Managing Cereal Price Risk with Derivatives

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SUMMARY

Price risk in commodities such as cereals is, unfortunately, a fact of life. Ignoring this risk is potentially dangerous and equates to taking a speculative view on the market.

Managing cereal price risk using derivitaves such as futures and options are being looked at by farmers as possible ways of managing cereal price risk and minimising volatility in cereal prices.

Derivatives were "invented" as hedging tools, instruments designed to allow growers and processors to reduce or remove price risk. Market participants can use futures (exchange-traded) or forwards (OTC) to lock in an underlying price or buy options (exchange-traded or OTC) to protect against adverse price movement. The great benefit of buying options is that it allows market participants to be protected yet still benefit from favourable underlying price movements. The problem with buying options is that, just like insurance, they cost money. If that cost presents a problem, then more sophisticated option strategies such as fences may usefully be employed.

Derivatives may be traded directly between counterparties (OTC) or on a recognised exchange such as LIFFE or the CME. Trading on exchange largely removes counterparty risk and is more transparent than trading OTC. However, OTC trading may offer more flexibility than standardised exchange derivatives.

INTRODUCTION

Derivatives are contracts that convey the right to buy or sell an asset ("the underlying") on a future date. These contracts, these pieces of paper are tradable, hence derivatives trading also being known as "paper trading".

Derivatives are so called because they **derive** from something physical. Wheat derivatives **derive** from physical wheat. Copper derivatives **derive** from physical copper and so on. More importantly, the **price** of wheat derivatives derives from the price of physical wheat. The **price** of copper derivatives derives from the price of physical copper and so on.

Derivatives may be traded on a Recognised Investment Exchange such as LIFFE in London or the Chicago Mercantile Exchange in the US. Unsurprisingly, such instruments are known as "exchange-traded derivatives". Derivatives may also be traded away from the exchanges, directly between counter-parties. This is known as "Over The Counter" or "OTC" trading. The principal advantages of trading on exchange are transparency and the removal of counterparty risk. The only perceived advantage of trading OTC is flexibility, the ability to specify trades to the counterparties' exact needs.

There are three **basic** types of derivative; futures (forwards), options and swaps. Futures (forwards) and options are widely used in commodity markets; swaps (in their true sense) are more likely to be used in interest rate and Forex markets than in commodities.

A futures contract conveys the right to buy or sell an asset on a future date. For example, one LIFFE Feed Wheat Futures contract represents 100 tonnes of (suitable quality) UK Feed Wheat. The price of these contracts is quoted in Pounds Sterling per tonne and various delivery months are available for trading (January, March, May, July, November). Contracts such as these that are traded away from a recognised exchange are known as "Forward" contracts. Futures and forwards are identical except for the fact that Futures trade on an exchange and Forwards trade OTC.

Option contracts convey the right **but not the obligation** to buy or sell an asset on a future date. There are two types of option; calls and puts. Calls convey the right but not the obligation to **buy** an asset on or before a given date in the future. For example, one LIFFE Feed Wheat November £140 Call conveys the right but not the obligation to buy (because it is a call) one LIFFE Feed Wheat Future (the underlying) at a price of £140 per tonne (the strike price) any time between now and the 8th of October, 2009 (the expiry date). Puts convey the right but not the obligation to **sell** an asset on or before a given date in the future. For example, one LIFFE Feed Wheat July £100 Put conveys the right but not the obligation to sell (because it is a put) one LIFFE Feed Wheat Future (the underlying) at a price of £100 per tonne (the strike price) any time between now and the 11th of June, 2009 (the expiry date).

Evolution

Derivatives originated in agriculture and evolved as a response to agricultural price risk. Price risk is simply the danger that the price of something will move in an adverse direction. Farmers, for example, are exposed to the price of their crop falling by harvest time. On the other side of the equation, bakers and millers are exposed to the price of grain rising. Both farmers ("natural longs") and processors ("natural shorts") are exposed to changes in grain prices, albeit in opposite directions

The largest contemporary derivatives markets are predominantly financial. Billions of dollars worth of bond, interest rate, equity and FX derivatives trade every day. Given the pre-eminence of such markets, it is all too easy to forget the agricultural origins of futures and options. Archaeological evidence points to the Phoenicians trading grain options two millennia B.C. In his book entitled "Politics", Aristotle recounts the story of Thales who bought options on olive presses to speculate on the price of olive oil rising. Post-Renaissance examples of derivatives use abound. 17th century Dutch speculators traded options during the well-documented tulip bulb mania of the 1630s. Both sides in the American Civil War used currency options, based upon the French Franc, to protect themselves against losing the conflict. And the first derivatives exchange of the modern era opened in Chicago in 1848, trading futures based on flour, seed and hay. The importance of agriculture as a driving force behind the development of derivatives is clear. Growers and processors needed mechanisms to hedge, to manage price risk. And speculators such as Thales were quick to spot the speculative opportunities that such instruments provide.

Derivatives Uses

Following on from the above section on evolution, it can be seen that the two main uses of derivatives are hedging and speculation. Despite the fact that derivatives were "invented" as hedging tools, the vast majority of derivatives use is now speculative. Futures and options are margined instruments. Rather than pay the full value of the underlying, a security deposit ("margin") is paid whenever a derivatives trade is opened. This means that derivatives trading is significantly more capitally efficient than cash or physical trading, a fact that provides opportunities for gearing or leverage. Put simply, with a fixed amount of trading capital, more derivatives can be traded than the underlying physical. This gearing works to speculators' advantage when they are right but clearly has the potential to create big problems when speculators are wrong. Nonetheless, futures and options are hugely popular instruments amongst the speculative community.

Having briefly considered the speculative use of futures and options in the above section, the next section looks in more detail at the use of derivatives as hedging tools.

Hedging With Derivatives

Price risk is a fact of life. Virtually all businesses are exposed to price risk in some way. Airlines are exposed to the price of jet fuel, exporters are exposed to FX rates, millers are exposed to grain prices and so on. And prices in just about all asset classes have become increasingly volatile bringing the issue of price risk to centre-stage.

To ignore price risk, to do nothing, is to take a view. If an airline decides not to hedge against rising oil prices then, implicitly, the airline is taking a view that oil prices will not rise. Whether it recognises the fact or not, the airline is taking a speculative view on the oil price. Consider a more specific example from the grains world.

A wheat farmer is a “natural long” of wheat. In other words, the farmer owns physical wheat and is naturally a seller of that wheat. The farmer is exposed to price risk. He wants the wheat price to go up and is exposed to the price of wheat falling.

What are the farmer’s choices?

1. Do nothing. Hope that the wheat price does not fall
2. Trade wheat futures or forwards.
3. Trade wheat options.

Consider the three choices in detail.

Hedging Choice 1: Do Nothing!

Clearly this choice is fine if the wheat price does not fall. However, if the wheat price does fall by harvest, then the farmer will sustain a loss. And if that fall is large enough, then the farmer will be forced to sell his crop beneath the cost of production, threatening his livelihood.

There are some who believe in mean reversion, who believe that “it all averages out in the long run”. Really? First of all, just because something happened last week, last month, maybe for the last 10 years, it does not mean that the same thing will happen tomorrow. Recent history has provided ample examples of this, in particular the various bank and insurance failures, failures that would have seemed unthinkable only a few short years ago.

Secondly, even if "it all" really does average out in the long run, short-term fluctuations ("volatility") can cause huge financial problems. Again, recent history provides ample examples of this, the best being the price of the world's most important commodity, oil. In the decade or so from 2008 to the present day, the price of oil rose from around \$10 to just under \$150 and all the way back down to around \$30, with various peaks and troughs in between. An airline that took a view that "it all averages out…" would, to an extent, have been right, in that oil started the decade at \$10 and ended the decade at \$30. Notwithstanding the fact that this is still a 300% price rise, the airline would almost certainly have found its business model under intense pressure when the oil price approached \$150 per barrel.

Finally, doing nothing, taking a chance that the market does the right thing is not conducive to a good night's sleep. A farmer who has decided not to hedge is, at best, likely to suffer a few sleepless nights and to spend more time than is healthy worrying about the price of wheat.

So doing nothing is not a viable choice. A wheat farmer, a "natural long" of wheat needs to hedge but how? The first choice is to trade the appropriate number of wheat futures.

Hedging Choice 2: Trade Futures/Forwards

Remember, a wheat farmer is a "natural long" of wheat. In other words, the farmer owns physical wheat and is naturally a seller of that wheat. The farmer is exposed to price risk. He wants the wheat price to go up and is exposed to the price of wheat falling. How can the farmer use futures or forwards to hedge this exposure?

Simply, the farmer can sell his crop forward. The farmer can agree to sell his crop on a date in the future at a price that is agreed today. The farmer has certainty. He no longer cares if the wheat price falls because he has a contract with his counterparty to sell at a fixed price. There are a few potential problems with this arrangement.

Firstly, the farmer is exposed to counterparty risk. That is, the person or company with whom the farmer has traded may default, they may not be able to meet their contractual obligations. Until recent times, counterparty risk has been seen as a relatively minor problem. However, the recent global economic crisis and the resulting avalanche of company failures has seen the issue of counterparty risk greatly elevated in importance. This problem may be addressed by using futures to hedge rather than forwards.

Remember, futures contracts are simply forward contracts that are traded on an exchange such as LIFFE of the CME. The performance of futures contracts is guaranteed by a central counterparty known as the "Clearing House". Counterparty risk is thus effectively removed.

A second advantage of trading futures rather than forwards relates to the farmer changing his mind. If the farmer has sold his wheat crop forward to hedge, then changes his mind for whatever reason, he is committed to the forward contract. It is unlikely that he will be able to reverse this contract at an economically viable price. If, however, the farmer sells wheat futures rather than forwards, then he may trade in and out of those futures at will. Unlike forward contracts, futures are transferable, they are freely tradable in the market, making such contracts far more flexible than their OTC counterparts.

A third problem with hedging in this way, whether with futures or forwards, is that the farmer is "locked in". In hedging his downside risk by selling forwards or futures, the farmer has protected himself against the price of wheat falling but, in so doing, he has removed the potential to profit from a rise in wheat prices. The farmer is "locked in". This may or may not be a problem. If the price of wheat rises between now and harvest, then the farmer may resent the opportunity cost. Further, if other farmers in his region have not hedged, they may benefit from rising prices and be in a better position commercially. This issue of competitive advantage/disadvantage tends to affect processors more than producers but still needs to be borne in mind.

Futures or forwards may be used to remove price risk but simultaneously remove profit potential. Depending upon commercial considerations, this may or may not be acceptable. What can the farmer do if he wants to remove downside risk yet retain upside profit potential? The answer is to trade options.

Hedging Choice 3: Trade Options

The farmer is exposed to the wheat price falling. He wants to remove this risk yet retain the potential to profit from a rise in wheat prices. Options convey the right **but not the obligation** to buy (calls) or sell (puts). The farmer needs the right to sell wheat at a certain price if he wants to, if he needs to. The farmer needs to buy a **put** option. Consider the following option prices.

Table 1: LIFFE November Wheat Options as at close 19th January, 2009

LIFFE November Wheat Futures = £128 (per tonne)

CALLS	STRIKE PRICE	PUTS
16.75	**120**	8.75
16.20	**121**	9.20
15.65	**122**	9.65
15.15	**123**	10.15
14.65	**124**	10.65
14.15	**125**	11.15
13.65	**126**	11.65
13.20	**127**	12.20
12.75	**128**	12.75
12.30	**129**	13.30
11.85	**130**	13.85
11.45	**131**	14.45
11.05	**132**	15.05
10.65	**133**	15.65
10.25	**134**	16.25

Notes to Table 1: Strike prices are listed in bold in the central column. There are more strike prices available than those shown, both above 134 and below 120. Call settlement prices are shown in the left hand column with put settlement prices shown on the right. During the trading session, there would be bid/offer spreads in all of the call and put prices. For the purpose of clear illustration, settlement (end of day) prices are shown.

The farmer could buy, for example, one November Wheat £120 Put (highlighted in Table 1)for a price of £8.75 (with a monetary value of £87.50) per contract. This gives the farmer the right, but not the obligation, to sell (because it is a put) one November Wheat Future (the underlying, which equates to 100 tonnes of suitable quality wheat) at a price of £120 per tonne (the strike price) any time between now and Thursday the 8th of October, 2009 (the expiry date).

In the event that the wheat price falls below £120 per tonne, the farmer can exercise his right to sell the equivalent of 100 tonnes of UK Feed Wheat at a price of £120 per tonne. He is protected to the downside. The farmer's worst-case scenario is selling his wheat at £111.25 per tonne (the strike price of £120 less the £8.75 paid for the put option). However, this is **not** what the farmer wants to happen.

The farmer **wants** the price of wheat to rise. In the event that wheat rises to, say, £150 per tonne, then he will allow his put option to expire worthless. Remember that put options convey the right **but not the obligation** to sell. The farmer will only exercise the put option if he wants to, if he needs to. It is, in essence, an insurance policy. In the event that the wheat price rises from the current level of £128 per tonne to £150, then the farmer will allow the £120 Puts to expire worthless and sell his crop at the improved price of £150 per tonne. He will lose the £8.75 per tonne that he paid for the option and make £22.00 per tonne on the improved underlying wheat price. He is £13.25 per tonne better off than he would have been had he hedged by selling futures at £128.

Of course, the farmer could have chosen to buy a different put. He could have bought a put with a higher strike price but it would have cost him more. He could, for example, have bought the £125 Put giving him the right to sell at £125, but this would have cost £11.15 per tonne as opposed to the £8.75 per tonne paid for the £120 Put. He could have "insured" himself at a better, higher price but the premium payable would have been greater. The choice of which strike put to buy is essentially a commercial decision. At what price does the farmer want or need protection? This is the strike that should be chosen.

In the above example, the farmer bought 1 November Put option, the underlying of which is 1 November Futures contract which in turn equates to 100 tonnes of UK feed Wheat. In terms of the size of the hedge, the farmer needs to buy the appropriate number of put option contracts. If his anticipated crop equates to 800 tonnes, then he needs to buy 8 puts to fully hedge his exposure.

In terms of tenor, of expiry date, the farmer needs to buy options which expire around the time that his crop is harvested. If he harvests in the autumn, then November options which (confusingly!) expire in October would seem appropriate.

One key aspect of the hedging process not yet discussed is price. In the above example, the farmer bought November £120 Puts at £8.75 per tonne. Is this a reasonable price? The answer depends upon the farmer's market view. If the farmer is prepared to spend £8.75 per tonne on "insurance", then he must believe that the wheat price can rise by at least £8.75 between now and expiry in October. Otherwise the puts are too expensive.

Hedging With Derivatives: Decision Tree

Assuming that price risk is hedged as a matter of good practice, derivatives offer a natural long such as a farmer the following choices.

If the farmer believes that the wheat price will **fall** between now and harvest, he could sell futures. This protects the farmer against a fall in the wheat price but simultaneously stops him from benefitting from a rise in the price of wheat. This may be a problem if there are issues of competitive advantage for the farmer.

If the farmer believes that the wheat price will **rise significantly** (specifically by more than the price of the puts) between now and harvest, he could buy some puts. He wants the wheat price to rise and for the puts to therefore expire worthless; they are simply price insurance policies. The farmer will then benefit by selling his crop at the improved underlying price.

If the farmer believes that the wheat price will **rise** but only **moderately**, then paying the price asked for the puts may not be justified. In such circumstances, the farmer might wish to explore the possibility of trading a "long fence" (aka "long collar"), a recognised and widely used option strategy designed to reduce the cost of protective options at the expense of "blue sky" profit potential.

Derivatives Resources

Futures and options prices are readily available through a range of media. The exchanges publish the settlement prices for their products at the close of each trading session, as well as (15 minute) delayed prices throughout the day. Web addresses are:

LIFFE (UK Feed Wheat, French milling Wheat, etc.): www.liffe.com

CME Group (US Corn, Wheat, Soybeans, etc.): www.cmegroup.com

Specialist derivatives brokers (listed on the above exchange websites) can offer guidance and information both in person and via their websites which often offer commentaries and technical analysis upon a range of commodities.

CONCLUSIONS

Price risk in commodities is, unfortunately, a fact of life. Ignoring this risk is potentially dangerous and equates to taking a speculative view on the market.

Derivatives "invented" as hedging tools, instruments designed to allow growers and processors to reduce or remove price risk.

Market participants can use futures or forwards to lock in an underlying price or buy options to protect against adverse price movement.

The great benefit of buying options is that it allows market participants to be protected yet still benefit from favourable underlying price movements.

The problem with buying options is that, just like insurance, they cost money. If that cost presents a problem, then more sophisticated option strategies such as fences may usefully be employed.

Derivatives may be traded directly between counterparties (OTC) or on a recognised exchange such as LIFFE or the CME. Trading on exchange largely removes counterparty risk and is more transparent than trading OTC. However, OTC trading may offer more flexibility than standardised exchange derivatives.

Cost/Price Squeeze: Implications for Cereal Farm Profits'

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SUMMARY

The 2006/2007 production year proved to be a very successful year for tillage farmers. Depletion of global stocks, drought in Australia and the demand for corn from US ethanol producers led to a dramatic price increase for all cereals within Ireland and globally. These price increases in turn led to a supply response. This increased production in turn had a negative impact on farm gate cereal prices in 2008 relative to 2007. Coupled with significant cost increases in key input variables, the estimated gross and net margins for cereals crops were considerably lower I n 2008 relative to 2007 returns. However it is anticipated that the price of key input variables such as fertiliser, land rent and fuel will decline in 2009. There is considerable uncertainty regarding cereal prices for 2009 harvest but based on current futures trading prices it is assumed that 2009 harvest prices will be slightly up on 2008 levels. The movements in input and output price variables are forecast to have a positive effect on gross and net margins for tillage farmers in Ireland in 2009 relative to 2008. However without any significant upward movement in cereal price or real reduction in input costs the forecasted net margin for the average producer in 2009 will be negative. Furthermore, a forecast of the returns to cereal production in 2009 shows that it is only the top one third of producers that can make a positive margin on rented land. Average and less efficient producers must be very cautious when rental agreements are being negotiated for 2009.

INTRODUCTION

The 2008 harvest year was an extremely difficult one for the tillage farming sector both in Ireland and internationally. After the unprecedented highs experienced for cereal prices at harvest 2007 the following twelve months witnessed a number of factors, economic, political and weather related, which resulted in a significant cost price squeeze for tillage farmers.

The unprecedented high cereal prices which were recorded at harvest 2007 originated from a number of sources. An increasing political focus on the climate change issue, resulted in an epidemic of 'biofuel friendly' policies across the world, most notably in the US. In key exporting countries this led to a shift of cereals out of food and feed use and into fuel production, which in no small way contributed to the rise in prices. Furthermore, the end of year grain stocks recorded on international balance sheets for a number of years has shown a steady erosion of stock levels which has emanated from increasing demand for cereal products due to population growth and consequent consumption growth. Countries which traditionally held significant stocks no longer have the capacity to release large volumes of product on to world markets to stabilise prices. Furthermore, the 2007 harvest price was also heavily influenced by the drought in Australia and the fall in the financial equity markets and a consequent increased speculative interest in agri markets.

Unfortunately for Irish and international cereal farmers the high cereal price experienced in 2007 was short lived and the 2008 harvest price in Ireland was down on average 35 per cent on 2007 levels. This sharp drop in prices can be attributed to an increase in cereal area, high yields for the 2008 harvest and the general uncertainty experienced in international financial markets due to the global down turn in the economy. This sharp decrease in price, coupled with high moisture levels recorded at harvest had a significant effect on the farm gate value of cereal products in Ireland in 2008. In addition to decreases in output value, Irish cereal farmers also experienced unprecedented price increases in key inputs, such as fertiliser, seed and fuel.

This paper will consider whether the output price decrease of the 2008 harvest represents an atypical occurrence or whether this experience will continue into the 2009 harvest. The costs of production on tillage farms in Ireland will also be considered to arrive at an estimate of tillage enterprise returns for 2008 and a forecast for 2009.

This paper uses Irish National Farm Survey (NFS) data (Connolly *et al* 2008) to conduct a review of the financial performance of tillage farms in 2007. Following this, price and costs are estimated for 2008 and price and costs forecasted for 2009. Finally the ability of Irish cereal producers to compete in an EU large EU is discussed.

Review of Economic Performance of Tillage Farms in 2007

Income on specialist tillage farms increased significantly in 2007 compared to the previous four years as shown in Figure 1 below. Relatively high cereal yields coupled with significantly higher farm gate cereal prices resulted in an average family farm income (FFI) in 2007 of just over €40,000 which is equivalent to a 50% increase on the average of the previous four years.

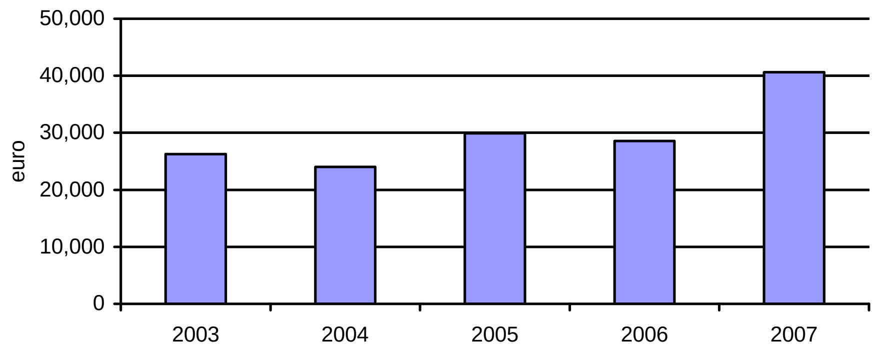


Figure 1. FFI on Specialist Tillage Farms in Ireland: 2003 to 2007
Source: National Farm Survey (various years)

To understand the economic performance of tillage farms in 2007 we begin with a review of the cost and return structure of the main cereal crops using NFS data. Figure 2 disaggregates the direct costs of production for cereal crops in 2007.

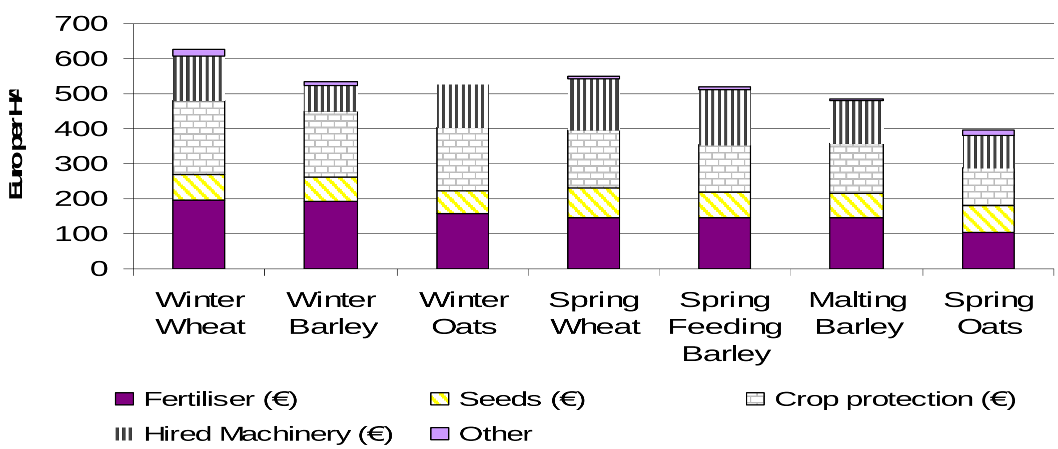


Figure 2. Composition of Direct Costs for Cereal Crops, 2007
Source: National Farm Survey (2008)

Figure 2 shows that in general, direct costs are higher in winter sown crops compared to spring sown crops, which is due to higher fertiliser and crop protection costs in winter crops. However, given that yields are generally higher in winter sown crops the more appropriate comparative economic indicator is gross margin which is shown in Figure 3

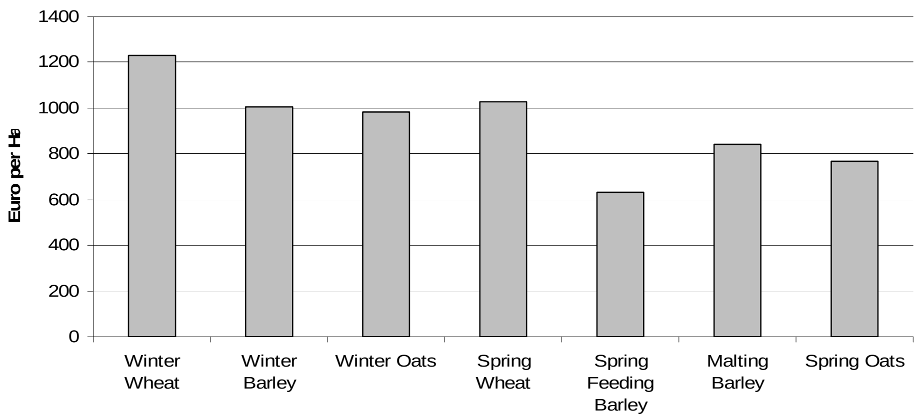


Figure 3. Gross Margin for Cereal Crops, 2007
Source: National Farm Survey (2008)

Figure 3 shows that the average gross margin for all winter crops is generally higher than the gross margin for spring sown crops, with winter wheat recording the highest margin of all crops. The gross margin for all cereal crops was significantly higher in 2007 compared to the average of the previous 5 years. The gross margin for winter wheat and spring barley in 2007 was 75 per cent and 55 per cent higher than the previous five year average respectively. While gross margin estimates are useful for comparative purposes it is also worthwhile to examine the shift in net margin over time. However for cereal crops it is difficult to allocate overhead costs to individual crops using NFS data. For this reason, net margin of the entire cereal enterprise of the specialist tillage farming population within the NFS is examined, shown in Figure 4 below.

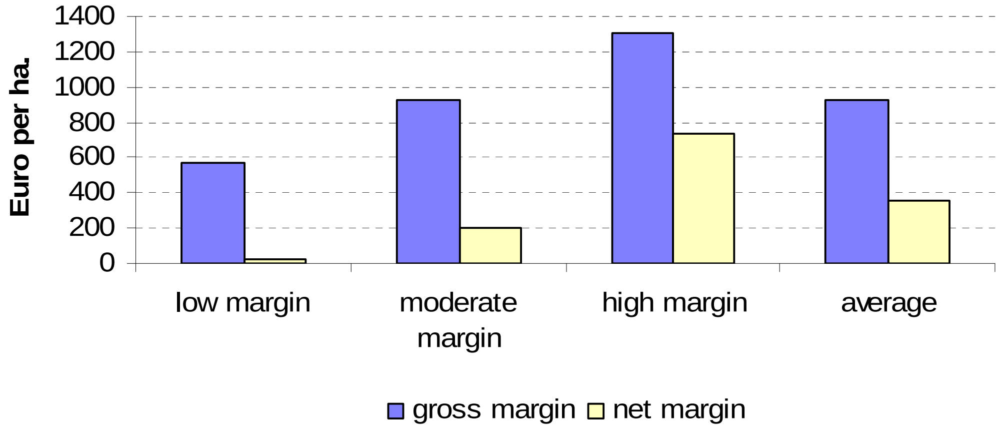


Figure 4. Cereal Enterprise Margins on specialist tillage farms, 2007

Source: National Farm Survey (2008)

Figure 4 shows that the average gross and net margin per cereal enterprise on specialist tillage farms in 2007 was approximately €900 and €350 per hectare respectively. To examine the variation in margin that exists on tillage farms, the weighted sample of 7,500 specialist tillage farms was classified into three groups. Farms were classified on the basis of gross margins; the best performing one third of farms are labelled high margin, the middle one third are moderate margin and the poorest performing one third of tillage farms are classified as low margin. The variation in margins across farms is apparent from Figure 4. The net margin for the cereal enterprise per hectare on high margin farms in 2007 was €730 per hectare compared to €200 on moderate margin farms and just under €20 per hectare on low margin farms.

What are the factors affecting farm profitability?

The data presented thus far in the paper shows that there are very large differences in margins on Irish tillage farms. In this section of the paper we examine some of the factors affecting farm profitability which farmers themselves could potentially have control over. The productivity of Irish tillage farmers is examined in this econometric analysis given that productivity is the main source of competitiveness over the medium to longer term upon which farmers potentially have control over.

This analysis of the productivity of Irish tillage farms employed an economic tool called Stochastic Frontier Analysis (SFA) for the construction of an index of Total Factor Productivity (TFP), using National Farm Survey data from 1996 to 2006. An index of TFP measures productivity growth taking into account the relationship between the change in output and the change in the use of all inputs. This measure of productivity growth differs from traditional ‘partial’ productivity indicators common in the literature, which compare output to a single input such as land, labour or animal numbers (for example, milk yields per cow or crop yields per hectare).One of the main sources of productivity change over time is technical efficiency and the TFP index over the time period is examined to determine why some farmers are more efficient than others.

In general, the results from the analysis have shown that technical efficiency is positively correlated with extension use, soil quality, the overall size of the farm, and the level of specialisation.

The coefficient for off-farm employment was not significant and therefore implies that farms with an off-farm job are no less efficient than farms without. This result highlights the need for farmers to critically analyse their on-farm time management to explore the viability of pursuing part-time employment outside of the farm.

The importance of the scale of operations is of particular interest. The analysis showed that increasing returns to scale are present in the tillage sector. This result shows that larger farms are more efficient.

The degree of specialisation will also be an important issue for the competitive future of Irish farming. Higher levels of specialisation lead to higher efficiency levels in the tillage sector.

Estimated Review of 2008 Performance

This section of the paper presents a review of the cereal sector in 2008. To provide an estimate of enterprise profitability for 2008, it was necessary to estimate the volume and price of inputs that were used as well the volume and value of outputs. The ensuing sections of the paper discuss first, the movements in input prices and usage in 2008, and second, the cereal market conditions and harvest yields in 2008.

Estimated Input Usage and Price 2008

Fertiliser

Fertiliser costs typically comprise about 27 percent of direct costs and 13 per cent of total costs on tillage farms. As illustrated in Figure 5, fertiliser types commonly used on tillage farms have increased substantially in price since 2000, with a very considerable increase occurring during 2008. The CSO recorded price in 2008 for CAN was approximately 120 percent higher than 2000 levels and for the compounds 0-10-20 and 14-7-14 the equivalent price in 2008 was approximately 130 per cent higher than the level in 2000. Increased energy prices, in particular the price of natural gas which is a key determinant of fertiliser price, has been the major driving force behind the upward trend for fertiliser prices throughout the early 2000s. In addition, in the past twelve months the shortage of supply of P and K compounds and the limited resources for future supply has had a significant upward effect on compound fertiliser prices. Given that significant upward pressure on fertiliser prices was evident during

2008, it is estimated that straight nitrogen products increased by approximately 55 per cent over 2007 figures, whilst it is estimated that compound fertilisers with significant P and K components increased by between 70 and 85 per cent on 2007 prices.

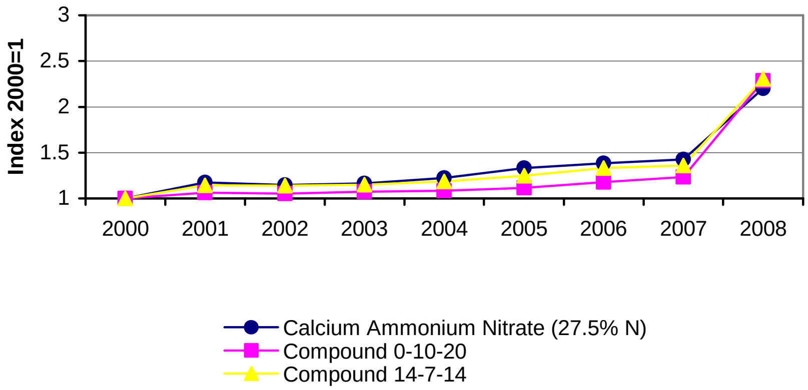


Figure 5. Price Index of Straight Fertilisers 2000 to 2008
Source: Central Statistics Office Data for 2000 to 2007. Authors' estimates for 2008.

On the usage side, DAFF figures indicate that fertiliser purchases in the 2008 fertiliser year (October 2007/September 2008) declined in aggregate by about 6 percent relative to the corresponding 2007 level. Given that this figure refers to all fertiliser usage on grassland and crop area it was necessary to consult reports from farm advisors to evaluate the usage change for crop farms. Reports from a number of sources seem to indicate that fertiliser usage per hectare was down approximately 10% in 2008 on 2007 levels. However, overall usage on crop farms may not be suggestive of this decrease given the increase in crop area between 2007 and 2008. However in gross margin per hectare terms it is assumed that for 2008 usage was down approximately 10 per cent. The reduction in fertiliser purchases reflects the considerable cost pressure on tillage farms as a result of the fertiliser price increase. Furthermore additional soil analyses were carried out during the year and as a result less fertiliser applied. The minor reduction in fertiliser usage on crop farms did not compensate for the significant increase in fertiliser prices leaving overall expenditure per hectare on fertiliser in 2008 significantly up on 2007 levels.

