	
Agro-chemical applications (use of Amistar nozzles, courtesy of Syngenta)	Demo area	Winter Barley Fungicide treatment to cereals Normal V low water volume	Winter Crops Fungicide treatment to cereals Normal V low water volume	
Decision support system (DSS) Septoria timer	Influenced overall farm policy	Winter wheat	Winter Wheat	Winter Wheat
Spring sub-soiling	Demo area on headlands		Spring Barley	

Take Home Messages:

- Teagasc BETTER farms are:
  - Demonstrating new technology at local level
  - Using financial tools to plan for future
  - Benchmarking best practise at farm level

- All growers should complete financial analysis of their businesses using tools such as:
  - Profit monitor
  - E-Crops recording programme

- Planning ahead can increase your profit by:
  - Identifying key areas for improvement
  - Tailoring crop agronomy to match the field situation
  - Putting the grower in more control of the crop input decisions

Acknowledgement: Teagasc would like to thank all who contributed to the Crops BETTER Farm Programme particularly the three host farmers and their families, the Department of Agriculture (for variety trials) and various seed and agri-chemical companies (for materials supplied).

Appendix 1: Wexford Crops BETTER Farm Rotation Planner

Proposed Crop Rotation

Area	Area	2009	2010	2011
3rd Field inside Dorans	9.0	W. Oats	W. Wheat	W. Oats
2nd Field inside Dorans	20.0	W. Oats	W. Wheat	W. Oats
Bertha Murphys	4.0		W. Wheat	W. Oats
Dorans Field	18.5	S. Barley	W. Oats	W. Wheat
Shed Field Lough	14.5	S. Barley	W. Oats	W. Wheat
Fallons Field Lough	19.0	S. Barley	W. Oats	W. Wheat
Killag	42.0	S. Wheat	S. Oats	W. Wheat
Ryans Clearistown	10.0	S. Wheat	S. Oats	W. Wheat
T. Murphys	29.0	S. Oats	S. Wheat	S. Barley
Yard Field Home	12.5	F. Beet	S. Barley	S. Barley
Larry Murphys	6.0	Fallow	S. Wheat	S. Barley
Station Field	12.5	S. Barley	S. Barley	W. Barley
Carthys 4 Fields	17.0	S. Barley	S. Barley	S. Oats
Jennys Field	22.0	S. Wheat	S. Barley	W. Oats
Nick Stafford	8.1	S. Barley	S. Barley	F. Beet
Behind House Home	10.0	S. Barley	S. Barley	S. Barley
Maura Dorans	8.0	S. Barley	S. Barley	S. Barley
H. Rath	26.5	S. Barley	S. Barley	W. Barley
Shed Field Seafield	22.0	S. Barley	S. Barley	S. Barley
Michaels House Seafield	8.5	S. Barley	S. Barley	S. Barley
Susans Field Seafield	8.0	S. Barley	S. Barley	S. Barley
Gerry Roches	5.5	S. Barley	S. Barley	S. Barley
Pier Field Home	7.3	S. Barley	Maize	S. Wheat
Harristown	12.5	S. Barley	Maize	S. Wheat
Pat O'Connors	22.0	Fallow	Fallow	W. Wheat
Total	374.4			

	2009	2010	2011
W. Wheat		30.0	126.0
W. Oats	60	50	55.0
W. Barley		0	39.0
S. Barley	207	152	109.5
S. Wheat	75	35	19.8
F. Beet	8	8	8.1
S. Oats		52	17.0
Other	50	50	50
Total	400	377.0	424.4

Appendix 2: Wexford Crops BETTER Farm Drilling Plan 2011

	Area	*2011*	*Variety*	*Sowing Date*
3rd Field inside Dorans	9.0	W. Oats	Barra	09-Oct
2nd Field inside Dorans	20.0	W. Oats	Barra	09-Oct
Bertha Murphys	4.0	W. Oats	Barra	10-Oct
Dorans Field	18.5	W. Wheat	Alchemy	30-Sep
Shed Field Lough	14.5	W. Wheat	JB Diego	01-Oct
Fallons Field Lough	19.0	W. Wheat	JB Diego	02-Oct
Killag	42.0	W. Wheat	Alchemy	28-Sep
Ryans Clearistown	10.0	W. Wheat	Alchemy	01-Oct
T. Murphys	29.0	S. Barley		
Yard Field Home	12.5	S. Barley		
Larry Murphys	6.0	S. Barley		
Station Field	12.5	W. Barley	Cassia	23-Sep
Carthys 4 Fields	17.0	S. Oats		
Jennys Field	22.0	W. Oats	Miscani	27-Sep
Nick Stafford	8.1	F. Beet		
Behind House Home	10.0	S. Barley		
Maura Dorans	8.0	S. Barley		
H. Rath	26.5	W. Barley	Cassia	24-Sep
Shed Field Seafield	22.0	S. Barley		
Michaels House Seafield	8.5	S. Barley		
Susans Field Seafield	8.0	S. Barley		
Gerry Roches	5.5	S. Barley		
Pier Field Home	7.3	S. Wheat		
Harristown	12.5	S. Wheat		
Pat O'Connors	22.0	W. Wheat	JB Diego	03-Oct
Total	374.4			

Appendix 3: Wexford Crops BETTER Farm Chemical Calculator 2010

Microsoft Excel - Chemicals Farm Quantities 2010 v1

Crop JB Diago Alchemy

Rates can be reduced for Alchemy

Product	Area Treated (hectares)	Rate per hectare	Acres per pack	Full rate/ha	Total Quantity required	Pack Size	No. of packs required	Notes
CeCeCe 750	16.00	2.25	5.49	2.25	36	5	7.2	
Proline	16.00	0.65	3.80	0.80	10	1	10.4	
Bravo 500	16.00	1.00	2.47	1.00	16	1	16.0	
Venture Extra	16.00	1.20	10.30	1.50	19	5	3.8	
Bravo 500	16.00	1.00	2.47	1.00	16	1	16.0	
Gleam	16.00	2.00	1.24	3.00	32	1	32.0	
Harmony Max SX	16.00	70.00	14.12	140.00	1120	400	2.8	
Foundation	16.00	0.650	19.01	1.25	10	5	2.08	

Notes

Crop JB Diago Alchemy

Rates can be reduced for Alchemy

Instructions | Chemical Totals | Crop (1) | Crop (2) | Crop (3) | Crop (4) | Crop (5) | Crop (6) | Crop (7) | Crop (8) | Master | Pivot Table All C

Machinery: Controlling your Largest Costs

Combine cost case study

Dermot Forristal
Teagasc, Oak Park

SUMMARY

Cost control has always been important but market volatility has made it paramount for survival. Machinery purchase decisions are particularly important due to their long term effects. Teagasc National Farm Survey data indicates machinery costs on tillage farms are high at €357/ha, or 44% of production costs. Similar survey data from the UK indicates lower costs on their farms. Scale, farming structure, weather, timeliness and decision making process may all contribute to these differences, but we have to be competitive. Earlier Oak Park cost research indicated a huge range of machinery costs on tillage farms, highlighting the scope for cost savings and the importance of getting the mechanisation strategy right for individual farm circumstances. Machinery costs and benefit are difficult to assess as depreciation and repairs/maintenance are highly variable and timeliness and quality benefits are difficult to quantify. An examination of combine costs using the Oak Park machinery cost programme highlighted the importance of scale, replacement strategy and combine size on harvesting costs. The use of second hand machines and longer replacement cycles is necessary on many farms to have competitive costs. Selecting a new combine with a greater harvesting capacity than required can be costly, adding 10 to 40% to costs. However on larger farms or where second-hand combines are used, extra capacity costs little extra. The use of crops such as winter barley, oilseed rape and spring wheat can extend the harvest season and reduce costs. Given the level of costs associated with machinery on tillage farms and the constraints of farm structure and weather which impact on machinery use, growers need better information on which to base mechanisation strategy decisions.

INTRODUCTION

Cost control is essential to ensure profitable crop production. While this was always the case, increasingly volatile markets make it essential for survival. Controlling costs in crop production is not simple – the oft quoted management mantra of 'taking the costs out of production' is frequently a complex task which involves careful valuing of the likely costs and benefits of applying resources and inputs. The response to fertiliser or plant protection product use, while variable in particular crop situations, is generally predictable from research trials. Other cost inputs such as machinery are difficult to deal with as calculating both the costs and benefits of mechanisation supply is challenging. Machinery is the largest single cost category and while it is often classified as a 'fixed' cost, it is anything but fixed in practice with mechanisation decisions influencing costs, crop performance and ultimately profit. In this paper machinery costs and the factors influencing them are discussed. Combine harvesting is used to illustrate the factors influencing costs and the decision making process that can be used to determine the correct machine choice for a particular farm.

Volatile markets

Crop production is subject to volatility arising from many sources: crop yield varies depending on seasonal factors largely driven by weather; input prices such as fertiliser vary depending on supply/demand and energy prices; and most importantly, grain prices vary considerably due to a variety of market factors. Grain market volatility has increased considerably in recent years and impacts hugely on profitability with lower price years giving rise to significant losses. While over a longer period, the average grain price in a volatile market may appear adequate for profitability, volatility brings particular difficulties:

- The response to high prices is frequently an increase in production, leading to increased demand, and consequently prices, of inputs and land. These increases tend to lag behind grain price leading to high input costs in years with poor grain prices.
- Cash flow is particularly difficult to manage and frequently longer term decisions such as machinery purchase are made on the basis of current year cash flow trends rather than on a planned basis where a longer term approach is taken.
- Extra interest charges are incurred as invariably the interest rates on borrowed money, in poor grain market years, is not compensated for by deposit interest in better years.

Excessive volatility demands a response to minimise its potential negative impact on profitability and farm viability. Elements of this response include:

- Cost reduction in all aspects of the business requiring careful cost/benefit analysis of inputs to determine the optimum use of all inputs.
- Taking particular care with longer-term cost decisions which may impact on costs for a number of years such as decisions about mechanisation supply. Avoid in particular locking-in to high costs which may be sustainable in a good year but may cripple a business in poorer years.
- The ability to respond appropriately to changes in market conditions, e.g. reduce land area rented if prices are uneconomic etc.
- Use of market tools such as forward selling to curb the extreme effects of volatility.

Machinery Costs on Tillage Farms

Machinery costs account for a considerable proportion of total crop production costs. There are a number of reference sources for machinery cost data, although each of these has limitations.

National Farm Survey and UK Farm Business Survey

In the Irish National Farm Survey(NFS), detailed cost information is recorded annually on a sample of 1029 farms (Connolly et al, 2010). The survey sample is divided into 6 main enterprises of which 'Mainly Tillage' is one. Farms in this category have other enterprises also with an average of 65% of the land associated with tillage crops. A summary of the cost breakdown on all tillage farms within this group, and a subset of this group defined as 'full-time' tillage farms is presented in the first two data columns of Table 1. This highlights the importance of machinery costs on these farms with the average annual cost amounting to €357/ha and €366/ha for 'all' and 'full-time' tillage farms respectively. While the average area farmed on the 'full-time' sub-set of tillage farms is much larger at 100ha compared to the 'all' farm group (57ha), surprisingly this increased scale did not result in reduced machinery costs. Depreciation and machinery operating costs are higher on the full-time farms. It's likely that a greater use of contractors on the smaller farms in the 'all' farm group keeps costs competitive. This highlights the need for careful mechanisation supply decisions.

Overall NFS data shows that machinery accounts for 43-44% of crop production costs (direct costs plus machinery) and 32-33% of total costs (including all overheads such as land rental etc).

The third column in Table 1 shows UK data from the farm business survey carried out by a network of six Universities / Colleges in the UK. This survey is similar but not identical to the Irish NFS so comparisons must be considered cautiously. The data presented is from the mainly cereals group of farms which comprises a sample of 357 farms where crops are grown on 80% of the farmed area. Machinery costs at €295/ha are considerably lower than on the Irish farms. The UK average farm size for this group, at 205 ha, is double that of the Irish full-time tillage farms. Overall costs on UK farms are lower although machinery accounts for a similar proportion of expenditure in both regions. There is a need to be competitive in our production costs and the apparent 20% difference in average machinery costs needs to be addressed. The need for additional machine capacity to cope with shorter work windows may legitimately impact on these costs, but equally factors such as: scale; distance between land blocks; field size; and the decision making process about mechanisation strategy, may be the cause.

Table 1: Machinery costs on tillage farms: adopted from 2009 NFS and UK farm business survey

	Ireland: 'Mainly Tillage' farms		England 'Cereals' (mainly cereals)
	All Farms (n=87)	Full-Time Farms (n=53)	All Farms (n=357)
Proportion Tillage (%)	64	66	80
Average farm size UAA (ha)	57	100	205
Machinery			
Contracting costs (€/ha)	116	93	65
Machinery depreciation((€/ha)	115	130	110
Machinery running ((€/ha)	126	143	120
Machinery total (€/ha)	**357**	**366**	**295**
Other direct (€/ha	454	494	378
Overhead excl machinery (€/ha)	269	300	310
Total costs (€/ha)	**1080**	**1160**	**983**
Machinery as percentage of:			
Direct+Machinery (%)	**44**	**43**	**44**
Total Costs (%)	**33**	**32**	**30**

Crops Costs and Returns Budgeting

The Teagasc Crops Costs and Returns booklet, which contains sample costings for individual crops, is widely used for planning purposes. While the input data in this booklet is based on product prices and contractor charges for machinery operations, it illustrates the significance of machinery costs which account for between 43% and 54% of the budget costs when grain transport is included.

Teagasc Oak Park Machinery Cost Survey

The detailed survey of machinery costs on a small number of tillage farms undertaken in the 1990s gives an insight into the variation in machinery costs on farms and the factors which may influence them (Forristal, 1995). The data presented in Table 2 is generated from the mid 90s data but indexed to 2011 values using an inflator of 54% based on price changes over the 15 year period. The figures given include all aspects of machinery costs with the exception of labour. The most notable feature of these figures is the huge range in costs recorded between farms for basically the same work (plough to harvest). The farms with the highest machinery costs had average annual cost per hectare figures of about three times that of those with the lowest costs. While scale had an impact on machinery costs, there was still a huge variation within farm size groups. In summary this survey highlighted the following key points:

- Machinery costs on farms are significant and the variation recorded indicated the scope that exists for cost savings on many farms.
- Scale impacts on machinery costs but it is not the largest factor. Smaller and medium sized farms need to control costs carefully

- The adoption of appropriate mechanisation strategies for the particular farm situation is vital. This includes consideration of ownership vs alternative supply options (contractor use, machinery partnerships etc) and the types of machines purchased and their replacement strategy.
- There is a need for improved decision making about machinery use on tillage farms.

Table 2: Machinery costs from 1990s farm survey indexed to approximate 2011 values

	Average	Range
Depreciation (€/ha)	155 (41%)	39 – 271
Interest (€/ha)	63 (17%)	12 – 120
Repairs (€/ha)	81 (21%)	26 – 129
Fuel (€/ha)	39 (10%)	22 – 48
Other (€/ha)	41 (11%)	-
Total (€/ha)	379	181 - 468

The points highlighted in the mid 1990s are still relevant. Reduced market support and increased market volatility makes mechanisation decisions even more important today. Irish crop producers must be competitive. Each grower must strive to have the appropriate supply of mechanisation, whether through ownership or alternatives, that allows good quality work to be carried out within acceptable time periods, at the lowest possible cost.

Achieving this objective is challenging. New research in this area is scarce as the variability in machinery cost information makes data acquisition expensive. Despite these shortcomings, at farm level a planned mechanisation approach with cost estimation will help achieve reduced machinery costs.

Mechanisation Strategy Planning

All farms have options in mechanisation supply. Machinery operations can be carried out using owned machinery or contractors. Growers can also work with neighbours to provide a full service (inter-farm contracting) or join together in a machinery partnership to achieve sufficient scale. Decisions concerning owning or using alternatives for some or all of a growers machinery operations should be based on costs, quality and timeliness. If machinery ownership is justified, the type and size (working capacity) of the machine and its replacement strategy (new or second hand and age at purchase and sale) then needs to be determined, again using costs and impact on timeliness as the main determinants. While this can be carried out on a single machine/operation basis, the whole farm context must be taken into account as tractors are shared across many operations and labour availability and indeed the growers own skills and preferences must be factored into mechanisation decisions.

Accurate estimation of the costs and benefits of machinery use is fundamental to mechanisation planning. Mechanisation decisions are particularly complex, because of the difficulty in estimating depreciation and repair costs and the long term nature of machine ownership. The impact of quality of work (e.g. seedbed preparation, even fertiliser distribution etc) is difficult to value. Estimating the value of timeliness is also challenging. Intuitively growers consider all of these factors when making choices about machinery but it is difficult to attribute accurate values to these costs and benefits. Consequently inappropriate mechanisation decisions that may have a long term impact on costs can result. When considering farm mechanisation the following pitfalls should be avoided:

- Failing to have an overall plan for mechanisation resulting in individual machines being replaced with similar when worn-out or broken down inhibiting future change.
- Allowing a single event e.g. bad harvest, to unduly impact on machine decision.
- Following trends in machinery development and technology without consideration of the scale needed to justify them
- Over-valuing independence in machinery operations when alternatives (contractor use / partnership etc) may be as effective and less costly
- Trying to achieve economies of scale by purchasing capacity in machinery first and then renting extra land at uneconomic prices to achieve scale
- Using short machine replacement cycles to manage cash flow rather than budgeting for the occasional big expenditure that a longer replacement cycle would cause
- Over–valuing timeliness benefits resulting in over-capacity, particularly where a new machine is purchased.

Machinery costing programme

A method of estimating costs is essential for mechanisation decisions. Very simple costing methods which assume constant rates of depreciation and repair costs do not give sufficient information to make choices and can give very erroneous results. Detailed depreciation and repair costs research was carried out in the 1970s and 1980s and equations linking depreciation and repair costs to age and use level for a range of machine types were developed. Unfortunately this level of data collection has not been repeated since and current costing equations are still heavily based on older data functions. The Oak Park research of the 1990s spawned the development of a machinery costing tool which relies on cost functions largely based on older research. The equivalent annual cost of individual machines is calculated based on: the category of machine; it's size; the replacement policy (new or used and age at purchase and sale); and it's annual use level. The cost is then expressed on a per hectare basis. The costing programme allows all of a farm's machines to be considered and then facilitates decision making by allowing the operator to vary the machine inputs to determine the impact on individual machine costs and overall farm costs. While the programme is limited by the appropriateness of the repair and depreciation cost functions and the inherent variability of actual farm costs, it gives cost figures that allow mechanisation strategies to be compared.