Seed

Purchased seed on crop farms is a less important input in expenditure terms in cereal production, comprising between 10 and 15 per cent of direct costs for cereal production and just over 11 per cent on average on all tillage farms in 2007. In terms of the composition of total costs, seed represented just over 6 per cent of total costs in 2007. In 2008 cereal farmers experienced a significant increase in seed costs relative to previous years due to the significant upward movement in the cereal markets. In autumn 2007 when seed supplies were purchased for the 2008 harvested winter crops, blue label seed cost increased by approximately 35 per cent, from €410 per tonne in 2006 to €550 per tonne in 2007. This cost increase was also evident in 2008 for spring sown crops relative to the 2007 sown spring crops. The magnitude of this figure is similar to the seed price index provided by the CSO. Given that there is very limited scope for home saving seed in direct reaction to sudden price movements in purchased seed price, the expenditure on seed in 2008 relative to 2007 was estimated to have increased by 35 per cent.

Crop Protection

The expenditure on crop protection by specialist tillage farms in 2007 accounted for 20 per cent of direct costs and 10 per cent of total costs. However the contribution of crop protection to the composition of costs can vary significantly depending on the crop, with the percentage spend on winter crops higher than on spring crops. For example on the winter wheat crop in 2007, crop protection costs accounted for 33 per cent of direct costs, compared to of 20 per cent for the average of all crops.

Compared to other significant costs on tillage farms, the increase in costs of crop protection has been limited over the recent past. Figure 6 shows the increase in costs of crop protection products from 2000 to 2008 was just under 3 per cent and the increase in costs between 2007 and 2008 was just under 1 per cent.

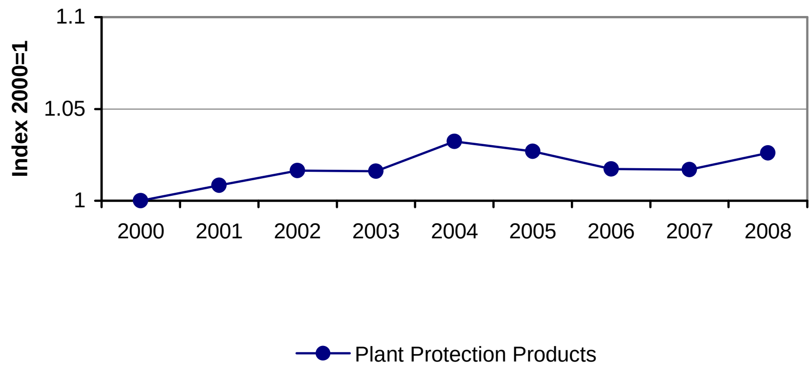


Figure 6. Price Index of Plant Protection products 2000 – 2008
Source: Central Statistics Office Data for 2000 to 2007. Authors' estimates for 2008.

Energy and Fuel

Energy and fuel are important inputs in crop production. Given that a number of direct costs and overhead costs are directly influenced by energy and fuel prices the trend in energy prices is of significant importance for the average tillage farmer. In this analysis it is assumed that hired machinery and transport costs from direct costs and machinery operating expenses from overhead costs are directly influenced by energy inflation. These cost items represented just under 25 per cent of total costs on tillage farms in 2007.

Based on the CSO estimates presented in Figure 7 below the price of fuel has increased by just under 80 per cent between 2000 and 2008. The most significant increase occurred between 2007 and 2008 when the estimated rise in the cost of fuel was 22 per cent. This estimation is based on a comparison of the motor fuel index from the CSO for 2007 and the first eight months of 2008. While it is acknowledged that fuel prices did decrease in the last few weeks of 2008 this decrease did not benefit the direct cost structure on crop farms given that the majority of the fuel costs occur in the first eight months of the year. Demand for these input items tends to be relatively inelastic with respect to price and therefore it is assumed that usage in 2008 was on a par with the 2007 level. Overall expenditure on fuel related items was estimated to be 22 per cent higher in 2008 relative to 2007.

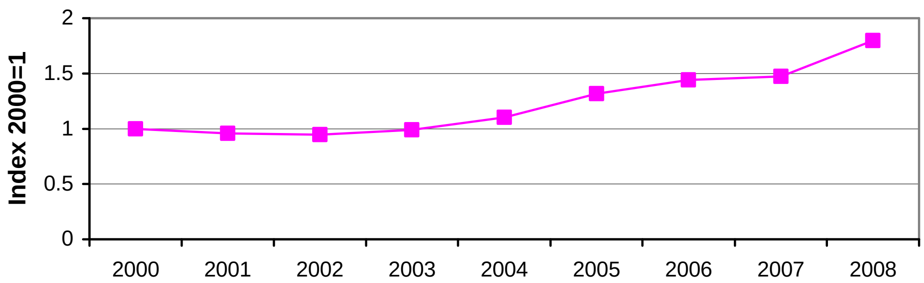


Figure 7. Price Index of Fuel products 2000 – 2008
Source: Central Statistics Office Data for 2000 to 2007. Authors' estimates for 2008.

All other direct and overhead costs

CSO estimates indicate that labour costs and agricultural 'other costs' increased by approximately 6 percent in 2008 relative to 2007.

The average cost of land rent in 2007 on specialist tillage farms was just under 8 per cent of total costs. Given that farm gate cereal prices increased significantly in 2007 there was a consequent increase in land rental prices. It was estimated that land rental prices increased by approximately 30 per cent in 2008 relative to 2007.

Estimate of Total Input expenditure for 2008

Total expenditure on all input items was estimated to have increased in 2008 relative to 2007. The most significant increase in expenditure occurred with fertiliser, which was estimated to increase by approximately 50 per cent between 2007 and 2008, taking into account estimated volume and value changes. On average, the increase in direct costs was approximately 25 per cent.

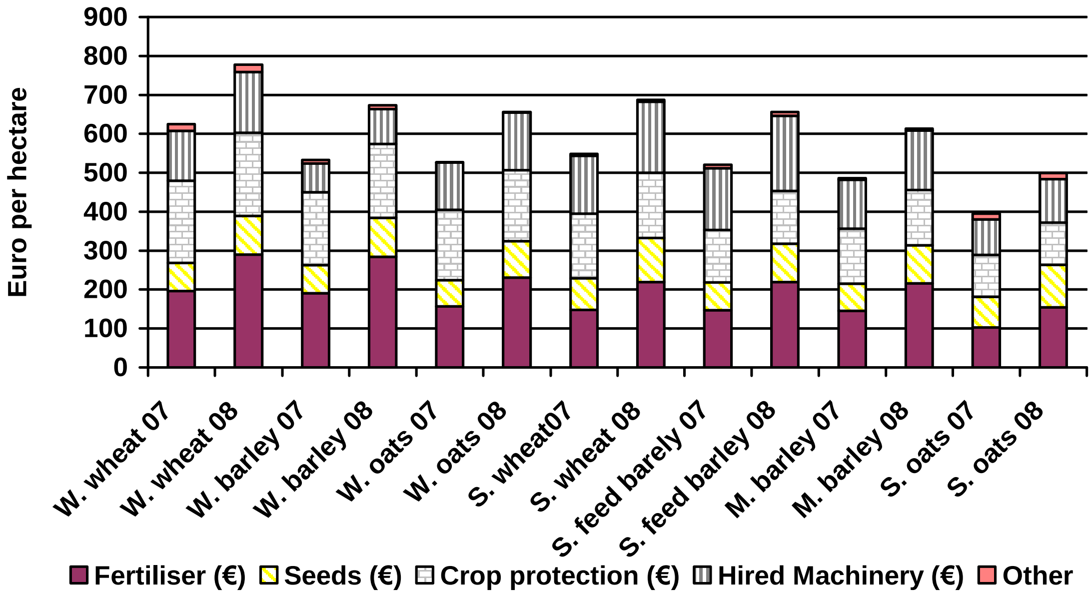


Figure 8. Direct Costs on Cereal Production in Ireland 2007 and Estimated for 2008

Source: National Farm Survey Data (2008) and Authors' Estimates (2008)

Estimated Output Values 2008

Price, yield and moisture levels in 2008

Unprecedented volatility has been witnessed in cereal prices in Ireland during 2007 and 2008, with prices reaching an unprecedented high in nominal terms in 2007, and a significant drop in prices in 2008. Figure 9 below shows that farm gate feed wheat, barley and oat prices at 20 per cent moisture were down between 30 and 35 per cent in 2008 relative to 2007. Malting barley prices in 2008 did not suffer to the same extent as some other crops, with prices down 12 per cent relative to 2007. Milling wheat and oat prices were down 20 and 30 per cent respectively on 2007 prices.

Given that the final farm gate cereal price is based on moisture differences above and below 20 percent, it is also important to consider the weather at harvest in 2008 which was relatively poor. Table 1 below shows that the average moisture for spring crops in 2008 was well in excess of that recorded in 2007; average moisture for spring barley and wheat was 5 points higher, and spring oats 4 points higher in 2008 relative to 2007. Winter wheat and oats were harvested at average moistures in 2008 similar to those recorded in 2007, while winter barley average moisture levels were just 1 per cent up on 2007 levels. It is however important to note that while the winter crops were harvested at similar moistures in 2007 and 2008, these levels are still significantly higher than those recorded in the recent past.

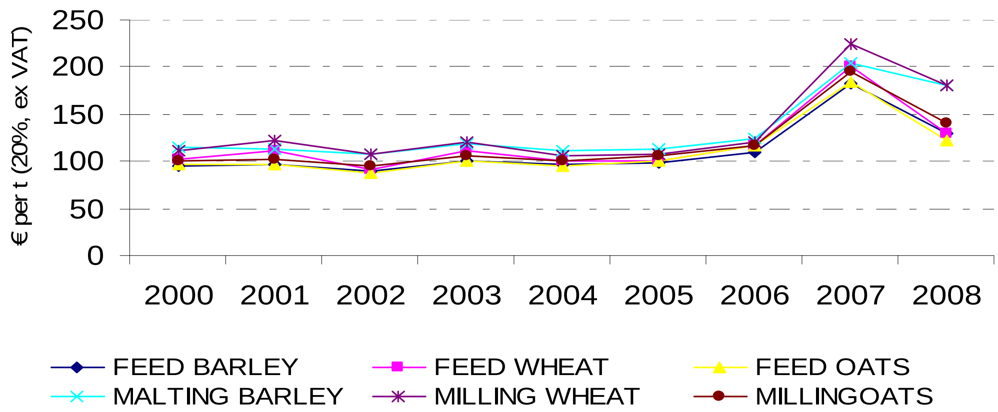


Figure 9. Farm Gate Cereal Prices, 20% Moisture, exVAT, 2000-2008

Source: Authors own estimates

The third variable which must be considered when output value is estimated is yield per hectare. Table 1 shows the average green yields obtained in 2007 and 2008. In general sowing conditions for winter and spring crops were relatively good for the 2008 harvested crop and weather conditions during the growing season were also favourable. Hence, most crops yields in 2008 were in excess of those recorded in 2007 on average. However, it must be remembered that these yields are green yields and not adjusted for moisture content.

Table 1. Average Yields and Moisture Levels, 2007 – 2008 Harvest

	Yield (tonne per ha.)		Moisture (%)	
	2007	2008	2007	2008
Winter Wheat	8.7	9.8	22	22
Winter Barley	7.6	8.3	18	19
Winter Oats	8.1	8	20	20
Spring Wheat	7.7	6.7	17	22
Spring Barley	6.6	6.7	17	22
Spring Oats	6.4	6.1	17	21

Source: CSO 2007 & Teagasc Harvest Report (2008)

Estimate of Total Output Value for 2008

Total output value per hectare for all cereal crops was estimated to have decreased in 2008 relative to 2007. The most significant decrease in output value per hectare was experienced in winter oats and the crop which experienced the least decline in output value was malting barley, taking into account price, yield and moisture levels. The average decline in output value per hectare in 2008 relative to 2007 was 30 per cent.

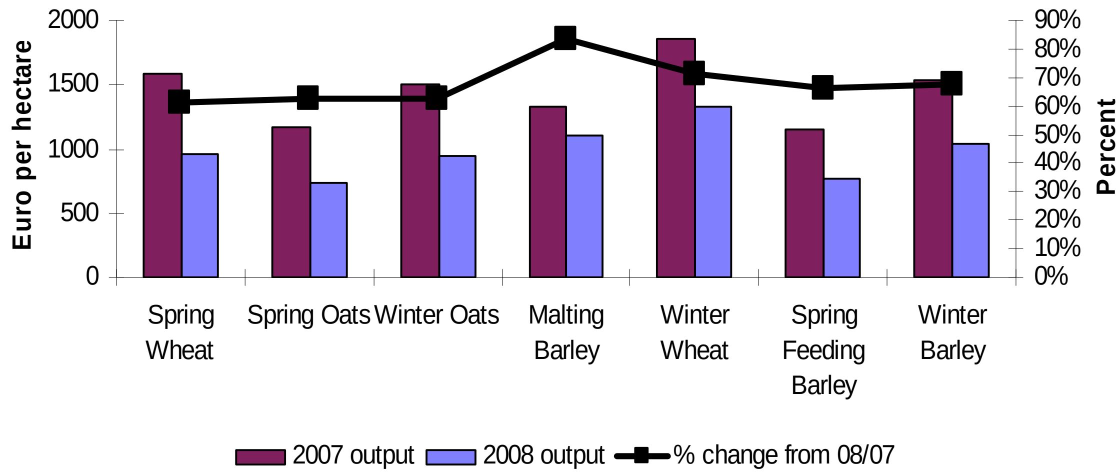


Figure 10. Actual Gross Output per Hectare 2007 & Estimated Gross Output per Hectare 2008
Source: National Farm Survey (2008) and Authors' own estimates

Review of Tillage Enterprise Margins in 2008

The review of cereal output value showed that the average farm gate price received by farmers across all cereal crops was approximately 30 per cent lower than the average price in 2007, while the review of input costs concluded that total direct costs were approximately 25 percent higher in 2008 than 2007. Figure 11 presents the effect on gross margin for each of the main cereal crops.

Figure 11 shows a significant decline in gross margin for all cereal crops in 2008 relative to 2007 due to the reduction in output value coupled with the estimated increase in direct costs. For example, the gross margin for winter wheat was estimated to be down by approximately €680 per hectare, while the gross margin for spring barley was estimated to be down by approximately €530 per hectare. It should be noted that the average gross margin figures presented are market based gross margins and therefore exclude all decoupled payments.

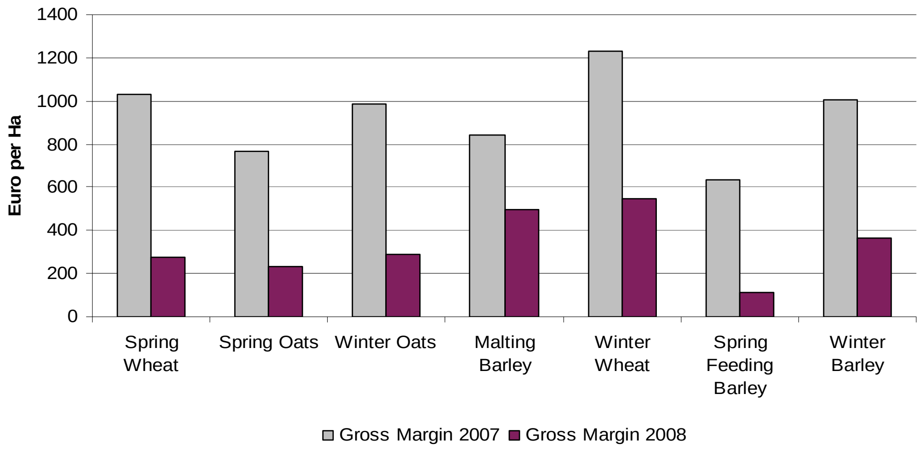


Figure 11. Actual Gross Margin in 2007 & Estimated Gross Margin for 2008 for each of the Main Cereal Crops

Source: National Farm Survey (2008) and Authors Own Estimates for 2008

Similar to the format used to present margins in 2007 earlier in the paper, the estimated gross and net margins for 2008, are presented for the cereal enterprise on specialist tillage farms, as well as the population disaggregated into one-third groupings based on margins obtained (Figures 12 and 13).

For the average farmer, gross margin per hectare was estimated to decrease from €925 per hectare in 2007 to €295 per hectare in 2008, a 68 per cent decrease. The high margin farmer experienced the largest decrease in gross margin, moving from a gross margin of €1300 per hectare in 2007 to a gross margin of €590 per hectare in 2008.

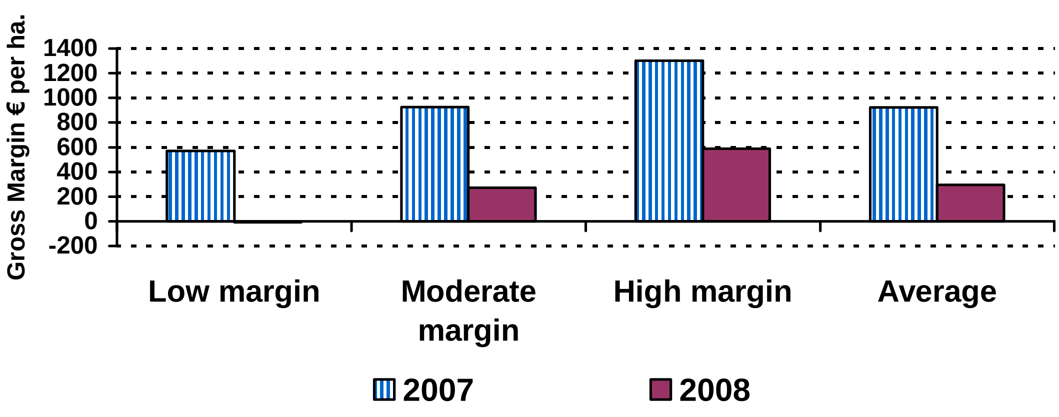


Figure 12. Actual Gross Margin 2007 and Estimated Gross Margin for 2008 for the Cereal Enterprise on Specialist Tillage Farms

Source: National Farm Survey 2008 and Authors' own estimates

Even more worrying than the previous estimates for gross margin are the estimates for net margin in 2008, which show a negative net margin for even the most efficient group of farmers. For the best performing one-third of tillage farmers the estimated net margin for 2008 was -€154 per hectare, and for the average farmer was -€330 per hectare. Given that the average SFP payment per hectare in 2008 for cereal farmers was €352 per hectare, the net margin estimates presented in Figure 13 show that the average farmer was left with only €22 per hectare after all costs were paid, and even the most efficient group of farmers had just under €200 per hectare remaining after all costs were paid.

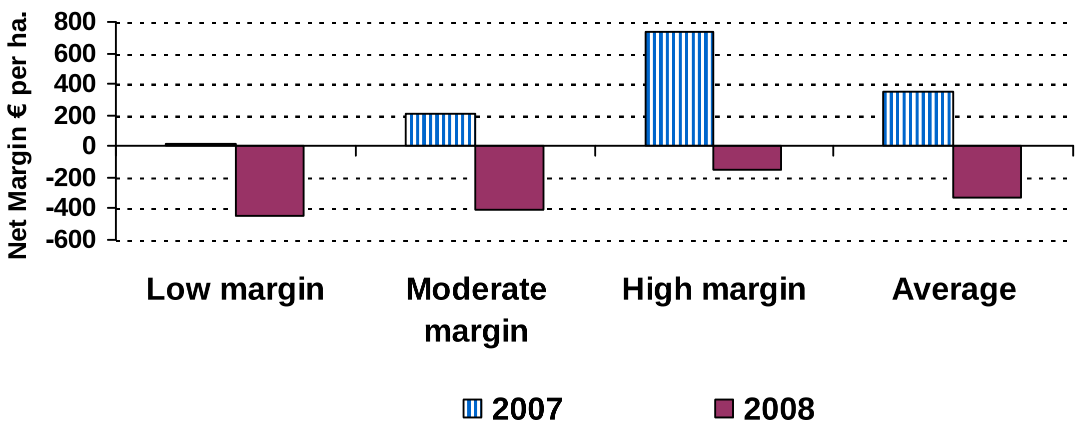


Figure 13. Actual Net Margin 2007 and Estimated Net Margin for 2008 for the Cereal Enterpriseon Specialist Tillage Farms

Source: National Farm Survey 2008 and Authors' own estimates

Outlook for 2009

In this section of the paper forecasts are provided on the expenditure for various input items in 2009, the farm gate cereal price that will prevail at harvest 2009 and the likely net margin of tillage farmers in 2009.

The Outlook for Input Expenditure

Fertiliser – usage and price

A number of factors need to be considered when price and volume changes for fertiliser on crop farms are forecast for 2009. While fertiliser prices continued to increase month by month for most of 2008, Urea prices decreased sharply in the beginning of October 2008 and Phosphate also witnessed a significant decrease in price in December 2008. The current manufacturers' prices of Urea is now back down to the level which prevailed early in 2007 and if this price were to be maintained through 2009 then Urea prices could be down by about 40 per cent on the 2008 level. However CAN prices have remained strong. Until recently there has traditionally been a strong price relationship between CAN and Urea but in recent weeks this relationship has not been maintained due to the supply origins of the two raw materials. However it would seem realistic to assume that downward adjustment in the CAN price can also be expected as a pull factor associated with the Urea price drop. A price drop of 10 per cent for CAN is assumed for 2009.

In the case of P and K demand is set to remain relatively strong and this does not create an environment in which prices are likely to fall. Given that fertiliser compounders in Ireland have stated that the majority of P and K ingredients are forward bought it is assumed in this analysis that the price of P and K ingredients purchased by compounders for use in fertiliser compounds for use on cereal ground in 2009 has been purchased at a higher price than the ingredients purchased for 2008. However due to a fall off in demand for fertiliser products globally a conservative estimate for P and K compounds to remain at farm gate prices similar to 2008 levels is assumed.

Additionally fertiliser usage in 2009 is expected to remain at 2008 levels, which was assumed to be a 10 per cent reduction on 2007 levels. Overall, it can be expected that fertiliser expenditure will decrease only very slightly in 2009. This expenditure drop will be somewhat less than the expenditure drop experienced on livestock farms due to the significantly higher proportion of P and K in compounds for cereals relative to grassland.

Seed – usage and price

As mentioned previously in the paper cereal farmers experienced a significant increase in seed costs in 2008 relative to previous years due to the significant upward movement in the cereal markets. However, at present blue label seed is being sold for similar prices to last year despite the significant reduction in cereal prices experienced at harvest 2008. The current failure of the Irish seed market to reflect the downward pressure on cereal prices can be explained by the failure of a large proportion of seed crops meeting minimum quality standards. Hence a large proportion of our seed requirement for 2009 was imported from the UK and this extra cost is reflected in a stabilisation in seed prices at 2008 levels.

Crop protection – usage and price

The increase in costs between 2008 and 2009 is forecast to be of a similar magnitude to the increase between 2007 and 2008, which was minimal at just under 1 per cent. Volume changes between 2008 and 2009 are forecast to be negligible.

Energy and Fuel – usage and price

Fuel costs in 2009 will depend on the evolution of crude oil prices. Current crude oil futures prices suggest that prices will drop back from the 2008 average during the course of 2009. For the purposes of this analysis it is assumed that fuel costs will decrease by approximately 20 per cent in 2009, which would leave fuel prices in 2009 similar to those recorded at farm level in 2007. In 2008, the increase in contractor charges was assumed to reflect the increase in fuel costs, but as fuel charges are forecast to decrease in 2009, the associated contractor charges are not forecast to decrease to the same extent. Half of the decrease in fuel costs is assumed to be translated to contractor charges in 2009. Assuming that usage is unchanged, expenditure on fuel and contractor charges are estimated to reflect the assumed price decrease.

All other direct costs and overhead costs

Given that forecasts for inflation are significantly lower for 2009 than those experienced in the recent past, labour costs and other agricultural costs are forecast to increase by between 2 and 2.5 per cent in 2009.

Given that farm gate cereal prices decreased significantly in 2008 there is presently a significant emphasis on decreasing land rental prices. It is assumed that land rental prices will decrease to those levels paid in 2007.

The Outlook for Markets

The cereals market has encountered significant volatility in recent years. The one question above all else which is being considered at present when planting decisions are being made is in relation to the expected farm gate cereal price in 2009. A number of factors must be taken into consideration when price forecasts for the coming harvest are being evaluated. To formally evaluate the risk associated with predicting the 2009 harvest price an econometric analysis was conducted to predict the probability that the 2009 farm gate price will be higher or lower than the 2008 price. This analysis was based on the LIFE futures price for September 2009. The regression analysis examined the historic relationship between (i) predicted futures price for the following harvest, made when planting decisions were been made, and (ii) the actual farm gate price paid at harvest one year hence. This regression analysis enabled a forecast to be made of the 2009 Irish farm gate cereal price for wheat taking into consideration the differences between the historic predicted values and the actual outcome. Based on this analysis a forecast is presented in Figure 14 of the probability that the 2009 farm gate wheat price will be higher or lower than the 2008 farm gate wheat price.

Figure 14 shows that there is significant volatility around the forecast for the 2009 harvest price. There is a 55 per cent probability that the wheat price at harvest 2009 will be higher than the 2008 price. However there is also a 45 per cent probability that the 2009 price will be lower than the 2008 price. Based on these probabilities the average predicted value from the model for the farm gate wheat price is €135 per tonne at 20 per cent moisture. However there is significant variation surrounding this figure and based on a 90 per cent confidence interval it is forecast that the figure could be as low as €85 per tonne or as high as €185 per tonne (Figure 15).

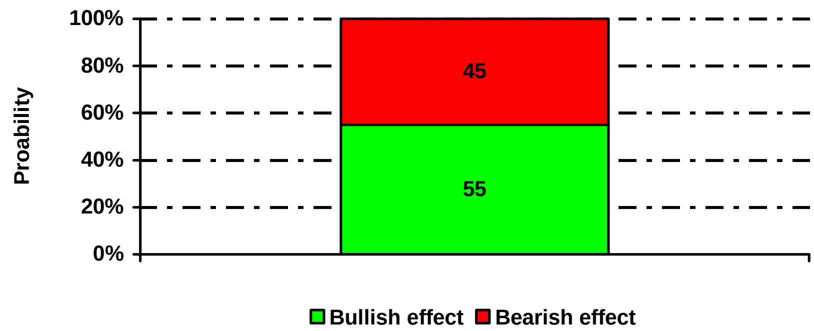


Figure 14.   Probability that the 2009 Cereal Price will be lower/higher than the 2008 farm gate price
Source: Authors' own estimates

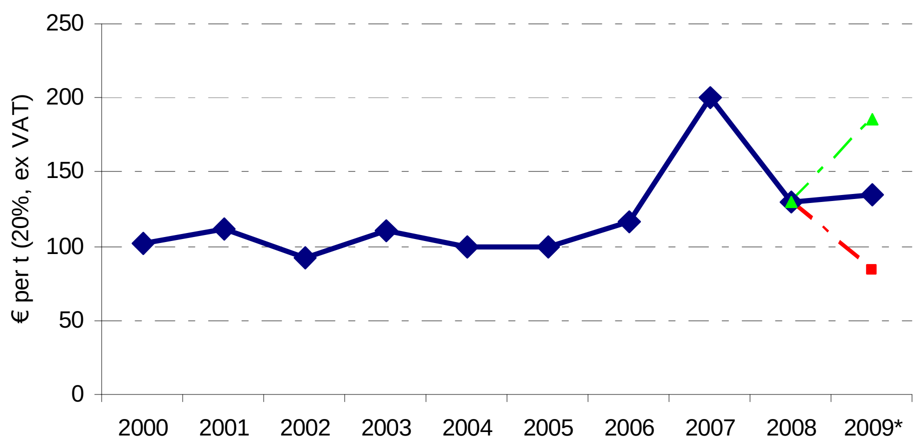


Figure 15.   Historic, Estimated and Forecasted Farm Gate Feed Wheat Price (2000 – 2009)
Source: Authors own estimates, 2009 forecast, at 90% confidence interval

While there is much speculation at present in relation to the forecasted price for 2009 the latest estimates for planted area in the EU would seem to indicate that there will be modest upward pressure on cereal markets in 2009 based on forecasted plantings. The latest edition of Strategie Grains (November 2008) has forecast a 1.8 per cent reduction in planted area in the EU for the 2009 harvest, down 1.07 m ha to 58.51 m ha. This decrease in plantings is one rationale for the slight increase in farm gate cereal price in 2009. However there still exists much debate as to the forecasted closing stocks in Ireland emanating from the large increase in production in 2008 relative to 2007.

With the caveat that much volatility surrounds the forecasted 2009 harvest price, based on the futures market forecast and the adjustments made in the regression analysis for predicted versus actual outcomes, it is assumed for this analysis that farm gate cereal prices will increase marginally in 2009, by approximately 5 per cent. In addition to farm gate cereal prices at 20 per cent moisture, account is also taken in the 2009 forecasted net margin for a return to average moisture levels in 2009, which would see an increase in revenue for some crops which were harvested at high moistures in 2008.

The Outlook for Tillage Enterprise Margin in 2009

Slight decreases in energy, fertiliser, rent, and contractor prices coupled with a low general inflation factor for other inputs, costs are likely to be slightly lower in 2009 relative to 2008. In addition, output value is expected to increase marginally over 2008 levels due to a slight increase in forecasted prices and improved harvest conditions relative to 2008.

Figure 16 presents the actual gross margin for each of the main cereal crops in 2007, and the respective estimates and forecasts for 2008 and 2009. The net effect of input price, output price and volume movements is a slightly higher enterprise margin forecast for 2009 for each of the main cereal crops but still considerably lower than the margins achieved in 2007. For example, gross margins for winter wheat are forecast to increase by approximately €35 per hectare, while gross margins for spring barley are forecast to increase by approximately €80 per hectare. The slightly higher increase in forecasted margin for spring barley relative to winter wheat is due to the relatively high yield of winter wheat achieved in 2008, hence if average wheat yields are achieved in 2009, this will represent a reduction relative to 2008. It should be noted that the average gross margin figures presented are market based gross margins.

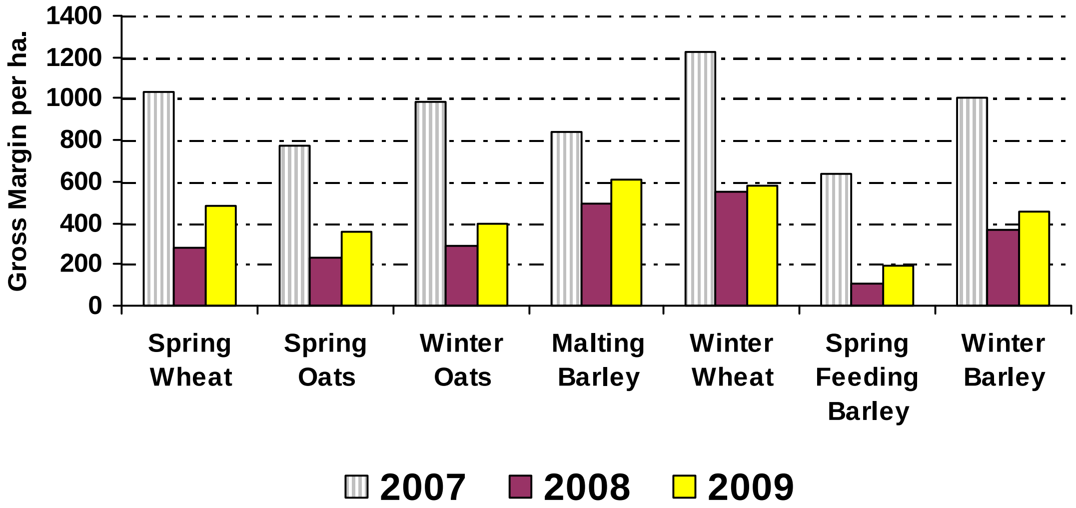


Figure 16. Actual 2007, Estimate 2008 and Forecast 2009 for Cereal Crop Gross Margins
Source: National farm Survey 2007 and Authors' own estimates

Similar to the format used to present margins in 2007 and 2008 earlier in the paper, the forecasted gross and net margins for 2009, are presented for the cereal enterprise on specialist tillage farms, as well as the population disaggregated into one-third groupings based on margins obtained.

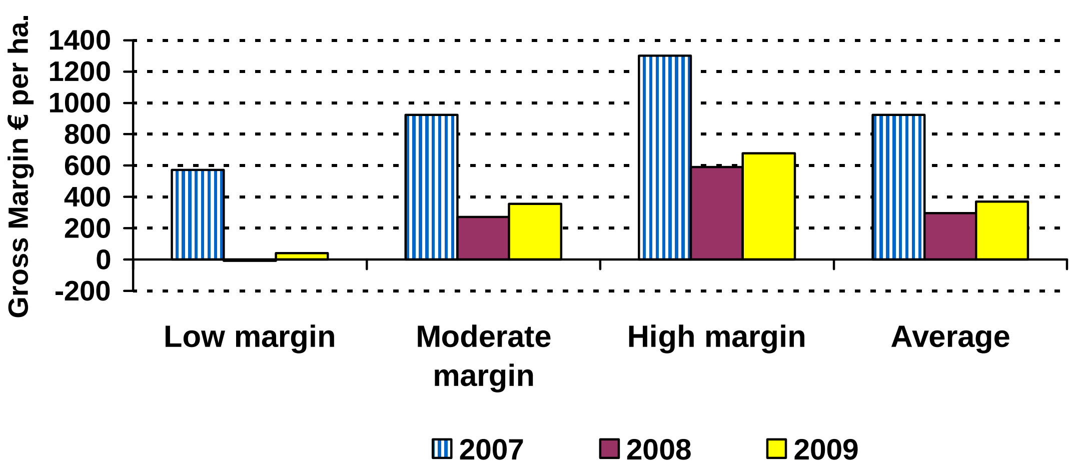


Figure 17. Gross Margin Actual 2007, Estimate 2008 and Forecast 2009 for the Cereal Enterprise on Specialist Tillage Farms 2008
Source: National Farm Survey Data (2007) and Authors' Estimates 2008 and 2009

Figure 17 shows that the forecast for 2009 on the average cereal enterprise on specialist tillage farms is for gross margin to increase by approximately 20 per cent or €70 per hectare relative to 2008. Figure 18 shows that net margin will improve by approximately €30 per hectare in 2009 relative to 2008. However the forecasted net margin for the cereal enterprise in 2009 relative to 2008 remains below zero meaning that the average tillage farmer must subside production with returns from the SFP.