Machine costs – combine harvesting costs

Crop production requires cultivation, sowing, fertilising, spraying and harvesting operations. Cultivation and sowing costs have been considered in previous years papers (Forristal, 2009). The largest single machine operation cost on farms is combine harvesting. In the remainder of this paper, to illustrate the impact of mechanisation decisions on cost, combine harvesting is considered. A number of factors are explored:

- The effect of replacement strategy on combine costs and cost components
- The impact of annual harvest area on the annual operating costs of combines of different replacement strategies.
- Combine options for five different farm sizes
- Timeliness: the cost of over-capacity and selecting crops to spread the workload

A total of 153 combinations of combine type, use level and replacement strategy were costed with the Oak Park costing programme. Details of the combine types costed are outlined in Table 3. The spot and field work-rate data was collected during earlier research on work-rates (Forristal, 2006) and is used to estimate seasonal capacity and to calculate hours for repairs and depreciation calculations. Nine different ownership or replacement options were used as outlined in Table 4. The annual areas on which the costs were based were: 50ha, 100ha, 200ha, 400ha and 800ha. The programme calculates depreciation, interest, repairs, fuel and labour costs and expresses these on a total cost and per hectare basis. Insurance costs and machine storage costs are not included. The repairs and depreciation functions used in the programme are derivatives of ASAE functions using Irish data (Williams 1978). Labour is calculated from the number of machine hours worked while fuel is inputted as a constant per hectare.

The costs generated need to be treated with caution because of the age of the datasets they are based on. The chances of error are least if different ownership strategies of either new or second hand machines are being compared. The used combine market plays a significant role in the value of trade-ins and the cost of second-hand machines. This can cause a significant change in the merits of owning new vs second hand machines. Comparison with contractors cost figures is always useful, but this should be done cautiously.

Table 3: Combine categories used in analysis

Category	Description	Price (€)	Spot workrate (ha/hr)	*Field workrate (ha/hr)*
1	4 walker	125,000	1.08	*0.81*
2	5 walker	166,000	1.93	*1.45*
3	5 W, hi spec	230,000	2.42	*1.82*
4	6 W, hi spec	271,000	2.97	*2.23*
5	*High output / Hybrid*	*347,000*	*4.05*	*3.04*

Table 4: Combine replacement strategies

Category	Purchase age (years)	Ownership period (years)	*Legend in figures and tables*
1 - New	0	5	*5*
2 - New	0	10	*10*
3 - New	0	15	*15*
4 - New	0	20	*20*
5 - SH[1]	5	5	*5 + 5*
6 - SH	5	10	*5 + 10*
7 - SH	5	15	*5 + 15*
8 - SH	10	10	*10 + 10*
9 - SH	10	15	*10 + 15*

[1] SH = Second-hand purchase

Cost components and replacement strategy

Combine costs were generated to determine the effect of age and replacement strategy on machinery costs. The principal machinery cost components are depreciation, interest, repairs/maintenance, fuel and labour. In the early years of a machines life, depreciation and interest charges are high and these tend to decline over time as the machine ages. Conversely as a machine accumulates more work or hours, annual repair and maintenance rates tend to rise even though the amount of work carried out each year is constant. These general trends are indicated in Fig.1.

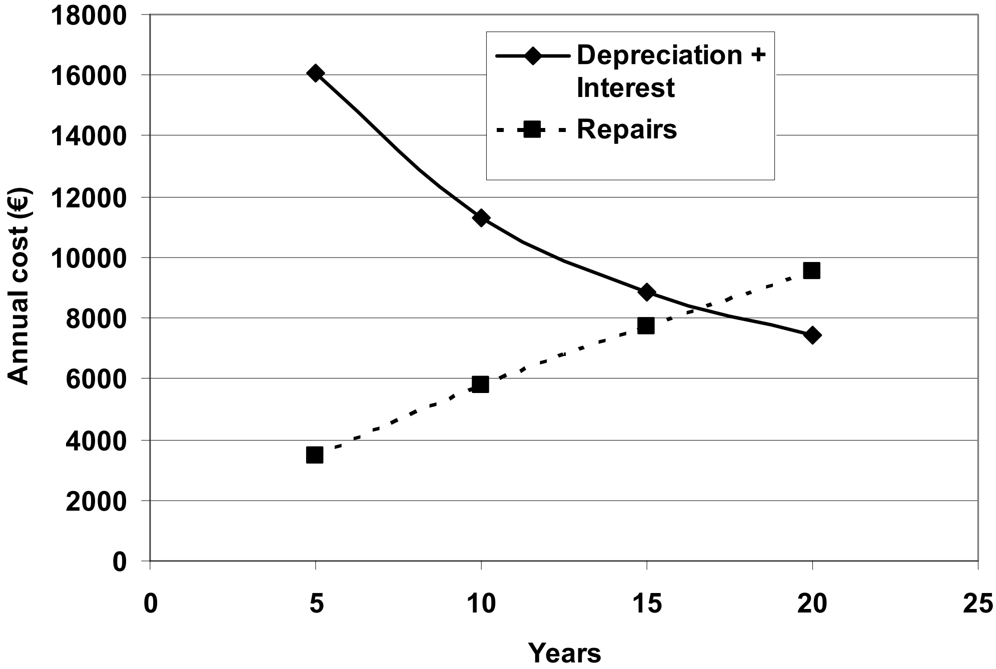

Fig. 1: Annual depreciation, interest and repair cost trends for a combine

In Fig. 2 the average annual costs per hectare for a category 3 combine with four different ownership strategies harvesting 200ha annually are shown. The total costs and cost elements are indicated. Where the combine is frequently replaced (e.g. every 5 years) costs are high and dominated by depreciation and interest charges with relatively small repairs and maintenance costs. As the replacement age is lengthened and second-hand options are considered, the total costs tend to reduce, but repairs and maintenance increase. Fuel and labour costs remain constant on a per hectare basis. While fuel use for a task like combining will remain relatively constant for most types of combine, labour costs will reduce as machine capacity increases e.g. a category 3 combine can have double the working capacity of a category 1 combine and consequently half the labour cost.

The trends in fig 2 are typical of those that are encountered when ownership strategies are compared across a range of use levels and combine categories. The use of longer replacement ages and second-hand machines tends to reduce costs but the magnitude of this effect will depend on use level and the market for second-hand machines. In practice, the least expensive option may not always be the most appropriate as machine reliability may suffer unduly. Considering the relatively large numbers of combines that have been sold since 2007, growers need to be very cautious about replacement policies. New machines and short replacement policies can be an expensive mix.

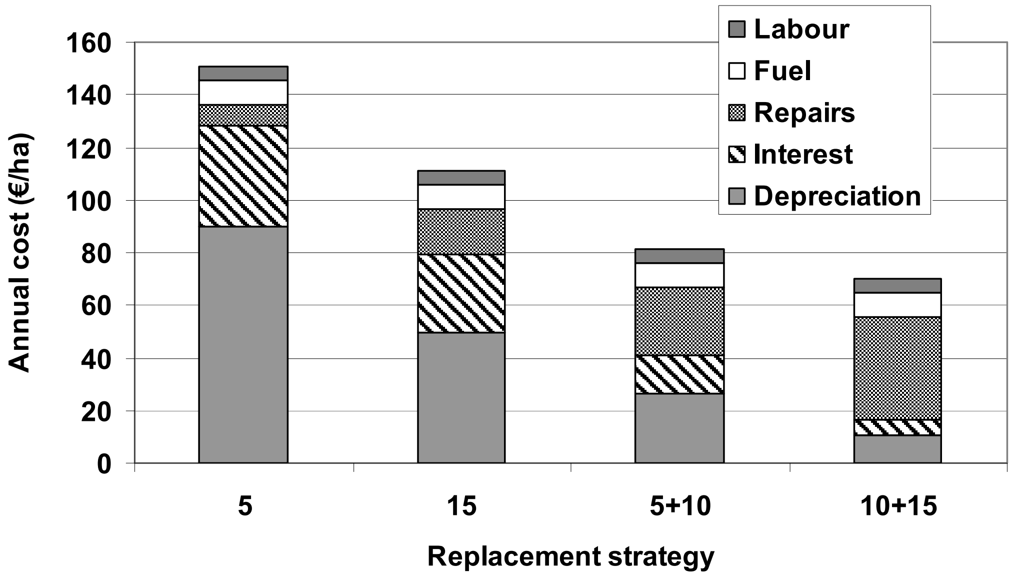

Fig. 2: Replacement strategy influence on annual cost components of a category 3 combine harvesting 200 ha per annum.

Annual Harvest area

The annual harvested area has a significant impact on combine costs and in particular on the viability of various replacement strategies (Fig.3). New combine purchase with replacement at 10 and 20 years are compared with second hand purchase of a 5 or 10 year old machine which is owned for a further 10 years. Clearly purchase of a new category 2 combine at 50 or 100ha annual use levels is not justified. At 100ha, judicious purchase of a second-hand machine would seem to be viable compared to typical contractor charges. Contractor charges vary from about €95 to €130 / ha. At 200ha all four strategies are viable compared to contractor use for this combine category, but with considerable differences between new and second-hand purchase. While a 400ha use level is included it would be beyond the capacity of a category 2 machine.

Combine options for different annual use levels

The machinery cost programme was used to evaluate possible combine ownership options for 5 different annual use levels or farm sizes. This allows ownership strategies to be compared but again some caution is needed in interpreting the figures.

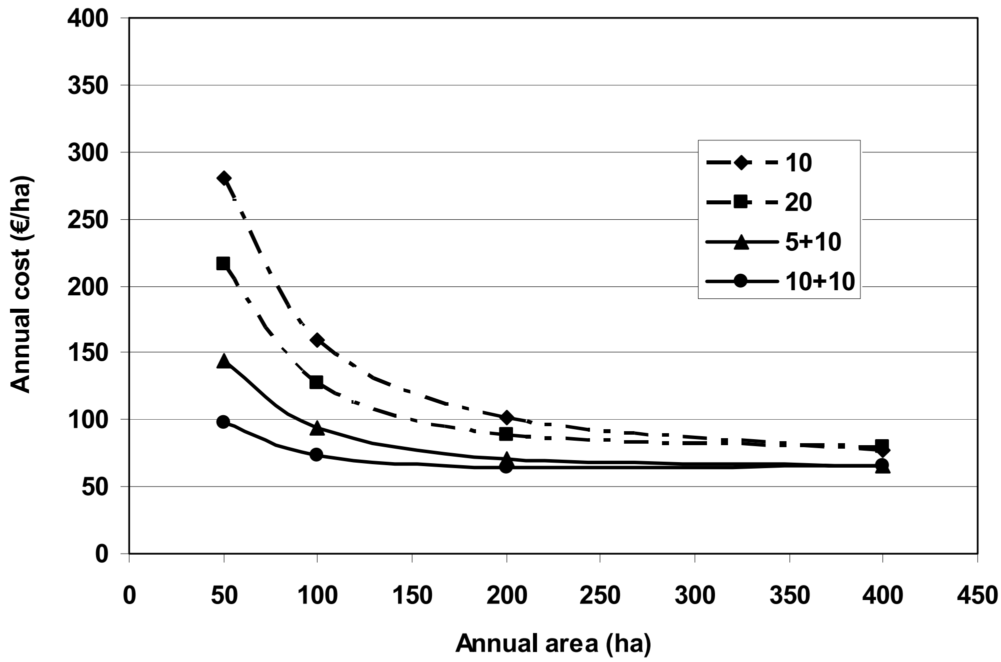

Fig. 3: Effect of annual area on the costs of four replacement strategies: category 2

50 ha annual use

With a very limited area, combine ownership on this size of unit is not normally justified (Fig.4). While the use of older second-hand machines can dramatically reduce costs towards the €100/ha figure, these costs do not include machine storage and insurance charges. In practice it is now nearly impossible to get second-hand category 1 or category 2 machines, as new machines of this size have not been sold in quantities in our main supplying market (UK) for some time.

100 ha annual use

In the past, a grower with this area would have considered ownership of a combine as the only option. The category 1, 2, 3, and 4 combines included in this analysis, would require 151, 85, 67 and 55 harvesting hours respectively to harvest the complete area. Ownership of a new combine is highly questionable on this size unit even with very long replacement cycles (Fig.5). Second hand units are needed to be competitive with contractor charges; with a category 2 machine (basic 5 walker) being the most viable option. In practice, availability of this type of second-hand machine may require alternatives such as contractor use or machinery partnerships to be used to achieve economies of scale.

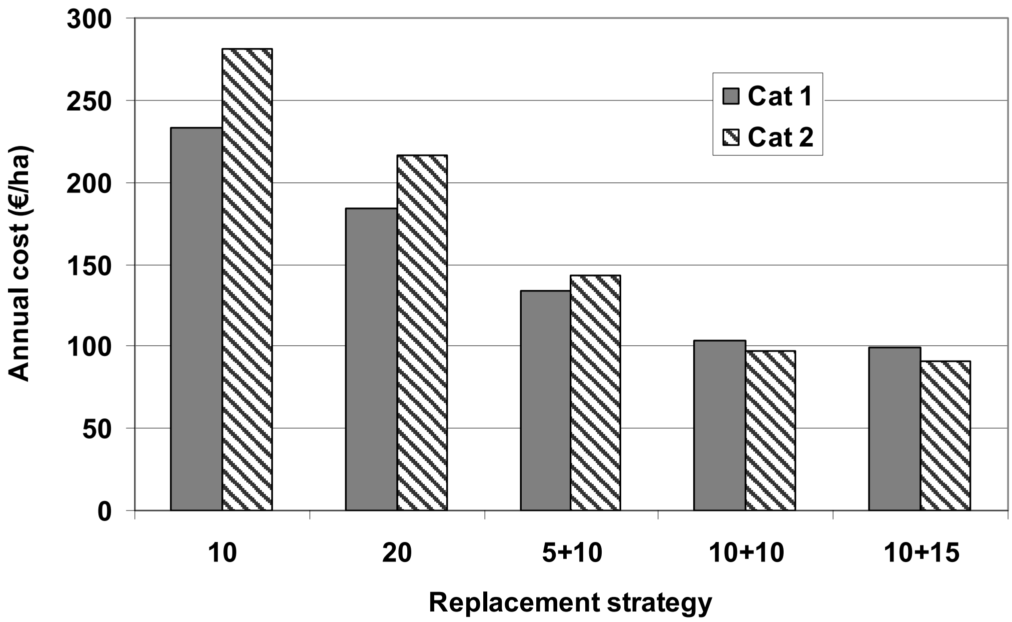

Fig. 4: Combine category and replacement strategy impact on costs: 50ha annual use.

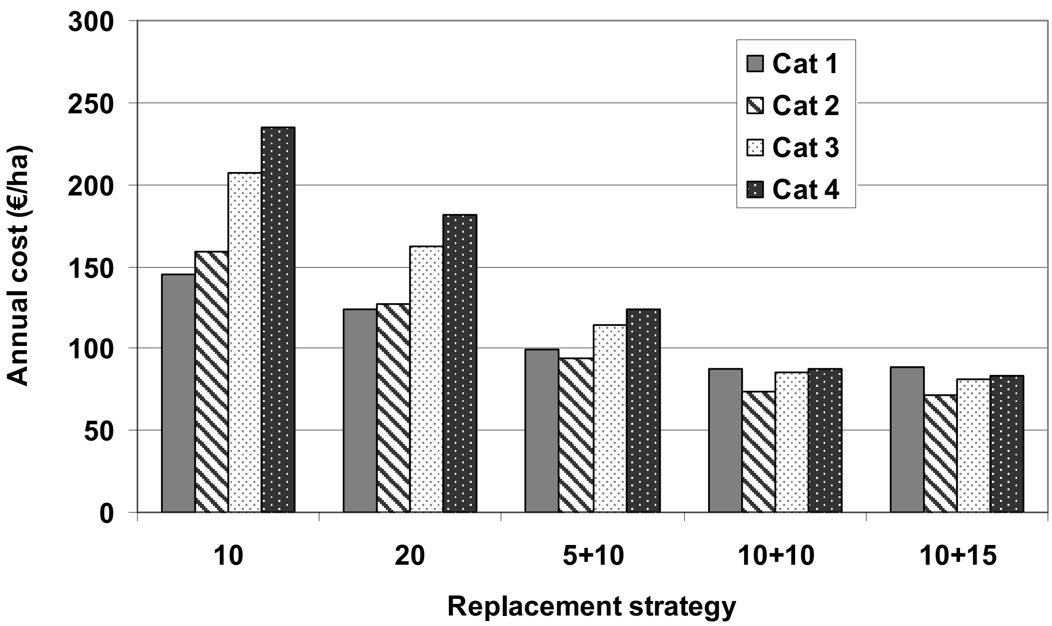

Fig. 5: Combine category and replacement strategy impact on costs: 100ha annual use

200 ha annual use

At 200ha annual use purchasing a new combine is justifiable but only if a relatively long replacement cycle is used (Fig.6). The category 2, 3, 4 and 5 combines included in this analysis, would require 169, 134, 110 and 81 harvesting hours respectively to harvest the complete area. While most growers with this area would like to run a category 3 size machine, a replacement cycle of 20 years is needed to justify ownership. A category 2 machine is less expensive to operate than a category 3 when purchased new. While in a good season a category 2 combine should have sufficient capacity for 200ha, if all sown crops have the same harvest window (e.g. winter wheat and spring barley), then this size of machine may struggle in a challenging harvest. Savings can still be made when purchasing second hand (provided the machines are available) and there is the ability to afford extra capacity (cat 4 and 5) second hand machines at minimal extra cost, which is always useful insurance against wetter seasons and the impact of breakdowns.

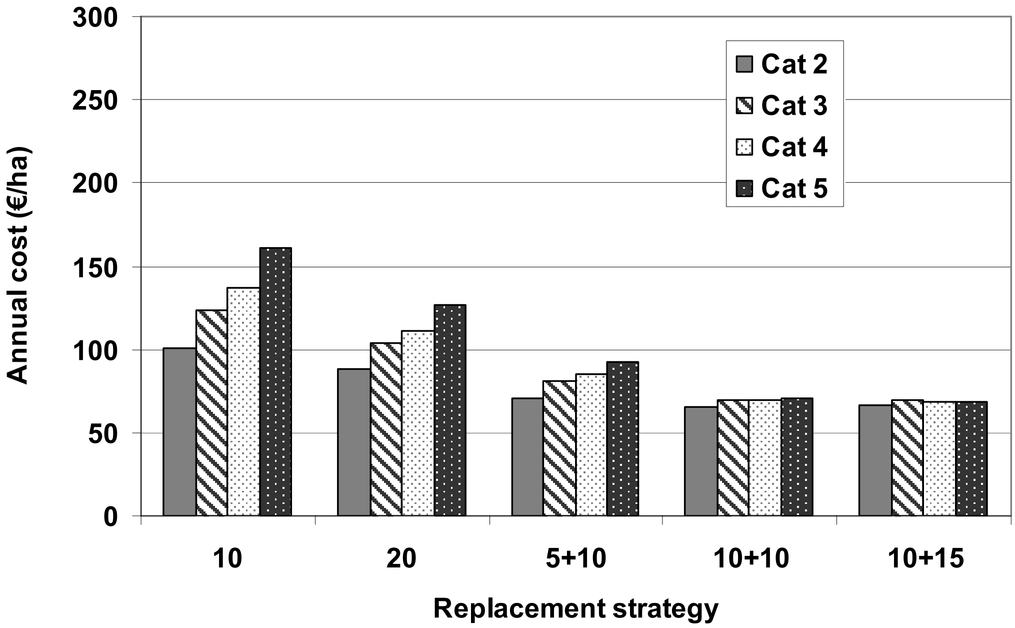

Fig. 6: Combine category and replacement strategy impact on costs: 200ha annual use

400 ha annual use

At this area, new purchase of a range of combine sizes is possible. The category 2, 3, 4 and 5 combines included in this analysis, would require 339, 269, 220 and 162 harvesting hours respectively to harvest the complete area. Unless a large proportion of crops with different harvest dates are sown, only the category 4 and category 5 combines would have sufficient capacity to handle this area.

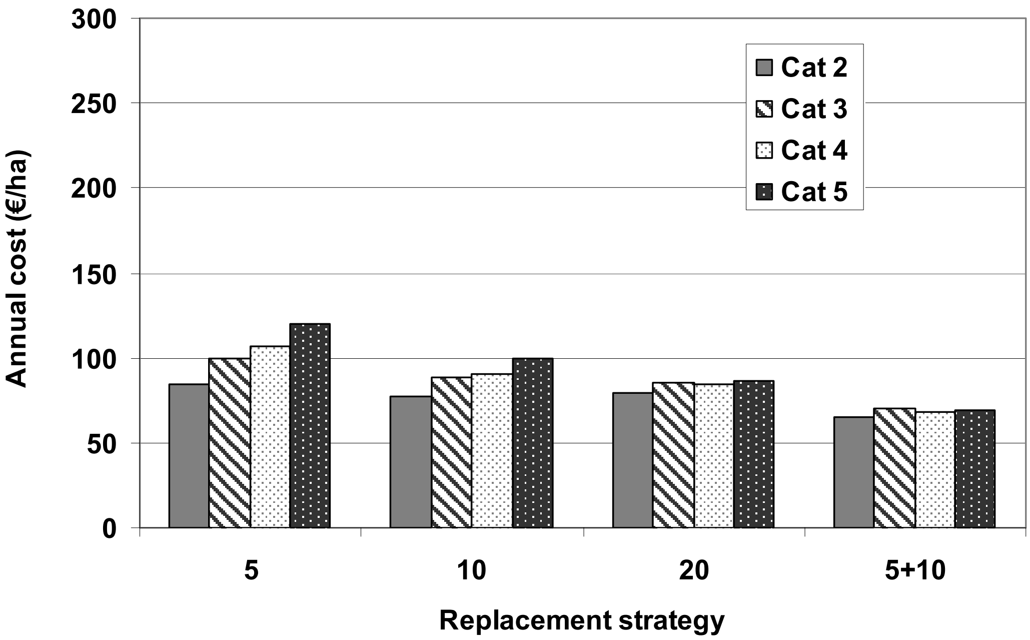

Fig 7: Combine category and replacement strategy impact on costs: 400ha annual use

800 ha annual use

While two single combine options are presented in Fig.8, it is unlikely that without exceptional selection of crops to maximise the harvest window, that one combine would be relied on to harvest this area. Nominally, 441 and 323 harvest hours would be needed with the category 4 and 5 machines costed. The lowest cost option may be to strive to achieve the full harvest with one category 5 machine by optimising the crop harvest window, but to have a back-up plan to bring extra harvesting capacity if needed.

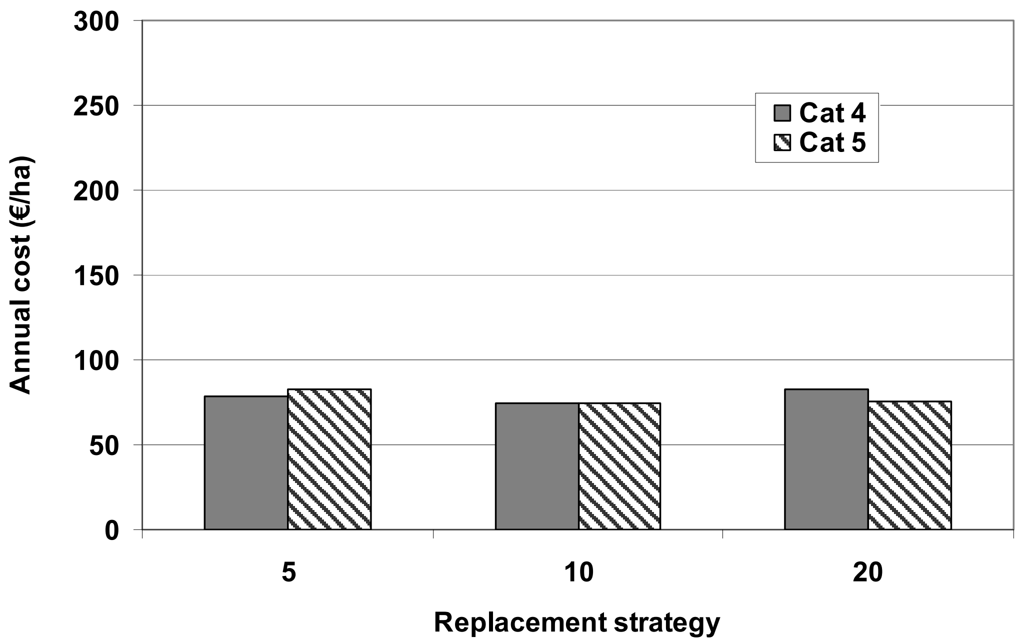

Fig. 8: Combine category and replacement strategy impact on costs: 800ha annual use

These cost estimates strongly support the use of longer replacement cycles and second-hand machines on farms up to 400ha. While the accuracy of the depreciation predictors coupled with the vagaries of the second-hand combine market could impact on these results, growers would be wise to consider combine purchase and replacement strategies very carefully. The more hectares covered and grain that can be put through a combine, the lower the costs will be.

Timeliness

Timeliness of operation can be defined as completing a task at a time that ensures the crop response is optimised. In combining terms, it means harvesting with acceptable physical losses, low moisture and good quality. It is achieved by having sufficient capacity to harvest the grower's crops within a working window that allows these criteria to be met. Weather and machine breakdowns can impact on timeliness in an unpredictable manner. While there has been little Irish timeliness research, a study in the late 1970s indicated that just 38hrs a week (range of 20 to 60+ hrs) were available for combining in the main harvest period. While there is a need for new research in this area, we can use these estimates of harvest time to tentatively determine harvest capacity with different sized combines.

Over-capacity cost

The unpredictable nature of weather and breakdowns, makes decisions about required machine capacity difficult. Do we demand sufficient capacity to harvest all grain at less than 20% moisture content in all years? Intuitively, this would be excessive and costly. A capacity that would allow harvest of most of the crop below 20% moisture content in most years would seem sensible. Does it pay to have extra capacity? While we do not have the data to predict the benefits in crop value, we can estimate the additional cost. In Figs 9 and 10, the cost of extra combine capacity at a number of annual areas is estimated for new and second-hand purchase respectively. Either one or two higher capacity combines ('Extra' and 'Extra+') are compared with a combine ('Basic') that has adequate capacity for the work in hand. If use levels are low, particularly with new machines, excess capacity can raise costs by 10 to 40% (Fig. 9). This stresses the importance of selecting the correct size of new combine for small or medium sized farms.

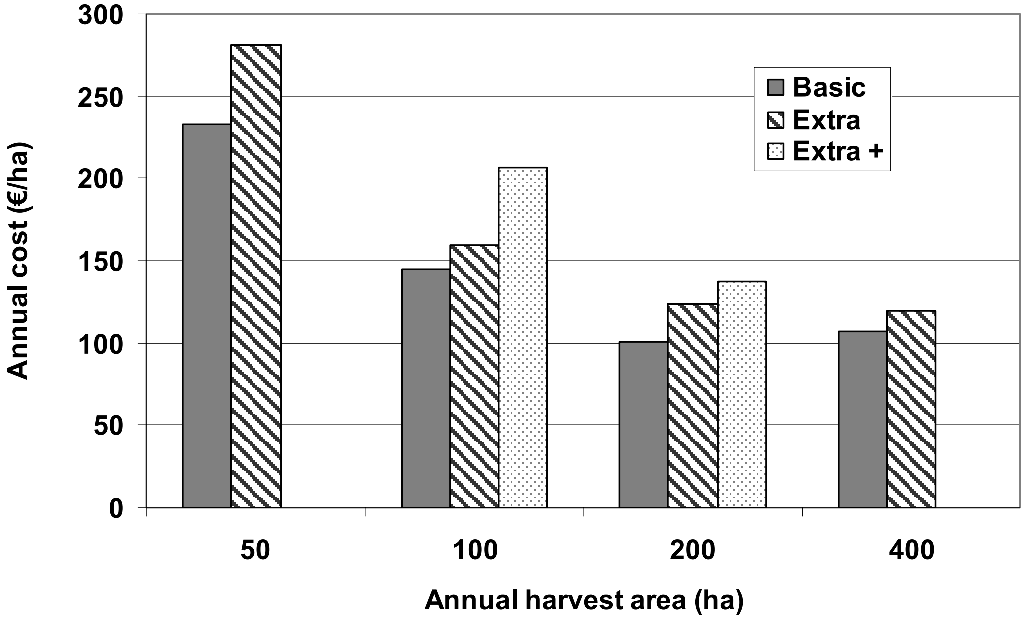

Fig. 9: Cost of operating higher capacity machines: new purchase, replaced at 10 years.

Conversely with second-hand machines (or very high use levels of new machines), increased machine capacity can come at a very modest extra cost (Fig 10). This allows extra capacity to be built in to the system which can cater for the expected poorer reliability of a second-hand machine.

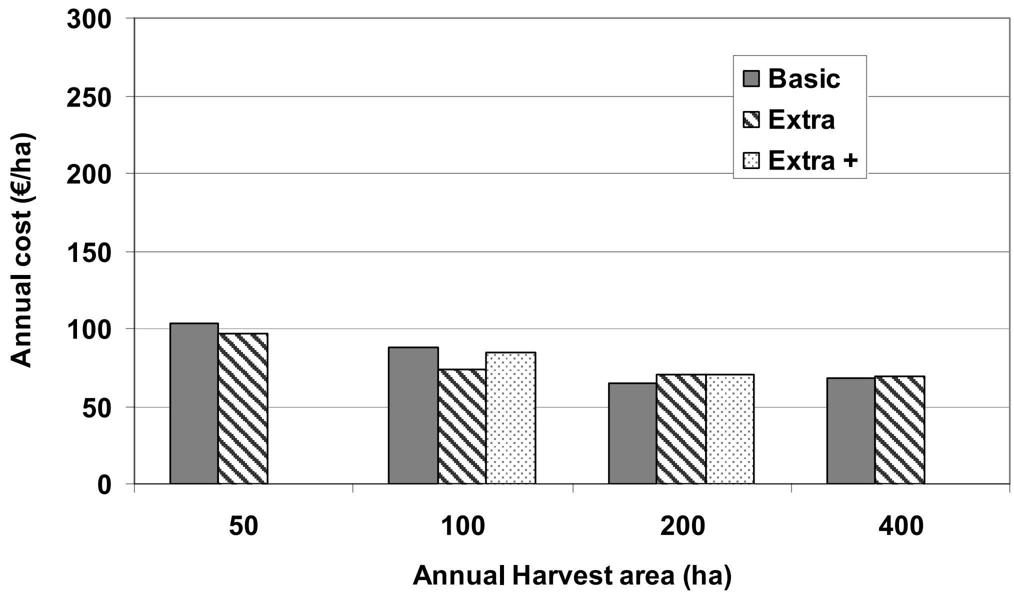

Fig. 10: Cost of operating higher capacity machines: second hand, replaced at 10 years

Crop choice and combine costs

The choice of crops can influence the available harvest window and consequently the need for harvesting capacity and combine costs. Winter barley, oilseed rape and spring wheat can significantly increase the harvesting season. In table 2, three different cropping options for a 400ha grower are considered. With spring barley and winter wheat only, and assuming the aim is to harvest it all within a four week period, gives us just 152 harvesting hours to budget on (38 hours per week). Even a category 5 machine will struggle with this load requiring 162 hours to harvest it. If the grower switched to winter barley instead of spring barley, the harvesting window is extended by at least two weeks, allowing a category 4 combine to handle the harvest giving a saving of €9/hectare over all grain harvested. In reality the savings may be greater as harvesting conditions in July are likely to be better giving increased performance and lower costs. Extending the season further by adding in oilseed rape and spring wheat would allow some further machine cost savings to be made as a Category 3 combine could now manage the harvest with capacity to spare.

Table 3: Crop choice effect on required combine capacity and costs: 400ha.

Option	Crop areas	Hours available	Combine size	Hours needed	*Cost (€/ha)*
1	200ha W. Wheat 200ha S. Barley	152	Cat 5	162	*100*
2	200ha W. Wheat 200 ha W. Barley	228	Cat 4	220	*91*
3	150ha W.Wheat 150ha W. Barley 50 ha WOSR *50 ha S.Wheat*	304	Cat 3	269	*88*

CONCLUSIONS

- To remain competitive, cost control is essential. The importance of machinery costs requires a more proactive approach to machinery cost analysis but determining costs and benefits is difficult. The tools we currently have, while useful, are limited by the research data on which they are based.
- The influence of machine capacity, replacement strategy and use level on combine costs requires users to carefully determine whether combine ownership is justified. Alternatives to ownership must be considered where annual harvested areas are limited.
- Where combine ownership is justified, replacement policies need to be carefully matched to the individual farm circumstances. This study indicates that on most farms long replacement polices and/or the use of second-hand machines is necessary to keep costs competitive.
- Crop choice, through its impact on available work time, can impact on required machine capacity and costs. Growers should consider machinery costs in their crop choice decisions.
- Given the level of costs associated with machinery on tillage farms and the constraints of farm structure and weather which impact on machinery use, growers need better information on which to base mechanisation strategy decisions.

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Agronomic and legislative factors influencing fertiliser decisions in 2011

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SUMMARY

Nitrogen prices have been increasing steadily over the past few months. This, combined with changes to the Action programme implementing the nitrates directive, means that a reappraisal of fertilizer N strategy for crops is required for 2011. Changes to the 'nitrates directive include increases in fertilizer N allowed for winter wheat , a change in the base yield for spring barley used to calculate additional N allowances, an additional fertilizer N allowance for malting barley, a change to the 'winter ploughing' rule and changes to the rules governing the use of organic manures.

Despite these changes achieving efficient use of fertilizer N is still paramount. However it must be remembered that the amount of fertilizer N required by a crop is variable and is influenced by a range of factors some of which can only be poorly predicted at the time of fertilizer application. The best that can be achieved is that, on average, fertilizer N inputs are correct. Fertiliser N effects on grain protein in spring malting barley are modest and relatively large inputs of fertilizer N would be required to raise very low protein contents to acceptable levels. Identifying and rectifying other causal factors may be a more economic means of achieving acceptable protein contents in the longer term and this is the focus of current work in Teagasc.

INTRODUCTION

During the recent review of the action programme implementing the Nitrates directive in Ireland a number of important changes which impact directly on arable cropping were made, many of which reflected the changes proposed by the Teagasc submission to the review process (Teagasc, 2010). These changes affect the amount of fertilizer N and P that can be applied to crops, the usage of organic manures on crops and the dates when arable land can be ploughed. The practical implications of these changes will be outlined and issues surrounding nitrogen recommendations for crops will be discussed.

Changes to the Nitrates Directive

Irelands current Action Programme implementing the EU Nitrates Directive is set out in SI 610 of 2010 (European communities (Good Agricultural Practice For Protection of waters) Regulations 2010). This document, more commonly referred to as the 'nitrates directive' includes a number of significant changes of relevance to the tillage sector.

Use of organic manures

A number of important changes have been made that affect the use of organic manures in arable situations. The most important of these is that the reference 'to any crop receiving dressings of organic fertilizer' has been removed from the nitrogen index for tillage crops. Heretofore where organic manures were applied to an arable field for two years in succession, the field was deemed to move from index 1 to index 2 in the third season with a consequent reduction in the amount of available N that could be applied. This reduction was aimed at accounting for the residual effect that organic manures have on soil N release in the years after their application. This militated against the use of repeated organic manure applications as most growers considered the reduction in allowed N between index 1 and index 2 too severe and would not be made up for by the residual N effect of the previously applied manures. Consequently, for most growers, application of organic manures to a field was effectively restricted to once every second season.

Examination of the literature would suggest that this system overestimated the potential residual effect of organic manures, particularly those with high proportions of nitrogen that became available in the year of application such as cattle and pig slurries and poultry manures.

In the revised Action Programme organic manures can be applied to the same field for two or more years in succession without having any effect on the soil N index. Growers will still have to reduce the amount of fertilizer N applied to crops which have received an organic manure application, to take account of the nitrogen in that manure, but application of manure in one season will not affect fertilizer N allowances in subsequent seasons. This change should have a positive impact on the use of organic manures for arable crops as it facilitates the application of organic manures to a field every year.

For those using spent mushroom compost (SMC) the availability of nitrogen in SMC has been reduced from 45% to 20%. The effect of this is to increase the amount of fertilizer N that can be applied to land that has received SMC. The N availability of other composts will now be based on the C:N ratio of the material being used.

Phosphorus

Heretofore, phosphorus applications to cereal crops (wheat, barley, oats) were limited to 45, 35, 25, and 0 kg P/ha at soil P Indices 1, 2, 3, 4 respectively. These rates were the same for all cereal crops, irrespective of yield expectations. It is well established that the majority of phosphorus in a crop is in the grain and that the concentration of phosphorus in grain is relatively stable. Higher yielding crops, therefore, accumulate and remove more phosphorus than lower yielding crops. It could be shown that where high yields were being achieved crops were removing more phosphorus than growers were allowed to apply which, over time, would lead to a reduction in soil P reserves. This can be seen in Table 1 where the P balance (the difference between P inputs from fertiliser and organic manures previously allowed and P removals in grain and straw) for a range of yield levels is presented. It can be seen that, particularly at soil P Index 3, that the amount of P being removed by the crop was greater than the amount of P being applied to the crop, which over time would lead to a depletion of soil P reserves. For higher yielding crops at Index 1 and Index 2 P inputs were usually sufficient to meet offtakes. However P inputs in excess of offtakes are required at soil P index 1 and 2 to allow soil P levels to increase such that Index 3 is achieved.

Table 1: Effect of yield on grain P offtakes by cereal crops for P Index 1, 2 and 3 soils and P balance using 'old' Action Programme rules.