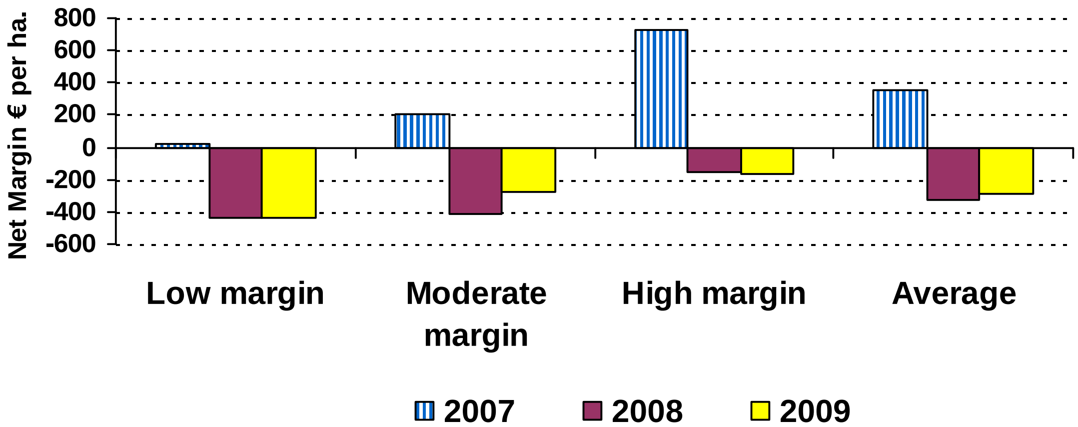


Figure 18. Net Margin Actual 2007, Estimate 2008 and Forecast 2009 for the Cereal Enterprise on Specialist Tillage Farms 2008

Source: National Farm Survey Data (2007 and Authors' Estimates 2008 and 2009)

The Production Decision - Will I sow the crop for 2009?

While the data presented in Figure 18 shows that the forecasted net margin from the cereal enterprise is negative for even the most efficient group of farmers in 2009 it must be remembered that a large proportion of fixed costs will be borne by the farmer even in a situation where the crop is not planted in 2009. Hence, to determine whether the return from growing the crop in 2009 will provide a positive or negative margin it is necessary to subtract the quasi-fixed cost items from enterprise gross margin. If the gross margin for the cereal enterprise remains positive after the quasi fixed costs are accounted for it makes economic sense to grow the crop in 2009. The fixed cost items assumed to be quasi fixed costs are labour and machinery operating expenses. These items would not be experienced if the land was not cropped in 2009. All remaining fixed cost items would be fixed regardless of the level of production, such as car, electricity, phone, machinery depreciation, building depreciation, and other miscellaneous fixed cost items. The forecasted margin results (on an owned land scenario or where the farmer does not have the opportunity to stack the SFP) when quasi fixed costs are accounted for are presented in Figure 19.

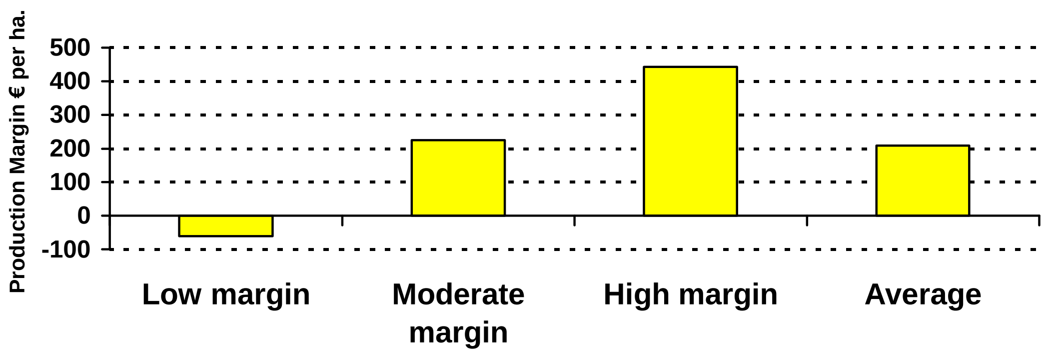


Figure 19. 2009 Forecasted Gross Margin (minus quasi fixed costs) for the Cereal Enterprise on Specialist Tillage Farms – Owned Land Sceanrio

Source Authors' Estimates

Figure 19 shows that the forecasted gross margin minus quasi fixed costs is positive for the moderately and higher efficient farmers in 2009. However the farmers with lower levels of efficiency are forecast to have a negative gross margin minus quasi fixed costs. It is important to remember here that these results refer to an owned land situation or where the farm operator does not have the opportunity to stack the SFP, hence land rent is ignored.

Figure 20 outlines the forecasted margin on a rented land scenario or where the farm operator has the opportunity to stack the SFP. The results from Figure 20 are applicable in a situation where the famer is making a sowing decision on a marginal unit of rented land. Land rent per hectare is assumed to be €250.

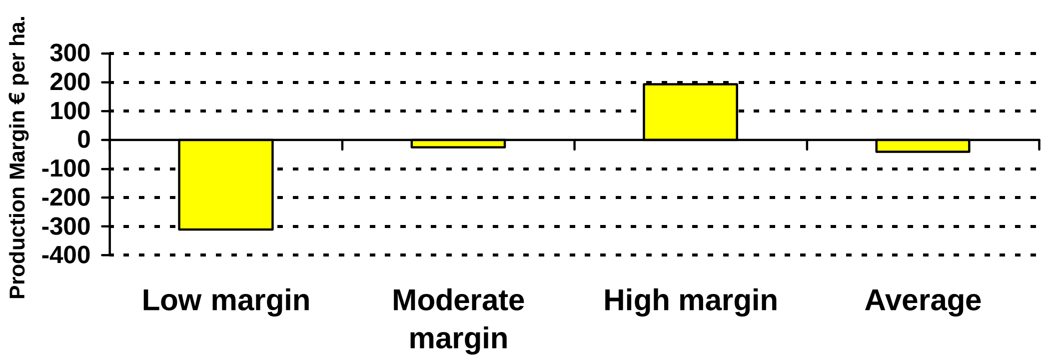


Figure 20. 2009 Forecasted Gross Margin (minus quasi fixed costs) for the Cereal Enterprise on Specialist Tillage Farms – Rented Land Scenario

Figure 20 shows that the forecasted gross margin minus quasi fixed costs is positive for only the most efficient farmers in 2009 when a land rent of €250 is assumed. Farmers with low and moderate levels of efficiency are forecast to have a negative gross margin minus quasi fixed costs. Hence, it is only the most efficient, top one third of farmers that can afford to pay €250 per hectare for rented land in 2009.

But what is our ability to compete in a Global Market Place?

While is it important to understand our cost and return structure to inform plating decisions, it is perhaps more important to understand our competitive ability in terms of the cost and return structure of our main trading partners. For this purpose, data from the European Commissions' Farm Accountancy Data Network (FADN) was consulted to determine how our costs compare to other cereal sectors within Europe. Further details on the results of this analysis can be found in Carroll *et al.*, 2008.

Costs of production as a percentage of market based output for specialist cereal farms were collated for the 2004/2005 period, the most recent years available. Figure 21 presents the competitiveness indicators based on the definition of cash and imputed costs as outlined in Box 1 below.

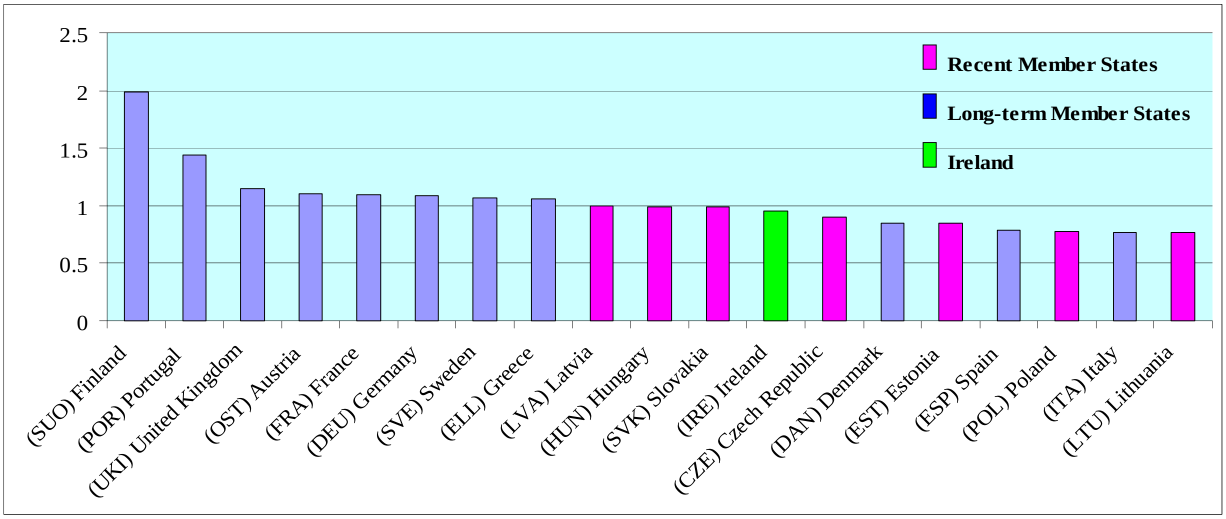
Box 1: Definition of costs

Cash costs: include all specific costs, directly incurred in milk production, for example fertiliser, feedstuffs, seeds etc. plus external costs such as wages of hired labour, rent and interest paid, plus depreciation charges.

Imputed costs: include family labour, equity capital and owned land. Imputed costs for land and labour were derived by using FADN measures of average land rental and agricultural labour rates in each country.

The examination of the cash costs of cereal production in isolation can be useful in that cash costs as a percentage of output value can be used to measure the resilience of the cereal sector to cope with a price-cost squeeze over the short run. For a true competitiveness comparison, however, it is also important to consider the opportunity cost of owned resources. This gives a measure of the total economic costs of production: in the long-run both cash and imputed costs must be covered if the business is to be sustained. Imputed costs can also be used as a leading indicator of the potential for the average cereal farmer in the EU MS to expand profitably, as they reflect the typical costs of land and labour in each country.

A: Cash Cost Competitiveness



B: Economic Cost Competitiveness

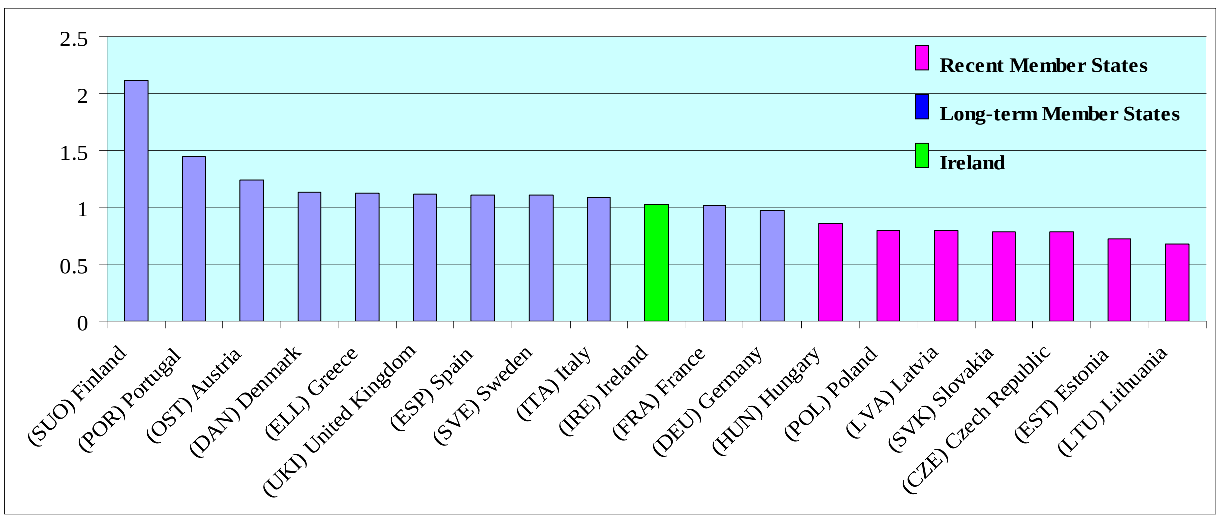


Figure 21. Cereals sector Cost Competitiveness for Selected EU Member States (indexed to weighted EU average)

Source: Carroll et al., (2008)

Recent Members States perform well for both cash and economic costs indicators but particularly so for economic cost competitiveness which is due to low opportunity costs associated with owned land and family labour. Average land rental charges (per hectare) for recent Members States are 27 euro compared to 181 euro for long-term members. Similarly, the average cost of hiring one working unit is 4,633 euro in recent members and 18,623 for long-term members. While Irish economic competitiveness appears relatively low at 10th place, the situation improves to 3rd (behind Germany and France) once only long-term Member States are considered and is slightly above (3 per cent) the overall EU average. Irish cash competitiveness is 8th overall and 4th for long-term states behind Italy, Spain and Denmark.

Further analysis of the competitiveness indicators presented in Figure 21 above shows that the low opportunity cost of Working Capital for recent Members is evident (Working Capital ratio for these countries is, on average, over 62 per cent lower than the overall EU average) and is the primary source of economic competitiveness for these countries. Ireland's competitive advantage lies in its relatively low Overhead, External Factors and Fixed Assets (imputed cost) ratios which are 12, 14 and 33 per cent lower than the EU average respectively. Its competitive disadvantage lies in its high Specific Costs and Working Capital ratios which are 14 and 20 per cent higher. The opportunity cost of owned land and labour is considerably higher than in competing EU members.

Given that the data presented above is based on data from 2004/2005 it is worthwhile to consider how Irish cereal farms may have shifted in terms of competitive ability in more recent times. Of particular concern in this regard would be the finding highlighted above whereby specific costs were considerably higher in Ireland in the base period. Given that fertiliser pries have increased significantly in recent times this finding is expected to have a negative impact on the relative competitiveness of Irish cereal producers.

CONCLUSIONS

1. The 2006/2007 production year proved to be a very successful year for tillage farmers. Depletion of global stocks, drought in Australia and the demand for corn from US ethanol producers led to a dramatic price increase for all cereals within Ireland and globally. These price increases in turn led to a supply response.

2. Increase in production in 2008 had a negative impact on farm gate cereal prices in 2008 relative to 2007. Coupled with significant cost increases in key input variables, the estimated gross and net margins for cereals crops in 2008 were considerably lower than 2007 returns.

3. It is forecast that the price of key input variables such as fertiliser, land rent and fuel will decline in 2009. There is considerable uncertainty regarding cereal prices for 2009 harvest but based on current futures trading prices it is assumed that 2009 harvest prices will be slightly up on 2008 levels. The movements in input and output price variables are forecast to have a positive effect on gross and net margins for tillage farmers in Ireland in 2009 relative to 2008.

4. However without any significant upward movement in cereal price or real reduction in input costs the forecasted net margin for the average producer in 2009 will be negative. Hence, even the top one third, most efficient cereal producers, will not retain their full SFP in 2009.

5. But even in a no sow scenario the farmer will still incur some element of their fixed costs to draw down their SFP. Based on this assumption the results of this research show that on owned land it makes economic sense for moderate and high efficient farmers to sow cereals in 2009. However, on rented land it only makes economic sense for the top one third efficient cereal farmers to pay €250 per hectare in 2009.

6. In terms of the competitive ability of Irish cereal producers, the opportunity cost of owned resources has a major impact on relative competitiveness. Recent member states to enter the EU have considerably lower total economic costs compared to long term member states within Europe. Land costs in particular in Ireland were considerably high than the EU average.

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The outlook for biofuels

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SUMMARY

While some progress has been made in developing an Irish infrastructure for biofuel production and use, feedstock and product price volatility, competition from unfairly-subsidised imports and uncertainty about future support policies are holding back investment in further development. Failure to expand our production capacity will increase our dependence on imports to meet EU substitution targets. The handling of two major policy issues, i.e. the change to an obligation system for transport biofuels and the development of a National Action Plan as required by the recent Renewable Energy Directive, will have a major bearing on the development of biofuel production in Ireland in the coming decade. The obligation system must give Irish producers at least a level playing pitch in their competition with imports; favouring highly sustainable first-generation fuels would achieve this objective as well as maximising greenhouse abatement and fuel supply security. The National Action Plan should focus on the biofuels best suited to Irish production, and propose a set of measures to maximise their production. Since the amount of biomass needed to meet the heating/electricity targets far exceeds current availability, production of energy crops needs to be rapidly expanded. Research to reduce costs and streamline the production of willow and miscanthus is urgently needed.

INTRODUCTION

The biofuel industry in Ireland has suffered severe turbulence in recent times. Market conditions have been very difficult. Pure plant oil (PPO) production has been hit hard by high rape-seed prices. Both PPO and biodiesel markets have been badly affected by "B99" biodiesel imports from the USA, subsidised by both the US Government and the Irish tax-payer and providing big profits for fuel importers; hopefully this madness will end soon. At present all biofuel sectors have been affected by the dramatic fall in oil prices. We have also had damaging public debates on two issues: the role of biofuels in food price increases and the sustainability of some biofuel production. All this, combined with uncertainty about future support policies at home and abroad and the extent to which these will affect the competitiveness of Irish biofuel production, are a source of concern among current and potential developers and investors.

In spite of these problems, some progress has been achieved:

- Four pure plant oil units have been built
- Our first significant biodiesel plant has come on stream in New Ross
- The use of wood chips for commercial heating has grown steadily
- Our first significant wood pellet plant has started production in Knocktopher
- About 2000 ha of perennial energy crops (miscanthus and willow) have been established

In the longer term, the agreement that has just been reached on an EU Renewable Energy Directive will have a major effect on biofuel developments in member states over the next ten years (Commission of the European Communities, 2008). In the new Directive, the target to produce 20% of our total energy from renewable sources by 2020 has been retained. A significant change is that this target refers to final consumption rather than primary generation, so heating or CHP will be favoured in comparison with straight electricity generation. The transport target has been modified to the achievement of the 10% target from all renewable sources, not solely biofuels. The extent to which this alters the biofuel target depends largely on the progress made with electric cars charged from renewable non-bio electricity.

The first test of member states reactions to the Directive will be in their submission of National Action Plans in pursuit of the Directive targets; the template for these plans is to be drawn up by June 2009, and the plans submitted by June 2010. It is to be hoped that these plans will not just re-hash existing support schemes, but will take a comprehensive view of each link in the chain of measures needed to bring the various technologies to commercial realisation.

Before trying to formulate the National Action Plan for Ireland, it is essential that we clarify what we want it to achieve. It should include the objectives behind the original EU Biofuels Directive, (i.e. supply security, environmental benefits and rural enterprise development) but could also include other national objectives (Commission of the European Communities, 2001**)**. The following are proposed as the objectives of the Irish plan:

1. To achieve a rate of substitution of biofuels into the transport fuel market that approximates to the substitution required by EU Directives
2. To provide an opportunity for native raw material producers and processors to maximise home production and processing
3. To incentivise farmers to use biofuels to supply their own fuel needs
4. To provide a platform on which second-generation biofuel technologies can be built
5. To minimise the cost to exchequer (i.e. tax-payer) and motorist
6. To maximise fuel supply security benefits
7. To maximise greenhouse gas benefits
8. To minimise the disruption of food production

The Action Plan will have to address the reality that achievement of the Directive targets will require the energetic use of biomass on a much increased scale. At a rough estimate we will require well over 4 million tonnes of energetic biomass, as against our present use of well short of 1 million tonnes. In drafting the Action Plan, we need to decide the balance we wish to achieve between home production and imports, and the process technologies that should be Irish priorities. The Action Plan will be critical to biofuel development in Ireland in the coming decade, and agriculture needs to make its collective voice clearly heard in its drafting.

Do we need Irish biofuel industries based on current technologies? Yes, for a number of reasons:

1. Oil prices are currently very low, but they will rise again as economies come out of their present slump
2. Existing food market prices are very volatile; alternative markets would have some stabilising effect
3. The costs and sustainability of biofuel imports will be recurring issues
4. The need to generate rural employment is once again with us
5. Failure to meet EU targets will eventually lead to substantial penalties

6. Those who argue that we should wait for second generation technologies want to build the second floor with no ground floor

Transport biofuels

Obligation system to replace excise relief

A significant Irish policy development in recent months was the publication of a Government discussion paper proposing an obligation system on oil companies as an alternative to the current excise relief system (Department of Communications, Energy and Natural Resources, 2008). It may be assumed that the support system that emerges from this consultation will be part of the National Action Plan to be submitted to the European Commission in 2011.

The publication of the consultation paper is welcome; with the current excise relief programme expiring in 2010, it is vital that the follow-up programme be put in place quickly to remove uncertainty about the future of Irish biofuel production. The support mechanism proposed is the issue of certificates per unit of biofuel placed on the market, and an obligation on fuel suppliers to redeem certificates to match their mineral fuel sales at the specified substitution level for that period.

Although the document preamble recognises the role that biofuels could play in providing Ireland with an emergency fuel supply, it is disappointing that the many other benefits that would accrue from native biofuel production are not acknowledged. While we must accept that any biofuel support scheme must allow free competition within member states, there is still scope to devise a scheme that would improve the opportunities of native producers.

Most transport biofuels are derived from farm produce, and their use on farms would help to secure food production in a fuel crisis. Several EU states have devised fuel excise systems to stimulate on-farm biofuel use for this reason. This possibility deserves to be examined in Ireland.

The preamble somewhat overstates the move to obligation systems among member states. Sweden for instance, one of the most successful adopters of biofuels, will stay with excise relief at least until 2013. France and Germany will not complete the phasing out of excise relief until 2012. But in the current financial climate it is unrealistic to expect that a full excise relief scheme covering an increased volume of biofuel could be maintained indefinitely. So we need to examine whether an obligation system can be devised that would maximise opportunities for Irish producers, even though the option of a selective top-up of excise relief may still be needed in some sectors of the biofuel market.

The arguments against biofuels

The obligation document lists the issues that have been used to tarnish the image of biofuels in recent times: little or no reduction of carbon emissions, raising of food prices and damage to vulnerable ecosystems. While these are legitimate concerns on a global scale, they have little relevance to current or planned Irish biofuel production. The food-fuel argument has already collapsed, with the increase in grain production leading to a rapid fall in prices and grower profit margins. With cattle numbers projected to fall and pig and poultry production under threat, Irish cereal growers will need new markets just to sustain their current production area. A big increase in our tilled area to produce arable biofuel crops will not happen. But Irish biofuel production can actually assist food production, by maintaining the tillage area and promoting the production of animal protein feed (DDGS, rape cake etc).

Ecosystem damage is already a big issue for many developing countries, and competition for scarce water resources will be a problem for the future. But these have little relevance in an Irish context, with a stable tillage area, comprehensive cross-compliance requirements linked to the Single Farm Payment, and an abundance of rain.

Greenhouse gas (GHG) mitigation by transport biofuels

On greenhouse gases, the EU Renewable Energy Directive is proposing an emission reduction of at least 35%, increasing to 50% in 2017, for any transport biofuel to count towards national target achievement. The obligation proposal also mentions the possible inclusion of a more favourable treatment of biogas and 2nd generation biofuels to take account of their expected more favourable greenhouse gas balance. One of the strengths of the biofuel production either in place or in planning in Ireland to date is its high level of sustainability. Since it is virtually all based on home-produced raw materials, the traceability of those feedstocks is also high. Current and planned Irish production could be classified as follows:

1. Biodiesel production by Green Biofuels, Ecoola, Eco Fuels and Greyhound Recycling is mainly from recovered vegetable oil (RVO) and tallow. An SEI-commissioned study carried out by Dutch consultants Ecofys has shown that the GHG emissions from RVO-biodiesel are over 80% lower than those from diesel (Sustainable Energy Ireland, 2004). Tallow biodiesel might be expected to give a similar value. Estimates in the Commission Directive confirm these figures. Second-generation biofuels will improve little on these levels.

2. Biodiesel produced from rape-seed oil (RME) would reduce emissions by more than half according to the Ecofys study, less than half according to the Commission. Any newly constructed sensibly-located plant should be able to exceed 50% GHG reduction.

3. Pure plant oil emissions can be estimated from the Ecofys report, from the Commission document and also from the Elsayed report (Elsayed et al, 2003). All would suggest a reduction of 55-60% compared with diesel.

4. For ethanol, Carbery Milk are producing from whey, a by-product feedstock, so it is probably safe to assume that their GHG emission is over 60% less than petrol. Inefficient corn-ethanol plants may well produce emissions similar to petrol, and these have aroused public doubts about all bio-ethanol production. But no such plants exist here.

   Ethanol Ireland, an Irish company, is currently working on plans to build a substantial wheat-to-ethanol plant in Waterford port. A modern efficient plant such as this proposal, using CHP and possibly a renewable source of plant energy as well as capturing the CO_2 emitted during fermentation, could achieve a GHG reduction of up to 70%. It could also provide an alternative market for home cereal production, and help to stabilise grain prices and the production area.

So current and planned Irish biofuel production has a high sustainability and traceability level, with big GHG reduction levels and no other issues of environmental or social significance. While 2nd generation biofuels have the potential to increase biofuel production per ha, their GHG emissions will not be much better than the current Irish plants. Even if/when 2nd generation technologies become commercially viable, Ireland will have a major challenge developing low-cost biomass supplies for such plants. So the aim of the new scheme should be to reward appropriately those biofuels certified as achieving a very high standard of sustainability, and in so doing to facilitate the continued development of high-sustainability 1st generation biofuel production to the maximum extent that feedstock resources will allow.

There is an opportunity for Ireland to develop a scheme that takes a lead in rewarding sustainable production, regardless of feedstock, technology or generation. Certificates should be allocated in proportion to certified greenhouse gas abatement, above a minimum abatement level of 35%. The certification process should include feedstock traceability. Taking account of a Commission suggestion that two certificates be allocated to 2nd generation biofuels, a possible allocation rate for the Irish scheme might vary on a sliding scale from one share at 35% GHG reduction to two shares at 85%.

Certificate trading

The whole basis of the obligation/certification system is dependent on the effective operation of a certificate trading system in which the certificates attain a value close to the fossil fuel excise and the buy-out penalty. The early stages of CO_2 trading have provided an example of what can go wrong with this type of market; a repeat of that experience would sound the death-knell for most Irish biofuel producers. Any monies collected as penalties should be used to top up the certificate price, as in the UK RTFO scheme. The temptation for government to use the scheme as a revenue source by setting a low buy-out penalty and retaining the proceeds needs to be firmly resisted

Other issues

All the biofuels for which certificates are issued should be in compliance with the most appropriate quality standard, e.g. EN14214 for biodiesel, DIN 51605 for pure plant oil, prEN 15376 for low-blend ethanol, etc. Import of poor-quality fuels will not only damage home production, it will antagonise motorists and reduce biofuel use.

In the debate about the obligation system, other biofuel support measures should not be forgotten. On the feedstock side, the carbon premium and top-up payment need to be maintained in as far as possible. On the market side, Sweden in particular has made very good use of a range of promotion measures. Conversion of public vehicle fleets to use biofuels, capital grants for processing, distribution and dispensing facilities, VRT and road tax reduction, reduced parking and congestion charges; all these have helped to increase the appeal of biofuels to the motorist. The application of similar measures in Ireland needs to be seriously considered as part of the Action Plan.

Biofuels for heating and electricity production

Markets

There are many different heat/electricity market opportunities for biomass feedstocks, either already developing or still to find a niche:

1. The use of pellets for home heating was kick-started by the boiler/stove grants available under the SEI Greener Homes Scheme. But growth in pellet use has been sluggish for a variety of reasons: initial uncertainty about pellet supply and quality, a few well-publicised installation problems, and more recently the fall in oil and gas prices. With the established Balcas plant in Enniskillen and the recently-opened D-Pellets plant in Knocktopher, pellet supply is no longer an issue. But it is vital that the quality of pellets, boilers and installation are all maintained at a high level to re-assure consumers who wish to change to a native, renewable fuel.

2. The heating of commercial buildings, mainly hotels, by wood-chip boilers has been advancing steadily, with up to 100 installations either operating or approved for SEI ReHeat Scheme grants. User reaction has been positive, but many new installations are being delayed by the uncertain economic climate. A pool of wood-chip suppliers has been developing, and with a few more additions most areas of the country will be covered. Farrelly Bros in Kells are making a

substantial investment in willow production for heating use. A wood-chip quality assurance scheme is in discussion between SEI, COFORD and the chip suppliers.

3. The open-fire and hand-fed stove market is still substantial; it is largely supplied by log-wood and briquettes. From the SEI annual energy balance, it appears that the domestic peat briquette market is equivalent to about 150,000 tonnes of dry biomass (Sustainable Energy Ireland, 2008).

4. The 30% peat substitution target set out in the Government's White Paper for the three peat-burning stations would require biomass to replace about 0.9 million tonnes of peat (Department of Communications, Marine and Natural Resources, 2007). Assuming net calorific values of 8 and 12 MJ/kg for peat and biomass respectively, about 0.6 million tonnes of biomass would be required to meet this target.

5. The Government White Paper also contains a 2020 target of 800 MW_e of electricity "with an emphasis on biomass-fuelled CHP". Even half this target would require about 2 million tonnes of biomass. The technology for very small CHP plants is still some way from commercial reality; a 35-140 kW Stirling-engine-based unit will be installed in Oak Park this year. Units from 1 to 5 MW would be more economic and could use mature technologies, but they would require a very large local heat demand. So it is difficult to see CHP based on biomass combustion making a big contribution to the White Paper target.

Feedstock options

Pellets at the Balcas plant are producing from sawmill residues; the D-Pellets plant is using forest thinnings. If/when these feedstocks become less available, the next possibilities are miscanthus or by-product materials such as cereal or rape straw or rape-seed cake. While all these materials have similar calorific values, their suitability as fuels would all be to some degree inferior to wood. So they are more likely to be used in bigger commercial boilers rather than domestic stoves or boilers.

In the event of a lack of wood-chip availability for commercial boilers, willow chips or miscanthus in pelleted or chopped form would appear to be the best alternatives. Pelleting is a substantial additional cost, but greatly simplifies handling. A satisfactory system of transporting and chopping miscanthus and conveying the chopped product into a boiler has yet to be developed. Burning of whole bales would be a low-cost solution, but control of stack emissions might be a problem.

A number of companies are currently exploring the potential of briquettes made from wood, miscanthus and cereal straw for burning in open fires or hand-fed stoves. The outcome of these efforts will be eagerly awaited.

The peat stations will be very concerned to use feedstocks that avoid the corrosion problems that have given them major headaches in recent years. But otherwise they should have the greatest flexibility to handle difficult fuels, and as bulk buyers their prices are likely to be the lowest. Also the Renewable Energy Directive will incentivise biomass use for heat or CHP rather than electricity. So the peat stations are likely to meet as much as possible of their needs from by-product or residue materials, and use energy crops as a top-up.

The principal candidate energy crops are miscanthus and willow, with hemp as a possible annual alternative. Miscanthus and willow are both perennial crops with an expected lifetime of up to 20 years. Both are expensive to establish but are supported by Department of Agriculture, Forestry and Food establishment grants of up to half the cost of establishment.

Approximately 1700ha of miscanthus have been established over the last two years. Establishment Grant applications for 2009 close at the end of this month; it is expected that at least 900ha will be sown this spring. The earliest miscanthus plantation established at Oak Park is currently in its 15^{th} year. No serious incidence of disease has been recorded during this period and although on light land it still has a harvestable yield over 10 t/ha of dry matter in good years. Very little fertilizer has been applied during this period and initial N fertilization trials have shown only a modest response. It is however expected that crops grown on some soils will require regular fertilization. Field losses have been a problem with some harvesting equipment; research is under way at Oak Park to overcome these problems and optimize the harvesting process.

There are approximately 350 ha of willow in the country at present, most of it established over the last two years. Rust infestation was a problem in earlier Teagasc trials, but it is expected that plantations will last up to 20 years and longer if a mixture of modern rust-resistant varieties is sown. Procedures for establishing willow are highly advanced and good establishment rates are typically achieved. However, harvesting and processing are more expensive than miscanthus, with drying a particular problem. A simple, inexpensive farmyard drying system has been developed at Oak Park for drying willow chips to 20% moisture or lower over the summer months.

The high establishment costs of these crops will be a continuing problem, and ways of reducing them must be found before the grants are reduced or phased out. Establishment of miscanthus has been somewhat erratic, and the harvesting, storage and planting of rhizomes needs to be researched with a view to improving emergence as well as reducing costs.

It would make very good national economic sense if we could transfer a small proportion of the land currently in unprofitable dry-stock to perennial biomass crops. This would reduce methane and CO_2

emissions and increase biofuel use, and generate significant rural employment. All that is needed is a mechanism to provide a long-term guarantee of a realistic price to potential producers.

Biogas

Finally, in spite of SEI's introduction of a 30% capital grant programme, a €0.12/kWhr feed-in tariff for the electricity produced, and a rapid expansion in other countries of the digestion of energy crops and organic wastes as well as animal manures, anaerobic digestion potential in Ireland remains untapped. Grid connection and planning problems, difficulties finding nearby heat uses and constraints for animal health reasons on the land-spreading of food waste digestate; all are combining to hamper progress. Yet AD offers the best prospect for small-scale CHP, and it could make some contribution to the White Paper 800 MW_e target. It also opens up potential for the energetic use of high-moisture crops such as grass, and in the longer term it may be feasible to operate fuel cells from methane. In summary, biogas can play a unique role in our bio-energy portfolio if we can find ways around the problems that are holding it back.

Biogas has the potential to be used in several different ways:

- In boilers or CHP plants, with minimal upgrading
- As transport fuel, after upgrading and with some vehicle modification
- Injected into the gas grid, again after upgrading
- As a fuel cell driver; this is still at a development stage, and fuel cell selection and feedstock upgrading are still in need of research

For the near future, CHP is the most feasible option. But research is urgently needed on the economics and practicalities of digesting grass and other energy crops along with animal manures, on the techniques, cost and scale economy of biogas upgrading processes, and on the state of development of the use in fuel cells of hydrogen-rich gases such as bio-methane. Teagasc hopes to construct a digester at Grange this year to begin investigating some of these issues.

CONCLUSIONS

Some key upcoming policy decisions will have a critical effect on the way biofuel production and use develops in Ireland in the coming decade. The confirmation of ambitious substitution targets in the Renewable Energy Directive and the growing likelihood of mandatory penalties for non-compliance will raise the stakes considerably as 2020 approaches. Given the long time-lag in the build-up of biofuel capacity, from the establishment of perennial energy crops to the development of processing facilities, action on the ground needs to begin without delay. The Action Plan required by the Directive will be a big test of our resolve to come close to achieving the 2020 targets.

The proposed Transport Biofuels Obligation System needs to be drafted in a way that is sympathetic to Irish production; one way of achieving this while still allowing free EU competition is to set and reward high sustainability standards. It will also be vital to ensure an active certificate market at a realistic price, by setting and adjusting the substitution level and buy-out penalty, providing a certificate brokerage service, using the buy-out penalty fund to support the market, and any other necessary measures.

Given the bulky nature of most solid biofuels, achievement of our heating/electricity goals will depend even more on native feedstock production. The biomass needed to come near the 2020 targets is far in excess of current Irish production. Transfer of some land from dry stock to energy crops would meet this need and also substantially improve our greenhouse gas balance. Given the long time-lag in such change, plans for its achievement need to be moved forward urgently.

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Can we reduce costs and increase profits with Min Till?

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SUMMARY

The minimum tillage system has been successfully adopted by a small number of large growers, but it now needs to be carefully considered as a potential cost saving measure for all growers. Crop performance and machinery cost and labour issues are addressed in this paper. Eight years of robust winter wheat trials indicate that despite individual year differences, min-till established wheat has performed as well as the plough-established crop. While min-till established spring barley has performed well on an easily cultivated site, early results from a more challenging trial site indicate that the type and timing of the cultivation system may have an impact on spring barley performance. Winter barley has been successfully grown under min-till management but grass weed control can be difficult, with sterile brome presenting a particular challenge. Preliminary winter oilseed rape research suggests it can be successfully grown using a min-till establishment system with no yield penalty. Additional grass weed control costs can be significant on sites where early sowing and non-inversion result in extra meadow grass and sterile brome problems. This can add up to €67 / ha which can impact on the cost benefits of the system. The Oak Park machinery costing programme was used to estimate machinery costs on 100ha and 400ha winter wheat units. The adoption of a min-till system could save €53/ha and €66/ha compared to ploughing on the 100ha and 400ha units respectively. The adoption of min-till can reduce the labour required to establish a crop from 2.14 to 1.01 hrs/ha. Coupled with a more even work distribution this can allow a 2 person team effectively replace a 5 person team where min-till is used to establish 400ha of winter wheat. This is a key attraction to larger growers.

INTRODUCTION

Minimum tillage crop establishment systems have been used in Ireland by some growers for the best part of a decade. While those growers that use the system establish a significant area of min-tilled crop each year, the system has not been adopted by the majority of cereal producers. There are many valid reasons for growers to be cautious about adoption including:

- uncertainty about the long-term performance of the system.
- suitability for spring crop production.
- suitability for wet establishment periods.
- grass weed difficulties.
- additional management skills and.
- difficulty valuing certain potential benefits
- the need for a different machinery complement.

However the potential benefits of the system such as reduced costs, and possibly improved sustainability, demand that we consider the min-till system carefully. Aspects of the system have been researched at Oak Park for eight growing seasons to date. Our work has focused on crop performance primarily, but we have also looked at many other aspects including: machinery/labour; impact on slugs, earthworms and aphids; and environmental aspects of the system.

Cost factors

To remain competitive and viable, crop production systems must be adapted to maximize profit opportunities. There are many factors which contribute to profitability such as crop yields, the value of output, input levels and the costs of inputs. As has been demonstrated dramatically over the 2007 and 2008 season, many factors both on the income and cost side, outside of a grower's control impact hugely on profitability. However factors within the grower's control also impact on costs. In difficult, and volatile market situations, the adoption of cost control options available to individual growers, or to the production sector within a region, may be the difference between loss and profit, and ultimately survival or failure.

Minimum tillage crop establishment must be considered as a system with the potential to significantly reduce some costs (particularly machinery / labour), while possibly raising other costs (weed control). The area of machinery costs is particularly difficult as machinery decisions are long-term in nature and elements of their cost, such as depreciation and repairs, are difficult to predict and determined by many factors such as machine types and capacities, ownership strategies etc. Adoption of a minimum tillage system may also impact on crop performance and have a long term impact on the soil, soil fauna and flora, and green house gas production, which are difficult to value, but need to be considered.

This paper builds on the previous reports of the minimum tillage research at Oak Park (Fortune 2005) and earlier machinery performance and costing work (Forristal 2006, 2008). It focuses primarily on two aspects:

- Crop performance: winter wheat, winter and spring barley and oilseed rape
- Costs: A costing comparison focusing on machinery cost estimates using the Oak Park machinery costing methodology.

Other aspects of the minimum tillage work such as impact on slugs / earthworms, soil and other environmental and sustainability factors are not included in this paper.

Crop Performance

Winter Wheat

The main focus of the min-till research at Oak Park has been the evaluation of the system with the winter wheat crop. We now have eight seasons of data comparing conventional plough-based establishment with min-till establishment using a replicated trial with large (24m x 30m) cultivation plots. The trial is sited at Knockbeg on a clay loam overlying a sandy clay loam. The effect of straw incorporation following harvest in both systems is also assessed. The trial layout underwent significant change for the 2008 season. While the basic cultivation plots remain the same, the crop is now sown in 2.5m wide sub-plots within the cultivation plots to allow various nitrogen rates to be applied. The objective of this change is to determine at a future date if the establishment system has an impact on nitrogen use efficiency. As the yield measurements are now taken from 2.5m x 15m sub-plots, there are significant edge effects which could add in excess of 10% to crop yields compared to the previous harvesting method where strips were taken from the middle of the plots.

The crop husbandry practice followed with the wheat trial largely mirrors current farm practice. In summary:

- Min-till plots were cultivated with a single pass of a tine cultivator (Horsch Terrano FX fitted with Mulch-mix tines) to a depth of 70 to 100mm. Plots were rolled immediately afterwards.

- Ploughed plots were ploughed to a depth of 200 to 250 mm, from a few days to a few weeks before sowing.

- Min-till plots were generally sprayed with glyphosate a few days prior to sowing following a stale seedbed period of a number of weeks (where possible) to eliminate volunteers and established weeds.

- Ploughed plots were cultivated with a rotary power harrow prior to sowing.

- All plots were sown with a Vaderstad Rapide 3m cultivator drill to a target depth of 40mm. The target sowing date was the first week of October but weather conditions determined the date (from 1st Oct to the last week of Oct)

- All subsequent crop treatments such as fertilizer, herbicide and fungicide application were the same on the ploughed and min-tilled areas. In summary these were:

  - 225kg N /ha
  - P and K as recommended from soil index
  - Standard 3-fungicide programme
  - Autumn herbicide of 5l/ha 'Trump' except 2006 (2l /ha 'Cougar')
  - Routine programme for Sterile Brome: 2 applications of 12.5g 'Monitor' up to 2007; 'Pacifica' 0.5kg/ha since 2008.

Winter Wheat performance

Crop establishment

In many of the trial years, there has been little difference in winter wheat establishment between the min-till and plough-based systems (Table 1). However when soil conditions are less than optimum, due to higher soil moisture contents, or particularly with later sowing dates, plant counts are often less with the min-till establishment system. Perhaps of more significance is that straw incorporation has not impacted negatively to date on crop establishment with either system. With winter wheat lower levels of crop establishment may not affect subsequent crop performance, particularly if the surviving plants are evenly distributed. The low counts recorded in the 01/02 season did not result in low yields.

Table 1: Plant establishment – winter wheat, Knockbeg, 2001-2008

Treatment	Plants/m2						
	01-02	**02-03**	**03-04**	**04-05**	**05-06**	**06-07**	**07-08**
Plough – straw	166	239	256	254	255	302	258
Plough + straw	171	254	256	255	254	305	257
Min-till – straw	123	240	239	230	248	269	253
Min-till + straw	124	237	234	229	250	267	251

Winter wheat yields

The impact of establishment system on winter wheat yields is illustrated in Fig. 1 and Fig. 2. (all grain yields at 15% moisture content). Because of the different plot layout imposed in 2008, the recorded yields would be expected to have increased by more than 10% due to edge effects on the narrow plots. While there have been significant differences between the two systems in individual seasons over the last three years, the yield differences have not favoured any particular system, with min-till established plots yielding better in 2006 and 2008 and plough-established plots doing best in 2007, when all yields on the site were very poor. Taking all years and both straw treatments into account, there has effectively been no differences in yield between both systems with the average yield for plough established crops being 10.2 t/ha and that for min-tilled crops being 10.4 t/ha. The cause of the variable differences over the last 3 years is not clear. Yields were particularly poor in 2007 when the min-till crop yielded significantly less than the conventionally established wheat. While there has been little difference in grain quality parameters between the establishment systems in most years, in 2007 the min-till established crop had much poorer grain fill with specific grain weights 3.5 kg/hl units lower than grain from the conventionally established plots. While take-all was not assessed in 2007, it’s likely to have contributed to the overall yield depression in 2007 and may have influenced the yield difference between the systems, even though in different circumstances, min-tilled crops exhibit less take-all.

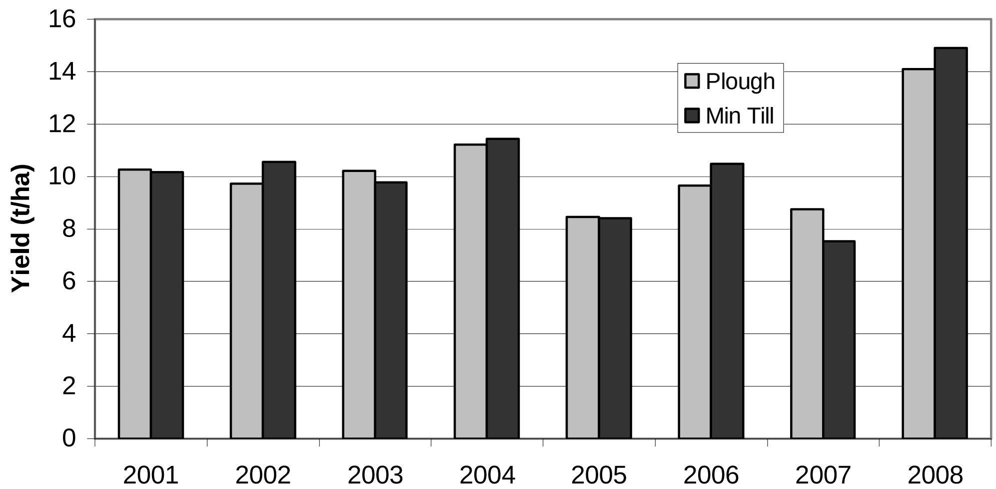

Figure 1. The effect of establishment system on crop yields (without straw incorporation)

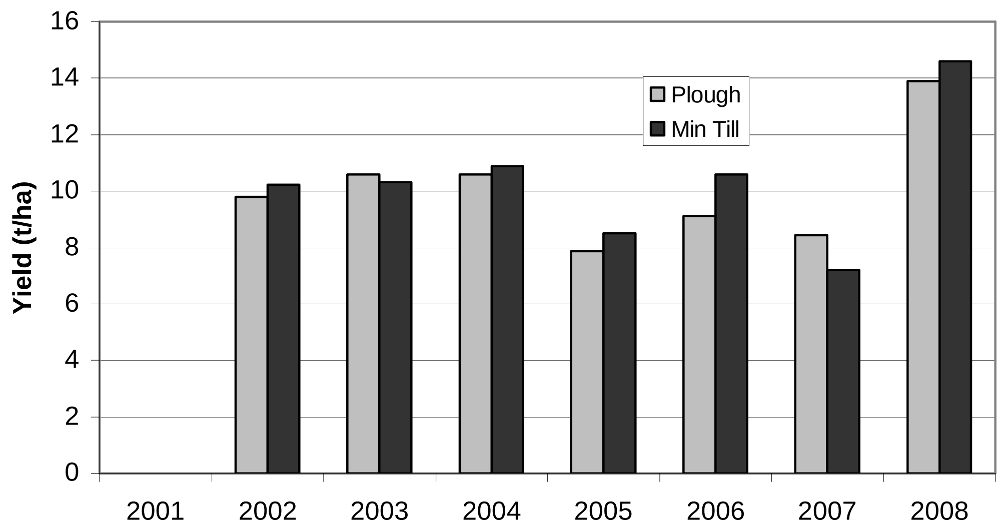

Figure 2. The effect of establishment system on crop yields (with straw incorporation)

While the incorporation of straw appeared to have some impact on the numeric yield figures achieved in individual years, the differences were not significant. Further analysis of a number of years data may be necessary to determine if the slight trend of straw incorporation reducing the yield in ploughed plots (Fig 3) is significant.

Grass weeds have tended to be a greater problem on the min-till plots on seasons where lower levels of herbicide were used. As sterile brome was also becoming established, routine herbicide treated has now been practiced for some years. Overall our experience with min-tilled wheat has been positive with comparable yields to plough-established crops.

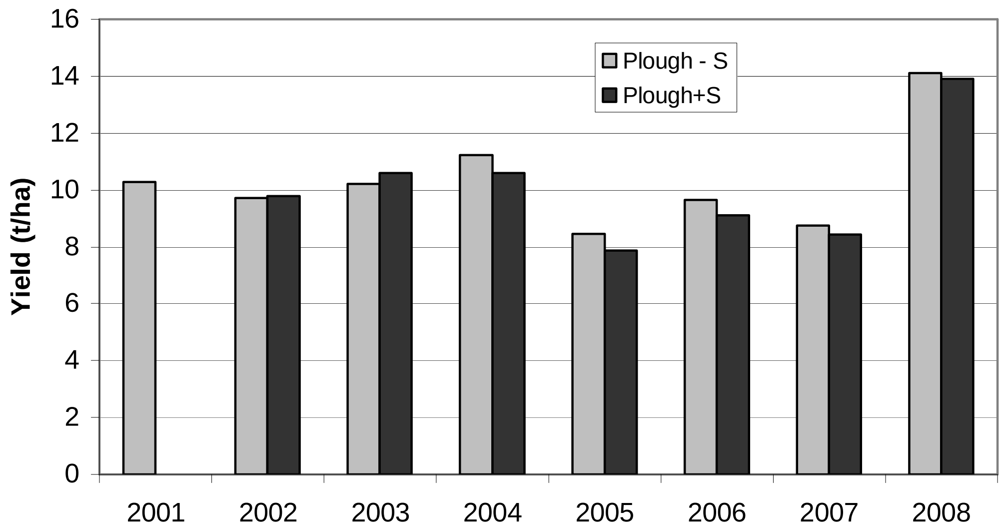

Figure 3. The effect of straw incorporation on crop yields with a plough-based system

Spring Barley

With the importance of spring barley to Irish cereal growers, it is essential to determine the merits of the min-till establishment system with spring cropping to:

- Determine if there are benefits to spring crop performance from adopting min-till.
- Allow those who practice min-till in a rotation, that includes spring cropping, to maintain all of their land in minimum tillage.
- Allow those with mixed winter and spring cropping to work with one establishment system and one compliment of machinery.

Against this background, establishment system research on spring barley was extended in 2007, with the addition of a second spring barley site at Knockbeg.

The original Clonaherk trial at Oak Park is a simple split-field trial located on a sandy loam soil which has been monitored since 2001. Stubble cultivation has generally been carried out post harvest, whereas ploughing is now carried out in the spring. Crop management is typical of commercial production systems with: 135kg/ha of N applied; single herbicide application and a two-spray fungicide programme. While plant establishment is frequently somewhat lower with the min-till establishment system, overall yields have been quite comparable (Fig 4). However there has been some variation from year to year with plough established yields being better in 2006 and 2008. The soil at this site is easily worked and both tillage systems create good seedbeds.

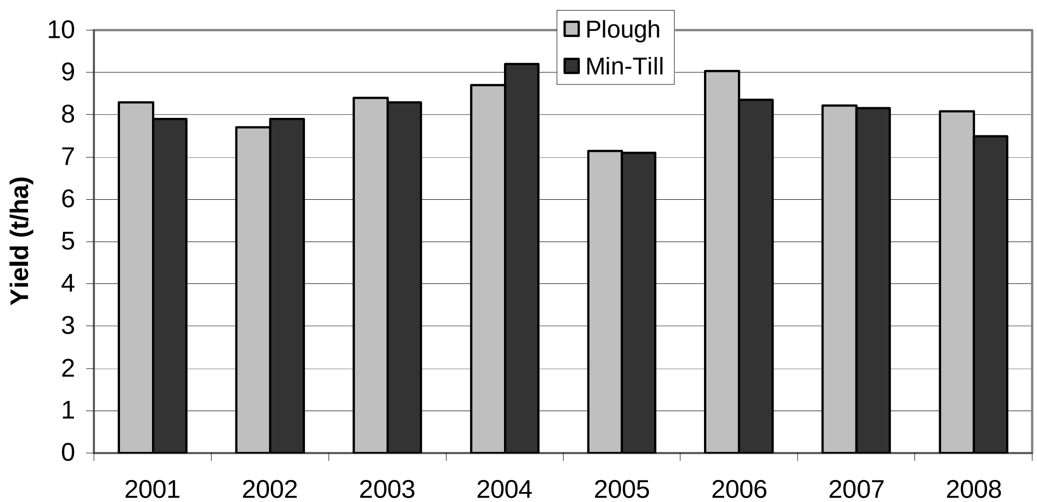

Figure 4. The effect of establishment system on spring barley grain yields (unreplicated)

A second fully replicated spring barley trial was established on a more challenging clay loam site at Knockbeg. The objective of this work is to compare the effect of four different establishment systems (incl three min-till) in combination with five different applied nitrogen levels on spring barley performance. The establishment systems assessed were:

- *Plough:* Conventional spring ploughing followed by cultivation with a rotary power harrow and sowing with a cultivator drill.
- *Min-Till – Autumn (MT-A):* Stubble cultivation post-harvest with no subsequent cultivation until spring sowing with a cultivator drill.

- *Min-Till – Autumn and Spring (MT-A+S):* Stubble cultivation post harvest with a subsequent cultivation in spring prior to sowing with a cultivator drill.

- *Min-Till – Spring only (MT-S):* Stubble cultivation in spring prior to sowing with a cultivator drill.

The nitrogen component of this trial is at an early stage and is not reported here. All other crop treatments are similar to those used by most commercial growers.

This trial is in place for just two seasons. In 2007, the plough-based system gave better crop establishment and a higher grain yield than any of the min-till treatments (Fig 5). In 2008, overall yields were much lower, and the autumn-only cultivation had significantly poorer establishment and yield than all other treatments. As we are comparing N rates in this trial, the sowing date for all cultivation treatments must be the same. In 2008 all sowing was delayed until April 7th as conditions were not suitable for sowing on the min-tilled plots. The control of volunteer growth over the winter period also proved problematic in the autumn of 2007 with excessive growth on some of the cultivation treatments requiring topping in the spring.

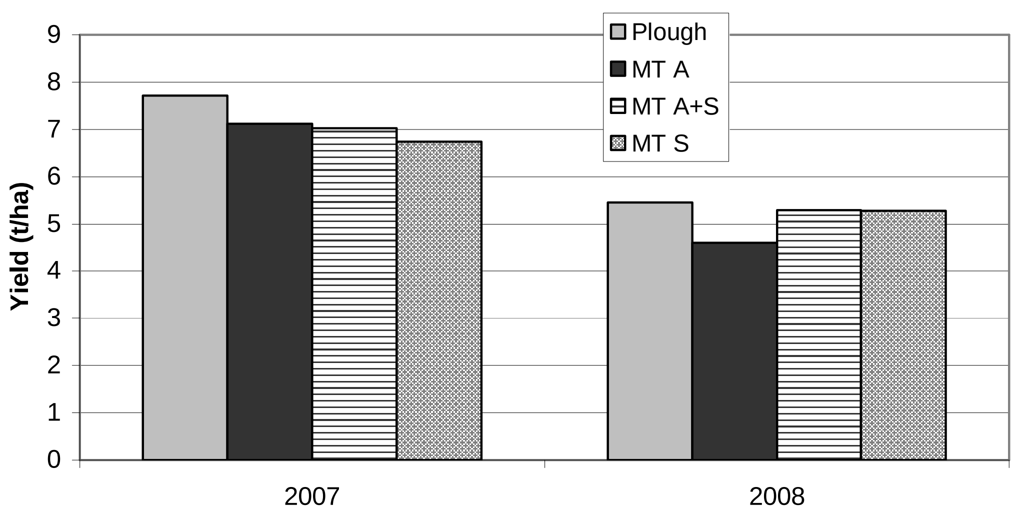

Figure 5. The effect of establishment system on spring barley grain yields (300seeds/m2, 105kg N/ha)

Winter Barley

The winter barley cultivation comparison is a split-field trial which has been monitored since 2001. Management of the crop is similar to that of most commercial crops with modifications to facilitate the control of grass weeds. Yields have varied considerably over the years (Fig 6). Grass weeds have proven more of a problem with winter barley because of the earlier sowing dates and more limited herbicide options. Annual meadow grass was responsible for significant yield reductions in the min-tilled plot in 2003. The use of high levels of Pendimethalin and Isoproturon (5l/ha Trump) herbicides have prevented this problem in subsequent years. A more significant challenge however has been the increase in Sterile Brome which increased dramatically in 2004 and 2005. As there are currently no chemical control options for this weed in winter barley, it was tackled in autumn 2005 by creating three successive stale seedbeds between harvest and sowing of the subsequent crop. This approach was successful, but it is an extra cost and can be difficult to achieve in the harvest to sowing interval. Since 2006 two stale seedbeds have been used in the harvest / sowing interval to keep sterile brome in check.

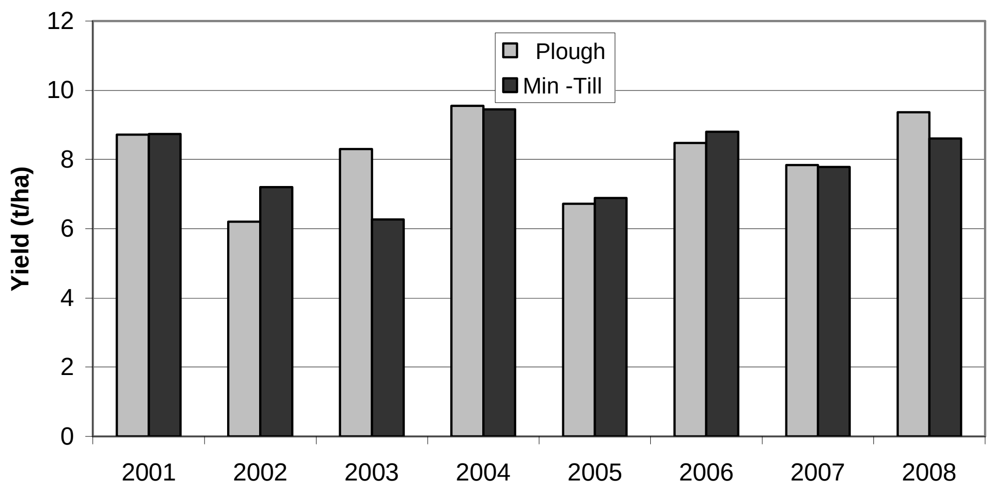

Figure 6. The effect of establishment system on winter barley grain yields (unreplicated)

Winter Oilseed Rape

As rape is an attractive rotation crop which would increase in popularity if the relative economics improved, a trial evaluating alternative crop establishment techniques was put in place for the 2006/2007 season. This ongoing fully replicated trial is evaluating eight different establishment systems over three years which are:

- A: Plough, press/roll, powerharrow/drill, roll
- B: Plough, press/roll, cultivator drill, roll
- C: Min-Till to 75-100mm (1 run), roll, broadcast sow, roll
- D: Min-Till to 75-100mm (1 run), roll, cultivator drill, roll
- E: Min-Till to 75-100mm (2 runs), roll, cultivator drill, roll

- F: Min-Till to 75-100mm (2 runs), roll, broadcast sow, roll
- G: Min-Till to 150-200mm (2 runs), roll, cultivator drill, roll
- H: Broadcast sow, roll with a 30% higher seedrate

In both seasons for which we have results, the cultivation system treatment did have an effect on plant establishment. The broadcast-only treatment (H) had a lower proportion of seeds establishing but as a higher seed-rate was used in anticipation of this, a more than adequate plant stand was achieved. Overall despite differences in plant establishment, the yields achieved with each establishment system were quite similar for both years reported here (Fig 7). While this data would suggest that min-till is a very suitable establishment system for oilseed rape, the crop established in the current season (2008/2009) in poor autumn sowing conditions may yield larger differences between treatments.

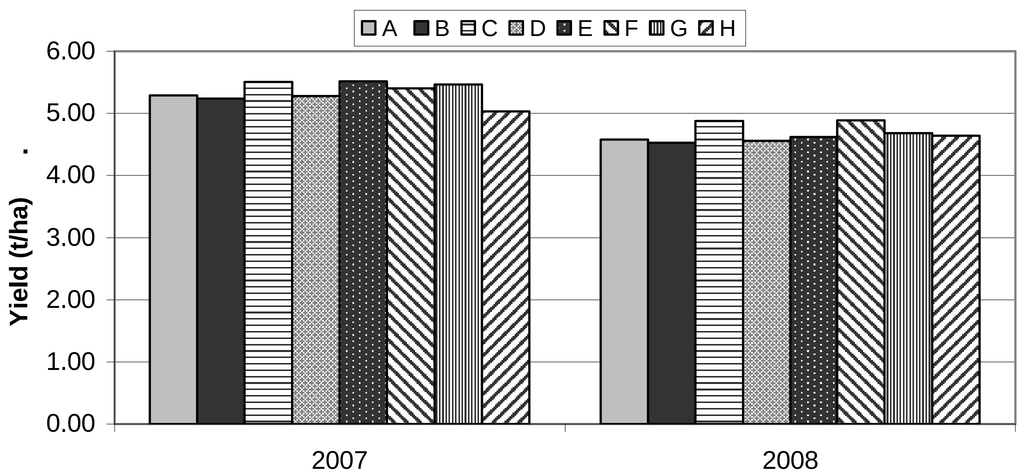

Figure 7. The effect of establishment system on winter oilseed rape yields

Minimum Tillage and Costs

The adoption of an alternative crop establishment system can have an impact on production costs. As winter wheat is the crop where we have most crop performance information and is the most relevant crop for early adoption of minimum tillage, cost considerations in this paper are restricted to this crop. The consideration of minimum tillage for spring crops or for a mixed winter/spring cropping situation is more complex and requires more robust spring crop yield data than we have to date.

From our research and observations to date the two most quantifiable costs associated with the adoption of minimum tillage are herbicide costs and machinery/labour costs. While environmental and sustainability factors may well be important, estimating their value is beyond the scope of this paper.

Extra herbicide costs

While the stale seedbed technique tends to reduce the number of broad leaved weeds developing compared to plough-based establishment, earlier sowing combined with non-inversion of the soil, increases the grass weed challenge, particularly annual meadow grass and sterile brome. In the absence of specific weed control research, our trial would indicate an extra spend on herbicides may be necessary compared to plough-based later establishment. The possible extra spend is indicated below:

	High Challenge	**Moderate Challenge**
Glyphosate (1.5l) for stale seedbed (€/ha)	8.50	8.50
Additional 1l /ha 'Trump' for grass weeds (€/ha)	8.50	0
'Pacifica' for Brome 500g/ha annually (€/ha)	50.00	
'Pacifica' for Brome 500g/ha every second year (€/ha)		25.00
Total additional herbicide costs (€/ha)	**67.00**	**33.50**

Clearly, additional herbicide costs can be significant and the build-up of specific problems must be avoided.

Machinery and labour

One of the primary drivers of the interest in minimum tillage is the potential to reduce machinery and labour costs, and in particular, the scope to adopt a machinery and labour system that is easy to scale up and operate on large areas.

The lower energy requirement of the shallower working minimum tillage system, is the key to it's potentially lower cost. Working the soil to a shallower depth requires less energy and consequently less tractor power. Previous Oak Park work estimated that the machinery energy input required to establish a crop using min-till was less than 50% of that with a plough based system assuming a single shallow (75mm) stubble cultivation run was used in combination with a cultivator drill. The stubble cultivation element in isolation only requires about 25 to 30% of the energy of a ploughing task. While a lower energy input translates directly into a reduced fuel requirement, the saving in machinery cost is much greater than that, as reducing energy input effectively reduces all costs as less tractor power is needed and less machine wear is incurred. If minimum tillage needs to be carried out to a greater depth (125 to 150mm) then there will be a corresponding increase in the costs of the stubble cultivation operation. Indeed there is evidence to suggest that at greater depths, the plough may be the more efficient method of primary cultivation, but this is a complex area where both the depth and intensity of the cultivation must be considered.

While in theory cost advantages from adopting a minimum tillage system could be estimated from the relative energy demands, in practice it is a far more complex calculation where individual machine types and matching of machine capacities and ownership strategies impacts on costs.

Machine Cost Estimates

As we have no machinery cost research data to allow plough-based and min-till machinery costs to be compared, we must rely on cost estimations to give us some indication of likely differences in costs. For this paper, the Oak Park Machinery Cost Programme was used to compare the machinery costs of minimum tillage crop establishment systems to those of plough-based systems. Machinery systems on farm units with winter wheat areas of 100ha and 400ha were costed. The Oak Park Machinery Cost Programme estimates an average annual individual machine cost based on:

- Machine type: e.g. Tractor, Plough
- Size/capacity of machine: e.g 100kW 4wd Tractor or 4 furrow reversible plough
- Ownership strategy: e.g. purchased secondhand at 5 years old and replaced after 10 more years.
- Use level: Area covered per year.

Using algorithms to calculate machine depreciation, repair and interest costs, the program allows a whole farm machinery cost to be estimated. Fuel and labour cost estimates are included. The programme is designed to be a comparative costing tool rather than a predictor of actual machinery costs. The program, which is now in spreadsheet format, allows the user to input a complete compliment of machines for a particular farming operation. In the examples costed here, the capacity or size of the machines was selected to meet the following criteria:

- Ploughing: Sufficient capacity to plough area in less than 200 field hours
- One /Pass sowing : Capacity to sow all in less than 120 hours
- Stubble cultivation: Capacity to cultivate all in less than 120 hours
- Cultivator Drill: Capacity to sow all in less than 120 hours

The age and replacement policies of the individual machines were selected to suit the task and work capacity while keeping costs low.

The cultivation machinery complements selected for the four combinations studied are outlined in Table 2. Included are the size and type of machines selected in addition to the ownership strategy as indicated by the purchase age and number of years the machine is retained.

Table 2. Cultivation machinery complements selected for costing analysis in this study

	100 ha Plough	100 ha Min-Till	400 ha Plough	400 ha Min-Till
Tractors	90 kW, N-20[a]	90 kW, 5-15	150 kW, N-15	190 kW, N-15
	90 kW, 5-15[b]	90 kW, 5-15	150 kW, N-15	120 kW, N-10
	60 Kw, N-20		120 Kw, N-15	
			120 Kw, N-20	
Primary cultivation	4 Furrow, N-10	3m cultivator, N-20	7 Furrow, N-5	5.5m cultivator, N-10
			5 Furrow, N-5	
Drilling	3 m O/Pass, N-7	3m cult-drill, 5-15	4 m O/Pass, N-5	6m cult-drill, N-10
			3 m O/Pass, N-5	
Other	Roller, N-20	Roller, N-20	Roller, N-10	Roller, N-10

Notes: [a,b] N-20: purchased new and retained for 20 years. 5-15 purchased s/h at 5 years and retained for 15 more.