Yield (t/ha)	Offtake (kg P/ha)	Allowed P input (kg P/ha)			Inputs – offtake (kg P/ha)		
		Index 1	Index 2	Index 3	Index 1	Index 2	Index 3
6.5	24.7	45	35	25	20.3	10.3	0.3
7.5	28.5	45	35	25	16.5	6.5	-3.5
8.5	32.3	45	35	25	12.7	2.7	-7.3
9.5	36.1	45	35	25	8.9	-1.1	-11.1
10.5	39.9	45	35	25	5.1	-4.9	-14.9

In SI 610 of 2010 base phosphorus inputs to cereals grown on soil P indexes 1,2,3 and 4 remain at 45, 35, 25 and 0 kg P/ha respectively. However where a grower is achieving yields in excess of 6.5 t/ha of wheat, barley or oats, irrespective of whether it is a winter or spring crop, an additional 3.8 kg P/ha for each additional t/ha above 6.5 t/ha can be applied at soil P index 1, 2 and 3. P still cannot be applied at soil P index 4. Therefore a grower achieving 10 t/ha of a cereal crop at soil P index 3 soil can apply the basic rate of 25 kg P/ha plus an additional 13.3 kg P/ha (3.5 t/ha over the base yield by 3.8 kg P/ t over the base yield). P input levels for a range of yield levels are outlined in Table 2. Whether or not a grower decides to use this extra allowance will be largely determined by fertilizer prices, grain prices and previous experience of the field in question. It should be noted that soils vary considerably in their ability to store and release phosphorus and it will take much longer for the levels of P measured in the soil test, which only measures a relatively small fraction of the total phosphorus in the soil, to reduce in some soils than in others.

Table 2: Allowed P application rates at different yield levels under 'new' Action Programme rules. For yields in excess of 6.5 t/ha there must be proof of higher yields to avail of higher application rates.

Yield (t/ha)	Index 1	Index 2	Index3	*Index 4*
6.5	45	35	25	*0*
7.5	46.9	36.9	26.9	*0*
8.5	50.7	40.7	30.7	*0*
9.5	54.5	44.5	34.5	*0*
10.5	*58.3*	*48.3*	*38.3*	*0*

Winter ploughing

The date after which ploughing, or spraying off of green cover, can commence has been changed from January 15 to November 30 for future years. This will allow more timely field operations and reduce the peak workload experienced on arable farms over the past few seasons where ploughing was delayed until February and March. Where ploughing can be carried out under suitable soil conditions and allowed to weather it should also allow a better seedbed to be created more easily with consequent benefits in crop establishment and fuel savings.

Fertiliser N

Under the action programme N inputs are restricted to set amounts for each crop at each of the four soil N indices. This N can be supplied as fertilizer, in organic form or as a combination of the two. For some crops there is provision to use increased amounts of N where yields in excess of a base level are achieved or where crops are being produced for a specific market (e.g milling wheat).

Winter wheat

The total amounts of available nitrogen (from both fertilizer and organic sources) that could be applied to winter wheat before and after the changes to the Action Programme are set out in Table 3.

The difference in allowed N input between Index 1 (applies where wheat is grown after a cereal or maize) and Index 2 (applies where a crop is grown after crops such as OSR, legumes, beet) has been reduced from 50 kg N/ha to 30kg N/ha which more accurately reflects the impact of rotational crops such as OSR and legumes on a succeeding winter wheat crop. Furthermore the N allowance has been increased by 20 kg N/ha for all N indices. Both these changes mean that the allowed N input for a winter wheat crop yielding 9 t/ha is now

210, 180, 120 and 80 kg N/ha for soil N index 1,2,3 and 4 respectively. The additional allowance of 20kg N/ha per tonne for proven yields in excess of 9 t/ha remains in place. This means that a grower who can prove a yield of 10 t/ha (farm average yield in any of the previous three seasons at 20% moisture) can now apply 230 kg N/ha to his winter wheat at soil N index 1.

Table 3: Allowed N inputs (kg N/ha) to winter wheat under the 'old' Action Programme and the revised Action Programme rules.

Action Programme	Soil N Index			
	Index 1	Index 2	Index3	Index 4
OLD	190	140	100	60
NEW	210	180	120	80

For proven yields in excess of 9 t/ha an additional 20 kg N/t can be applied

Spring barley

Low proteins in spring malting barley have been reported over the last number of seasons leading to rejection of barley for malting purposes which has had significant economic implications for the growers concerned. The reasons for these low proteins are unclear but may be related to insufficient fertilizer N inputs. There is also a view amongst growers that inputs of N allowed under the old Action Programme were insufficient to produce high yield of spring barley (both feed and malting). These concerns have been addressed in the new Action Programme.

In the old Action Programme the allowed available N for spring barley was 135, 100, 75, 40 kg N/ha for soil N index 1,2,3 and 4 respectively. Where yield in excess of 7.5 t/ha could be proven an additional 20 kg N/ha for each additional tonne could be applied. However the national average yield has been less than 7.5 t/ha indicating that for many growers it was not possible to avail of this additional fertilizer N.

In the new Action Programme the base yield above which additional fertilizer N can be applied has been reduced from 7.5 t/ha to 6.5 t/ha. Therefore growers who have achieved average yields in excess of 6.5 t/ha in any of the last three seasons can apply an additional 20kg N/ha for each additional tonne/hectare above 6.5 t/ha. This applies to both feed and malting barley.

Furthermore, in the case of malting barley, where the malting barley is grown under contract to a purchaser of malting barley, an extra 20 kg N/ha may be applied where it is shown on the basis of agronomic advice that additional nitrogen is needed to address a proven low protein content in the grain.

Fertiliser N Recommendations in Practice

While the majority of fertilizer N recommendation systems set out fertilizer N application rates for various N indexes it is important to understand that the optimum amount of N to apply to a crop can be highly variable, even where the same crop is grown in the same field year after year. This is illustrated in Figure 1 where response curves for spring barley from a range of sites, all at soil N index 1, over four seasons are presented (Conry, 1997).

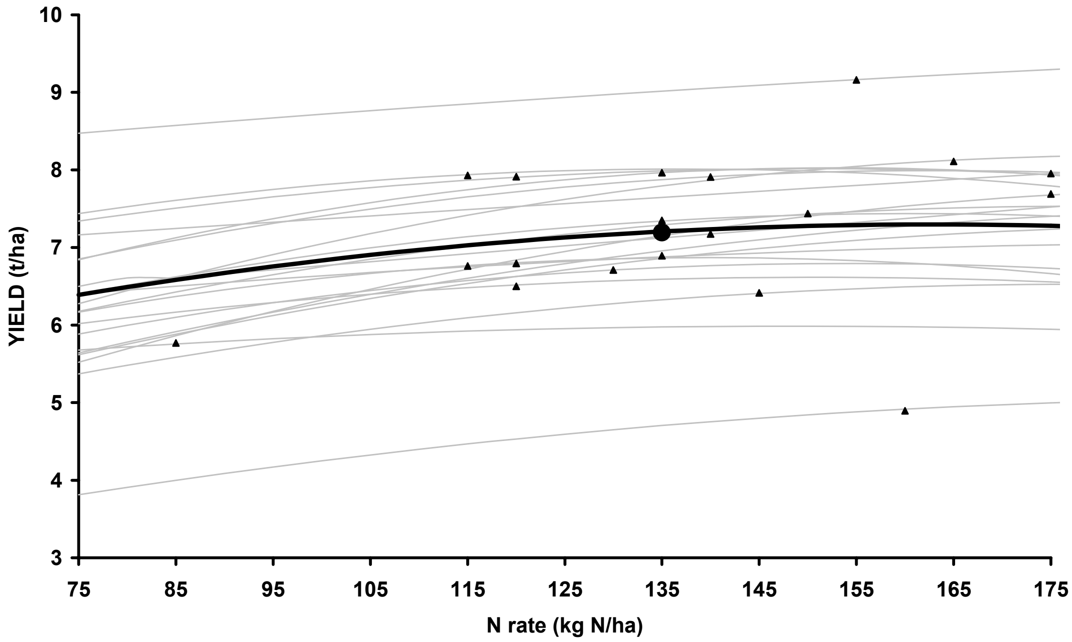

Figure 1: Response of grain yield to applied fertilizer N in spring barley.

Data are from four sites over four seasons. The bold line is the 'average' response curve. Solid triangles indicate the economic optimum fertilizer N rate for each response curve. The economic optimum N amount for each site, at fixed grain and fertilizer prices, is presented as a black triangle on each response curve. This clearly indicates the variability involved, which is due to biological rather than economic factors as the same grain and fertilizer prices were used for all sites in the study.

Obviously grain and fertilizer prices also vary considerably which add further to the variability. Unfortunately it is very difficult to predict what the economic optimum fertilizer N would be for any particular site in advance of applying fertilizer. Indeed it is only possible to determine the exact economic optimum for any site retrospectively from experiments where a range of different levels of fertilizer N have been applied. Therefore the standard approach is to carry out a number of fertilizer N response trials on sites representative of where a crop is grown, at a particular N index, and determine the average economic optimum N rate for that index.

The 'average' response curve is shown in bold in Figure 1. Since the economic optimum N amount is very difficult to accurately predict in advance and given the variability involved it should be clear, therefore, that there will always be a considerable degree of uncertainty associated with fertilizer N recommendations. This means that in practice some crops will be overfertilized and some will be underfertilized but that, on average, profit will be maximized.

Current research work at Oak Park is attempting to improve the accuracy with which economic optimums can be predicted and thereby reduce the number of crops being over or under fertilized. This work aims to produce more site specific fertilizer recommendations by taking into account factors such as soil type, soil chemical characteristics and weather conditions.

Sources of variability

It is difficult to fully explain the variability in optimum N rates. However variability in the amount of N supplied by the soil to the crop and variability in the recovery and utilization efficiency of the N available to the crop (both that from the soil and from the fertilizer) are likely to be largely responsible. All of these factors are strongly influenced by weather patterns during the growing season, which are to a large extent unpredictable. However, particularly in the case of soil N supply, there are a number of other influencing factors involved which could potentially be more accurately predicted and this provides scope to improve fertilizer recommendations and it is these factors which current work is focusing on.

Variation in soil N supply

The soil provides significant amounts of nitrogen to a crop. Typically the soil will provide sufficient N to produce 30-50% of the final yield. The objective is to supply sufficient N as fertilizer in addition to this soil and supply and to meet crop demand. However the amount of N supplied to a crop by the soil is variable. The current soil N index system attempts to estimate the amount of N supplied by the crop and modify fertilizer N recommendations accordingly. Hence fertilizer N recommendations for soil N index 4 (cereals grown after long term grass) are lower than those for soil N index 1 since the soil N supply will be greater. However factors other than previous crop such as soil type, organic matter content and soil chemical and biological characteristics also affect soil N supply and these are currently not taken into account in the N index system used in Ireland. Work is currently in progress at Oak Park to determine if any of these factors can be used to improve the accuracy with which then soil N supply can be predicted and potentially allow more site specific fertilizer N recommendations.

Weather conditions before and during the growing season can also have a significant effect on how much nitrogen becomes available from the soil. The amount of plant available nitrogen released from the large pool of organic nitrogen in the soil will be largely dependent on soil moisture and particularly soil temperature. During cold springs release of N from the soil is likely to be reduced.

Periods of wet weather can also result in nitrogen (both that released from the soil and that applied as fertilizer) being leached from the soil and therefore becoming unavailable to the crop. The high rainfall experienced in 2008 and 2009 during the growing season is likely to have lead to some loss of N from the system which in turn may be partly responsible for the low protein levels experienced in those two seasons. However wet weather during the period before the crop is sown may also lead to loss of mineral N in the soil which would otherwise have become available to the crop after it was sown.

While weather conditions that occur after fertilizer application will obviously be largely unpredictable at the time of fertilizer application the weather that occurred before fertilizer application could potentially be used to modify fertilizer recommendations. For example the amount of overwinter rainfall can influence the amount of mineral N in the soil at the start of the growing season which in turn can influence the amount of fertilizer N required. Therefore knowledge of overwinter rainfall could potentially be used as a criterion for determining fertilizer N rates.

Variation in nitrogen recovery and utilisation

Fertilizer N is not recovered with 100% efficiency by cereal crops. Recovery of fertilizer by cereal crops can typically range from 40 -70% although in practice recovery rates many crops will have recovery rates in the range 50-60% This can have a significant effect on the amount of fertilizer N required to meet crop demand. Where a crop requires 100 kg N/ha a recovery rate of 70% would mean that 143 kg N/ha fertilizer N is required. However if the recovery rate is only 40% the fertilizer N requirement would be 250 kg N/ha.

Many factors affect how efficiently a crop recovers N. Any factor that affects rooting will tend to reduce N uptake so factors such as compaction and root disease will reduce fertilizer recovery. Attempts to predict the fertilization recovery rate in advance of applying fertilizer have been largely unsuccessful to date due to the large number of factors involved.

Grain protein content in spring barley

While additional nitrogen has been allowed for spring malting barley it should be noted that many factors other than fertilizer N affect protein (and yield) in spring barley. It must also be remembered that fertilizer N has only a modest effect on grain protein content in spring barley. It should also be remembered that where protein levels have been acceptable in the past there should be no reason to apply additional N to increase protein and in many cases there may even be a deleterious effect of additional N in the form of crop lodging.

Work at three sites with contrasting soil types over a number of years clearly indicates that protein is affected both by site and year. In these experiments a range of fertilizer N rates were applied at each site in each season (Conry, 1997). The effect of soil type on protein content can be clearly seen in Figure 2. On the heavy soil protein content was unresponsive to fertilizer N and was always higher than on the light and medium textured soils. On the light and medium textured soils protein content increased linearly in response to fertilizer N although the increase in protein content was relatively modest (~0.25 % per 10 kg N/ha). However it should be noted that the protein level on the light and medium soil never reached the protein content achieved on the heavy soil irrespective of how much fertilizer N was applied. Generally trial work would indicate that the increase in grain protein content is in the order of 0.15 to 0.25% per 10 kg of applied N. Therefore to increase protein content by 1%, say from 8% to 9% would take 40 to 65 kg N/ha. This suggests that where very low proteins are being obtained it may not be economic to increase protein using fertilizer N.

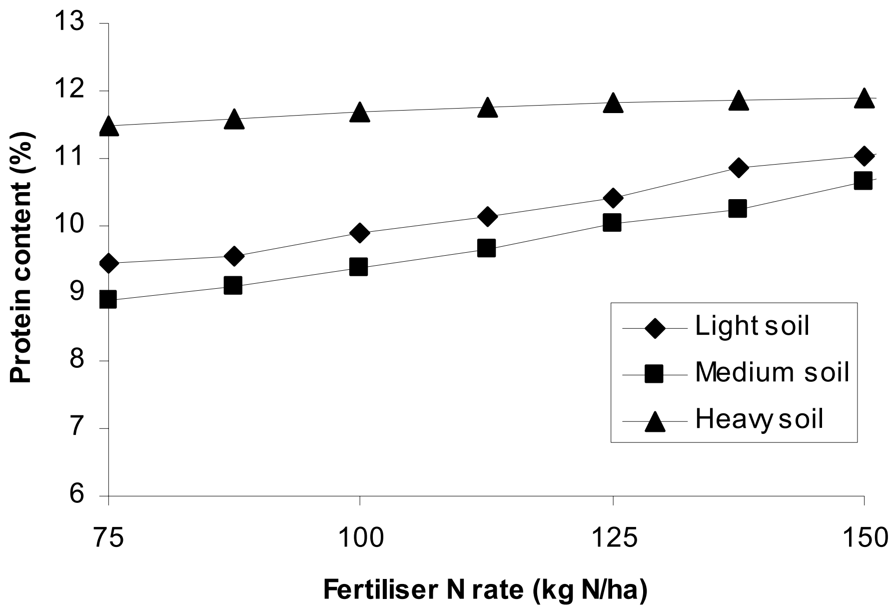

Figure 2: Effect of soil type and fertilizer N on grain protein content of spring barley.

Variety also has a significant effect on protein content. In the past high protein contents were often a problem in barley destined for malting and consequently the variety selection process tended to select varieties with reduced protein content. This was beneficial to the grower at a time when barley with low protein content received a premium. However changes in brewing techniques mean that higher protein barley is now acceptable for malting and barley with low protein has become less desirable.

There is also a strong seasonal effect on grain protein content which is linked to seasonal effects on crop growth and on soil N supply.

Work is commencing within Teagasc to explore more fully the reasons for variability in grain proteins in barley under Irish conditions. This work is taking the form of a survey of commercial barley fields over three seasons where a soil sample for soil characterization taken before sowing, a grain sample at harvest and details of the field history and crop management will be collected from a range of commercial barley fields around the country. The resulting information will be analyzed to determine the relative importance of a range of factors on grain protein content.

Timing of N for protein

There has been relatively little work examining the effect of N timing on protein content in spring barley, particularly at later growth stages. In work carried out at Oak Park in the early nineties (Conry, 1995) either one-third, two thirds or all of the fertilizer was applied to the crop at sowing and the remainder applied at the tillering stage. Two sowing dates (March sown and April sown) were included in the experiments. There was a strong trend for grain protein to decrease when more than one third of the N was applied at sowing to the early sown barley (Figure 3). This effect was not as pronounced for later (April) sown barley. This suggests that for early sown barley (i.e. barley sown in February or early March) fertilizer N inputs at sowing should not be excessive. Indeed where very early sowing is being practiced (i.e. in February or early March) it may be prudent not to apply any fertilizer N at sowing and apply the first N after the crop has emerged.

Normally fertilizer N is applied to spring barley in two applications, the first either at sowing or as soon as the tramlines are visible and the second at the tillering stage. While experimental evidence on this is limited and often conflicting in general it would appear that, provided that there are not conditions where significant losses of N occur, there is not a large benefit from delaying fertilizer N inputs after the tillering stage of spring barley. On lighter soils where the risk of N loss during the season is higher than for other soil types delaying some of the N may be beneficial. Additionally where low protein content has been experienced previously it may be beneficial to apply fertilizer N later in the season than heretofore although amounts applied should not exceed 20-30 kg N/ha and should be applied before the booting stage at the latest.

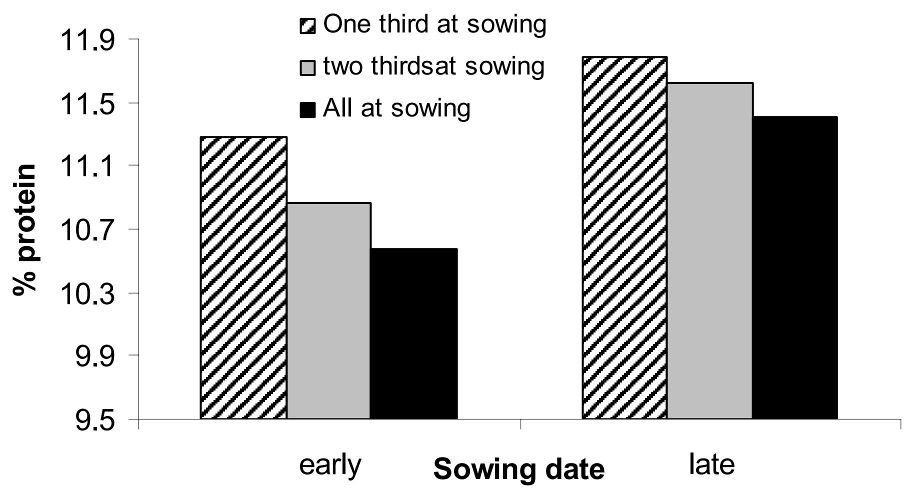

Figure 3: Interaction between sowing date of spring barley and proportion of total fertilizer N applied at sowing on grain protein content of spring barley. Data are averages of three sites over three seasons

CONCLUSIONS

- The revised Nitrates Action programme allows
  - Winter ploughing to begin on Dec 1
  - Higher P rates for cereals
  - No reduction in N index for successive organic manure applications
  - Higher N rates for winter wheat and spring barley
  - Additional N for malting barley
- The economic optimum N for a crop is highly variable and difficult to predict accurately
- Work is ongoing to explain the causes of variability in economic optimum rates to allow more accurate recommendations
- Fertiliser N has only a modest effect on grain protein in malting barley

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Septoria sensitivity and disease control

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SUMMARY

Monitoring of the sensitivity of Irish *Septoria tritici* populations to the triazoles fungicides has continued in 2010. Isolates with reduced sensitivity to both tebuconazole and metconazole remain in the population. An increase in the frequency of *S. tritici* with reduced prothioconazole and epoxiconazole sensitivity was recorded at most sites and they are now deemed to be endemic in the population. Monitoring of boscalid sensitivity (used a representative of the SDHI fungicides) shows the Irish population is currently sensitive, with a limited distribution of sensitivity.