In calculating the machinery costs, the other essential machinery operations such as fertilizer spreading, spraying, combining and grain haulage are also included, as the selection of cultivation system can impact on costs of other machinery operations which require tractors.

The estimated cost savings that can be made through the adoption of minimum tillage are outlined in tables 3 and 4, for 100 ha and 400 ha units respectively. The cost estimates in these tables include: depreciation; interest; repairs and maintenance; fuel and labour which are summed from the individual machines selected in the system. In addition to the plough and shallow minimum tillage options, two further min-till options are costed: a 50% deeper stubble cultivation run (approx 120mm in lieu of 80mm) and a system where 25% of the area is ploughed each year. While many growers may not want to invert their soil after a number of years of min-till, this system is practiced in other regions and the costs may be analogous to working deep occasionally with non-inversion cultivators.

With the smaller farm working 3m wide equipment, adoption of minimum tillage can substantially reduce machinery costs amounting to a farm saving of €5337 per annum or €53/ha. Where deeper minimum tillage is practiced, the savings are reduced to €32/ha. If rotational ploughing were practiced, it would result in a saving of €38/ha compared to a full ploughing system, even though a plough has to be retained on the farm in addition to the stubble cultivation equipment.

Table 3. Annual total machinery costs and cultivation costs on 100 ha winter wheat unit

	Plough	**Min-till**	**Min-till**	**Min-till**
			Deep	25% Plough
Cultivation Cost/ha (€/ha)	148	82	99	98
Relative Cost	100	55	67	66
Total Machinery cost (€)	34,975	29,638	31,802	31,192
Cost / ha (€/ha)	350	296	318	312
Relative Cost	100	84	91	89
Saving on farm (€)	0	5,337	3,173	3,783
Saving per ha (€/ha)	0	53	32	38

A similar pattern is seen with the 400ha unit although in this case, because of the suitability for larger scale operation the savings per hectare for the total machinery complement are larger at €66 / ha, despite costs being generally lower than the 100 ha unit. In this situation the total machinery costs reduce more than the cultivation costs as the larger scale allows the reduction in necessary tractor power per ha to be fully exploited, unlike the smaller unit. While the same criteria were used for the selection of machinery for both systems and consequently the comparison is equitable, there may be scope for further cost reductions with careful machine strategy selection. These cost estimates indicate that considerable cost savings can be made by the adoption of minimum tillage. As competitiveness is vital, these savings cannot be ignored. However, the impact of adopting min-till on: other costs; crop performance; and long term environmental and sustainability impacts must also be considered.

Table 4. Annual total machinery costs and cultivation costs on 400 ha winter wheat unit

	Plough	**Min-till**	**Min-till** Deep	**Min-till** 25% Plough
Cultivation Cost/ha (€/ha)	138	80	97	92
Relative Cost	100	58	70	67
Total Machinery cost (€)	125,829	99,433	107,539	102,674
Cost / ha (€/ha)	315	249	269	257
Relative Cost	100	79	85	82
Saving on farm (€)	0	26,396	18,290	23,155
Saving per ha (€/ha)	0	66	46	58

Labour requirement and demand pattern

The mechanical simplicity of the min-till cultivation system and lower specific power requirement compared to ploughing, makes it easy and less expensive to increase capacity. This allows ground to be worked quickly and a lower level of labour per hectare worked. While it is theoretically possible to scale-up plough based systems similarly, the unwieldiness of very large ploughs coupled with the need for disproportionately large tractor sizes makes this unattractive. The labour required for the machinery operations associated with crop establishment in the examples costed, is estimated in Table 5

Table 5. Estimated labour required for different establishment systems on two areas.

System	Plough	Min-Till	Plough	Min-Till
Area (ha)	400	400	100	100
Total cultivation hours (h)	856	405	291	174
Hours per hectare (h/ha)	2.14	1.01	2.91	1.74
Labour units at crop establishment	4	1	2	1
Additional support	1	1	1	1
Total establishment team	5	2	3	2

This indicates that considerable savings can be made in labour demand by adopting the min-till system with requirements more than halved on the larger farm. While the costs associated with this are included in the figures in Tables 3 and 4, in practice, the reduction in sowing team size is perhaps of most benefit as it is difficult to get skilled labour for a short time period. The distribution of the labour required for establishing the crop is favourable with minimum tillage (Fig. 8). The stubble cultivation and roll/pressing operations are separated from the sowing operation. Conversely most growers operating a plough-based establishment system seek to have the capacity to do all operations together resulting in peak labour demands of more than four times that of the min-till system (Fig. 9). The downside of the min-till labour demand distribution is that the stubble cultivation operation often coincides with harvesting of the previous crop. Overall the min-till system is very attractive from a scale and labour use perspective and this is one biggest attractions of the system to large growers and/or those seeking to increase scale.

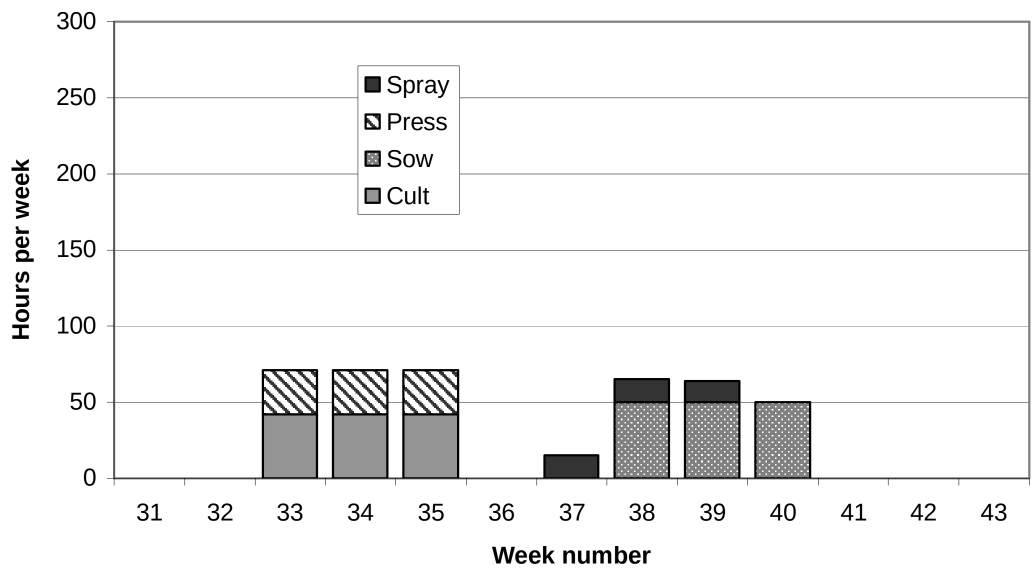

Figure 8. Weekly demand for labour for machine operations in a min-till system

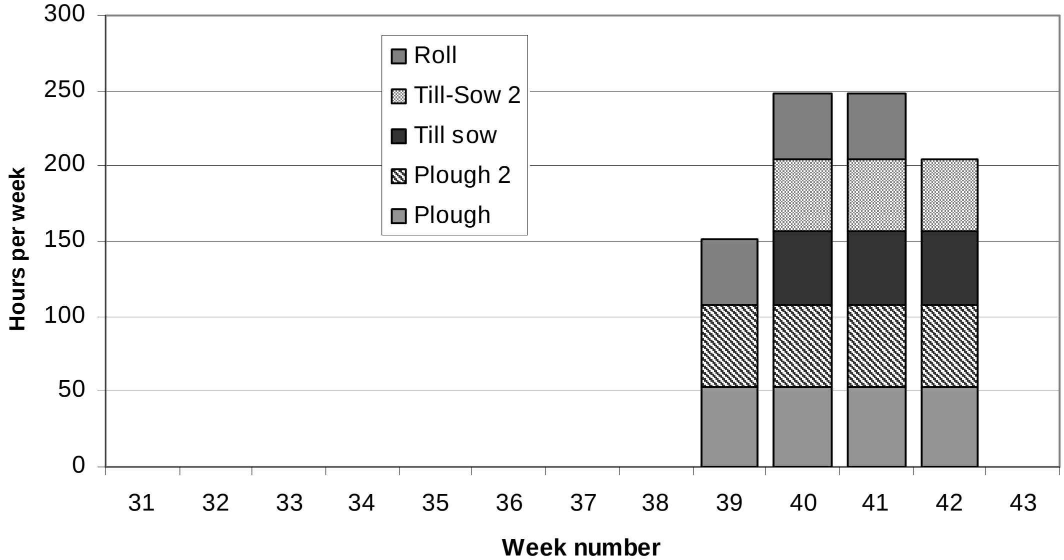

Figure 9. Weekly demand for labour for machine operations in a plough-based system

CONCLUSIONS

1. The minimum tillage system has been successfully adopted by a small number of large growers. It is now time to consider it's wider adoption.

2. In robust Oak Park trials with winter wheat, while there have been performance differences in specific years, overall the min-till established wheat has performed as well as a plough-established crop, over an eight year period.

3. While min-till established spring barley has performed well on an easily cultivated site, early indications from a more challenging trial site indicate that the type and timing of the cultivation system may have an impact on spring barley performance.

4. Winter barley has been successfully grown under min-till management but grass weed control can be difficult with sterile brome presenting a particular challenge.

5. Early indications suggest that winter oilseed rape can be successfully grown using a min-till establishment system.

6. Additional grass weed control costs can be significant on sites where early sowing and non-inversion result in extra meadow grass and sterile brome problems. Additional herbicide costs could come to an additional €33 to €67 / ha which can negate the machinery cost benefits.

7. In the absence of relevant research data, the Oak Park machinery costing programme can be used to compare the machinery cost and labour demand of plough-based and min-till machinery systems.

8. On a 100ha winter wheat unit, the adoption of a min-till system could save €53/ha compared to ploughing. A saving of €66/ha is estimated on a 400ha unit amounting to €26,396 /yr.

9. The adoption of min-till is very attractive from a labour perspective as it can reduce the labour required to establish a crop from 2.14 to 1.01 hrs/ha. On a 400ha unit a 2 person team could effectively replace a 5 person team where min-till is used for crop establishment.

10. Labour efficiency coupled with the ease of increasing machine capacity makes the system very attractive for larger growers.

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Acknowledgement

The authors wish to acknowledge significant input from others in the min-till work reported here. The crop trials reported in this paper were devised and developed by T. Fortune (retired). T. Kennedy and J. Connery are also involved in other aspects of this work not reported in this paper. F. Ryan provides crucial mechanisation support.

Maximising returns from fungicides

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SUMMARY

In 2008 Septoria levels on Winter wheat were moderate to high despite the dry early summer. Response to fungicide programmes was satisfactory in 2008 on all cereal species. On some trial sites fungicide programme trials on winter wheat and winter barley improved yield by up to 2.0 t/ha while trials on spring barley gave a 1.4 t/ha increase. Omitting a fungicide application on winter wheat at T1 resulted in a lower yield despite little disease pressure in the early season.

In spring barley two-spray programmes yielded higher than a single application. In winter wheat T1, T2and T3 spray timings give similar yield responses. Fungicide trials on wheat and barley showed economic yield responses to a number of fungicide programmes. However, yield responses were lower in both wheat and spring barley in 2008 compared to the results obtained in 2007.

While there is a lot of discussion currently about the implications for cereal production arising from pesticide proposals contained in the EU directive (91/414) it is unclear how serious a constraint it will be on future yields in this country. Control of disease with fungicides is now an essential part of cereal production and this is unlikely to change over the foreseeable future. Fungicide usage in Ireland has increased over the past thirty years and the efficacy of the products has improved over the same period. Results with Decision Support Systems (DSS) over the past few years offer some scope in future crop protection strategies. They take into account factors such as disease pressure, varietal resistance, fungicide dose response and weather information. DSS systems can reduce the number of sprays or rates of products while still giving a favourable economic outcome.

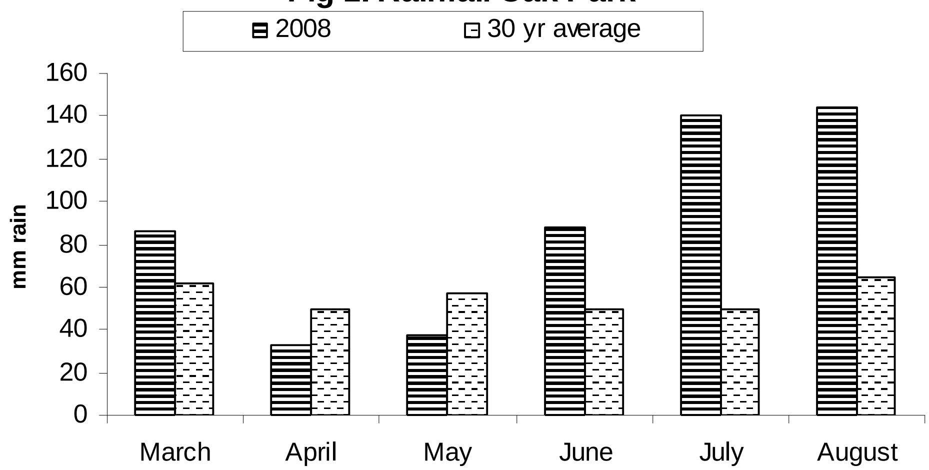
INTRODUCTION

The yield of winter cereals in 2008 were higher or equal to the average of those of the previous five years while spring cereals yielded somewhat below average.

The weather pattern over the growing season of 2008 was unusual and followed a broadly similar pattern to that of 2007. Figure 1 shows the rainfall pattern for 2008 compared with the thirty year average.

April was sunnier and dryer than normal with temperatures close to normal values. May was the warmest and sunniest on record with rainfall values half of normal. In contrast June was wetter than normal with rain on many days with temperatures close to normal for most of the month. The first half of July was wet and relatively cool. Rainfall for the month was also above normal. August was also a month of high rainfall and above normal temperatures resulting in one of the longest and most difficult harvests for many years.

Fig 1. Rainfall Oak Park



In early April septoria was present on wheat crops. The dry period in April and May slowed the development of this disease. However the excessive rainfall in June facilitated the spread of septoria and levels were increasing by the end of June. The continuing wet weather resulted in increasing levels of septoria by early July. Despite the wet weather ear blight caused by Fusarium spp., while present in many crops, did not reach high levels. Wet weather at flowering favours infection by the ear blight pathogens and as the long wet spell did not begin until after flowering this undoubtedly reduced disease levels. In contrast ear blight was very prevalent in 2007.

Disease levels remained low on winter barley, the crop was starting to mature when the wet period began.

Spring barley crops had traces of net blotch and rhynchosporium through May and June but did not develop until the wet weather in mid to late June. Powdery mildew was present in many crops during May and Early June.

Fungicide Use on Cereals

At the present time, when there are questions about the future availability of many of the agrochemicals used on tillage crops due to the EU directive 91/414, it might be useful to reflect on the development of fungicide use on cereals in Ireland.

Wheat yields have been increasing steadily since the 1950's. In fact they have increased on average by approximately 100 kg per ha per year over this period. In the five decades since 1950 yields have increased from the then average of less than 4 t/ha to the present day yields which average 8.5 t/ha to 10 t/ha.

There have been two main factors responsible for this yield increase. The first improvement is from plant breeding and especially from the introduction of the semi-dwarf varieties in the early 1970's. These varieties, while allowing growers to increase nitrogen usage without causing lodging, had physiological advantages such as greater numbers of grains per ear and changes in how they portioned assimilates.

The second factor in yield improvement is due to changes in technology and husbandry practices and the introduction and widespread use of agrochemicals - herbicides, growth regulators and fungicides. It has been estimated that half the yield improvement over the past five decades has come from plant breeding and half from changes in husbandry practices.

In Ireland cereals were predominately spring sown up to 1977. The diseases that were problematic at that time were much the same as at present. The root diseases take-all and eyespot were regarded as the main problems inhibiting yields and research concentrated on understanding the epidemiology of these and devising strategies to minimise their yield loss effects.

Foliar disease problems were leaf and glume blotch of wheat caused by Septoria nodurum, (Septoria tritici, presently the major wheat pathogen, was rare) powdery mildew on both wheat and barley and leaf scald of barley caused by Rhynchosporium secalis. These diseases presumably were causing yield loss but it was difficult to quantify the losses as there was no way to control these pathogens to allow comparison of diseased and healthy crops. There were practically no fungicides available and the sowing of resistant cultivars coupled with agronomic measures were the methods used to reduce losses caused by disease.

Arrival of Fungicides

Mercury based seed dressings had been used for many years to control seed borne diseases. The first foliar fungicides for use on cereals became available commercially in the early 1970's. The MBC group of fungicides were the first group of systemic fungicides to appear. Initially their use could only be justified economically on crops of high cash value such as glasshouse crops. Benomyl, sold by Du Pont as Benlate, was the one of earliest foliar fungicides used on cereals. The fungicides in this group were especially useful for the control of eyespot and they increased yield through eyespot control and the subsequent reduction of lodging. In addition they reduced the levels of foliar diseases such as septoria, mildew and rhynchosporium resulting in increased longevity of green leaves thus further enhancing yields.

Fungicide trials using MBC fungicide carried out at Oak Park in this period saw eyespot levels in wheat reduced from 97% to 12%. Yields of wheat were increased by upwards of 25% through the control of both eyespot and foliar diseases while barley yields were improved by 12% to 15%. The practice then was to apply a single spray at growth stage 31/32. Specific trials to assess disease loss carried out at this time using multiple sprays showed that losses from foliar disease could be as high as 35% of yield.

Ethirimol (Milstem) and tridemorph (Calixin) became available around this period. These were specific mildewicides. Milstem was used extensively as a seed dressing especially on susceptible barley cultivars, while Calixin was applied as a foliar spray on the less susceptible cultivars and also on wheat.

These two latter fungicides had a narrow spectrum of disease control. The first of the broad-spectrum products- the triazole group of fungicides, triadimefon (Bayleton) was launched in 1977 and dominated the market for a number of years. It was very effective when applied as a straight and its activity was enhanced against both wheat and barley diseases by co-formulating it with either MBC (Bayleton BM) or captafol (Bayleton CF). Later, in 1987, captafol was prohibited on safety grounds. Other products to appear at this time were propiconazole (Tilt) and fenpropimorph (Corbel) which are still in use at present.

The entry into the EEC in 1973 resulted in an increase in cereal prices. This price increase and the later change to higher yielding autumn – sown crops justified the use of high inputs and new technologies to achieve maximum yields. These new practices especially the introduction of tramlines facilitated the use of agrochemicals right throughout the growing season. High levels of nitrogen coupled with a number of fungicide applications to crops became an standard part of cereal production.

Up to the end of the 1990's there was a steady introduction of new cereal fungicides that were superior to the older chemistry. They are now familiar names such as prochloraz (Sportak), tebuconazole (Folicur), flusilazole (Lyric, Sanction, Punch), epoxiconazole (Opus) and prothioconazole (Proline). In addition the appearance of the strobilurins promised and delivered for a short time a new era in cereal disease control. A major breakthrough in this period was the launch of silthiofam (Latitude) which was the first product that could reduce the yield losses caused by take-all.

2008 Fungicide Trial Results

Despite the dry weather in the early part of the growing season there was a worthwhile response to disease control on all cereals. Programme trials on winter wheat improved yield by 2.0 t/ha Table 1, while similar type trials on barley increased yield by 2.0 t/ha on winter barley and 1.4 t/ha on spring barley Table 2.

Table 1. Yield Response to Spray Programmes on Winter Wheat t/ha

	Arklow, Co. Wicklow	Duleek, Co. Meath
Average yield of all programmes	9.7	10.7
Yield of Untreated	7.6	8.5
Average Response	2.1	2.2

Table 2. Yield Response to Spray Programmes on Barley t/ha

	Winter Barley, Oak Park	Spring Barley, Oak Park
Average yield of all programmes	9.3	6.6
Yield of Untreated	7.2	5.2
Average Response	2.1	1.4

Programme Trials

Winter Wheat

Programme trials on winter wheat were carried out at two locations in 2008, Co. Wicklow and Co. Meath.

There were seven pre-T1 treatments included in these trials. Understandably because of the dry spring there was no yield response to any of the pre-T1 treatments.

Five products were applied at T1 with standard treatments at T2 and T3. There was no yield difference between any of the treatments again because of the low early season disease pressure. Table 3 shows the results of the T1 treatments.

Table 3. T1 Treatments Winter Wheat 2008. Yield and % Disease

Treatment l/ha	**% Septoria 3rd Leaf**		**Yield t/ha @ 15%**	
	Wicklow	Meath	Wicklow	Meath
Venture 1.5	60	37	9.8	10.6
Opus 1.0	87	52	9.8	10.7
Opus + Bravo 1.0 + 1.0	40	49	9.9	10.8
Tocata 2.0	63	51	9.6	11.0
Proline 0.8	78	51	9.6	10.6
Untreated	100	100	7.6	8.5

Similarly a number of products were applied at T2 with standard products at T1 and T3. There were small yield differences between treatments but at each site there were treatments that were significantly higher yielding than others. Results are shown in Table 4.

Table 4. T2 Treatments Winter Wheat 2008. Yield and % Disease

Treatment l/ha	% Septoria 3rd Leaf		Yield t/ha @ 15%	
	Wicklow	Meath	Wicklow	Meath
Opus 1.0	87	52	9.8	10.7
Prosaro 1.2	75	40	9.7	11.0
Venture 1.5	79	32	9.6	11.1
Opus + Amistar 1.0 + 0.5	81	----	9.3	----
Opus + Bravo 1.0 + 10	43	30	10.1	10.8
Venture + Modem 1.5 + 0.5	----	34	----	11.4
Opus 1.0 *	87	----	9.1	----
Untreated	100	100	7.6	8.5
L.S.D			0.4	0.5

** No T1 treatment was applied.*

There was a similar approach for T3 product applications. Results from this are shown in Table 5. Again as in the previous spray timings yield differences between products were small.

Table 5. T3 Treatments Winter Wheat 2008. Yield and % Disease

Treatment l/ha	**% Septoria 3rd Leaf**		**Yield t/ha @ 15%**	
	Wicklow	Meath	Wicklow	Meath
Caramba 1.0	87	37	9.8	10.6
Caramba + Bravo 1.0 + 1.0	88	65	9.5	10.8
Caramba + Modem 1.2 + 0.4	88	51	9.5	10.4
Caramba + Amistar 1.2 + 0.4	80	61	9.7	10.4
Folicur + Modem 0.8 + 0.4	91	41	9.9	10.7
Prosaro 1.0	82	68	9.7	10.7
Proline + Amistar 0.6 + 0.4	78	57	9.8	10.8
Proline + Modem 0.6 + 0.4	87	56	9.3	10.6
Venture + Jenton 1.0 + 1.0	71	59	10.2	10.9
Untreated	100	100	7.6	8.5
L.S.D			0.4	0.5

Table 6. Winter Barley Fungicide Programme Results 2008

Programme	**% Brown Rust**	**% Rhyncho**	**t/ha @ 15%**
Opus 0.5 Opus 0.75	3	18	8.3
Opus + Bravo 0.5 + 1.0 Opus + Bravo 0.5 + 1.0	3	10	9.2
Stereo 1.8 Fandango + Bravo 1.0 + 1.0	4	16	9.1
Fandango 1.0 Fandango + Bravo 1.0 + 1.0	2	4	9.2
Proline 0.8 Fandango + Bravo 1.0 + 1.0	2	10	9.2
Venture + Jenton 1.2 + 1.0 Venture + Jenton 1.2 + 1.0	2	3	9.2
Stereo 1.8 Proline + Amistar Opti 0.3 + 1.25	3	13	9.0
Capalo + Modem 1.6 + 0.5 Capalo + Modem 1.6 + 0.5	1	7	9.4
Fandango 1.0 Fandango 1.0	2	5	9.4
Proline + Modem 0.8 + 0.5 Fandango + Bravo 1.0 + 1.0	1	2	9.8
Untreated	22	18	7.3
L.S.D			0.9

Winter Barley

While disease levels on winter barley were low to moderate in 2008 there was still a good yield response to fungicide application. Results are shown in Table 6.

There was very little yield difference between the various programmes. The addition of Bravo to Opus at both T1 and T2 improved the yield by 1 t/ha. In general in this trial disease levels were low, however brown rust became severe on the untreated area and undoubtedly had a large effect on the yield of these plots.

Spring Barley

Spring barley trials were carried out at Kildalton Agricultural College and at Oak Park. As was the case with winter wheat and winter barley, disease levels were low early in the season and increased as the wet period continued. Net blotch was the main disease at the Kildalton site while powdery mildew was the main disease at Oak Park. Because of the low disease pressure most of the treatments at the Kildalton were applied as a single treatment at growth stage 59/65. The two spray treatments however yielded higher indicating the desirability for a two-spray programme even in a low disease season. Table 7 shows a summary of this trial.

Table 7. Spring Barley Fungicide Trial Kildalton 2008. (cultivar Wicket)

Treatment	Average Yield t/ha
One-spray treatments gs 59/65	5.7
Two-spray treatments gs 37 + 65	6.3
Untreated	4.6

The superior performance of a two spray programme was also evident in the spring barley trial at Oak Park. Results of the T1 treatments with a common T2 are shown in Table 8. The single robust treatment at T1 did not compare with the better two-spray programmes.

Table 8. T1 Fungicide Trial Spring Barley Oak Park 2008. (Cultivar Sebastian)

T1	**T2**	**Yield t/ha**
Stereo 1.0	Fandango + Bravo 1.0 + 1.0	6.35
Proline 0.4	Fandango + Bravo 1.0 + 1.0	7.05
Proline + Corbel 0.4 + 0.3	Fandango + Bravo 1.0 + 1.0	7.85
Corbel 1.0	Fandango + Bravo 1.0 + 1.0	6.97
Stereo + Corbel 1.0 + 0.3	Fandango + Bravo 1.0 + 1.0	6.69
Punch C + Corbel 0.625 + 0.3	Fandango + Bravo 1.0 + 1.0	6.26
Fandango 1.0	Fandango + Bravo 1.0 + 1.0	7.39
Mantra 1.0	Fandango + Bravo 1.0 + 1.0	6.20
Fandango +Corbel + Bravo 1.0 + 0.3 + 1.0	No T2	6.55
Untreated		5.21

The results from the various programme trials reinforce the fact that many spray programmes are very robust and a major critical factor in disease control is timing. In certain seasons, depending on disease pressure, there will of course be yield differences between programmes and product choice becomes more important in such situations

Decision Support Systems are one method of maximising the returns from cereal disease control measures. Decision Support Systems should provide appropriate advice on the correct timing for fungicide sprays, using the minimum dose necessary and giving the maximum economic return. A number of DSSs have been evaluated in field trials at Oak Park. Most of them are PC or internet based and one is an in-crop instrument the Theis Septoria Timer. A DSS trial was carried out at Oak Park in 2008. Results are shown in Table 9.

There was no significant difference between the yields from the various treatments in this trial. There are differences between the Margin Over Fungicide Costs (MOFC) between the various systems. This is a result of the differences in number of sprays or product rates recommended by each system.

Table 9. Decision Support Systems Trial Winter Wheat (Humber) Oak Park 2008

DSS	% Septoria		Yield	MOFC
	Flag leaf	2nd leaf	t/ha	€/ha
PC Plantevaern (Danish Online)	11	37	10.9	203
Opticrop (Dutch Online)	44	50	11.1	192
ProPlant Expert (German Online)	16	42	11.3	286
Septoria Timer	8	24	11.4	274
Routine 3-spray	4	8	11.5	248
Untreated	98	100	8.5	
	LSD	0.7		

EU Pesticide Directive

Members of the European Parliament voted on 13th January 2009 in favour of revised regulations for crop chemicals. – EU Chemicals Directive 91/414. It is expected that the Agriculture Council will meet at the end of February and that the legislation will be formally adopted and will come into force in 2010. The main change in this legislation from previous legislation is that active ingredients will be judged on a hazard basis rather than the current risk basis. While the final outcome is not clear at the time of writing, what is known is that most of the threatened products will not be withdrawn until 2018 or later.

CONCLUSIONS

- Septoria levels on Winter wheat were moderate to high in 2008 despite the dry early summer.

- Response to fungicide programmes was satisfactory in 2008 on all cereal species.

- Disease control programmes on winter wheat all gave similar yield responses in 2008. Omitting a fungicide application at T1 resulted in a lower yield despite little disease pressure in the early season.

- Two-spray programmes in spring barley yielded higher than a single application.

- T1, T2and T3 spray timings in winter wheat give similar yield responses.

- Two Decision Support Systems gave a lower number of spray applications and reduced fungicide use in winter wheat compared with the standard programme.

- The implications for cereal production arising from EU directive 91/414 are as yet uncertain.

Efficient use of nitrogen for tillage crops

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SUMMARY

Nitrogen is a key nutrient for crop production. The cost of nitrogen fertiliser has increased dramatically over the last two years and this has led to a reappraisal by many growers of the amount of N applied to their crops. The basis of nitrogen fertiliser advice for cereal crops in many countries is a nitrogen response curve which reflects the change in yield as a result of increased additions of fertiliser N. From such a curve the economic optimum N rate can be calculated for different fertiliser prices and grain prices. Calculation of economic nitrogen rates for anticipated fertiliser prices and grain values in the current season indicates that the optimum has not changed dramatically despite changes in fertiliser and grain prices. However it does indicate that higher fertiliser costs will inevitably lead to reduced profitability and scope for fertiliser cost savings without compromising profitability is limited.

While urea is a cheaper nitrogen source than CAN loss of N through ammonia volatilisation can lead to less efficient use of nitrogen by the crop when urea is used. Efficient use of urea is likely to be confined to early applications to winter crops when soils are moist and temperatures are low. Applying the main split of nitrogen to winter wheat as urea is possible but losses are likely if conditions are dry around the time of application. Urea should be well incorporated, before sowing, if being used for spring barley and excessive applications should be avoided as germination may be affected. It should also be noted that urea is more difficult to distribute evenly over wide tramlines than other fertilisers. Organic manures, where available, can satisfactorily substitute for purchased fertiliser and offer a cost effective alternative to fertiliser N. Where these manures are available growers should incorporate them into their fertilisation plan and take adequate precautions to ensure maximum use of the nutrients in the manures.

INTRODUCTION

The cost of nitrogen fertiliser has increased dramatically over the past number of years. The main drivers of this increase were higher gas prices and increased demand around the world. The price of fertiliser on the world market has relented somewhat in recent months as reductions in demand, as a result of reduced grain prices and perhaps lack of credit due to the financial crisis, and significant reductions in gas prices begin to feed into fertiliser prices. However, in the longer term it is unlikely that nitrogen fertiliser prices will return to the levels that prevailed four to five years ago unless new manufacturing processes less reliant on what are likely to be increasingly more expensive fossil fuels are found. However, as is likely with the price of cereals the price of nitrogenous fertiliser is likely to be volatile going forward. This presents considerable difficulties to growers trying to plan their crops in advance.

With the increased cost of fertiliser it is imperative that efficient use of fertiliser nitrogen is achieved in crop production. The total nitrogen requirement of a crop can be satisfied by some combination of nitrogen present in the soil, applied organic nitrogen sources and applied fertiliser nitrogen. While a grower can determine how much nitrogen is externally supplied the supply of nitrogen from the soil over the growing season can vary considerably between sites and seasons, and this causes some difficulty when attempting to determine the correct amount of fertiliser N to apply. Unlike other nutrients such as P and K where soil tests can give a good indication of the likely response to applied fertiliser, there is no reliable soil test for nitrogen under our variable climatic conditions that will accurately predict the likely response of a crop to nitrogen. In the absence of such a soil test the previous cropping history is used to give an indication of the likely supply of nitrogen from the soil and this is the basis for the soil N index system, which is used to discriminate between soils with different potential soil N supply. The current N index system is given in Appendix 1. In some other European countries, including the UK, the mineral nitrogen in the soil to 90 cm depth either in autumn or spring, before fertiliser application, is sometimes measured to give an indication of soil nitrogen availability. This system has not been extensively tested under Irish conditions, but given our wetter and more variable climate, it may be less suitable to Irish conditions.

The difficulty with trying to estimate the likely release of nitrogen from the soil during the season can be understood when it is taken into account that the average tillage soil in Ireland can contain 8.5 tonnes of nitrogen per hectare in the plough layer or in the order of 15 tonnes of nitrogen to 60 cm depth (Herlihy, 2002). Most of this nitrogen is in organic form and is only slowly, and largely unpredictably, converted into forms that the crop can use.

Nitrogen application can have strong visual effects when applied to a crop, even if that crop is under stress. However these visual effects are not always transferred into yield which is the main criterion of importance. For example nitrogen applied to a crop growing in compacted soil may give a 'good colour' to the crop but the crop may still yield poorly. This visual effect can lead to higher than required N application to crops. Efficient use of nitrogen by a crop requires that all other factors affecting crop growth are optimised. In particular soil factors such as pH and potassium status should be carefully assessed. The efficiency of nitrogen use by a crop will be reduced where soils have a low pH or where insufficient potassium is applied to the crop

It is important that nitrogen is efficiently used in crop systems as nitrogen not utilised by a crop can be susceptible to loss to the environment by leaching or in gaseous form. Losses of N from crop systems to the environment are inevitable, the objective must be to minimise these losses without unduly compromising yields or profitability. Field trials have shown that residual nitrate in the soil at harvest, which can be subject to overwinter leaching, can increase considerably where amounts of fertiliser N in excess of the economic optimum are applied (Chaney, 1990).

The N Response Curve

The basis for fertiliser N advice for cereal crops in many countries is the fertiliser N response curve. This curve plots the response of grain yield to fertiliser N over a range of fertiliser N levels. Data for these curves is derived from field trials where a range of fertiliser levels, from very low levels to levels well in excess of what would be expected to give the maximum yield, are applied to plots of the crop being tested. As the response to fertiliser is known to be influenced to some degree by season, site, weather patterns etc. data from a number of sites over a number of seasons is normally used to construct such curves with reliability. An example of such a curve for N rates between 0 and 300 kg N/ha, applied as CAN, for winter wheat in Index 1 situations is given in Fig 1. While this curve is derived from a series of trials, that were carried out at a number of seasons and sites, it is still based on a limited dataset and therefore any information taken from it must be treated with some caution.

It can be seen that at low rates of nitrogen addition relatively large increases in yield are achieved by each additional N increment but this decreases as N rate increases. A key point that should be remembered is that the response of a cereal crop to nitrogen is not affected by the cost of nitrogen or the value of grain; the cereal crop has no knowledge of either! Therefore the fertiliser nitrogen rate that gives maximum yield will not change, unless more efficient varieties of wheat become available that give maximum yield at lower nitrogen rates.

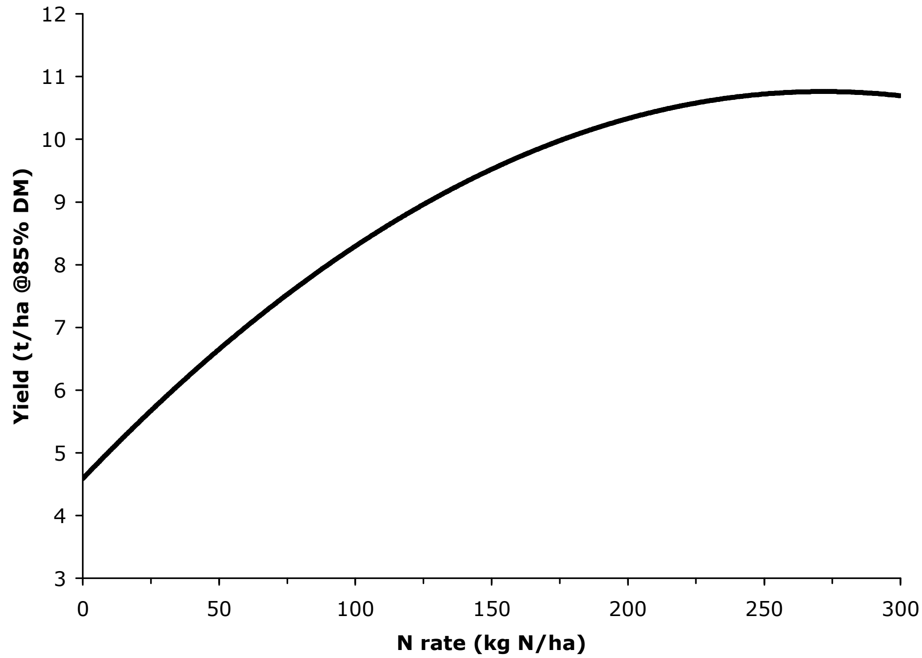

Figure 1. Response of winter wheat grain yield to fertiliser N at soil Index 1

Economic Optimum N Rate (Nopt)

What does change as fertiliser costs and/or grain values change is the rate of nitrogen which gives maximum profit to the grower. From the response curve it can be seen that at very low N rates there is a large response to each incremental N addition. So for the initial 20kg of fertiliser N applied there is a relatively large response to N (circa 0.8 t/ha). As more fertiliser is applied this response is reduced. So as fertiliser N is increased by 20 kg N/ha from 100 to 120 kg/ha the yield response is only 0.5 t/ha. Further along the curve a 20 kg N/ha increase from 250 kg N/ha to 270 kg N/ha only gives 0.01 t/ha of a yield increase. If costings are put on these using a grain price of €160/t (dry) and a CAN price of €380/t it is revealed that the initial 20 kg N/ha increment gives a return of €100 (0.8 t @ €160/t less 20kg N@ €1.41/kg = €128 - €28 = €100). The 20 kg N/ha increment from 100 to 120 kg N/ha gives a reduced return of €52 while the 20kg N/ha increment from 250 kg N/ha to 270 kg N/ha resulted in a loss of €26. From this it is clear that at some point along the curve a point will be reached where the value of the yield increase given by an increment of 1kg N/ha will be equal to the cost of that 1 kg N fertiliser. It can also be seen that if fertiliser N level is increased above this point the value of the additional yield increase will be lower than the cost of fertiliser and therefore a loss will be made.

The N rate at which the value of the yield increase to an increment of N is equal to the cost of that increment of N is known as the economic optimum N rate (Nopt). This is the fertiliser N rate which gives the maximum profit from fertiliser use.

Optimum N Rate Vs. Maximum N Rate

There is a clear distinction to be made between the economic optimum N rate and the N rate that gives maximum yield (N max). The only time the two will be the same is where fertiliser N has no cost associated with it. Where fertiliser N has a cost the economic optimum N level will always be less than the N level that gives maximum yield.

Using data from the response curve it can be shown that increased fertiliser costs invariably leads to reduced profitability, irrespective of the amount applied, all other things being equal. However, the economic optimum N rate will always give the greatest profitability. This is presented graphically in Fig. 2. This figure outlines the margin over fertiliser cost (value of increased grain yield as a result of fertiliser N – cost of that fertiliser N) for fertiliser N levels between 50 and 300 kg N/ha at constant grain price for two CAN prices, €360/t and €400/t. It can be seen that the margin over fertiliser cost is greatest for both CAN costs at the economic optimum N rate and decreases at N rates higher and lower than Nopt. It can also be seen that margin over fertiliser cost is lower at each N rate for the higher priced CAN. Therefore reducing fertiliser N inputs below the economic optimum level in an attempt to increase profitability when fertiliser N prices increase will be counterproductive, it will lead to reduced profitability all other things being equal. Of course if reductions in nitrogen below the economic optimum will lead to reduced requirements for other inputs such as fungicides, then it may be beneficial to use N rates lower than the optimum. This will be discussed in a subsequent section but the potential to do this may be limited.

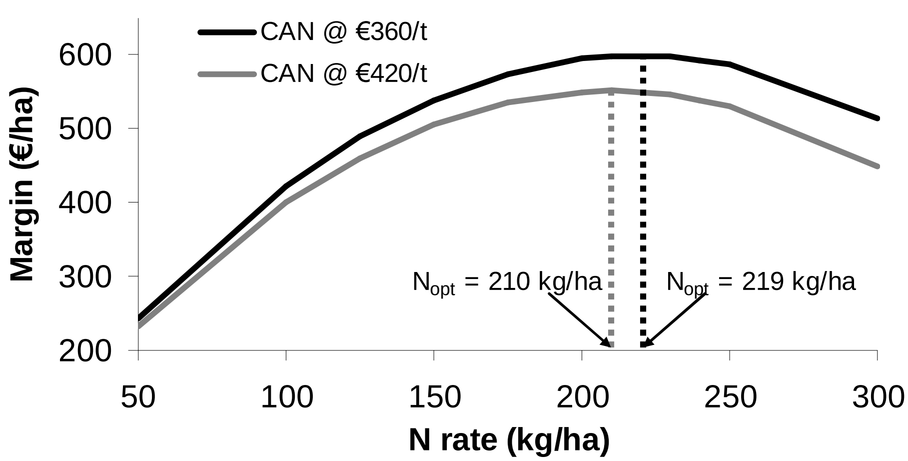

Figure 2. Margin over fertiliser cost for winter wheat at two CAN price levels at a constant grain price.

Effect of fertiliser cost and grain value on N_{opt}

The economic optimum N rate is dependent on both grain price and N fertiliser cost. As fertiliser price goes up and/or grain value goes down the economic optimum N rate decreases. Similarly as fertiliser price goes down and/or grain value goes up the economic optimum N rate will increase. The point at which the value of the yield increase to an increment of N is equal to the cost of that increment of N i.e. the economic optimum N rate, will depend on the ratio of fertiliser price to grain value and this ratio is often referred to as the break even ratio (BER). It is essentially the kilograms of grain that is required to pay for a kilogram of nitrogen and is calculated by dividing the value of 1 kg of grain by the value of 1 kg of nitrogen. The BER for a range of grain values and can costs is given in Table 1. It can be seen that for a grain price of say €150/t the BER will change from 8.4 where CAN costs €340/t to 10.4 where CAN costs €420/t. This means that it takes 8.4 kg of grain to pay for 1 kg of nitrogen when CAN costs €340/t but this increases to 10.4 kg grain to pay for 1 kg of nitrogen when CAN costs €420/t assuming a grain price of €150/t. Therefore at a BER of 8.4 it makes economic sense to apply nitrogen until such time as an additional kilogram of nitrogen gives less than 8.4 kg additional grain in return.

The economic optimum N rate will change as fertiliser cost and/or grain value changes i.e. as the BER changes. However, the changes in the optimum N rate are often not very big even when dramatic changes in either fertiliser price or grain value occur. For example at a constant grain price of say €150/t dry, increasing the cost of CAN from €300/t to €450/t, a 50% increase, would decrease the economic optimum N rate by only 15kg N/ha.

Table 1. The break-even ratio (BER), which is the kgs of grain required to pay for a kg of N, at a range of CAN prices and grain values

Grain Value	**CAN Cost €/t**				
(€/t dry)	**340**	**360**	**380**	**400**	**420**
130	9.7	10.3	10.8	11.4	12.0
140	9.0	9.5	10.1	10.6	11.1
150	8.4	8.9	9.4	9.9	10.4
160	7.9	8.3	8.8	9.3	9.7
170	7.4	7.8	8.3	8.7	9.2
180	7.0	7.4	7.8	8.2	8.6
190	6.6	7.0	7.4	7.8	8.2
200	6.3	6.7	7.0	7.4	7.8

Winter wheat in 2009

The economic optimum N rate for winter wheat at soil Index 1 for a range of break-even ratios is given in Table 2. BER values for different grain values and fertiliser costs are given in Table 1. If it is assumed that CAN prices will be around €380/t and taking a dry grain price of €160/t which would give a BER of approximately 9, then the economic optimum N rate for winter wheat would be around 218 kg N/ha. If the grain price was €140/t, giving a BER of 10, then the economic optimum would be 212 kg N/ha. In other words a change of 1 point in BER leads to a change of approximately 6 kg N/ha in the economic optimum. Similar recent research in the UK found that as BER changed by one point the economic optimum changed by approximately 10 kg/ha (Sylvester-Bradley et al., 2008).

Table 2. Effect of changes in the break-even ratio on the optimum N rate for winter wheat at soil index 1

BER value* (€/kg grain:€/kg N)	Optimum N rate (kg N/ha)
7	230
8	224
9	218
10	212
11	206

NOTE: N application rates in excess of 190 kg N/ha for winter wheat at soil index 1 require proof of yields in excess of 9t/ha at 20% moisture to ensure compliance with SI 368 of 2006.

** break-even values for a range of CAN prices and grain values are given in Table 1.*

SPRING BARLEY

An extensive set of trials was carried out at five locations between 1990 and 1993 examining the response to fertiliser nitrogen of spring barley (Conry, 1997). The soils included in the trial series ranged from heavy textured clay soils to light textured soils, all of which were deemed to be at soil N index 1. Subjecting this data to the procedures outlined allows the optimum N rate to be determined for a range of grain values and fertiliser costs. It was apparent that there were no consistent differences between sites in terms of the optimum N rate despite the large variation in soil types in the study. As with the wheat example one of the striking conclusions that can be drawn is that even quite dramatic changes in either fertiliser price or grain value do not lead to very large changes in the optimum N rate.

While these trials were carried out some time ago, more recent trials in Ireland would indicate that the response curve generated are still valid. Recent UK work compared the response of old and recent spring barley varieties to determine if newer, higher yielding varieties had a higher optimum nitrogen rate than the older varieties (Sylvester-Bradley et al., 2008). The conclusion from this work was that although newer varieties had higher yields the optimum nitrogen level was not significantly increased. This was because new varieties used nitrogen more efficiently than old varieties and were able to produce more yield per kg nitrogen input.

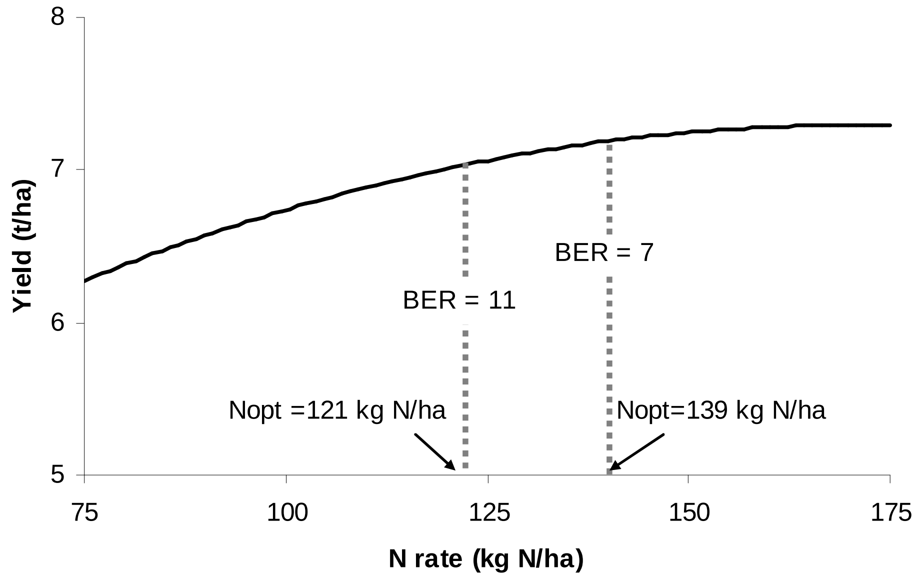

Figure 3. Response of spring barley to fertiliser N level showing the economic optimum N level at two levels of BER

The effect of changes in the break even ratio (BER) on the calculated economic optimum N rate is presented in Fig 3 and Table 3. In Fig 3 two extreme BER values are presented but it can be seen that the change in optimum N rate is relatively modest (18 kg N/ha or 14 units/acre). A change of BER from 7 to 11 would require a change in CAN price of €170/t at constant grain price, or a change in grain value of €70/t at constant CAN price.

Spring barley in 2009

The optimum N rate for a range of break-even ratios is given in Table 3. For the current season it would appear that the price of CAN is likely to be in the region of €380 giving a cost of €1.41 per kilogram of N. Grain price is obviously uncertain but taking a value of €160/t (dry) this would give a BER of approximately 9 (1.41/0.16) which would indicate an optimum N level of 130 kg N/ha for spring barley in an Index 1 soil. Recent work in the UK indicated that the optimum N rate for spring barley at a BER of 9 was approximately 126 kg N/ha (Sylvester-Bradley et al., 2008).

Table 3. Effect of changes in the break-even ratio on the optimum N rate for spring barley

BER value* (€/kg grain:€/kg N)	Optimum N rate (kg N/ha)
7	139
8	135
9	130
10	126
11	121

NOTE: N rates in excess of 135kg N/ha for spring barley at soil index 1 require proof of yields in excess of 7.5t/ha at 20% moisture to ensure compliance with SI 368 of 2006.

* *break-even values for a range of CAN prices and grain values are given in Table 1.*

Factors Interacting With Nitrogen

The previous sections examined optimum rates of nitrogen from trials where every effort was made to ensure that inputs other than nitrogen were applied at robust rates such that the main limiting factor was nitrogen. However, the question arises as to whether the requirement for other inputs reduces if N level is reduced below the economic optimum level. If this was the case then the reduced profitability as a result of using lower than optimum N rates may be negated by reduced requirement for other inputs. Published work examining the effect of changes in N rate on the optimum level of other inputs has been relatively limited. However some work has examined the effect of N rate on optimum fungicide levels.

Fungicides

It is well accepted that plants receiving nitrogen fertiliser tend to be more susceptible to disease than plants grown without fertiliser N. Increases in fertiliser nitrogen level have been shown to increase the level of septoria in a winter wheat crop (Leith and Jenkins, 1995). This might suggest that reducing fertiliser N input could lead to reductions in fungicide requirement. Published work examining this effect would appear to be sparse but the indications are that the potential for significant reductions in fungicide requirement as a result of fertiliser N reductions without compromising profitability are limited. Leitch and Jenkins (1995) indicated that in unsprayed plots the potential yield reduction resulting from a 100kg N/ha increase in fertiliser level, due to increased septoria levels, was only about 5%. This would indicate that reducing N rate from 200 kg N/ha to 150 kg N/ha would increase yield as a result of reduced septoria by approximately 0.25t/ha assuming an initial 10t/ha crop. However using the response curve presented earlier would indicate a yield decrease due to the reduction in fertiliser of 0.5 t/ha. This indicates that potential to use reductions in fertiliser N inputs to reduce fungicide inputs may be limited. Olesen et al (2003) did report that the economic optimum fungicide rate did decrease as fertiliser N rate decreased under Danish conditions. However in those trials very low rates of fungicide were used. Work in France indicated that while there may be some scope for reducing fungicide inputs as N fertiliser is reduced where mildew or brown rust were the main diseases, there was limited scope for fungicide reductions where septoria was the main disease (Verjux, 1997). They concluded that factors such as climate and varietal susceptibility had a far greater effect on septoria than fertiliser N inputs. Recent work at Oak Park examining the interaction between fungicide and nitrogen indicated that there was little evidence to justify significant reductions in fungicide inputs to winter wheat as a result of reductions in N fertiliser inputs (Forristal and Burke, 2008).

Cover crops

Given that over-winter cover crops can accumulate significant amounts of nitrogen it could be postulates that when incorporated this nitrogen would become available to the subsequent crop and thereby reduce the fertiliser N requirement of the subsequent crop. However, work at Oak Park, examining a range of cover crops found that that the fertiliser N requirement of spring barley was unaffected by incorporation of cover crops. It is thought that while the nitrogen was released from the cover crops, it was released too late in the growing season to reduce the fertiliser requirement of the crop. In these trials the cover crop was incorporated close to sowing of the subsequent spring barley crop and earlier incorporation of the cover crop may have improved the synchrony between cover crop N release and crop requirement. However, indications from French work would indicate little consistent benefit of non-leguminous cover crops on the fertiliser nitrogen requirement of subsequent spring sown crops.

Urea Vs Can As A Nitrogen Source

Urea is normally a considerably cheaper source of nitrogen than CAN. At anticipated prices for the coming season a kilogram of nitrogen as urea will cost approximately 62% that of a kilogram of N as CAN (Table 4). However the efficiency of use of urea by the crop is not always as good as for CAN. This reduced efficiency of urea is usually attributed to greater loss of N through the process of ammonia volatilisation than occurs with CAN. Recent UK work indicated that N losses due to ammonia volatilisation averaged 22% of applied N where urea was applied compared to 3% of applied N for ammonium nitrate (Chadwick et al. 2005). When applied to the soil urea is broken down to ammonium which is susceptible to being converted to ammonia gas which can be lost to the atmosphere. This loss will be exacerbated where drying conditions and/or high pH (as a result of recent liming for example) are encountered, particularly if soil temperatures are high.

Table 4. Cost comparison of urea and CAN as a source of N

Fertiliser	% N	Cost/t	Cost per kg N
CAN	27%	380	1.41
Urea	46%	400	0.87

Winter wheat

Urea may be an option for winter wheat, particularly the first split, where the grower does not need to apply other nutrients e.g. phosphorus or potassium. Where either of these nutrients are required a compound fertiliser is likely to be more economical.

Gately et al. (1994) demonstrated that soil moisture conditions and rainfall around the time of urea application were a key factor in determining the effectiveness of urea as a fertiliser for winter wheat. Where the soil was dry before and after application urea was substantially inferior to CAN as a nitrogen source. Where the soil was moist at the time of application and there was some rainfall after application urea was as effective as CAN. More recent work by O'Reilly (1999) indicated that urea could be as effective as CAN as a nitrogen source for winter wheat but was not consistently as effective. Recent UK work concluded that urea is often an inferior source of N, in their case compared to ammonium nitrate (Dampney et al 2006). They found that 20% more N needed to be applied as urea to give a similar yield compared to a given level of ammonium nitrate.

The overall conclusion is that it would appear that urea can be an option for the first split of nitrogen on winter wheat, which will normally be applied when soil temperatures are relatively low and the soil is likely to be moist. Applying the main nitrogen split as urea is possible but there is the potential to lose significant amounts of the applied N if soil/weather conditions are dry around the time of application favouring loss.

Spring barley

Gately et al. (1988), reporting on trials under Irish conditions where both fertiliser were broadcast, concluded that CAN was a more efficient form of nitrogen for spring barley than urea, but suggested that if the urea was worked into the soil soon after application there would be little difference between the two. However, in a series of trials comparing a range of fertiliser types under Irish conditions Conry (1997) found that using urea as the nitrogen source for spring barley gave lower yields compared to where CAN was used in eight out of nine experiments across a range of soil types. The yield reductions were generally of the order of 0.2-0.4 t/ha but in two experiments the yield reduction as a result of using urea was over 1.5 t/ha. In these experiments the urea was applied to the soil surface immediately after sowing and worked into the surface soil, using a rake, such that approximately 95% of the urea prills were covered with soil. The CAN was not worked into the soil. This would be expected to significantly reduce the amount of nitrogen lost fro the urea by ammonia volatilisation. However the lower grain yields would suggest that even when incorporated urea is not as effective a nitrogen fertiliser as CAN type products. However in these trials the urea was only worked into the surface soil. Better incorporation, as would likely occur if the urea was spread before cultivation and sowing, may increase the effectiveness of urea for spring barley.

Ammonia released as a result of urea decomposition is detrimental to germinating seeds so if it is to be used at sowing care should be taken so as to avoid placing the seed too close to the urea fertiliser.

Spreading urea

A key problem with using urea is that it is less dense than CAN and therefore it is more difficult to throw it over wide tramlines. This becomes a problem where tramline widths in excess of 20m are in use. Parkin et al. (2005) found that correctly prepared, calibrated and operated twin disc spreaders could achieve a satisfactory application of a quality granulated urea at 24 m bout widths without the need for further machine improvements. In this instance they defined a quality urea product as one having a median particle size greater than 3mm with very few fines. However, in practice it is likely to be very difficult to achieve good spread patterns with urea at these tramline widths and given the consequences of achieving a poor spread pattern, this practice is not to be recommended. In practice growers should aim to be spreading urea at maximum bout widths of about 18m or preferably less. Granular urea will give better spread patterns than prills particularly at bout widths above 12 m.

Applying urea as a solution during the early part of the growing season, as opposed to after flag leaf emergence to improve protein content, has been examined experimentally and by some growers. This can overcome difficulties with wide tramline widths and ensure even application across the spreading bout. However there are a number of difficulties associated with this process also. There can be a high risk of crop scorch, particularly if the urea solution is applied under bright conditions. Dissolving the urea can be a time-consuming procedure without investment in proper facilities. Because of these problems this method of urea application should only be attempted by experienced growers with access to suitable equipment.

Nitrogen Timing

Many experiments have been carried out to determine the optimum timing of nitrogen for cereal crops. Large variations in optimum timings have been found depending on a range of factors including site and climatic conditions. An optimum application strategy will be one where sufficient N is available to the crop to meet its requirements throughout the growing season, without having excessive amounts present in the soil at any time, which can be susceptible to loss in our unpredictable climate.

Winter wheat

N uptake by a winter wheat crop will generally be quite low over the winter months and begin to increase as the crop enters stem extension. Large amounts of N are required by the crop between GS 32 and GS 59, the period when the crop is producing large amounts of green leaf area and biomass. As the crop proceeds through grain fill the developing grain will require a nitrogen supply which if not got from the soil, will be taken from the leaves at the expense of green leaf area and hence yield.

An optimum nitrogen strategy will aim to apply some nitrogen at the beginning of spring growth (GS28-30) to ensure leaf and tiller production is not compromised. Generally 30-50kg N/ha will be sufficient at this stage. The main application of nitrogen should be made before GS32 to ensure that there is sufficient nitrogen in the soil to satisfy the crops requirements during the period of rapid growth that takes place between GS 32 and GS 39. Typically in an Index 1 situation this will mean applying 50-60% of the total N dose at GS 31-32. In some cases all the remaining nitrogen can be applied at this stage. However this strategy can leave the nitrogen vulnerable to loss if very wet weather follows in the weeks after application. A better strategy, which reduces the risks of losses, may be to apply a third split of 30-50 kg N /ha at GS 37-39. As a general rule, where more than 100 kg N/ha is to be applied, the N should be split into two applications, and where more than 150 kg N/ha is to be applied three applications should be considered.

Spring barley

For spring barley the number of viable tillers and the number of grains per tiller are important contributors to yield. Both these parameters are determined early in the life of the crop. For this reason all the nitrogen should be applied to a spring barley crop before GS 32 and preferably before GS 31.

Timing of N application to spring barley will vary depending on time of sowing and end use. Generally where spring barley is sown in February, there is no requirement for N application at sowing. When N is applied at sowing in February, no more than about 40 kg N/ha should be used to avoid the risk of N loss. N application will normally be made to early sown barley soon after emergence of the crop. If more than 100 kg N/ha is to be applied, the total nitrogen will normally be applied in two applications; the first and largest soon after emergence and the second during mid-tillering.

For March sown barley a proportion, usually not more than half, can be applied at or before sowing and the remainder applied at early to mid-tillering. For later sown barley a greater proportion of the N will be applied at or before sowing but not more than 75 kg N /ha should be combine drilled to avoid the risk of poor establishment.

Organic Manures

Organic manures such as cattle/pig slurry and poultry manures can be an efficient and cost effective source of nitrogen (and other nutrients). Where such products are available every effort should be made to use them and thereby reduce the amount of artificial fertiliser that must be purchased. An estimate of the monetary value of organic manures is given in the next paper. Growers are now legally bound to reduce the amount of chemical fertiliser they apply to crops where organic manures are applied as outlined in SI 378 of 2006. Typical nutrient content of a range of organic manures is given in Table 5. The proportion of N in these organic manures deemed to be the equivalent of chemical fertiliser according to SI 378 of 2006, is given in Table 6. Work at Oak Park with pig slurry and to a lesser extent cattle slurry has shown that these availabilities are achievable under Irish conditions.

Table 5. Typical N, P and K levels in organic fertilizers1,2

Organic Fertilizer Type		N kg/t[3]	P kg/t[3]	K kg/t[3]
Cattle slurry		5.0	0.8	4.3
Pig slurry		4.2	0.8	2.2
Sheep slurry		10.2	1.5	5.4
Dungstead manure (cattle)		3.5	0.9	4.0
Farmyard manure		4.5	1.2	6.0
Poultry:	Slurry (layers 30% DM)	13.7	2.9	6.0
	Broilers / deep litter	11.0	6.0	12.0
	Layers (55% DM)	23.0	5.5	12.0
	Turkeys	28.0	13.8	12.0
Spent mushroom compost		8.0	2.5	8.8

1. Values shown for N and P content are those that must be used for compliance with SI 378 of 2006.
2. Dry matter and nutrient contents can vary widely between farms.
3. 1 tonne slurry = 1000 litres or 1 m3. 1000 gallons = 4.5 tonnes. 1000 gallons/acre = 11 tonnes/ha.

Source: Coulter and Lalor 2008.

Table 6. Nutrient availability in organic fertilizers (as prescribed by SI 378 of 2006)

	Fertilizer replacement value %[1,2]		
	Nitrogen		Phosphorus
Organic Fertilizer Type	**From Jan 1 2008**	**From Jan 1 2010**	**From Jan 1 2007**
Pig and poultry manure	40	50	100
Farmyard manure	25	30	100
Spent mushroom compost	40	45	100
Cattle and other livestock manure (including that produced on the holding)	35	40	100

1. Fertiliser replacement value refers to the percentage of the total nutrient content that will potentially repalce chemical fertiliser application to the crop following application
2. The fertiliser replacement value to be used is determined by the application date.

Source: Coulter and Lalor 2008

A key issue to be aware of when using slurries or manures is that a proportion of the nitrogen is readily lost when exposed to the air. This will reduce the likelihood of achieving the availabilities outlined in Table 6. For this reason it is recommended that organic manures are incorporated into the soil as soon as possible after application. This is particularly important where the organic manures contain a high proportion of the nitrogen in the form of ammonium as is the case with cattle and pig slurry. Where these are being used on spring crops they should be applied before sowing and incorporated soon after application preferably within 2-3 hours. For poultry manures incorporation should ideally take place within 24 hours. Where organic manures are being applied to growing crops incorporation is not a realistic option. In this instance the main means of reducing losses will be though choice of spreading technique and time of application. For slurries ideally a trailing hose type machine would be used which will reduce ammonia losses compared to a splashplate type machine, as well as ensuring more even application. Timing of organic manures to growing crops should be such as to coincide with the requirements of the crop.

The nitrogen content of organic manures can vary considerably between farms and between batches within a farm. While nitrogen contents given in Table 5 can be used as an indication of the N content of manure, ideally the manure being used should be tested for nitrogen content. This particularly important with liquid organic manures such as pig slurry and cattle slurry as the nutrient content will be related to the amount of water in the slurry.

CONCLUSIONS

- The economic optimum N level for crops is dependent on both grain price and fertiliser cost.
- Dramatic reductions in fertiliser N are not warranted based on current fertiliser costs
- The main consequence of increased fertiliser prices is reduced profitability. Reducing fertiliser N application rates below the economic optimum will not counteract this reduction in profitability.
- Reductions in other inputs, such as fungicides, should be made on a case by case basis. Reducing fertiliser N does not automatically mean that the requirement for other inputs, such as fungicide, will be reduced.
- Altered agronomic practices such as reduced cultivations or introduction of cover crops are unlikely to significantly affect the requirement for fertiliser N.
- Urea is a cost effective option for early applications to winter crops.
- Urea can be less effective than CAN for later applications, particularly if applied when the soil is dry.
- Organic manures should be considered as a cost effective nutrient source where available.

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Appendix 1. Determining soil nitrogen index for tillage crops

Continuous tillage: - crops that follow short leys (1-4 years) or tillage crops			
Nitrogen Index			
Index 1	Index 2	Index 3	Index 4
Cereals Maize Vegetables receiving less than 200 kg/ha nitrogen	Sugar beet Fodder beet Potatoes Mangels Kale Oil Seed Rape Peas, Beans Leys (1-4 years) grazed or cut and grazed. Swedes removed Any crop receiving dressings of organic fertiliser Vegetables receiving more than 200 kg/ha nitrogen	Swedes grazed in situ	
Tillage crops that follow permanent pasture			
Index 1	Index 2	Index 3	Index 4
Any crop sown as the 5th or subsequent tillage crop following permanent pasture	Any crop sown as the 3rd or 4th tillage crop following permanent pasture. If original permanent pasture was cut only, use index 1	Any crop sown as the 1st or 2nd tillage crop following permanent pasture (see also Index 4). If original permanent pasture was cut only, use index 2	Any crop sown as the 1st or 2nd tillage crop following very good permanent pasture which was grazed only

Source: SI 378 of 2006

Appendix 2. Maximum fertilisation rates of nitrogen on tillage crops

Crop	Nitrogen Index			
	1	2	3	4
	Available Nitrogen (kg/ha)			
Winter Wheat[1]	190	140	100	60
Spring Wheat[1, 2]	140	110	75	40
Winter Barley[1]	160	135	100	60
Spring Barley[1]	135	100	75	40
Winter Oats[1]	145	120	85	45
Spring Oats[1])	110	90	60	30

[1] Where proof of higher yields is available, an additional 20kg N/ha may be applied for each additional tonne above the following yields;

Winter Wheat - 9.0 tonnes/ha   Spring Wheat - 7.5 tonnes/ha

Winter Barley - 8.5 tonnes/ha   Spring Barley - 7.5 tonnes/ha

Winter Oats – 7.5 tonnes/ha   Spring Oats – 6.5 tonnes/ha

The higher yields shall be based on the best yield achieved in any of the three previous harvests, at 20% moisture content.

[2] Where milling wheat is grown under a contract to a purchaser of milling wheat an extra 30 kg N/ha may be applied

Source: SI 378 of 2006

Plan to maximise the return on investment in P and K applications to cereal crops

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SUMMARY

The price of fertilisers are having a significant impact on cereal crop profitability and are forcing growers to analyse crop productions costs and tailor crop nutrient requirements. It is essential to have recent soil test reports for the fields on your farm and select suitable fertilisers depending on crop nutrient requirements. P fertilisers are a key component to maximising grain yields and crop returns. It is essential now to control costs on a field by field basis and ensure efficient use of applied nutrients to maximise returns. Chopped straw and organic manures where available offer considerable opportunities to reduce fertiliser inputs costs per hectare. Typical fertiliser inputs represent 30 - 40% of the total production costs for spring barley. Chopped straw can reduce fertiliser costs by ~17 - 21% while an application of $22m^3$/ha pig slurry can reduce fertiliser costs by 35 - 45% depending on soil P & K index. Omitting P & K applications will result in a grain yield loss in the region of 0.2 – 1.5t/ha depending on soil fertility, soil structure and soil type. Current nutrient advice for cereal crops will ensure high yielding crops and should only be adjusted on the basis of a soil test report.