Although disease pressure and levels were relatively low in 2010 differences were observed between fungicide products in their ability to control septoria when assessed at doses ranging from quarter to double the recommended dose. As in previous years mixtures of triazole fungicides outperformed their equivalent solo products at most of the doses assessed. The addition of the SDHI bixafen to prothioconazole (Aviator) also enhanced disease control over that of prothioconazole alone.

While it is enviable that selection for *S. tritici* with reduced sensitivity to triazoles and SDHIs will occur, careful management of their usage will help prolong their effectiveness. Avoidance of a triazole at T0 and the mixing of a multi-site fungicide with good septoria activity (e.g. chlorothalonil) at the key septoria timing should be routine practise.

INTRODUCTION

Owing to our mild climatic conditions and long day length during the summer month's Irish winter wheat crops have the potential to be the highest yielding in the world. Unfortunately it is often these same climatic conditions that hamper our ability to do so. With an ability to reduce yields of untreated crops by anything up to 50% septoria tritici blotch (often referred to as septoria) is undoubtedly the most economically devastating disease of Irish winter wheat crops.

Whilst globally septoria, caused by the fungal pathogen *Septoria tritici* (also known as *Mycosphaerella graminicola*) is regarded as one of the most important diseases of wheat, it is under Irish conditions that it can truly show its destructive capabilities. As a wet weather disease it thrives when the summer months of May, June and July are warm and wet when yield is being formed. By infecting leaves and producing lesions which can either reduce the area of or kill the leaves essential for grain filling, septoria will if left unchecked reduce the quantity and quality of the subsequent grains and hence their profitability. Although dry weather conditions are unmistakably one of the greatest means of controlling this disease, it is something that we often do not have the luxury of or can predict.

Due to the limitations of cultivation etc to reduce levels of this disease and with only moderate levels of disease resistance (at most) in the majority of commercially cultivated varieties the most effective control method currently available is the routine application of fungicides at the key stages in the crops life. Resistance to fungicides among cereal pathogens in Ireland has been recognised since the early 1980s, most notably resistance to the MBC fungicides. The speed and immediate consequences resistance to strobilurin fungicides had upon the industry in 2002/2003 highlighted the reliance Irish wheat production systems have upon effective fungicide chemistries.

Since the loss of efficacy of the strobilurins in 2002 the triazole fungicides (in particular epoxiconazole and prothioconazole) have, with support from the protectant chlorothalonil and SDHI fungicide bosclaid, been the cornerstone of winter wheat fungicide programmes. With this increased usage comes the potential for increased selection of strains of the pathogen with reduced sensitivity. This possibility was first highlighted in 2004 – 2005 with the emergence of reduced sensitivity to tebuconazole and metconazole, and more recently in 2008 – 2009 with the emergence of strains with reduced sensitivity to both epoxiconazole and prothioconazole (O'Sullivan & Kildea, 2010). With septoria control so reliant on the latter fungicides this paper reports the most recent sensitivity monitoring data on the Irish population and outlines how we can best use these products to ensure continued effectiveness and longevity. Furthermore, with the expected introduction of new SDHI chemistries this coming season the sensitivity of the 2010 population to the SDHI fungicides is presented along with how best this group of chemicals can be incorporated into disease control programmes whilst at the same time protected as far as possible from resistance development.

Fungicide Sensitivity

Since 2003 the sensitivity of Irish *S. tritici* populations to the most common fungicides used for its control (epoxiconazole, prothioconazole, tebuconazole and more recently boslcaid) has been annually monitored. Each season infected leaves are collected from commercial winter wheat crops throughout the main wheat growing regions in early spring (pre- fungicides) and July (post- fungicides). Individual *S. tritici* isolates are taken from each leaf and their sensitivity to the different fungicides determined under laboratory conditions. By comparing the sensitivity of the populations within seasons and with previous season's, shifts in sensitivity can be detected. In most cases high levels of disease control were achieved in 2010 due to the dry spring and summer and as such isolate numbers were lower than in previous years.

Sensitivity to Folicur and Caramba

The first shifts in sensitivity to the triazole fungicides in the Irish population were identified to tebuconazole (Folicur) between 2004 and 2005 (O'Sullivan *et al.* 2007). These shifts in sensitivity significantly affected the field performance of tebuconazole (Kildea, 2009). The shift was associated with the mutation I381V in the triazole target site 14α-sterol demethylase (coded by the gene CYP51) these strains also showed a shift in sensitivity to metconazole (Caramba), although to a lesser extent and under field conditions when used at the recommended rate Caramba continues to provide good disease control (Kildea, 2009). Surprisingly no sensitivity shifts to epoxiconazole (Opus) and prothioconazole (Proline) were detected in these strains.

Monitoring of the 2010 *S. tritici* population shows that these strains have been maintained in the population, with an apparent slight increase in their frequency (Fig. 1). Their presence will therefore continue to affect the field performance of tebuconazole if applied alone for septoria control.

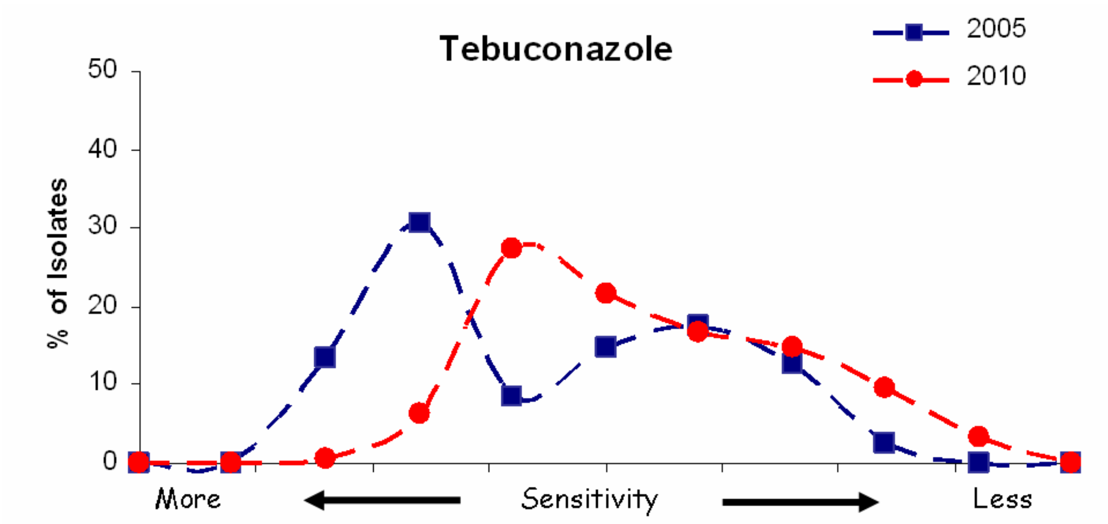
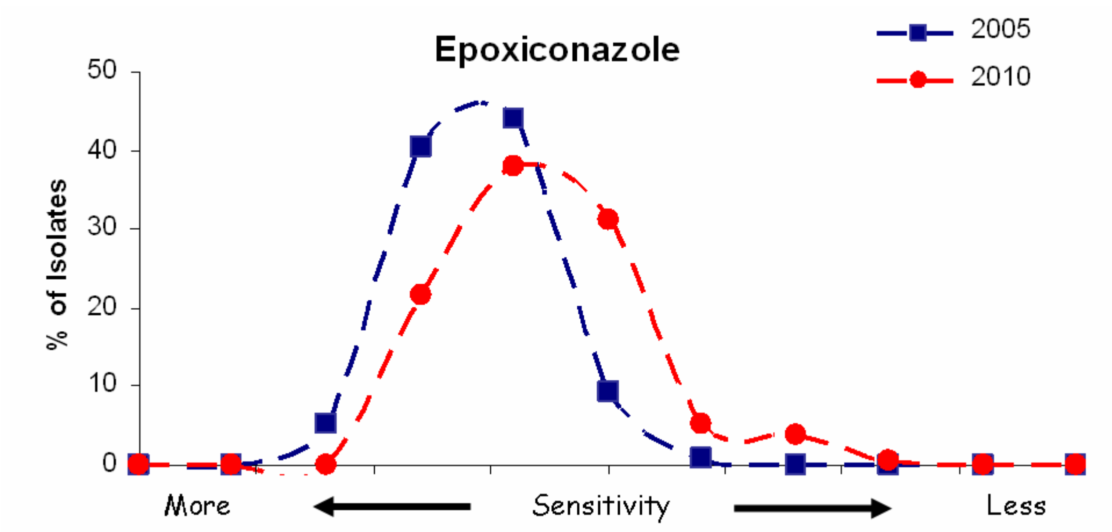


Fig. 1. Sensitivity of the Irish *Septoria tritici* population in 2010 to tebuconazole compared to that recorded in 2005.

Sensitivity to Opus and Proline

As they are currently the most effective fungicides available for septoria control monitoring the sensitivity of the Irish *S. tritici* population to epoxiconazole (Opus) and prothioconazole (Proline) has been at the forefront of the cereal pathology programme at Oak Park. Since the commencement of sensitivity monitoring in 2003 until spring 2008 the septoria population was deemed sensitive and stable to both epoxiconazole and prothioconazole (represented by the sensitivity profiles from 2005 in Fig. 2).

In July 2008 a large proportion of isolates from a single site showed reduced levels of sensitivity to prothioconazole. Such isolates had not previously been detected in the Irish population. They also showed reduced sensitivity to epoxiconazole (although the effect was smaller). Analysis of the target site identified an additional mutation S524T in combination with the mutations V136A and Y461S, which had previously been the dominant combination of mutations present within the Irish population (for further details see National Tillage Conference Report, 2010).



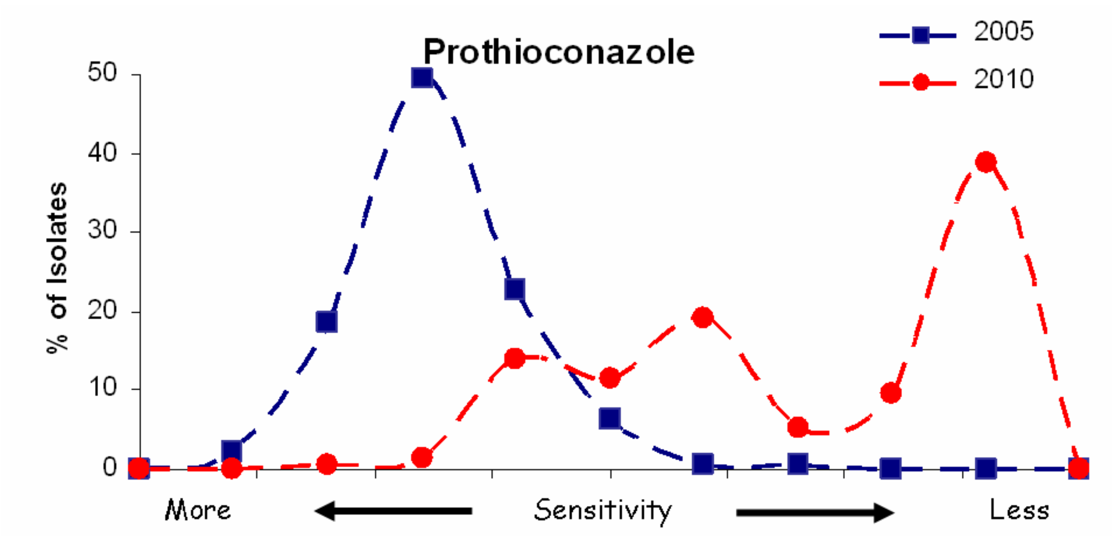


Fig. 2. Sensitivity of the Irish *Septoria tritici* population in 2010 to epoxiconazole and prothioconazole compared to that recorded in 2005.

Selection for these strains has continued and they now constitute almost 50% of the population assessed in July 2010 (Fig. 2). These strains have now been detected in all but one of the commercial crops sampled as part of the monitoring programme and are hence deemed to be endemic within Irish wheat crops. As with the isolates found in 2009, these strains remain sensitive to both tebuconazole and metconazole. In 2010 a small number of isolates (<5%) also showed higher levels of reduced sensitivity to epoxiconazole, as well as decreased sensitivity to prothioconazole. A number of these isolates also showed reduced sensitivity to metconazole and tebuconazole, and possibly highlight the combination of the various mutations affecting the triazoles (Fig. 2). Further analysis is ongoing into these isolates including analysis of mutations in the target site. Their presence and that of Irish population of septoria as a whole will continue to be monitored in 2011 season.

Sensitivity to the SDHI fungicides

Although SDHI's are not a new fungicide group (boscalid has been available in mixture with epoxiconazole for use on winter wheat crops since 2005, while older fungicides such as carboxin belong to the same family of fungicides) the expected introduction of new SDHI fungicides with improved control of septoria (see Product comparisons – 2010 below) in 2010 is a welcome development. Analysis of the 2010 Irish *S. tritici* population to SDHIs has revealed a sensitive population with a limited distribution of sensitivity (Fig. 3).

As single site inhibitors there is the potential that *S. tritici* will develop resistance to these fungicides and strategies aimed at minimising the possible development and spread of such resistances should be implemented. All SDHIs marketed for septoria control are likely to only be available pre-formulated or approved for use in tank mixes with a triazole partner active against *S. tritici*. However, as both these fungicide groups are single site inhibitors (albeit acting at different sites), and as outlined above the triazoles are under pressure of developing insensitivity it is advisable that an unrelated multi-site fungicide with strong *S. tritici* activity, e.g. chlorothalonil be included in any application of these products. Eventual development of insensitivity or resistance is almost inevitable, however, the time it takes for it to develop and how long new groups of chemistry remain useful to the farmer is dependant on how they are used. The use of mixtures of as many actives as possible will delay the development of resistance for as long as possible.

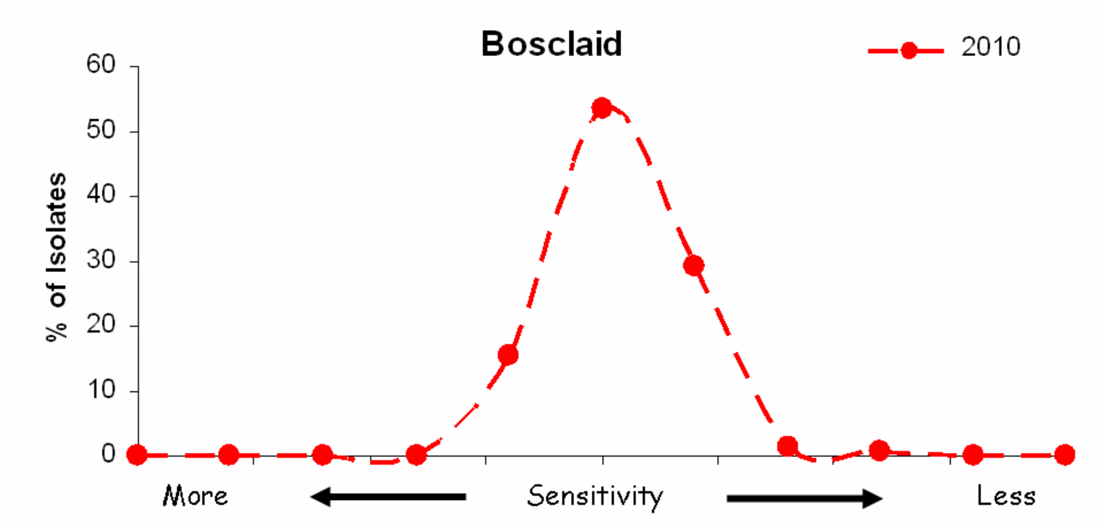


Fig. 3. Sensitivity of the Irish *Septoria tritici* population in 2010 to the SDHI fungicide boscalid.

Comparison of the 2010 *S. tritici* sensitivities to the triazole and SHDIs has found no evidence for cross-resistance in the current Irish population between these chemistries. Due to an expected increase in their usage in the coming seasons future routine monitoring will include a wider selection of SDHI chemistries.

Product comparisons - 2010

As a means of comparing the efficacy of the key fungicide products available for septoria control dose response trials were conducted at Ballyragget, Co. Kilkenny. Fungicide sensitivity assessments of *S. tritici* obtained from this site in spring 2010 (pre-fungicide applications) confirmed the presence of strains with reduced sensitivity. In line with previous seasons comparisons were made at doses from untreated to twice the recommended dose and sprays were applied as single applications at flag leaf emergence on the 25th of May (commonly referred to as the T2 application).

Due to dry weather conditions during the months of May and June and the ensuing low disease pressure, disease levels were relatively low following all treatments, including the untreated. These limited disease levels resulted in no significant differences between observed between treatments in the subsequent yields. Differences in disease control, as assessed for leaves 1-3 on the 2nd of July were however observed between the various treatments (Fig. 4).

Surprisingly all four solo triazoles displayed similar levels of disease control at the various dose rates (with the exception of Opus at double the recommended dose). As in previous seasons the pre-formulated triazole mixtures continue to out perform their solo equivalents. The addition of bixafen (an SDHI) to Proline in the pre-formulated product Aviator increased disease control over that provided by Proline alone.

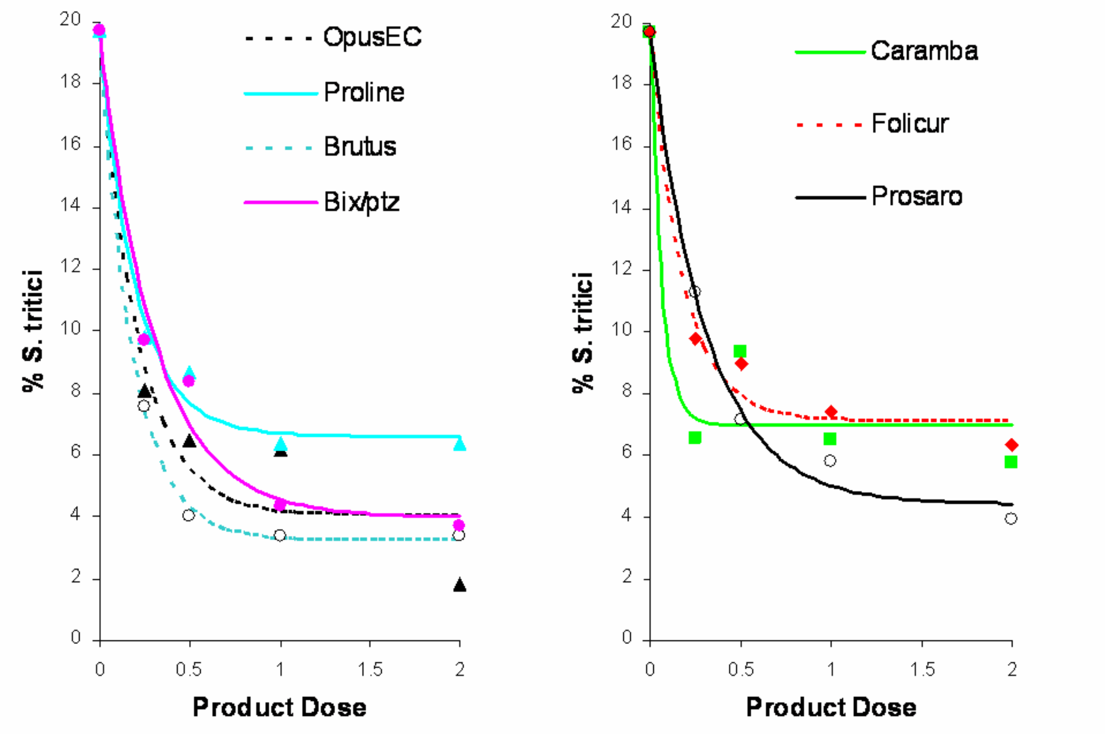


Fig. 4. Dose responses of the different fungicide products for septoria control as determined from disease levels on leaves 1, 2 and 3 on the 2nd of July.

Reducing selection pressure at T0

Due to the volatility of grain markets in recent years increased pressure has been upon growers to ensure crops yield to the maximum of their potential. Due to the unpredictability of weather conditions in late spring, applications of what is commonly the first winter wheat fungicide application (T1) can often be delayed. If the T1 fungicide is significantly delayed disease can already be present on leaf 3 before the fungicide is applied. To reduce this risk an early fungicide application, primarily aimed at septoria in early to mid April, often referred to as a T0 application has become common place in high disease situations (such as early sown crops).

Traditionally such applications have tended to be reduced rates of a triazole aimed at reducing septoria levels and thus providing some flexibility for the T1 application. In light of the recent shifts in triazole sensitivity (described above) changes in this practise a required both from an anti-resistance and disease control point of view. Evidence from trials in 2009 suggest any field affects of the recent shifts in sensitivity observed to epoxiconazole and prothioconazole are likely to manifests themselves predominately as reductions in the persistence of each fungicide (see National Tillage Conference report 2010). With reduced rates of application this persistence is likely to be further eroded and the flexibility once provided by a reduced rate triazole at T0 may well be compromised. Furthermore, while a fungicide application at T0 will often not directly influence yield, it is very likely to select for *S. tritici* with reduced triazole sensitivity reducing the effectiveness of triazoles later in the fungicide programme.

To assess if this triazole treatment can be replaced by the multi-site protectant fungicide chlorothalonil the performance of both fungicides were assessed at Knockbeg in 2010 when the T1 application was applied on time or delayed by almost two weeks (Table 1). Disease levels and pressure were high prior to the T0 application and the presence of *S. tritici* with reduced triazole sensitivity was confirmed at the site. Disease levels on leaf 4 (target of T0 application) were assessed on 26th May. As with the product comparison trials the unusually dry May did reduce disease pressure considerably and no differences were observed between the fungicides in the flexibility they provided the T1 application. Similarly no differences were observed in their subsequent yields.

Table 1: Effect of T0 fungicide treatment on septoria disease control

T0 16th April	T1 29th April	Late-T1 12th May	% Septoria on leaf 4 26th May
Untreated	Untreated	Untreated	3.4
Bravo (1.0)	Proline (0.6) + Bravo (1.0)	-	1.05
Bravo (1.0)	-	Proline (0.6) + Bravo (1.0)	0.3
Opus (0.5)	Proline (0.6) + Bravo (1.0)	-	1.55
Opus (0.5)	-	Proline (0.6) + Bravo (1.0)	1.375

CONCLUSIONS

- Selection for *S. tritici* with reduced sensitivity to epoxiconazole and prothioconazole has continued during 2010. Strains with reduced sensitivity to both tebuconazole and metconazole also continue to be present in Irish populations.

- Cross-resistance between the different resistance groups (epoxiconazole and prothioconazole) and (tebuconazole and metconazole) is currently limited. The use of mixtures or sequences of either resistance group at the different timings should therefore be used.

- At the key septoria timings (T1 and T2) triazoles or triazole / SHDI mixes should not be applied without a mixing partner that is multi-site with good septoria activity.

- Current *S. tritici* populations are sensitive to the SDHI fungicides with no cross-resistance between the SDHIs and triazoles identified.

- Avoid the use of a triazole at T0

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Oilseed rape management & disease control

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SUMMARY

Oilseed rape is a useful break crop, but it must be managed correctly to perform consistently. To maximise yield a moderately sized crop at flowering must be produced ensuring adequate light interception by the plant leaves during seed set. In contrast to cereal crops all of the yield is formed after the start of flowering, and there is no direct contribution from growth produced prior to flowering to yield. Pre-flowering growth needs to form sufficient crop to intercept all of the light and provide sufficient seed sites to store the yield, as crop size increases above this size incident light is used less efficiently and yield declines.

The optimum canopy size of 3.5 GAI at flowering can be achieved by reducing seed rate or delaying drilling in the autumn. Because of the risk of poor establishment and pest damage most growers prefer to establish a thick crop over winter and use spring management to target the optimum canopy size. Spring management options include tailoring N use (usually delaying and reducing applications) and/or the use of triazole fungicides as plant growth regulators. Once the maximum yield potential has been set by optimising canopy size, the duration of seed filling needs to be maximised to ensure complete seed fill, primarily by the use of late N applications and thorough disease control.

INTRODUCTION

Oilseed rape is a crop with a somewhat chequered history in Ireland. It was first grown in the mid 1970's but its area did not exceed 1000 ha until the 1980's. The area has varied since, largely dependant on price or the level of financial support given to the crop, but the area has only infrequently exceeded 6,000 ha; the area limited to some extent by the lack of a significant domestic market. There is evidence in the national wheat yields that since the demise of the sugar beet industry and a significant proportion of the non-cereal break crop area that yields may be suffering. Non-cereal crops that can maintain the yields of cereals in the rotation as well as perform financially themselves would therefore prove very valauable.

In contrast, in the UK the area has been consistently above 333,000 hectares since the late 1980's, in part due to a large domestic market, and peaked at nearly 700,000 ha in 2007 (FAO Stat). Despite the much greater interest in the crop in the UK the yield has remained stubbornly static since 1986 after increasing rapidly from the early 1960's (Berry and Spink, 2006). This long term lack of progress has prompted significant effort to understand the yield forming processes. This has allowed the quantification of the yield potential in a range of environments and the identification of management practices that could be employed to increase yield.

Yield Formation

In common with any other combinable crop, the yield of a crop of oilseed rape is dependant on a combination of the number of seeds produced per unit area and seed size. The relative importance of these two yield components varies between crop species; in oilseed rape seed number is by far the most important accounting for 85% of the variation in yield between crops (Mendham *et al*, 1981). It would seem obvious that to maximise seed number per unit area the crop should be managed to maximise flower and therefore pod number per unit area. This is not the case however. Experiments carried out in the late 1990's and reported by Lunn *et al.* (2001) demonstrated that as pod number per unit area increased, seed number per pod declined. Further analysis of this data in Berry and Spink (2006) showed that seed number per unit area was maximised at a pod number of about 7,000 per m^2 (Figure 1). Seed number is set in a 200-300 ^oC days period (2-3 weeks) starting at mid-flowering. It has been suggested that at less than 6,000 pods per m^2 there is insufficient green canopy to intercept the incident light resulting in sub-optimal seed number. As flower number increases to produce more than 8,000 pods per m^2, the proportion of incident light that is intercepted or reflected by the pod layer increases to the point that seed set is reduced as light penetration to the lower parts of the plant is reduced. Lunn *et al* (2001) identified that a green area index (GAI - the ratio of above ground green area to the ground area it occupies i.e. the m^2 of green material per m^2 of ground area.) of about 3.5 at flowering was optimal to maximise seed number per m^2.

Once seed number has been set, seed filling starts and lasts for about 715 ^oC days above a base temperature of 4.2 ^oC (Mendham *et al.* 1981), giving a seed filling period of about 43 days. In common with the period of seed number determination, there is no movement of stored reserves into the developing seed, and seed filling is therefore entirely dependant on current photosynthesis. In order to maximise seed filling it is important to ensure that the maximum potential duration of seed filling is realised and that incident light is utilised as efficiently as possible.

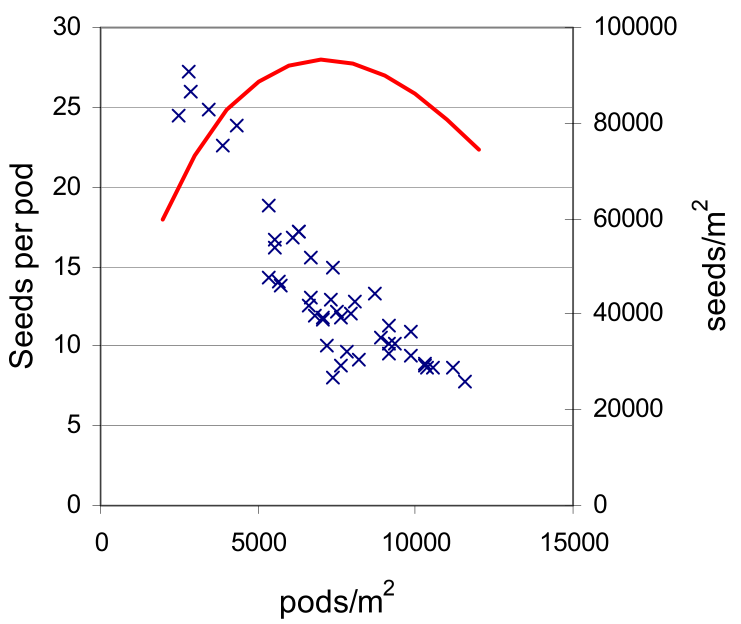

Figure 1: ... pod (crosses) ... by solid line).

A number of agronomic and environmental factors such as disease and drought can result in premature senescence of the canopy which will result in the full seed filling period not being realised. These will be dealt with later. The structure of the crops canopy during pod filling can also be of importance due to variation in the radiation use efficiency of leaves, stems and pods. The radiation use efficiencies of pods and stems have been reported to be only 2/3 and 1/3 respectively of that of leaves (Major 1977), therefore dense canopies with high pod numbers that intercept all of the light in the pod layer will utilise the light less efficiently than sparser crops that maintain some leaf in the canopy during seed filling.

Berry and Spink (2006) estimated that with current varieties of oilseed rape and the best management practices, the maximum yield of oilseed rape in UK conditions would be about 6.5 t/ha at 91% dry matter (DM). The yield potential in Irish conditions might be slightly higher due to higher radiation receipt and reduced drought risk. They also estimated that given some genetic improvement, to combine the best characteristics from the best varieties then there was the potential to increase maximum yield to 9.2 t/ha. Previously Spink and Berry (2005) had used similar methods to examine the yield of commercial crops and crops grown in recommended list trials in the UK which yielded 3.1 and 4.1 t/ha @ 91%DM respectively. Yields in recommended list trials had continued to increase over the previous 2 decades whilst they had remained static in commercial crops. A number of possible management differences were identified which may be restricting the yield of commercial crops, including; shorter rotations, greater use of minimum tillage (sometime in inappropriate conditions), earlier drilling, higher seed rate, lower fungicide use, less sulphur use and possibly lower nitrogen use. It appears therefore that growers may have been reducing inputs and management effort put into OSR as a results of declining prices when EU price support was removed and as a result failed to exploit the increased yield potential of new varieties.

Crop Management

The aim of any crop management strategy is to maximise output for the minimum cost. In the case of oilseed rape the analysis above shows that this should primarily be to maximise seed number per unit area and that this is best achieved by producing a moderate canopy size of 3.5 GAI at flowering. In order to put the target canopy size into perspective conventionally managed early drilled crops with seed rates of 120 seeds (6 kg/ha) with early applications of nitrogen can achieve canopy sizes of double this. Once the maximum seed number has been set the objective of management is to maximise the rate of, and prolong, seed filling for as long as possible to maximise seed size.

Sowing date and seed rate

Oilseed rape crops are often drilled early in the UK to get the crop established before cereal drilling begins. Crops would frequently be drilled in the second half of August, with many growers looking to finish oilseed rape drilling before the first week in September. Autocasting, which involves spreading the seed behind the combine header when the previous cereal is being harvested was an establishment technique increasing in popularity in the UK around the turn of the millennium, but resulted in the crop being drilled in early August or sometimes July.

The crop has traditionally be sown at seed rates of 120 seeds/m^2 or 6 kg/ha in the UK. Recommended seed rates were reduced for hybrid varieties often sold in area packs rather than by weight. The justification for lower rates was increased autumn establishment as a result of hybrid vigour, although the more cynical would say it was because of the higher seed cost.

Early drilling and high seed rates are used to provide insurance against poor establishment and pest damage (pigeons and slugs), and to increase competition against weeds. It is however widely reported that early drilling and high seed rates reduce seed yield (eg. Jenkins and Leitch, 1986; Leach *et al* 1991; Leach *et al.* 1994; Mendham *et al.* 1981). Lunn et al (2001) compared 120 and 60 seeds/m2 and normal (late August) and late (late September) sowing date over four seasons (1996-1999). Halving the seed rate increased yield in 3 of the 4 years at both early and late drilling dates, and resulted in a small decrease in 1 year when establishment was very poor (Table 1). Delaying drilling resulted in no yield effect in 2 years and reductions in the other two.

Table 1: Effect of normal (late August/early September) and late (Late September/Early October) drilling date and High (120 seeds/m2) and Low (60 seeds/m2) seed rate on Yield t/ha@91%dm, Herefordshire UK (From Lunn *et al.* 2001)

		1996	1997	1998	1999
Sowing date	Normal	4.20	5.05	4.72	3.10
	Late	4.29	4.75**	3.91**	2.94
Seed rate	High	4.06	4.84	4.27	3.18
	Low	4.44	4.95	4.36	2.86**

Level of significance * <0.05, ** <0.01, ***<0.001, if not marked effect not significant

Seed rate response trials carried out at Oak Park in harvest years 2006-2009 showed little yield response to seed rates above about 75 seeds per m^2.

The effect of early drilling or high seed rate is to increase canopy size, often to above the target of 3.5 GAI at flowering resulting in reduced seed set, unless some form of remedial action is employed. Delayed drilling and lower seed rates could therefore be used to optimise canopy structure but because of the risk of poor establishment and pest and weed problems most growers prefer to drill earlier and maintain higher seed rates and utilise spring management to achieve the target canopy size.

Nitrogen use

Lunn *et al.* (2001) calculated that the oilseed rape crop must take up 50 kgN/ha to increase canopy size by 1 GAI; subsequent work has confirmed this across a range of varieties, N rates, sites and years (Berry & Spink, 2009a). In order to achieve the target canopy size of 3.5 GAI by flowering the crop must therefore take up 175 kg/ha of N.

Oilseed rape is also highly efficient at acquiring available soil mineral nitrogen over the autumn and winter period, particularly if early sown. A survey of commercial crops in the UK in 2006 showed that the average GAI in mid February was 1.5 GAI (Berry & Spink, 2009b) indicating that the crops had already taken up 75 kg/ha of N. Mineral nitrogen in the soil or already taken up by the crop in the spring has been shown to be used with at least 100% efficiency in oilseed rape. That is an unfertilised crop will contain at least as much nitrogen at harvest as can be measured in the soil and crop in spring, Berry and Spink (2009a) reported the actual efficiency to be 107%. Crop and soil N supply in the spring can therefore be subtracted from the total needed to produce the canopy, and the remainder supplied from artificial sources. Berry and Spink (2009a) showed that the efficiency with which fertiliser N was used was 57% at fertiliser rates close to the optimum. The efficiency was higher at low (100 kgN/ha) N rates at an average of 67% and as low as 43% at an N rate of 240 kgN/ha. The canopy size of the crop in the spring can be accurately estimated by taking a digital photograph and loading it onto www.totaloilseedcare.co.uk.

The information above can be used to calculate exactly the amount of N that must be applied to a crop to achieve the target canopy size of 3.5 GAI and 7,000 pods per m2. For example, an early drilled crop that has taken up all of the available N and has a GAI of 2 in February will require:

Target =	GAI 3.5 @ 50kgN/GAI =	175kg/ha
February canopy size	2 GAI =	100kgN/ha
Shortfall =		75 kgN/ha
Nitrogen required at 60% efficiency (75kg/60%)*100% =		125kgN/ha

Once the amount of N fertiliser has been calculated a decision has to be made over the timing. The N fertiliser must be applied in time for the crop to take it up before flowering, however, early N applications result in greater production of flowers and pod numbers and should therefore be avoided. Schjoerring *et al.* (1995) showed that the rate of N uptake was 3 kgN/ha/day. If we want the N to be taken up before flowering we can therefore work back from the expected date of flowering how many days it would take for the N to be taken up, in the example above 75 kg would take 25 days, so 25 days before the start of flowering would be the latest date that n application could start.

The N rates calculated above will produce a crop with a canopy size of 3.5 GAI and containing 175 kgN/ha. Because oilseed rape seed is a high protein seed, this will only provide sufficient n for a 3.5 t/ha crop yield. Yield potential in Ireland is significantly above this, and without additional late N the crop will senesce early and produce poorly filled seeds. A number of authors have demonstrated the relationship between crop yield and N requirement and shown that for every additional 1 t/ha of yield an additional 60kgN/ha must be applied to supply an additional 36 kgN/ha crop uptake (eg. Holmes and Ainsley, 1979). This additional nitrogen should be applied late to avoid the production of excessive flower and pod numbers. Experimentally it has been applied at early flowering but in a commercial farming situation should be spread as late as an even spread pattern can be achieved with the machinery available. If the crop in the example above had a yield potential of 5 t/ha it would need an additional 90 kgN/ha applied late in addition to the 125 kgN/ha applied earlier in the season.