INTRODUCTION

Over the last two years fertiliser prices have increased dramatically with nitrogen (N) prices increasing by approximately 60% while phosphorus (P) and potassium (K) prices have increased by 91% and 74%, respectively (CSO, 2008). Cereal prices are also fluctuating and current low grain prices have significantly reduced cereal profitability. Controlling P and K fertiliser costs is a major factor in maintaining farm profitability. In order to reduce the eroding margin effects of high fertiliser prices it is essential to maximise the return from applied fertiliser inputs. Growers and advisors need to fine tune fertiliser recommendations on a field by field basis to ensure optimum nutrient applications for yield and positive crop margins.

Nutrient management and fertiliser planning are key components of nutrient legislation (e.g. S.I 378 of 2006) which places limits on annual N and P application rates to tillage crops and the utilisation of organic manure. An annual fertiliser plan now needs to be drawn up at the start of each year based on the cropping area; crops; livestock; and soil test reports. Maintaining and keeping fertiliser plans and associated records on farm for 5 years is required by the Department of Agriculture as part of cross compliance.

In the future there will be more emphasis on the need to recycle nutrients, especially P, due to decreasing reserves of the world's finite resources (Johnston, 2008). Therefore it is essential to improve P use efficiency on farm through better recovery of P from fertilisers and organic manures in crop production.

Fertiliser planning will ensure that crop nutrients are available in a sufficient and balanced supply to meet crop nutrient requirements. Optimum nutrient supply is required to maximise returns from applied fertilisers. Soil fertility status will have a major effect on the cost of meeting crop nutrient requirements in any one season. Therefore it is essential to have up to date knowledge of the soil nutrient status on the farm through reliable soil analysis. There will be a large difference in field returns from fields that are deficient in soil P and K compared to fields that require only maintenance or zero application rates.

This paper addresses the importance of tailoring crop P and K inputs based on soil P and K reserves through soil analysis. The basis of the current P and K nutrient advice and options available to reduce P and K applications while still maintaining profitable cereal production are also identified and discussed.

Fertiliser usage

Figure 1 shows the national consumption of N, P and K in Ireland over the last number of years. In the last 10 years N usage has declined by 30%, while P and K usage has had a larger decline of 45 – 50%.

This decrease in P and K usage is reflected in the types of fertilisers applied to Irish farms during the same period. There has been a switch away from high P and K type fertilisers to more medium or high N plus low P and K type fertilisers. For example in 1998, 34,000 tonnes of 0-10-20 and 86,000 tonnes of 10-10-20 were applied compared to approximately 6,500 and 40,000 tonnes respectively today. This is possibly driven by the introduction of environmental schemes coupled with low margins in agriculture during that period. The question one may ask is what effect will this change in fertilizer usage have on: 1) soil nutrient levels, and 2) on production over time?

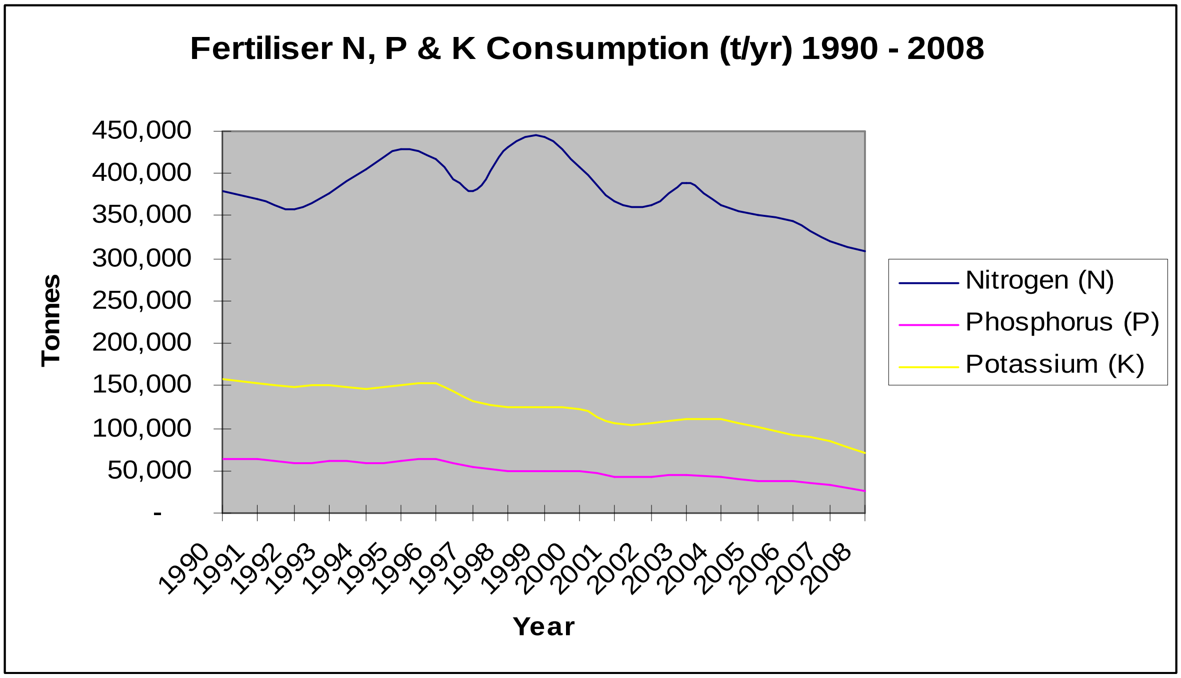

Figure 1. Annual fertiliser consumption in Ireland (1992-2008)

Trends in P and K status of Irish tillage soils 1987 – 2006

Johnstown Castle analyses 50 – 60,000 soil samples annually. The results for all tillage crops soil samples analysed during the 20 year period from 1987 to 2006 are summarised in table 1, and show how fertility on Irish tillage farms has changed over the last 20 years. Regarding soil P fertility levels, the data shows that there has been a slight decrease in the number of fields tested at soil index 1 and 4 and a slight increase in fields at index 2 and 3. Potassium indices have remained much the same over the same period with approximately 55% of fields tested at index 1 and 2 and 45% of fields at index 3 and 4.

Table 1. Percentage of tillage soil samples in each soil P and K index range for the period 1987 – 2006

Soil Index	1987 - 1991	1992 – 1996	1997 - 2001	2002 - 2006
		P		
1	23	19	15	16
2	29	29	30	32
3	21	23	25	25
4	24	29	30	27
		K		
1	18	22	18	18
2	37	37	37	37
3	25	23	24	24
4	20	18	21	21

Source:- Teagasc, 2008

Soil fertility status will have a major impact on the profitability of cereal crops as it is the basis to fertiliser recommendations and determines the costs incurred in meeting crop requirements. The majority of soil samples for cereal crops analysed at Johnstown Castle are index 2 or greater. With approximately 16 – 18% of samples index 1, these soils will have a higher nutrient requirement and consequentially incur higher productions costs. Also, land that is low in P and K are often deficient in other nutrients such as lime and trace elements.

Soil fertility and crop margins

Table 2 shows the effect of soil fertility index on the cost involved in meeting the N, P and K requirements for spring barley *(Nutrient advice as per current recommendations)*. The cost of meeting N, P & K requirements has increased significantly over the last 2 years. For example at soil P & K index 1 the cost of meeting P & K requirements in 2006 was €150/ha where in 2008 it increased to €268/ha. The effect of an increase or decreases of 20% in fertiliser prices for 2009 on fertiliser costs at each soil index are shown. Soil fertility is having a major effect on the costs incurred in meeting P & K cereal crop requirements. The viability of crop production on low fertility soils needs to be examined closely to ensure fields are returning a positive margin.

Table 2. Fertiliser (N, P & K) costs for growing 7.5t/ha spring barley (€/ha)

	2006[1]	2007[1]	2008[1]	+ 20%	- 20%
N	€113	€117	€183	€220	€152
			P and K		
1	€150	€157	€268	€329	€228
2	€123	€129	€219	€269	€187
3	€96	€101	€170	€209	€145
4	0	0	0	0	0

[1]*Source:- Fertiliser prices from CSO average yearly figure*

Table 3 shows the effect of grain price and soil fertility (index 1-4) on the projected returns for spring barley in 2009. Crop margins vary widely depending on grain price and the cost of meeting nutrient requirements at the different soil P & K indexes (1-4). If fertiliser costs increase by 20% in 2009 a grain price of €150/t would be required to return a positive margin. To realise a positive return at a grain price of €125/t fertiliser prices would need to decrease by 20%.

Table 3. The effect of grain price and fertiliser costs on the crop margin (€/ha) for a 7.5t/ha spring barley in 2009

Fertilizer price (vs. 2008)	**+ 20%**			**- 20%**		
Soil P & K Index	**Crop Margin/ha varying grain price (€/ton)**					
	€100	**€125**	**€150**	**€100**	**€125**	**€150**
1	-€352	-€165	+€23	-€183	+€5	+€192
2	-€292	-€105	+€83	-€142	+€46	+€233
3	-€232	-€45	+€143	-€100	+€88	+€275
4	-€23	+€165	+€352	+€45	+€233	+€420

* *Teagasc, Costs and Returns, 2009*

Soil fertility – the basis of crop nutrient advice and fertiliser planning

Soil fertility is a key determinant of the productive capacity of soils, as are the more complex and sometimes little understood interactions between the biological, chemical and physical soil properties. Good farming practice aims to manage these three properties essential to optimize yields of crops in environmentally friendly ways. To ensure crops respond to soil nutrient levels it is essential to have good soil management practices in place to take consideration of soil organic matter, soil structure and the maintenance of an active soil microbial population (Johnston, 2005).

Lime and Soil pH

Lime is an essential nutrient in tillage crops as the majority of crops grown in Ireland prefer soils with soil pH levels approaching neutrality. Where soil pH is low, it needs to be corrected in order to ensure applied fertiliser and manure nutrients are plant-available. Where soils are deficient in lime, it will result in reduced grain yield. Also other inputs, notably, N, P and K will be used less efficiently.

Correct soil pH is essential for the uptake and availability of soil nutrients. The major nutrients N, P and K as well as calcium (Ca) and magnesium (Mg) show a marked reduction in availability in acid conditions. Our high rainfall means that we have to replace lime lost through leaching and crop uptake to maximise production and profits from cereals. Tillage soils need to be maintained at a soil pH of approximately 6.5 depending on the crops in the rotation. The cost of lime maintenance is small with an annual cost in the region of €8/ac/yr.

Figure 2 shows that the average lime requirement for tillage soil samples tested at Johnstown Castle has dropped from 4t/ha to 2t/ha over the last 20 years (1987 – 2006). This would indicate that Irish tillage soils have a low lime requirement. However, it remains essential to base lime applications on a current soil laboratory test to identify the soil's lime requirement as it is linked to the soil type and soil buffering capacity.

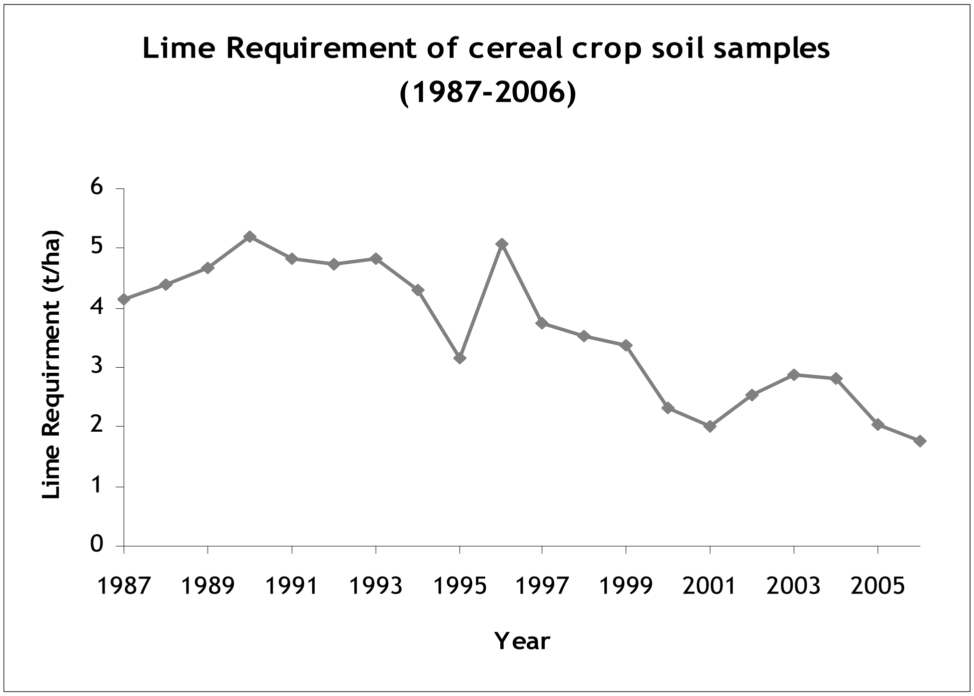

Figure 2. Average lime requirement for tillage soil samples test between 1987 –2006

Where high levels of lime are advised (>7.5t/ha), half should be applied pre – ploughing and the remainder post ploughing and tilled in. Lime takes up to two years to have its full neutralizing effect on soil acidity; it should be applied well before sowing for acid sensitive crops such as barley.

Soil P and K Fertility

Soil analysis measures the nutrients that are available for uptake by the plants root system. Within the soil there are many pools of soil nutrients from those in soil solution to very slowly available soil reserves (see figure 3). The plant root system will take up nutrients from the soil solutions which are replaced by the readily available pool; as this pool is depleted it is replenished by the less readily available pool. The supply of nutrients from these two pools will depend on previous fertiliser and manure applications; crop offtakes; and the soil type. When fertiliser is added to the soil it gets distributed between the three pools. It is essential to maintain soil fertility levels in the optimum range for the crops being grown in the rotation and the soil type. The essential feature of crop nutrition is that there should be sufficient P and K in the soil solution and the readily available pool to meet both maximum daily demands for each nutrient in the early stages of growth and the maximum uptake to achieve optimum yield. (Johnston, 2005).

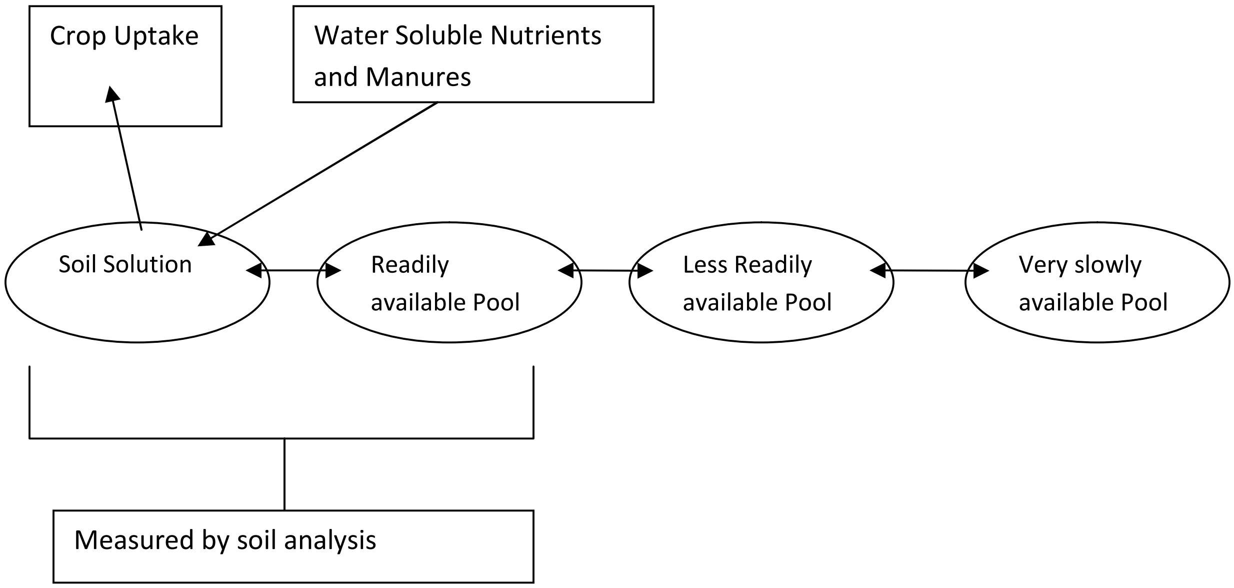

Figure 3. Schematic representation of P and K reserves in soil, and the various pools with differing plant availability.

Soil Analysis

Fields should be soil sampled at the same time of year (Sept- March), every 3 – 5 years to a depth of 10 cm. Take a minimum of 20 soil cores from the sampled area to ensure a representative sample for reliable results (*see appendix 1- Taking a soil sample*).

Soil analysis is a costly exercise, but it should be considered as an investment. The costs can be easily recovered through better nutrient advice and improved fertiliser use. For example take a 10 acre field where a S4 (pH, major and micro nutrients) soil test is taken every 5 years, the cost of soil analysis is €0.68c/ac/yr this is currently ⅔ of the cost of 1kg of K fertiliser. Costs can also be spread over as number of years by sampling fields on a rotational basis, for example sample 20% of the farm every 5 years. Once the fertility status of the farm has been established, fields on the farm need to be blocked into common soil P and K indexes and apply fertilisers as per nutrient advice.

Soil Index System

In Ireland, Morgan's extractant is used to measure plant available P and K in the soil and represents the availability of the nutrients to root hairs. Based on the P and K levels extracted from the sample during this procedure, soils can be classified on a descriptive basis as shown in table 4. As the soil nutrient status increases the response to the applied nutrient declines. The aim is to maintain soil at the target index which is target index 3 for cereal crops.

Table 4. Soil nutrient Index, response and soil test range for P and K

Index	Nutrient Response	P (mg/l)	K (mg/l)
1	Definite	0 – 3.0	0 – 50
2	Likely	3.1 – 6.0	51 – 100
3	Unlikely / tenuous	6.1 – 10	101 – 150
4	None	>10	>150

Maintain Soils at Target Index 3 for P and K

The soil P and K status will change very slowly over time as nutrients are held within the soil matrix. Maintaining adequate soil nutrients will allow the plant roots maximum opportunity to find sufficient nutrient in anyone season. High yielding crops take up significant quantities of K during the growing season. For example, during the late flowering stage a winter wheat crop can have in the region of 210 kg/ha of K taken up. If this peak requirement is not available, grain number and grain fill will be affected thus prejudicing both yield and quality. This is a key reason for maintaining the adequate soil reserves which can supply these plant peak demands more satisfactorily than fresh fertilizer applications. Potash is also returned to the soil during crop ripening and with the senescence and shedding of older leaves.

Soils will have different levels of available P and K which has been built up from the application of fertilisers and manures over time. The level of available soil P and K at which yield response levels out is known as the critical soil P and K level or target index (see table 4). Crops such as potatoes, beet or beans may show a response to freshly applied P and K and show an increase in yield at the target index.

Currently it is accepted that when soils are maintained at the target index (index 3), then the amount of P and K applied should replace crop offtake. When soils are below the critical level, additional P and K above that removed in crop offtakes need to be applied to build up soil reserves to the target index.

Response to P and P advice

P response curve

Figure 4 is a schematic representation of a P response curve for cereals, based on data modified from UK trial work data indicating the relationship between soil P status and grain yield response in spring barley. When all other nutrients are available and not limiting, the point at which the response curve levels off is the 'critical value' for that crop and that soil type. Below the critical value, yield will be lost. Figure 4 has been modified for Morgan's P and the critical value can be seen to between 6 - 7 mg/l.

Where soils are above the target index (i.e. index 4) no additional nutrient is required until the soil index falls to index 3. This will take a number of years depending on the soil type. Soils at the target index (index 3) only require a maintenance P application. Where soils are below the target index additional nutrient plus maintenance should be applied to build towards the target index. Soils should be tested every 4 – 5 years to identify changes in soil index.

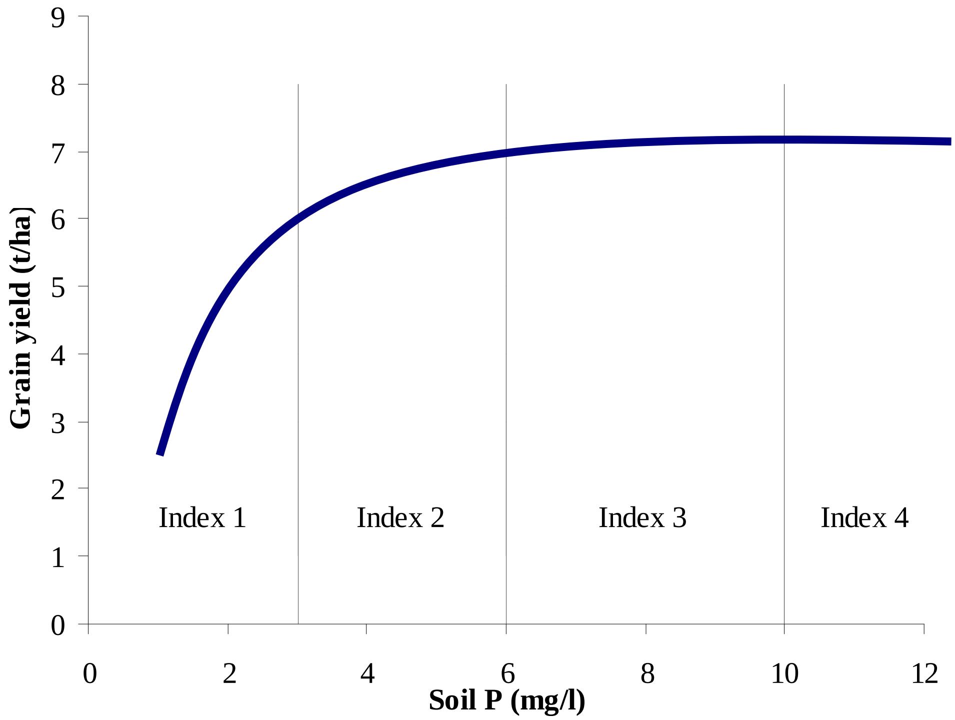

Figure 4. Relationship between soil P and grain yield in spring barley

(UK data modified from Olsens to Morgans P)

Cereal crops may also show symptoms of P deficiency symptoms on soils that are deficient in plant available P. P is essential in the early stages of plant development. When plant symptoms appear and Crop yield potential can be reduced when plant deficiency symptoms appear. Therefore apply P early where required to meet crop root and shoot development. A cereal plant deficient in phosphorus will appear stunted, dull, light green to purple or blue colour.

P Advice

P advice for cereal crops is shown in table 5. The majority of P is removed in the grain with small amounts of P removed in the straw.

One way to reduce the usage of P is the incorporation of straw for example a 10t/ha winter wheat crop will return 4kg P/ha which will help reduce P applications and meet crop P requirements.

Table 5. P application rates for cereal crops

Soil P Index	P Advice (kg/ha)
1	45
2	35
3	25
4	None

Source: - Major & Micro Nutrient Advice For Productive Agricultural Crops, 3rd Ed., 2008.

Response to K and K advice

K Response Curve

Figure 6 is a schematic representation of a K response curve modified from UK trial work data indicating the relationship between soil K status and grain yield response in spring barley and winter wheat. Yield increases with increasing soil K up to the critical value, beyond which further improvements in soil K fertility has no effect. Soil fertility will vary within fields due to climate and soil condition. Therefore soil analysis is not a precise measurement as figure 6 indicates. The index system is the basis to manage crop fertiliser applications and has been developed to provide a general pattern of crop response to applied nutrient (PDA, 2005). Figure 6 has been modified for Morgans K; the critical value can be seen to occur at approximately 100 mg/l of Morgan’s K (index 3).

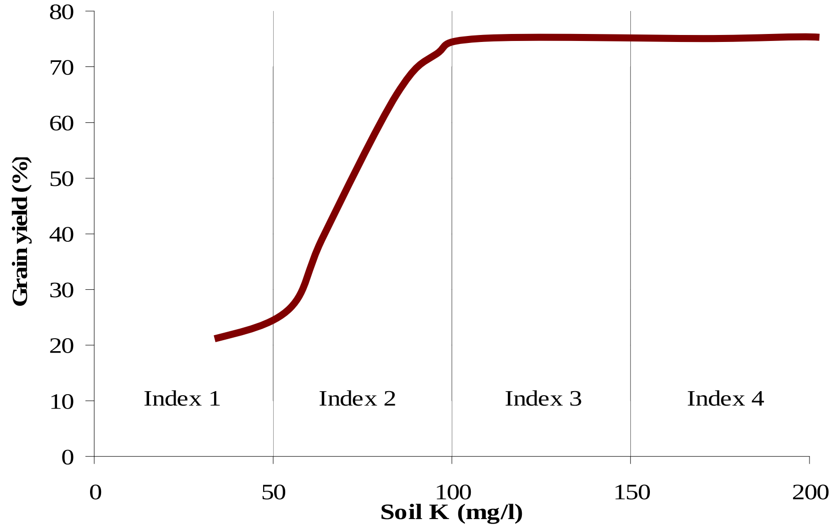

Figure 6. **Relationship between soil K and grain yield in spring barley and winter wheat**

(UK data modified from Olsens to Morgans K)

To avoid limiting crop yield potential and encountering crops showing K deficiency, apply crop K requirements to meet demands throughout the season. Potassium deficiency in cereal crops causes yellowing and chlorosis to the edge and tip of older leaves, with progressive senescence.

New K Advice

Potassium is vital for grain yield and quality and is required in larger amounts than any other nutrient. Potassium deficiency is usually linked to light soils as K is more soluble than P and can be leached on light soils. It therefore remains less critical to get the K on early in the season compared to P.

Teagasc K advice has been revised to take account of the high yield potential of new cereal varieties. Table 6 shows new K advice for cereals where straw has been removed. Fertilizer K applications need to be adjusted based on the crop's yield potential. For wheat and barley crops; increase or decrease the K rate by 10kg/ha per ton depending on crop yield potential.

Soil K will fall faster than soil P as the crop removes 2 – 3 times more K than P. On index 4 soils K applications can be omitted as there is generally no response to freshly applied K. It remains vital to test soils regularly and monitor the reduction in soil K in the absence of K applications.

K – Releasing Soils

In the new K advice, soil K release is not taken account. Soil K release will vary depending on soils clay content – heavy soils will release in the region of 20 – 40kg K/ha/yr, light soils will release relatively small amounts of K annually.

Soils have a capacity to annually release different levels of K which can reduce crop K requirements. This information is best got from experience or local soil knowledge in conjunction with previous cropping, fertiliser applications levels, soil analysis results and crop yields. Fertiliser programmes should be adjusted to take account of the ability of soils to supply K to crops.

K Fixing soils

These soils show low K fertility when analysed and render applied K unavailable over time. It is virtually impossible to raise the K status of these soils to index 3. Apply rates close to maintenance (index 3) levels each year. There are a small number of counties which have K fixing soils and are most commonly found in Carlow, Dublin, Kildare, Laois, Meath and Offaly.

Table 6. K advice for cereals where straw is removed (kg/ha)

	CROP[1]				
Soil K Index	**Winter Wheat[2]**	**Spring Wheat[2]**	**Winter Barley[2] Spring Barley[2]**	**Winter Oats[3]**	**Spring Oats[3]**
1	140	130	115	160	140
2	125	115	100	145	125
3	110	100	85	130	110
4	0	0	0	0	0

1. Assumed crop yields:

   Winter wheat = 11 t/ha Spring wheat = 8.5 t/ha

   Winter Barley = 8.5 t/ha Spring Barley = 7.5 t/ha

   Winter oats = 9.0 t/ha Spring Oats = 7.5 t/ha

   Rates above assume no release of K from the soil.

2. For wheat and barley crops: increase or decrease K rate by 10 kg/ha per tonne increase or decrease in grain yield.

3. For oat crops: increase or decrease K rate by 15 kg/ha per tonne increase or decrease in grain yield.

Source: - Major & Micro Nutrient Advice For Productive Agricultural Crops, 3rd Ed., 2008.

Nitrogen and Potassium Interaction

High yielding winter and spring cereal crops have similar requirements, in that each springtime, they need to efficiently capture sunlight and convert it into energy in dry matter. This is the foundation to high grain yields. Tillage crops take up the majority of N and K during the early months to sustain leaf growth. Nitrogen has a key role here in that it stimulates roots, shoots numbers and increases the leaves and internode length. Cereals require a balance of nitrogen and potassium to obtain full yield response to applied nitrogen. If there is a shortage of potassium, nitrogen is not taken up or used less efficiently. Careful optimization of nitrogen is a waste of time if K supplies are not adequate. Trials carried out examining the effect of different soil and fertiliser K levels on the efficiency of N uptake by winter wheat show that crops grown on low K fertility sites only took up 64% of the N that was taken up by crops on soils with adequate K (index 3). Insufficient K applications with adequate N applications resulted in lower grain yields and a lack of K causing crop lodging due to weaker straw (Milford, G and Johnston, J, 2006).

The soil index system and Teagasc P & K nutrient advice

The following points summarise how to approach nutrient management within each soil index category:

Soil Index 4

- Where soils are at P and K index 4 there is the opportunity to omit P and K applications for a number of years.

- Soil P and K levels will decrease depending on the initial soil level, the seasonal crop offtakes, and the soil type.

- Monitor soils nutrient status regularly to maintain sufficient soil P and K for maximum grain yield.

- Beware of fields with poor soil structure and apply soil improvement techniques where required.

- When fertilisers are not applied the soil K levels will fall more slowly on medium to heavy soils than on light soils.

Soil Index 3

- While maintenance is normally advised in index 3 soils, it maybe possible to omit P and K for one year and to apply maintenance applications there after. As there is little information on the effect of withholding fertiliser P and K inputs to commercially high yielding cereal crops on P and K rich soils.

- Where P and K applications are withheld it will lead to drop in the soil P and K fertility status which will have to be rebuilt at a later date.

- It must also be remembered that a soil analysis report showing a fertility status of P and K index 3 is only an average reading for the area tested. Within the sampled area there will be some variation in soil fertility for example there maybe areas that are lower or higher than index 3.

Soil Index 2

- Soils at P and K index 2, it is necessary to apply P and K advice as per recommendations.

- Withholding P and K at soil index 2 will result in a loss in grain yield and a further drop in soil P and K status.

- Fresh P and K applications are critical on these soils to ensure full crop yield potential is realised.

- It may be possible to reduce nutrient applications on these soils to maintenance applications rates where it is expected that the price of P and K will reduce in the near future.

Soil Index 1

- Soils at P and K index 1 are deficient and have a definite requirement for fresh P and K applications to meet crop requirements for grain yield.

- It is essential that crop P and K requirements are applied to the seedbed at sowing to ensure a readily available supply of water soluble P during early stages of root and tiller development.

- At current fertiliser / grain prices it may be difficult to justify the production of cereal on these soils.

- Organic manures may be a most cost effective means of supplying the higher P & K requirements of index 1 soils.

Reducing Crop P & K Requirements

1. Nutrient Value of Straw

The increase in fertiliser prices has increased the nutrient value of straw. Straw is an excellent source of K and also contains small amounts of P. Returning chopped straw to the soil (see table 7) will help reduce K fertiliser costs. For example, the straw from a 11t/ha winter wheat crop will return 56 kg/ha of K and 4.5 kg/ha of P to the soil. Straw will also bring other benefits such as improving soil structure by adding organic matter to the soil. The decision to chop straw will depend on its monetary value and local demand at harvest time. It is important that where straw is chopped, that it is spread evenly across the field during chopping to ensure even nutrient distribution.

Table 7. P and K removed in straw per ton of grain

	Straw P and K Removal per ton of grain (kg/ha)	
Crop	**P**	**K**
Winter Wheat / Barley	0.4	5.1
Spring Wheat / Barley	0.4	6.7
Oats	0.4	9.7

Souce (DEFRA, 2006)

Table 8 shows new K advice and nutrient value of chopped and incorporated straw. Straw incorporation can significantly reduce crop nutrient requirements for the following crops and in the above example the straw from an 11t/ha grain crop can reduce the cost of fertiliser by approximately €70/ha.

Table 8. K advice for cereals where straw is not removed (kg/ha)

		CROP[1]					
		Winter Wheat[2]	**Spring Wheat[2]**	**Winter Barley[2]**	**Spring Barley[2]**	**Winter Oats[3]**	**Spring Oats[3]**
Contribution of K in Chopped straw		60	60	45	50	85	75
K Advice at each soil K Index	1	80	70	70	65	75	65
	2	65	55	55	50	60	50
	3	50	40	40	35	45	35
	4	0	0	0	0	0	0

1. Assumed crop yields:

Winter wheat = 11 t/ha   Spring wheat = 8.5 t/ha

Winter Barley = 8.5 t/ha   Spring Barley = 7.5 t/ha

Winter oats = 9.0 t/ha   Spring Oats = 7.5 t/ha

Rates above assume no release of K from the soil.