This 'Canopy management' approach to N use was tested in a series of 9 experiments reported by Berry and Spink (2009a). Compared to the conventional approach, adoption of a canopy management strategy resulted in a yield increase of 0.36 t/ha with no overall difference in the amount of N applied.
The key message of the canopy management work can appear counter intuitive a small and backward crop requires earlier and larger applications of N, while large forward crops will have yield maximised by delaying and reducing applications.

Plant growth regulators

There are no products registered as Plant Growth Regulators (PGR) for use in Oilseed rape. Some of the triazole fungicides approved for use in the crop are however, well known to have growth regulatory activity, in particular tebuconazole (Folicur) and metconazole (Caramba) which notes on its label that it can reduce the height of oilseed rape.
These two products have been extensively researched to identify how and when they should be used for the maximum yield benefit. In the experiments reported by Berry and Spink (2009a) Folicur was applied at either 0.5 l/ha to crops with a GAI of less than 1 in February and at 1.0 l/ha to crops with a GAI of more than 1; all applications were made at green bud. The yield response was up to 0.32 t/ha; there were 2 varieties in the experiments and the average yield response was greater at 0.15 t/ha on Winner, the tall variety, than on Castille (0.10 t/ha) the short variety.

A more thorough analysis is contained in Berry and Spink (2009b) where 13 experiments containing 173 comparisons of crops with and without Caramba applied. Crops with a GAI of less than 0.8 in March at green bud showed an average yield loss of -0.14 t/ha with Caramba, whilst those with greater than 0.8 showed an average yield increase of 0.21 t/ha. The individual yield responses in crops with a large GAI were significantly greater. The biggest yield responses tended to come from later applications in April at late green bud to yellow bud or early flowering, compared to March treatments at early green bud. The yield responses were attributed to a number of improvements in the crop including; reduced plant height, reduced lodging, increased root length density, and increases in seed number and seed size.

Disease control

The key diseases of oilseed rape are light leaf spot (*Pyrenopeziza brassicae*) , Phoma (*Leptosphaeria maculans*) and Sclerotinia (*sclerotinia sclerotiorum*). In general they all cause yield loss during pod fill, although light leaf spot causes its greatest yield losses if severe early infections occur and plants are lost over winter.

Both light leaf spot and Phoma spread from the stubbles and residues left by the previous year's crop. It is important therefore to ensure that the stubbles of neighbouring previous crops are buried before the following crop emerges in the autumn to reduce disease pressure. The degree of spread is however limited with spore dispersal thought to decline rapidly at distances over 200m for Phoma and 400m for light leaf spot. Despite the fact that the main yield robbing period for both diseases is during flowering, they require control measures to be taken much earlier in the season.

In areas where light leaf spot is common, a resistant variety is vital and a prophylactic autumn application is needed in November/early December. In lower disease pressure areas an autumn spray is not necessary, but an application should be made if greater than 25% of plants are infected before stem extension. If such circumstances occurred in a high risk area, a follow up spring spray would be needed. Control before the green buds are visible is vital, as it is through infection of the flower buds and subsequent damage to the pods, that the main yield losses occur.

Phoma spreads into crops during the autumn and winter causing phoma leaf spot. Epidemics occur earlier in the life of the crop and are more severe when there are more than 20 days rain in August and September. Leaf spots appear 120 ^{o}C days after infection, and the disease then grows down the leaf petiole and into the stem. Once the disease has entered the stem fungicides offer no control, consequently a spray should be applied once 10% - 20% of plants have leaf symptoms. The lower threshold applies to crops with small leaves as there is less distance for the infection to grow to enter the stem and therefore a shorter time in which to apply the fungicide. A second spray may be necessary if infection occurs early in the autumn and disease builds back up to the threshold again, but it is the early infections that are most damaging. Yield loss occurs when the fungus that has entered the stem in the winter causes stem cankers in the following summer during pod filling, effectively cutting off the water supply to the pods.

Sclerotinia causes yield loss in much the same way as phoma by causing collapse of the plants vascular system during pod filling. In contrast to the previous two diseases however, infection occurs in the late spring when the crop is flowering. Infection occurs from sclerotia which can survive in the soil for 10 years after being produced in a previous susceptible crop (OSR, potatoes, lettuce, carrots, celery, spring beans and peas) or introduced in seed. Sclerotia can vary in size from 1-20 mm long and look like rat droppings. When the soil is warm and moist the sclerotia germinate to produce a small trumpet shaped mushroom like fruiting body 5-15 mm across called an apothecia. Dry conditions are then required for the apothecia to release air borne spores, which land on the petals of the crop during flowering. Damp conditions are then needed to stick the petals onto the stems of the crop and the fungus grows from the petal and into the stem. Because of the sequence of conditions needed for an epidemic they are very difficult to predict and control is often based on the previous history of the site. Fungicides are usually applied at early to mid-flower to coat the petals and stems and prevent the disease entering the stem.

CONCLUSIONS

Oilseed rape has considerably more yield potential than most growers are currently achieving. It has the potential therefore to make a useful economic contribution to a rotation, as well as improving the performance of the cereals in the rotation. In order to get the most out of the crop clear management targets need to be understood and set. The crop can vary significantly year to year depending on autumn and winter conditions, but in all but the most extreme conditions the crop will maintain its yield potential, as long as subsequent management is flexible and responsive to the state of the crop.

- Aim to produce a moderately sized oilseed rape crop with a flowering GAI of 3.5
- Small poorly established crops require earlier applications and higher rates of N than larger crops.
- Disease control needs to start early with burying of trash of previous crops and autumn or winter applications of fungicides for light leaf spot and phoma.

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Winter Barley: Maximising Yields

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SUMMARY

The acreage of winter barley has increased steadily over the past five years and the estimated area in 2011 may be close to 35,000 hectares. Underpinning the increased acreage is increasing yield as seen in the Central Statistics Office (CSO) national average yields and yields from variety trials (Department of Agriculture, Fishery and Food).

Data from the Teagasc National Farm Survey shows the top one third of growers are producing 1.2 t/ha more grain than the average grower in the survey, which is contributing to a €10 per tonne decrease in the cost of production. For any grower knowing their costs per tonne of grain produced will enable them to be in a stronger position to trade grain through the year. The opportunities to forward sell and use the spot market should help the grower to smooth volatility of current grain prices.

Profitability is driven by output and costs of production. A key component of output is yield and yield in winter barely is closely associated with the number of grains m^2. As the number of grains/m^2 increase yield should also increase. Winter barley has limited capacity to compensate (yield) for low plant populations through increasing the number of grains per head or grain weight. However, there is good scope to increase the number of heads per m^2 (which will increase grain number m^2). The starting point to achieving a high grain number is therefore to maximise tiller production during early canopy growth and maintain as many as possible until harvest. Husbandry practices that growers can focus on include; early sowing date, adequate plant numbers in spring, early nutrient application, careful use of growth regulators to increase tiller numbers. Recent work carried out by Teagasc suggests targeting a larger part of the fungicide spend to the earlier part of the season will achieve good disease control and increase yields compared to the traditional fungicide applications.

Careful attention to husbandry in the early part of the season will, therefore, help to increase yields which will reduce the costs of production per tonne and increase returns.

INTRODUCTION

In the late 90's many growers switched away from winter barley to spring barley as the crop was viewed as expensive to grow and the yields appeared to have plateaued on farm and in trials. However popularity of the crop has increased again over the past five years (see Figure 1). Reasons for the increased popularity may include: increased yields of winter barley among many winter barley growers, increased varieties, decreased yields from spring barley, spreading work load at planting and harvest, increased selling opportunities for winter barley straw, entry for winter oilseed rape, etc.

Achieving a consistently high average yield is a major challenge for all growers. This paper will look at ways to achieve high yields, with a focus on the main driver of yield in winter barley (grains/m^2) and give pointers as to key agronomic practices to maximise it.

The potential economic return from crops is a strong driver of cropping decisions by growers. The paper will also look at the yield trends and cost of production of winter barley which should help growers to better target their input spend.

Economic return

There are two key factors to profitability; output (yield and sales) and costs of production.

Yields

Yields of winter barley can be tracked over the past 15 years by examining data from the Central Statistics Office, Teagasc National Farm Survey (NFS) and the Department of Agriculture, Fishery and Food (DAFF) official variety trials.

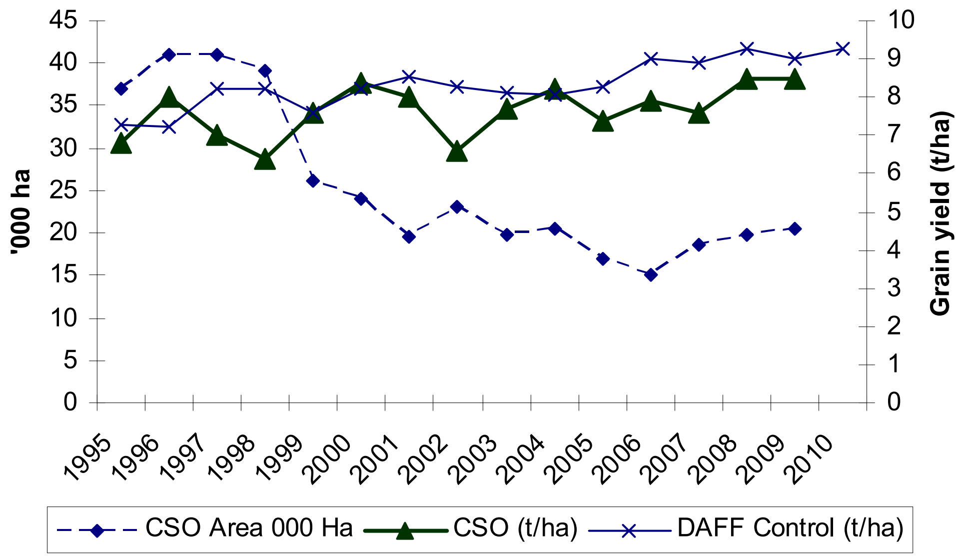

Figure 1. Average area grown and average yields (t/ha) achieved (CSO), Winter Barley Recommended Variety List control varieties yield (DAFF)

The CSO yield data shows a slight increase in yield over the past 16 years but the increases are small. However over the past four years average winter barley yields are rising and are now constantly above 8/t/ha for all groups shown in Figure 1.
The five year rolling average yields from the DAFF Winter Barley Variety Recommended List between 1992-1996 (Av. 7.86 t/ha) and 2006-2010 (Av. 9.09 t/ha), shows a substantial yield increase of 1.23 t/ha over the period.

However average yields can often mask the real story where the top growers can achieve substantially more yield than the average grower thereby increasing income from the crop.

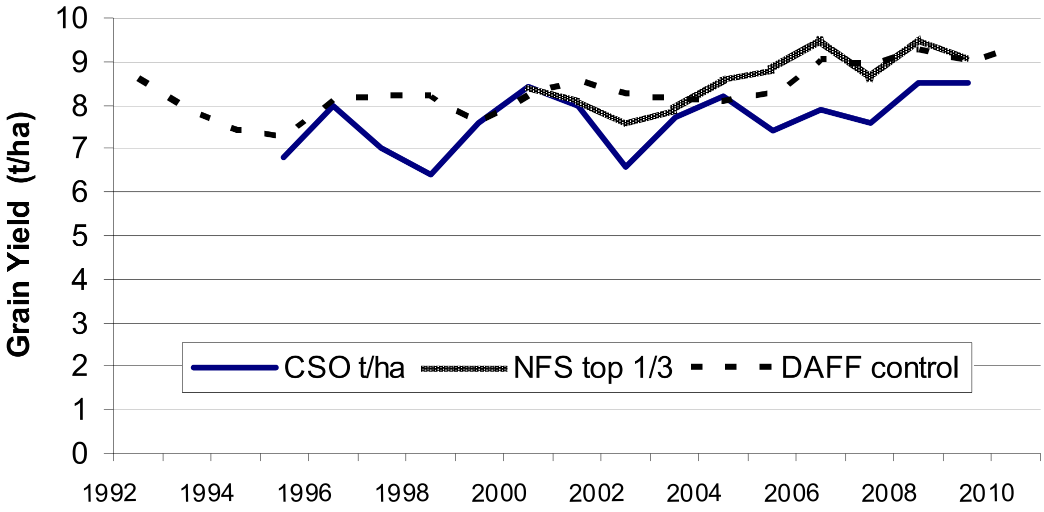

Figure 2. Average yield data from the CSO, NFS and DAFF 1992-2010

Data from the NFS shows that, on average over the past 10 years, the top 1/3 of growers have achieved a yield of 8.6 t/ha or 1.1 t/ha more than the CSO national average yield. Factors such as land and rotational position are at play but managerial expertise and timeliness of inputs are also a part of increasing yields.

Costs

The yields and costs of growing winter barley from the Teagasc National Farm Survey for the last four years are outlined in Figure 3. The data shows the growing costs per ton of grain of all winter barley crops in the survey. The costs of production are in €/t and are calculated by dividing the costs by the average yield achieved in those years. Both yield and cost of production influence the final figure.

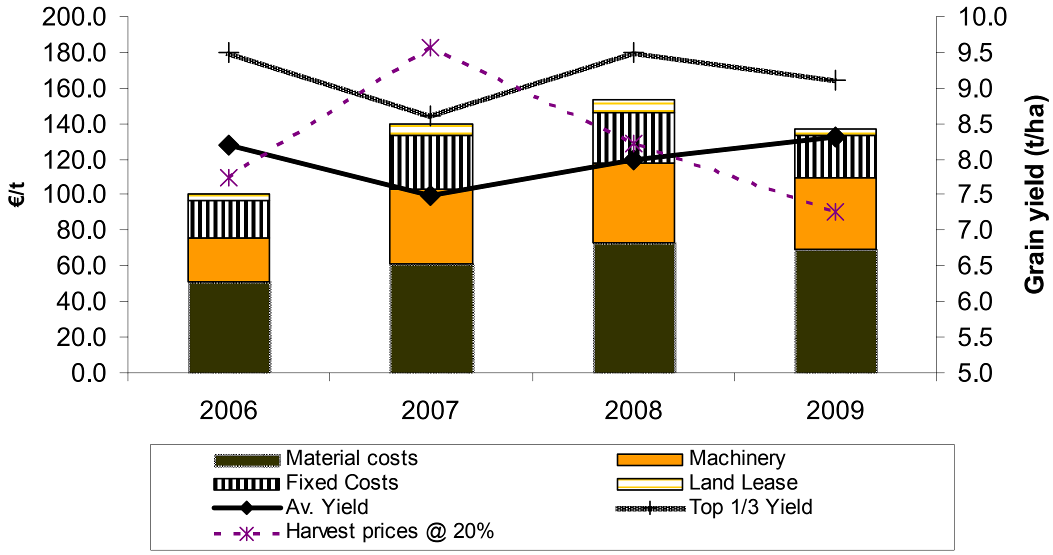

Figure 3. National Farm Survey Winter barley production costs (Average of all groups, yields(average and top 1/3) and harvest prices (J. O Mahony, Teagasc).

Note: costs depicted in the bar chart and grain price correspond to the left hand axis (€/t) and yields are depicted in lines corresponding to the right axis (t/ha)

From figure 3, the "top 1/3" of growers are producing 1.2 t/ha more grain than the average grower in the survey. This contributed to the "top 1/3" reducing their costs of production by €10/ton compared to average grower over the period. This improved yield attained by the top 1/3 of growers influenced the reduction in production costs however this group incurred higher machinery costs.

The bar chart in Figure 2 shows an average cost of production of €130/t for the average growers with materials and machinery close to 50% and 30% of costs respectively. The graph shows production costs peaking in 2008 at €153/t due to increases in material costs and energy prices. Average costs of production per tonne are higher than the harvest price (at 20% MC) available in both 2008 and 2009.

In many situations the level of inputs are relatively static and only small reductions can be achieved without compromising yields. Strategies to better purchase inputs such as; buying for cash, buying in bulk or buying goods in advance can help reduce costs. However, getting more yield for each unit of input can also achieve a lower production cost and higher margin per tonne.

Selling Decisions

Volatility in cereal prices is a major part of the arable business now but growers can use their skills and knowledge from the farm to help manage this volatility. The average price for barley over the past three years (at harvest 20% MC) was €127 (Prevailing National Price, J O Mahony, Teagasc). However, volatility over a last five year period, at harvest, resulted in a prices variation from as low as €98 per tonne to €183 per tonne. All economists and industry experts assure us this trend of volatility will continue.

All growers should carry out a break down of production costs to help to identify profitable forward or spot selling opportunities. Table 1 shows an example of how the breakdown of these figures can help a grower identify a selling opportunity.

Table 1: Production costs for winter barley (based on Teagasc Costs and Returns 2011).

	€/t			
	2010	2011	2011(Yield +10%)	2011(Yield -10%)
Yields*(t/ha)*	9	9	9.9	8.1
Materials *(€/t)*	59	83	75	92
Machinery *(€/t)*	42	42	38	46
Fixed Costs *(€/t)*	21	21	19	23
Land Rental *(€/t)*	(36) [a]	(36) [a]	(32) [a]	(40) [a]
Total Costs	121 (157) [b]	146 (181) [b]	133 (165) [b]	162 (201) [b]

[a] rented land @ €190/ha 2010 & 2011 , [b] includes land rental value

The revenue for straw is not included in table 1 as it can vary considerably from area to area. The figures in table 1 show that a grower achieving a high yield can produce barley for €146/t, on owned land, not including straw. However with a lesser yield and land rental costs incurred, the production costs mount to €201/t not including straw.

The die has been cast as regards planting for 2011 but decisions as to the eventual selling price are still very much in the mix. At the time of writing barley can be forward sold for harvest 2011 for €165/t at 20% MC. Growers may be unwilling to sell into a rising market (at the time of writing) but still want to sell at the top of the market. The real question is; when to sell? Most will tell you sell when you are making a profit but determining whether a price leaves a profit is up to an individual grower to determine. Given the example in table 1 with a forward price of €165/t available at harvest, a grower renting land and not achieving a high yield is set to loose money excluding the value of straw.

Knowing production costs will help when making decisions when selling grain and are essential to work out the potential value of land rental. In order to compare the production costs to the eventual selling price its best to work in euros per tonne for the major production costs.

Grower Action
Calculate production costs for 2010-11 on a per tonne basis which will help to inform a cropping programme, profitability from land rental or a selling decision/strategy

It is not possible to give growers a definitive selling strategy to follow but many will agree that selling grain on one day (harvest) is inherently more risky than selling a number of times through the year. Forward selling can be a useful tool to spread risk and also can be used to calculate if a profit can be attained from rented land.

The foundations of yield

The final yield in cereals can be calculated by multiplying the components of yield. The components of yield are; ear number, grains per ear and weight of each grain. In order to maximise yields in winter barley we need to focus on the components of yield which have the most influence on final yield.

Winter barley has the potential to create a huge canopy but only under the correct conditions. At its peak an average winter barley canopy will expand to about 6.0 GAI (Green Area Index, the total area of leaves and green stems per unit of ground area covered by a plant) at ear emergence (GS59), but could be almost double that in a very large crop. This canopy can fulfil a huge yield potential if there are sufficient grains to fill. However the limiting factor in barley is generally grain numbers. Work has shown that grain weight has a limited impact on final yield where as increasing grain numbers has a close relationship to increasing yield (figure 4).

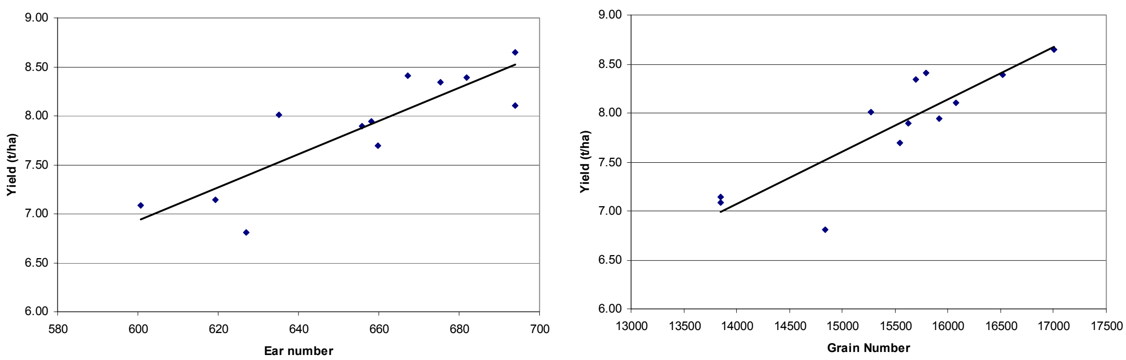

Figure 4. Relationship between grain number per m^2 and ear number per m^2 in spring barley at Kildalton, 2009

There is limited scope to increase the number of grains per ear in barley. In response to low plant population winter barley can increase number of grains per ear by 20-30% but this is 30-50% lower than the increases recorded in winter wheat. However there is potential to increase ear number in winter barley with increases of over 5-fold being recorded in low plant populations.

Grower action
Concentrate efforts, on early season growth, to increase tiller/ear numbers to produce high yields. Producing and maintaining these tillers to final ear numbers at harvest is critical.

Winter barley early growth habit

Barley development is largely governed by variety choice and sowing date. The speed of crop development is influenced by temperature (warmer conditions speed development), vernalisation (cool conditions to trigger flower initiation) and the photoperiod (long days advance floral development). Leaf production is affected by daylength and temperature (referred to as thermal time). Each leaf requires a set amount of thermal time to emerge and later sown crops accumulate less thermal time and produce fewer leaves.

Tillering is one of the most important components of final yield. Tillering is affected by temperature but also water and nutrient availability. Tillering starts after leaf three emerges and continues through the autumn. Tillering resumes once nutrient availability improves in the spring. Sowing date has a strong influence development. Tiller numbers are reduced by late sowing, delayed emergence, low autumn temperatures or poor nutrition. Early sown crops tiller for longer and can compensate somewhat for lower plant numbers. Later sown crops pass through their development stages faster and complete each stage more quickly, than crops sown earlier.

The key for growers is to ensure adequate early season growth to promote the maximum shoot/ear numbers which is required to achieve high grain numbers thus ensuring the best possible chance of high yields in barley.

Growers should examine the following areas to maximum yields through the growing season.

Site and sowing date

The starting point to determine yield of any crop is the site and variety selected. Winter barley is best suited to medium –heavy, deep, fertile, moisture retentive, but free draining soils. Differences between yields on light soils compared to heavy soils of 1.0 t/ha have been recorded at Oak Park.

Winter barley is moderately tolerant to take-all. Poor root development, poor grain development and high screenings are often associated with take-all infection. Where infection is likely, delayed sowing (but not past mid October) into a good seedbed and a 15% increase in early spring nitrogen can help delay symptoms. The addition of a seed dressing such as Latitude has not resulted in an economic response in trials in Oak Park.

Growers should choose a variety to maximise the potential of the chosen site. However careful attention should be given to varieties agronomics characteristics such as standing ability, disease resistance, etc. Choosing a variety based on site may hinge on some of the following factors: high disease area (choose variety with highest scores for wet weather diseases), site elevation (choose variety with the best standing power), for soils with high fertility (choose a variety with the best standing power), etc.

Perhaps more important than variety selection, is the seeding rate and time of planting chosen, as these factors will have a much larger influence on final grain numbers than other decisions through the growing season. Early sowing plays an important role in ensuring an adequate crop platform is established to build ear numbers. Oak Park trials have shown sowing after September can substantially reduce yields. In heavier soils delaying sowing until mid-October and November gave yield reductions of 8% and 30% respectively. On lighter soils yield reductions were 4% and 16% respectively. This lower yield was due to reduced ears numbers per m^2.

For high yield potential target a viable plant population of 225-250 plants per m^2 in the spring should be targeted. It is essential to factor in establishment and over winter losses when calculating a seed rate. Table 2 gives guideline seed rates to achieve a plant population of 225-250 viable plants the following spring.

Table 2: Suggested seeding rates for winter barley

		Seeds/m2			
Sowing date (week)		**Sept- 3rd Week**	**Sept – 4th Week**	**Oct – 1st Week**	**Oct – 2nd Week**
Target plants m^2 (Autumn)		260	270	280	280
% Establishment		90%	85%	80%	75%
	TGW*	**Kg/ha**			
Amarena *(6 row)*	47.8	138	152	167	178
Saffron	57.9	167	184	203	216
Leibniz *(6 row)*	52.7	152	167	184	197
Anisette	55.1	159	175	193	206
Boost *(Hybrid)*[a]	*48.6*	112	124	136	145
Famosa	56.3	163	179	197	210
KWS Cassia	58.1	168	185	203	217

Seeding rates in table 2 can be adjusted for seedbed conditions and seed germination. The seeding rates assume over-winter plant losses in barley are higher than in wheat therefore the crop will need higher plant numbers entering the winter than final desired plant number.

Grower Action
Sow winter barley early, no later than early October (area specific), aiming to establish 225-250 plants in the spring

Barley type

Two row varieties have proved most popular to date due to their high hectolitre weight compared to six row varieties.

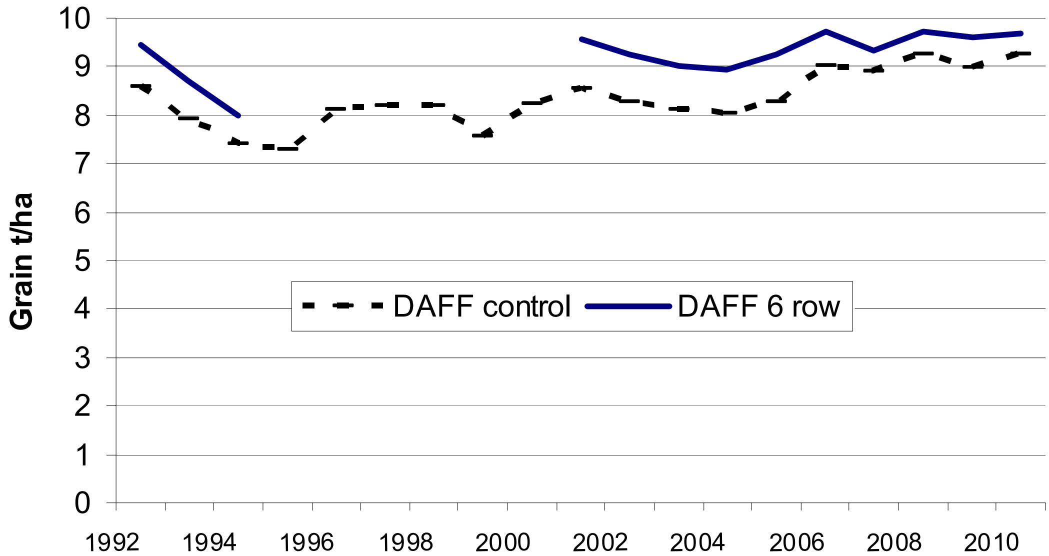

Figure 5. DAFF Winter Barley Recommended List Variety trial data control yield results 1992-2010

Figure 5 shows that six row varieties continue to out yield two row varieties, however the difference between yields of the two row and six row varieties has narrowed over the past ten years. The five year rolling average shown the difference between the two row and six row varieties has narrowed from 0.96t/ha (2001-2005) to 0.53t/ha (2006-2010). Even though six row varieties are higher yielding (Figure 5) and locally growers are reporting high hectolitre weights, DAFF trials still show a substantial gap between the hectolitre weights over the past ten years (Figure 6).

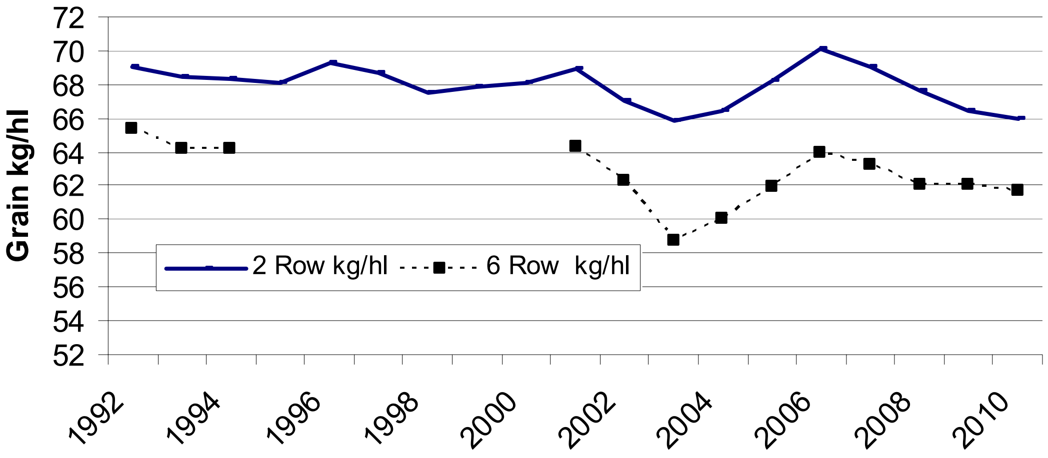

Figure 6. Hectolitre weight of two and six row barleys from DAFF Recommended list trials 1992-2010

Although six row varieties are capable of exceeding 64 kg/hl they will not make this specification every year.

Mixing two row and six row varieties is common on the continent but less common in Ireland. The aim of growing a mix of a two row and six row variety is to (i) increase the yield of the two row and (ii) to increase the hectolitre weight of the six row variety.

Trial work carried out recently over three years in Oak Park, by Dr Richie Hackett, did not show a consistent trend in favour of mixing two and six row varieties compared to unmixed. The results indicate six row varieties out yield two varieties. When the two row and six rows are sown as a mixture the resulting yields are higher than a two row but below the yield expected from a six row. Much the same result could be expected for hectolitre weights with the mixture of two and six row barleys weighing around the average of the two or six row if grown separately.

Work from Denmark suggests mixes can be successful but are very specific to the varieties used. Their work suggests combinations of particular varieties complimenting each other better than others due to growth habit, early season growth etc.

Hybrid barleys have been on the Irish market for a number of years but have, so far, failed to gather mass appeal. Hybrid yields have kept a step ahead of two row varieties but struggle to match the best two row barleys for hectolitre weight in DAFF trials. Hybrid seed is more expensive to produce but can be sown at lower seeding rates due to hybrid vigour. Work carried out in UCD concluded that hybrids barleys have high yield potential and will perform at lower seeding rates (as low as 150 seeds/m^2) which can be used in commercial production, Tom McCabe, D Wall and D Fewer, (2005).

Pest Control

BYDV is carried by aphids (mostly the bird cherry aphid) and is passed to the plant, through feeding, during early plant development. Dr. Tom Kennedy in Oak Park found significant yield loss (of up to 2.2-3.4t/ha) can occur from BYDV infection therefore control of aphids is essential in early and late sown crops. For crops emerging after mid-October adequate control can be achieved by a single post emergence aphicide application in the first week in November. Earlier emerging crops will normally require two applications the first in mid-october with a second in early November. Alternatively a seed dressing such as Clothianidin (Redigo Deter) can be used to protect early season growth against aphid attack,a follow up treatment may be needed for very early sown crops.

Grower Action
For post emergence control of aphids, apply two aphicides, one in mid-October and one in early November, for crops emerged before mid October. For crops emerging after mid October one aphicide in the first week of November.

Slugs and leather jackets can occasionally cause problems but early sowing and rapid establishment generally enables the crop to grow away from these problems.

Nutrition

Root development is dependent on a good supply of phosphate in the rooting zone during the early stages of growth. Potassium (K) also plays a critical role in plant development. A potassium deficiency can decrease yields, reduce nitrogen efficiency and reduce disease resistance. Winter barleys requirement for both P and K is low in the autumn but increases in early spring with rapid uptake from mid March until late May.

The offtakes (grain and straw) from a 9 t/ha crop of winter barley are; Phosphorus (P) 34 kg/ha, and Potassium (K) 88 kg/ha. The soil will supply some of these off takes and should be taken into account before applying these nutrients. The revised nutrient allowances under the Nitrates Action Programme are given the R. Hackett, (2011, at this conference).

Autumn nitrogen is not recommended for winter barley as trials have shown it to be uneconomic and can increase lodging risk.
Nitrogen application should aim to maximise early season growth by feeding the developing crop to ensure tiller survival and ensure sufficient ears/grains develop and are taken through to harvest.

Research from the Home Grown Cereals Authority (HGCA) indicates nitrogen uptake in barley occurs as outlined in table 3:

Table 3: N uptake in Barley (HGCA, 2005)

Growth Stage	Nitrogen uptake/day (Kg/N/day)	Total uptake (Kg/N/ha)
Mid-March to GS31	1.2	65
GS31-39	3.1	128
GS 39-59	1.8	163

Growers should target roughly one third of nitrogen towards early canopy development (mid tillering when growth takes off in spring) to stimulate tiller survival and grain development. As the table shows nitrogen uptake is rapid during the growth phase (GS 31-39). However nitrogen uptake slows from flag leaf emerged stage to head emerged (GS 39-59) and the plant takes up relatively little nitrogen or redistributes within the plant after head emergence (GS 59).

Grower Action
Apply nitrogen (approx 1/3) in Late Feb/Early March to boost tiller production and apply the bulk of nitrogen (approx. 2/3) in late March /Early April. Late applications of nitrogen are poorly used and increase lodging risk.

The addition of sulphur can be beneficial especially on light sandy or gravely land. UK data suggests yield increases of between 5-28% with yield increases of 7% recorded in light gravely limestone soils in Oak Park. Winter barleys requirement for sulphur is 12-18 kg/ha per year. Application should be targeted at early canopy development with the first application of N.

Growth Regulation

Chlormequat Chloride (CCC) can be used to manipulating early season growth in winter barley. It has been variously reported that using CCC can improved water use efficiency, increased root growth, suppression of apical dominance resulting in increases in number of ears, and can delay senescence helping grain filling. However given all these benefits numerous trials concluded that yield increases following the application of CCC are variable and usually small. A review of a large data set of trials in the UK reported a slight increase of yield following the use of CCC on barley, the effect mainly being due to decreased tiller death, generally there is little effect on lodging risk.

Grower Action

The application of CCC to barley crops, early in the season, once good growing conditions in spring are established, is generally worthwhile (due to low cost and compatibility with spray programmes).

Later season growth regulation e.g. Cerone, Terpal, etc, is recommended where a crop is being pushed for maximum yield. The combination of CCC in early spring followed by a later season application of a growth regulator combined with the varieties standing characteristics offers the best combination for a standing crop at harvest, when striving for high yields.

Disease control

Wet weather diseases such as Rhynchsporium and Net Blotch pose the largest threat to reducing yield. Other leaf diseases such as Mildew, Ramularia and Rusts can also reduce yield but present a lower risk than the wet weather diseases. Yield responses from the application of a fungicide of over 3.5 t/ha have been recorded in Oak Park.

Recent UK research has shown increases in yield from the application of autumn and early spring applications are higher than previously thought. These responses are attributed to additional greening in early canopy formation resulting in increased light interception and higher grain numbers per m^2.

Trials carried out by John Spink, Oak Park in 2010 at sites in Cork and Oak Park, have shown early spring disease control resulted in higher responses than previously thought. Traditionally the spend on winter barley favoured a higher spend later in the season however Oak Park work suggests an increased spend earlier in the season may be more profitable.

Table 4: Winter Barley fungicide trials yields (t/ha) in Cork and Oak Park, J Spink 2010.

	Cork			Oak Park		
	with Fungicide (t/ha)	without Fungicide (t/ha)	P value	with Fungicide (t/ha)	without Fungicide (t/ha)	P value
Autumn	9.15	9.25	NS	8.18	8.11	NS
Tillering	9.27	9.12	0.05	8.21	8.08	0.05
31-32	9.32	9.07	0.001	8.27	8.02	0.001
39-45	9.23	9.16	NS	8.20	8.10	NS
59	9.24	9.15	NS	8.22	8.07	0.05

Results from Table 4 indicate that overall in 2010 yield responses were small, however, there was not a uniform yield response to the application of fungicides at all timings. There was no yield response to an autumn fungicide application. There is a significant yield response to a fungicide treatment at the tillering stage (T0) in both sites. This application is earlier than current commercial practice. There were also very significant yield response at both sites following a fungicide application at the traditional T1 (GS31-32) timing. Yield responses following the application of a fungicide at GS 39-45 and GS 59 are not as clear. Of all the later treatments, only the late timing GS59 (heading out) at Oak Park gave a significant response.

Grower Action
Target more of the fungicide spend early in the season. Watch for early disease development (before stem extension) and apply a fungicide to control the disease if necessary. Applying three rather than two fungicides through the season will allow flexibility and good return for spend.

CONCLUSIONS

Maximising income from winter barley is a combination of achieving high yields at reasonable cost but also achieving the highest average selling price possible. Establish your costs as accurately as possible, calculations should be based on the costs of production per tonne. This will enable you to formulate a selling strategy and hopefully achieve a higher margin per tonne sold.

Winter barley yields have increased over the past 18 years with the DAFF national variety trials showing a 1.4t/ha increase in yields over that period. There is scope for all growers to increase yields with the top 1/3 of growers in the NFS achieving 1.2 t/ha more yield than the average yields of growers in the survey, thereby contributing to reducing their production costs by €10/t.

In winter barley there is a high correlation between high grain numbers per m^2 and high yields. Practices which will help to maximise and retain these grains are generally carried out in early canopy management and are as follows:

- Plant winter barley before the end of September with a target population in spring of 225-250 plants/m2

- Control aphids in mid-October and/or early November (depending on sowing date)

- Ensure adequate nitrogen is available to promote tiller production in early spring. The bulk of nitrogen should be applied before rapid canopy growth (GS31). Little nitrogen is taken up by the crop after heading (GS59)

- Early growth regulation is not guaranteed to increase yield but trials indicate more often than not it will increase yields.

- Target disease control early. Plan to spend a larger part of your fungicide spend earlier in the season to control disease and thereby increasing grain numbers.

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