2. For wheat and barley crops: increase or decrease K rate by 10 kg/ha per tonne increase or decrease in grain yield.

3. For oat crops: increase or decrease K rate by 15 kg/ha per tonne increase or decrease in grain yield.

Source: - Major & Micro Nutrient Advice For Productive Agricultural Crops, 3rd Ed., 2008.

2. Organic Fertilizers

Organic manures are not always available to tillage growers due to location and difficulties with operations in springtime. However, where there is a source of organic manures in the form of mushroom compost or livestock manures they can offer benefits in controlling fertiliser.

Under the *SI 378 of 2006* the nutrient value of organic manures must be accounted for and deducted from the total crop nutrient applications. Nutrient legislation sets nutrient values for organic manures. In reality livestock manures tend to be variable due to manure type, animal diet and dry matter which will alter the nutrient content of the manure. For example an application of pig slurry at 22m^3/ha to a spring barley crop will replace 27% of the crops N requirement and make P and K savings depending on soil nutrient levels. In financial terms this is worth in the region of €147/ha at current fertiliser prices. Table 9 below shows the possible savings from a range of organic manures at appropriate applications rates to tillage crops.

Table 9. Typical fertiliser N P and K and economic values of organic manures

Manure Type	*Crop Available N kg/ha (€ value)	Total P kg/ha (€ value)	Total K kg/ha (€ value)	Total value per application**[1]
Pig Slurry (22m³/ha)	37 (€48)	18 (€58)	48 (€41)	€147
Poultry Litter (10t/ha)	44 (€57)	60 (€193)	120 (€103)	€353
Cattle Slurry (33m³/ha)	58 (€75)	26 (€84)	142 (€122)	€281
Cattle FYM (25t/ha)	26 (€34)	30 (€97)	150 (€129)	€256

**N availabilities as per SI 378. Fert. Values: [1]March 2008 Fert. N - €1.29, P - €3.22, K – €0.86 m³/ha ÷ 11 = 1,000gal/ac. **Cost of spreading not included.*

Quality of imported manures

In order to reduce the risk of nutrient variability in organic fertilisers it is essential that manures are well agitated at time of spreading. It is also useful to know the manure's nutrient content as this will ensure that the crops fertilizer requirements are satisfied. Each manure type has average values listed for N, P and K, but to get closer to the real values, nutrient analysis can be carried out either on farm with nutrient tester kits, or certified laboratory analysis. This will allow more precise fertilizer planning in satisfying the crops nutrient requirement. In addition it will help reduce the risk of over or under-supplying nutrients to the crop.

Ensure full account is taken of the P and K content of any manures applied and adjust fertiliser programmes depending on manure type and applications rates in order to fully realize the fertilizer replacement value.

1. Apply organic manures to crops or fields that have an N, P and K requirement and reduce bag fertilizer accordingly.
2. Apply slurry accurately and evenly across the field and ensure suitable soil and weather conditions at time of application.
3. When importing slurry ensure that the 170kg org N/ha limit is not exceeded.

4. Apply accurately the required rate of slurry and make fertilizer adjustments for nutrients supplied in organic manure see table 9.
5. Manure P and K can be considered equivalent to fertiliser P & K, except on with soils P or K index 1 or when growing a responsive crop.
6. It is important to ensure maximum N recovery. Apply manures in early spring and incorporate within 4 – 6hrs of application. This will reduce N loss to the air by approximately 50% when compared to surface application without incorporation

3. Placement of P fertilisers

Seedbed placement of fertilisers at sowing time will result in more precise and targeted applications of crop nutrients resulting in greater nutrient availability and efficiency. The benefit of fertiliser placement is well-established and is a profitable practice for cereal crops grown on soils with low P or K status. In addition to enhancing grain yield, starter fertilisers also increase early season plant growth through faster crop emergence and better root development. In cold or damp springs when soil temperatures are low, crops will have a readily supply of water soluble P to meet the demands of early root / tiller development.

Placement of fertilisers will increase P fertiliser efficiency compared to broadcast applications. Typically fertilisers will contain N & P or N, P & K. Generally, fertilisers containing N & P have given enhanced uptake of both nutrients. The main factor influencing crop response to fertiliser placement is the existing soil fertility status. In a review of P & K placement it was concluded that placement seldom influences crop yield response on high P fertility soils. On low fertility soils fertiliser placement was more effective than broadcast applications in fast crop establishment and ensuring maximum grain yields (Bundy,et al, 2005).

4. Timing of P and K applications

Generally P & K fertilisers are applied to tillage crops before cultivations in the autumn or spring. It is essential to incorporate applied fertilsers / manures as soon as possible to reduce the risk of nutrient loss. With high nutrient costs it is critical to apply nutrients at the correct stage to get the best value from inputs.

Phosphorus

Phosphorus has a major role in the early establishment of cereal crops especially in root development. Phosphorus tends to be immobile in the soil. Therefore it is essential that P is in the seedbed close to the seed during establishment. On index 1 soils P should be applied to the seedbed at sowing time to ensure adequate supply to the crop at early stages of development. This is also beneficial on poor structured soils as roots find it difficult to find P in such soils. On well structured soils at index 2 and 3, P can be applied as top dressing during the growing season.

Potassium

Although K is slightly more mobile than, P it is good practice to apply K to the seedbed at sowing time where soil reserves are low. Again where soil structure is poor it is best to apply K to the seedbed to ensure easy access for plant roots. On light soils where K levels may be low, it is best to split K applications for winter cereals between autumn and spring. At soil index 3, K can be applied at any time as the K applied is replenishing K offtakes in the crop.

Within *S.I. 378 of 2006* the application of P is not permitted from the 15th September to 12th - 31st January depending on location. There is no restriction on the application of K fertilizer.

5. Soil management practices on farm

Soil nutrient availability is dependent on the soil physical characteristics. In order for soils to function and supply plants with sufficient nutrients during periods of peak seasonal demand, it is essential that soil structure has a good structure, good depth of top soil and high levels of soil organic matter. Where soils have been compacted it will restrict root development and root exploration for soil nutrients in the rooting zone. Soil organic matter is vital to healthy and active soils. Recent research work from Rothamsted has shown that soils which received FYM for many years not only had higher levels of soil organic matter but also had higher levels of available soil P. Soil structure needs to be considered when interpreting soil test results.

Taking a P and K Holiday?

Current indications are that fertiliser prices are not going to decrease back to prices pre 2007 even though oil prices have taken a major drop in the last number of months. With low crop value and high input prices there is a large temptation to reduce or omit P and K applications for a year or so in order to maintain crop profitability. The world supplies of P and K is set to remain tight through to 2011, when new fertiliser production capacity is expected to come on stream.

Soil fertility is a long term investment for your farm as soils are required to deliver high yielding grain crops annually. With this in mind soil fertility needs to be managed with future crop production requirements in mind.

Before omitting P & K fertilisers in the current season you must know the following:

1. The current soil fertility status of your soils.

2. Trial results and effects of withholding P and K nutrient applications.
3. Previous fertiliser / manure history.
4. Soil management practices on the farm.

The effect of omitting P and K applications on soil fertility levels

Research work from Teagasc, Oak Park, (table 10) shows soil P fertility status for the Cereal Inputs Trial carried out from 1994 to 2004. The management of the high inputs system received recommended rates of P. Even though the recommended rates of P were applied soil P results have levelled out and now show a soil P index 3. This indicates that P removed from the field at harvest time was not replaced in full which inevitably lead to reduced soil fertility.

Table 10. Cereal Inputs Trial, Knockbeg 1994 – 2004*

Soil P Status			
System	1994	2004	Av. Drop in Soil P/Yr
Soil P			
Low Input	20	5.7	**1.4 mg/l**
High Input	16.4	9.7	**0.67 mg/l**

*Source:- * Oak Park Research Centre*

The low input systems trial received no fertilizer P for 10 years; on this soil type soil P has fallen quickly by 1.4mg/l/yr, P fertilizer is now applied at recommended rates to curtail a further drop in soil P fertility.

The effect of omitting P and K applications on grain yield

Research work from the UK (HGCA, 1999) indicates large yield difference between sites and withholding P applications to cereal crops. Some sites showed a yield loss in year one and other sites did not show a yield loss until year four after omitting P. The yield losses recorded depended on the sites initial P status, generally where soil P status was low (index 1) yield loss was recorded earlier. Sites that had high initial P levels show a small yield difference after a number of years (3 years) and larger yield reductions there after.

This trial work also showed that grain yield responses of 0.19 – 1.49t/ha to freshly applied P on sites which had P withheld for a number of years and soil P levels had reverted to soil index 1.

For K, where soil K levels are high there is little loss in grain yield from withholding K applications. On sites with low soil K (index 2) due to withholding K applications there was a increased yield response of 0.18 - 0.78t/ha to fresh fertiliser K applications.

However, in these experiments there was number of sites which maintained soil P and K levels even though P and K was withheld during the period of the trial. This is possibly due to soil physical properties and their ability to release plant available P and K from soil reserves.

Current economic pressures are forcing growers to analyse there production costs and ensure that crops are being grown as efficiently as possible. Omitting P and K must be based on good information as it is easy to make a cost saving that affects yield and leads to a larger loss. Where soil reports are unavailable it is essential to apply maintenance P and K applications to replace crop nutrient removals in order to reduce the risk of poor crop performance.

Trial work above clearly demonstrates that where P and K fertiliser applications are omitted there is the definite risk to reduce grain yield due to the followings:

1. Insufficient P and K to support full yield
2. Reduced uptake of other nutrients especially nitrogen
3. In continuous winter wheat a increased risk of take all infection

The effect of Omitting P and K on cereal crop margins

The effect of taking a P & K holiday on crop margins will depend on the soil fertility status of your soils. As can be seen from the research data above the yield loss from omitting P is in the range of 0.19 – 1.5t/ha for cereals. For K yield responses up to 0.78t/ha have been recorded. P & K omission will also result in a decline in soil fertility status which needs to be considered also. A reduction in P & K applications will reduce crop yield potential and in turn will significantly reduce the return from other inputs (nitrogen, fungicide, herbicides etc) applied to the crop. In addition grain prices have been extremely volatile over the last 2 years reaching unexpected highs and lows.

Benefits of High Soil P & K

Many trials have shown the benefits of building / maintaining soil fertility which ensures that crops have a sufficient supply of readily plant-available P & K in the soil. Research from Rothamsted has clearly shown that soils with high levels of K increase the grain yields of cereals.

A trial consisting of four crops, potatoes, sugar beet, barley and oats were grown in a rotation on a sandy soil with three levels of K in the Reference experiment at Woburn (table 11). As the soil K increased the yields of all four crops increased, again it was justified to build up and maintain an adequate supply of readily available plant-available K in the soil (Johnston, 2007).

Table 11. Yields of four arable crops grown on a sandy loam soil at three levels of exchangeable K in 1960 – 1969 (adapted from Widdowson and Penny, 1972 and Williams, 1973).

	Soil K Status		
	30	109	258
Crop		Yields, ton/ha	
Potatoes, tubers	10.1	25.2	44.3
Sugar beet, sugar	2.8	5.36	7.32
Barley, grain	2.82	4.07	4.37
Oats, grain	4.62	4.49	5.04

CONCLUSION

The profitability of cereal production is being eroded through the rising costs of fertilisers coupled with low grain prices currently. The cost of fertiliser has increased significantly in 2008 and price current prediction for 2009 will seriously question the viability of some tillage production systems on low fertility soils. This creates a large element of risk involved in growing cereals on low fertility soils as the costs of production are exceeding crop returns. A grain price increase of €30 – 50 /t would have a marked effect on the profitability of cereal crops and would reverse the current situation. There are a number of ways to make more cost effective use of applied P & K fertilisers;

1. Where up to date soil analysis results are not available from the past 3 – 4 years on farm, contact your local Teagasc advisor and organise the taking soil samples as soon as possible. A soil sample is the cost equivalent of one 50kg bag of fertiliser compound.

2. Check soil pH status and where lime is low apply as per recommendations.

3. Apply P & K fertilisers as per soil test results and aim to maintain soils at the target soil index (index 3) to maximise grain yields.

4. Omitting P & K applications on index 1 & 2 soils will produce lower yield and may also result in poor crop N use efficiency.

5. Omit P & K applications on soils with high fertility status (index 4).

6. Where possible, recycle organic manures and ensure full account of N, P & K values of organic manures are deducted from crop nutrient requirements.

7. Where straw has been chopped and incorporated deduct nutrients in straw from crop nutrient requirements.

8. Ensure good soil structure by timely soil cultivations as poorly structured soils will reduce root development and limit access to soil and applied nutrients.

9. Ensure fertiliser spreaders are calibrated and operating correctly.

10. Check soil minor nutrients and take corrective action where soils are deficient.

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Appendix 1: - CSO average fertiliser prices by year (2005 – 2008).

	€/tonne			
	2005	2006	2007	2008*
CAN (27%N)	213	227	235	366
Urea (46% N)	383	415	419	436
Granular Super P (16% P)	276	287	300	547
Muriate of Potash (50% K)	276	300	315	523

** Prices for November & December averaged for 2008*

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Business & Technology Service for Tillage Farmers

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SUMMARY

Most of the world's leading agricultural economists and economic organisations such as the OECD are predicting grain prices to increase over the next 10 years but this comes with a warning of increased volatility in the market place. The last two years have highlighted this volatility with grain prices reaching a high of €250/t in 2007 to the low of €120/t in 2008.

Business and Technology advisors have an important role to play in supporting farmers to maximise their income when prices are high and to help steer farmers through the difficult times when prices are low. This is delivered to farmers by providing them with a detailed business and agronomy service.

The case study outlined in this paper highlights the difficulties associated with the tough harvest of 2008 and the reduced output that occurred due to low grain prices. The farmer featured in this paper used the Teagasc profit monitor in 2008 and had a variation in margins from different crops from €166/ha to €-225/ha with the average at €-81.

The profit monitor results are used as a basis to form a budget for 2009. At €125/t (at 20% moisture) for barley in 2009 it is possible to leave a margin on owned land but substantial savings will have to be made in input costs and land rental to achieve the same margin on rented land.

INTRODUCTION

Teagasc has recently launched a sectoral road map for all the main agricultural enterprises. The sectoral road map for tillage sets out the anticipated shape and size of the sector in 2015, with steps to improve the environment and land use. The Teagasc Business and Technology service will play a large role in achieving this vision.

In this paper I will outline the key activities undertaken by a Business and Technology advisor and the role that the advisor has in helping the farmer achieve their goals. I will also outline the interactions between advisor and farmer through a case study of a farmer based in Cork.

Teagasc Tillage Business & Technology Programme

The goal of the Business & Technology (BT) programme is "to support farmers to make an income, consistent with their desired needs, aspiration and lifestyle". The new BT Tillage Crops Programme is tailored to individual farmer needs. It places a renewed emphasis on farming for profit by focussing on two main drivers for innovation and efficiency:-

1. A detailed business service giving whole farm appraisal and planning as well as improving crop, machinery and labour efficiencies

2. A crop agronomy service providing planned approach to inputs as well as time critical advice on crop husbandry and market opportunities.

The BT Tillage programme is delivered by means of farm visits / consultations, crop walking, newsletters, leaflets, texts, emails and the web. Discussion groups, seminars, open days, field walks and short courses are used where appropriate.

The programme is provided by 17 Business and Technology Tillage advisors located in all the major tillage counties. The service is supported by 4 tillage specialists and research work done at Oak Park Research Centre.

Delivery of Tillage Business and Technology Programme Options

The options programme aims to help farmer's assess the current farm situation by establishing the facts in terms of farm income, household income, living expenses and future income needs. The programme helps identify options for the generation of additional income, ways in which quality of life can be enhanced and draw up a plan to build a better future. The € Profit Monitor is the corner stone of an options plan.

€ Profit Monitor

The Teagasc €Profit Monitor (€PM) is a secure internet-based program designed so that the adviser or farmer can input the information on-line. The profit monitor provides an accurate analysis of the profitability of the farm on an enterprise by enterprise basis and on a crop by crop basis. The primary sources of information for the eprofit monitor are the Teagasc e-crops programme, Teagasc Machinery Programme, tax accounts and loan details. The annual tax accounts provide useful financial information (for tax purposes) but the eprofit monitor will more closely match financial realities on the farm. It can also build up data for each crop and present it in a multi-year fashion as well as comparing your figures to national and local averages. It is normally completed at the end of each year by Teagasc advisors in consultation with the farmer. A vital element of completing a profit monitor is to use it to make a budget for the following year

E – Crops Programme

The Teagasc E-crops program is an Excel based computer program which generates an instant gross margin on a field by field basis. It is also an acceptable method of recording your chemical and fertilizer data for Cross-Compliance and the Grain Assurance Scheme. It can be completed periodically throughout the year or filled from your field diary at the end of the crop season on your home computer. A completed E-Crops programme provides most of the information needed to complete a profit monitor. There are currently 20 farmers using the e-crops programme in my area.

Fertiliser Planning

Fertiliser planning is one of the most important tasks to complete on any tillage farm for two reasons, firstly for cross-compliance reasons and secondly for financial reasons. Cross-Compliance requires farmers to estimate crop fertiliser requirements at the start of each year and also to have year end records available for cross-compliance inspections. The cost of fertiliser has increased by 60% in spring barley at a time when margins are being eroded by falling grain prices. Therefore careful fertiliser planning by using recent soil test results and the use of organic manures is critical to ensure profitability.

Crop Agronomy

Crop walking is an essential part of the business and technology service to farmers. Independent and time critical advice is important for the attainment of maximum yields. Advisors are well placed to give advice on all inputs by walking a large area of crops during the season and rely use on the results of research work done in Oakpark and at various locations around the country for when formulating recommendations.

Discussion Groups

Currently there are 20 Tillage Discussion groups in the country. The local advisor facilitates the meetings which are held on the member's farms throughout the year. All topics relevant to tillage farming are discussed from agronomic to financial to machinery.

These meetings are an invaluable source of information for farmers as problems encountered by one farmer may have been encountered by another farmer recently and as often happens that the answer to a problem comes from another farmer rather than the advisor.

Technology Transfer

Seminars are held in the spring and autumn in all the tillage counties every year along with farm walks and open days to update farmers on the latest varieties and to provide farmers with the latest technical updates. Farmers receive monthly newsletters, crop reports and a harvest report through out the season. Short courses are generally run during the winter and these courses cover topics such as financial planning and fertiliser planning.

Energy Crops

Energy crops are becoming an increasing important section of the agricultural sector. Energy crop calculators are available to all clients to evaluate the return on investment of the crop. To date most interest has been in miscanthus and willow.

BETTER Farms

Teagasc is strengthening its partnership with commercial farmers through the development of the BETTER (Business, Environment, Technology through Training, Extension and Research) Farm Programme. This model for technology uptake will be delivered on commercial farms to demonstrate the impact of new technologies and to carry out on-farm research. There will be four of these farms nationally with one in Cork.

Single Farm Payment

The single farm payment still is a major body of work that has to be completed for clients every year. The aim is to complete at lest 75% of the single farm payments on-line as this reduces the chances of any errors occurring and having the data available electronically makes the fertiliser planning process more efficient.

Case Study

In order to provide an insight into how the Business and Technology programme works at farm level I will outline the typical interactions that I had with one farmer based in Cork during 2008.

Background

The farmer in this case study is an intensive tillage only farmer who owns 60.5 Ha and is renting a further 38.6 Ha. The soil type would be classified as a medium loam. Historically the cropping regime on the farm was based around the sugar beet crop. Since the demise of sugar beet he has increased his area of spring barley and has grown winter oilseed rape as a break crop. His cropping details for 2008 are shown in table 1.

Table 1. Cropping Details 2008

	Total	Winter Wheat	Spring Wheat	Spring Barley	W.O.S.R
Owned Land	60.5	8.1	12.2	28.2	12.0
Rented Land	38.6	0	14.9	23.7	0
Total	99.1	8.1	27.1	51.9	12.0

He uses a plough and one-pass system to establish his crops. The machinery policy on the farm is mainly to purchase good second hand machinery and keep it for 5-10 years depending on wear. He employs part-time labour and also has family labour available during busy times especially the harvest.

Business and Technology Service

During the spring of 2008 after he finished his single farm payment application we completed the fertiliser records for 2007 and planned fertiliser for 2008. Table 2 shows this fertiliser plan which is required under cross-compliance.

Table 2. Fertiliser Plan 2008.

Reference Yields for Tillage Crops (if applicable) Crop	Highest av. yield @ 20% in 3 yrs (t/ha)	Yield above reference (t/ha)
Winter Wheat	10.0	1.0
Spring Wheat		
Winter Barley		
Spring Barley		
Winter Oats		
Spring Oats		

N advice for grazing (Available N kg/ha)

No grazing Livestock on holding

Organic Manure Usage	Total Available (t)	Total Used (t)	Remainder (t)

	N	P	K
Total Chemical Fertiliser recommended for all Crops (kg)	14,579	2,418	7,866

NPK recommendation for each crop

Field Name	Townland	Parcel No.	Area (ha)	Soil Sample	Soil Index N	P	K	Crop	Yield above reference (t/ha)	Organic Manure	Rate (t/ha)	Chemical N (kg/ha)	Chemical P (kg/ha)	Chemical K (kg/ha)
0	0	0	3.22	No Soil Test	2	3	3	Winter Wheat	1.0			160	25.0	105
0	0	0	6.27	No Soil Test	1	3	3	Spring Barley				135	25.0	85
0	0	0	4.10	No Soil Test	1	3	3	Spring Barley				135	25.0	85
0	0	0	1.15	No Soil Test	1	3	3	Spring Barley				135	25.0	85
0	0	0	1.38	No Soil Test	1	3	3	Spring Barley				135	25.0	85
0	0	0	4.88	No Soil Test	2	3	3	Winter Wheat	1.0			160	25.0	105
0	0	0	10.10	No Soil Test	1	3	3	Spring Wheat (Feed)				140	25.0	85
0	0	0	12.00	No Soil Test	1	3	3	Oilseed Rape				225	20.0	25
0	0	0	2.22	No Soil Test	1	3	3	Spring Barley				135	25.0	85
0	0	0	4.10	No Soil Test	1	3	3	Spring Barley				135	25.0	85
0	0	0	3.85	No Soil Test	1	3	3	Spring Wheat (Feed)				140	25.0	85
0	0	0	1.38	No Soil Test	1	3	3	Spring Barley				135	25.0	85
0	0	0	7.25	No Soil Test	2	3	3	Spring Wheat (Feed)				110	25.0	85
0	0	0	5.80	No Soil Test	1	3	3	Spring Wheat (Feed)				140	25.0	85
0	0	0	6.99	No Soil Test	1	3	3	Spring Barley				135	25.0	85
0	0	0	12.50	No Soil Test	1	3	3	Spring Barley				135	25.0	85
0	0	0	5.90	No Soil Test	1	3	3	Spring Barley				135	25.0	85
0	0	0	6.01	No Soil Test	1	3	3	Spring Barley				135	25.0	85

Under this plan he is allowed to use 14,579kg of N and 2,418kg of P. Soil test results were not current so all of his soil was assumed at index 3 for P and K. All crops were index 1 for N except for the winter wheat which followed winter oilseed rape and one field of spring wheat that followed setaside. His allowance on winter wheat was increased by 20kg per ha as a result of having achieved a yield in excess of 10t/ha in one of the previous 3 years.

He soil sampled all of his land in the autumn of 2008 and he will use these results for the fertiliser plan in 2009. The results of the soil tests put approximately 5ha in index 2 for P and 30ha in index 4 for P with the remainder in index 3. Most of the land was in index 3 for K. The other feature of the soil test results was that the soil was low in Zinc and this confirmed a problem that we had discovered during the year especially in spring barley.

As a result of soil testing the land, at current fertiliser prices with P costing €3.90/kg, this will result in a net saving of €2,800 in phosphate on the index 4 soils.

Recent research work done in Johnstown Castle has shown that where organic manure is ploughed down within 6 hours of application that the availability of nitrogen is enhanced so he intends to source pig slurry this spring to further reduce fertiliser costs.

Prior to this year he had been using the Irish grain assurance scheme book to record his pesticide data but this year I set him up with the Teagasc E-crops programme on his home computer. This now allows him to have all the information required for cross-compliance purposes and it also enables him to track financial inputs and gross margins on a field by field basis. Once he has completed the input costs and inputted the fixed costs into the programme all the information will be entered into the profit monitor. We used the Teagasc machinery programme to calculate his machinery costs and we used the lending company's year end statement for his lease costs and other fixed costs came directly from his accounts. The single farm payment is excluded from all calculations. The results as outlined in table 3 were not as he had hoped as it had been a very difficult year but it provides a firm footing to do a budget for 2009.

Table 3. Profit Monitor Tillage – All Crops / ha

CROP			Total	Winter Wheat	Spring Wheat	Spring Feed Barley	O.S Rape - Winter
	Owned Land		60.5	8.1	12.2	28.2	12.0
	Leased Land		38.6	0.0	14.9	23.7	0.0
	Total Tillage Adj. Ha		99.1	8.1	27.1	51.9	12.0
	Tonnes			84	193	371	49
	Tonnes / Ha			10.37	7.12	7.15	4.08
	Kg of N / Ha			190 /Ha	140 /Ha	135 /Ha	220 /Ha
GROSS OUTPUT							
Sales	Crop		997	1,348	890	912	1,368
	Straw / Tops		166	207	155	203	0
	Bonus		0	0	0	0	0
Gross Output			**1,163**	**1,556**	**1,045**	**1,116**	**1,368**
VARIABLE COSTS							
	Seed		87	86	94	86	75
	Fertiliser		277	410	293	242	308
	Lime		0	0	0	0	0
	Herbicide		51	40	37	49	98
	Fungicide		96	176	106	89	45
	Insecticide		8	10	10	9	0
	Growth Regs.		3	10	9	0	0
	Scutch Control		8	8	8	8	8
	Contractor	Plough / Till / Sowing	0	0	0	0	0
		Spraying	0	0	0	0	0
		Fert. Spreading	0	0	0	0	0
		Harvesting	0	0	0	0	0
		Other	0	0	0	0	0
	Levies and Transport		0	0	0	0	0
	Sundry Var. Costs		0	0	0	0	0
	Total Variable Costs		531	740	557	484	534
Gross Margin			**632**	**816**	**488**	**632**	**834**
FIXED COSTS							
	Hired Labour		50	67	45	48	59
	Mach. Running		110	147	99	105	129
	Mach. Leases		86	115	77	82	101
	OD & Credit Int.		21	28	19	20	25
	Loan Interest		0	0	0	0	0
	Car (Farm)		25	34	23	24	30
	E.S.B (Farm)		21	28	19	20	25
	Phone (Farm)		9	12	8	9	11
	Dep. Build		10	13	9	10	12
	Dep. Machinery		142	190	128	136	167
	Repairs and Maint.		0	0	0	0	0
	Insurance		35	47	31	33	41
	Prof. Fees		32	43	29	31	38
	Sundry Fixed Costs		26	34	23	25	30
	Land Lease		145	0	203	171	0
	Total Fixed Costs		713	759	713	716	668
Net Profit			**-81**	**56**	**-225**	**-84**	**166**

Table 4. All Crops per /Ha

	Total	Winter Wheat	Spring Wheat	Spring Barley	W. Oilseed Rape
T/Ha		10.37	7.12	7.15	4.08
Output					
Grain	997	1348	890	912	1368
Straw	166	207	155	203	0
Total	1163	1556	1045	1116	1368
Variable Costs	531	740	557	484	534
Gross Margin	632	816	488	632	834
Fixed Costs	713	759	713	716	668
Net Profit	**-81**	**56**	**-225**	**-84**	**166**

Output per ha was lower for all crops than had been anticipated, but this was more of a consequence of a poor price rather than yield. Variable costs were higher than had been planned for at the start of the year with the biggest increases being associated with fertiliser on all crops. The land rental costs and the reduced yield resulted in spring wheat having the lowest net margin. Fungicide cost on spring barley at €89 per ha was highlighted and needs to be reduced in 2009 to achieve a positive margin over fungicide cost. However, the fixed costs on the farm are under control with machinery costing €338/ha. Land rental cost will have to be addressed for 2009. Overall the farm lost €81/ha in 2008 and this resulted in the farmer eating into his single farm payment.

The real value of this report is that it accurately reflects the costs on the farm and forms a solid foundation in preparing a budget for 2009. The farmer has three main questions;

1. Can I grow a crop on my own land?
2. Can I continue to rent land?
3. If I rent land what savings will I have to make to achieve the same margin as on my own land?

To answer these questions we are going to do the analysis on spring barley because it will be the largest crop on the farm in 2009 and it will be grown on both rented and owned land. A number of assumptions have been made to complete the budget.

1. Both the owned and rented land have the potential to produce a yield of 7.5t/ha.
2. Straw will yield 20 4x4 round bales per ha and will make €10 per bale from the field.
3. Grain price will be €125/t delivered @ 20% moisture.
4. Seed and sprays will be projected for 2009 based on the 2008 profit monitor.
5. The fixed costs recorded in the 2008 profit monitor will be used as there are no expected changes in the machinery profile for 2009.
6. Both the rented and owned land is at index 3 for P and K, and index 1 for N.
7. Fertiliser prices used are; Can €380/t and 18-6-12 €530/t
8. Total N used will be 135kg/ha. Base fertiliser will be 370kg/ha of 18-6-12 and reduced fertiliser input will be made up of 31m³/ha of cattle slurry incorporated at ploughing.
9. Last years land rental price of €372 per ha will be used.

Table 5. Budget analysis for 2009

	S.Barley Own Land	**S.Barley Rented Land**	**S.Barley Rented Land Using Organic Manure**
Output	1140	1140	1140
Seed and Sprays	210	210	210
Fertiliser	290	290	103
Gross Margin	640	640	827
Fixed Costs	545	545	545
Land Rent	-	372	**187**
Net Margin	95	-277	95

- The answer to the farmer's first question is yes he can grow a crop on his own land but at a low margin of €95.

- Paying the same land rent as 2008 will result in a net loss of €277/ha.

- In order for the farmer to make the same margin on the rented land as his own land he would have to make savings on the cost of growing the crop. In this instance he would incorporate 31m³ of cattle slurry per ha. The land rent would be reduced to €187/ha.

The temptation in this situation is to rely on non cash costs (depreciation) to justify land rental. Machinery deprecation is a real cost on tillage farms, although not a cash cost affecting the bank balance every year. Depreciation is a figure which should reflect the reduced value of a machine(s) from the time of purchase to the time of sale. Without this provision there would be no money left in the business to purchase newer machines once the old ones have worn out.

If one could confidently predict that grain price would increase again in 2010 then one could use part of this depreciation provision in 2009 to support cropping and regain lost ground with increased profits in 2010. Caution must be taken with this strategy as this is effectively asset stripping (using the value of machines to support loss making).

It must be remembered that where owned land does not generate enough income to pay for fixed costs (excluding land rental), then land rental (positive margin after land rental) can be considered. This will reduce fixed costs thus not eating into the Single Farm Payment.

In this example the total fixed costs for spring barley in 2008 was €713 and €171 of this was for land rental leaving €545/ha to be covered by the crop. Of the €545/ha, €136 of this relates to machinery depreciation.

Another alternative for the farmer would be to stack his entitlements and join Reps which would yield €10,065 per annum. Overall fixed costs would reduce but fixed costs per ha would increase.

Employing a contractor to do all the work would increase the cost of production and would make it very difficult to make a positive margin on owned land.

CONCLUSIONS

1. The business and technology tillage programme for commercial farmers is placing a renewed focus on farming for profit.

2. Substantial savings can be made by using soil test to assess soil fertility.

3. High yields will have to be achieved on all land that is farmed in 2009 to ensure a level of profitability. Land that cannot achieve high yields has little chance of leaving a positive margin.

4. Land rents will have to reflect the quality of the land. Reductions in variable costs will also have to be achieved for rented land to leave a positive margin.

5. The objective in a year of low grain prices is survival and retention of the single farm payment. Grain prices remain positive in the long term.

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Challenges and Opportunities in Tillage Farming –

A farmers view

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SUMMARY

The challenge for every tillage farmer in these fluctuating times is to keep a viable farm enterprise in operation. The complete farm business must be evaluated and areas which are loosing money identified. Positive action needs to be taken as indecision, in effect, allows external factors to determine the fate of a farm enterprise. The banking crisis coupled with the international downturn has implications at farm level. Tillage farms need to address costs and maximize farm payments. Alternative enterprises are an ideal way for tillage farmers to use their spare time productively. New enterprises can complement the existing farm business and offer an income buffer in challenging times. There are pitfalls which need to be recognized but with appropriate management, these can become very successful businesses in their own right.

The traditional model of grain marketing in Ireland, where a merchant or co-op purchased green grain at harvest and speculated on price, may not be feasible in these volatile times. There is a need to introduce forward selling, perhaps initially by tillage farmers agreeing to supply the market throughout the year at a

fair market price and not waiting in anticipation of market peaks. We need to introduce stability into the Irish grain market, to restore confidence and keep tillage farmers in business. Tillage farmers need to get value for money from modulation. Very few tillage farmers have gained directly from this tax. A portion of these monies should be allocated to establish an emergency fund for the farming industry.The poor interpretation of European law is sullying the waters of opinion of the Irish farming community towards Europe. The inspection industry, whose lifeline is agriculture, should have a positive, constructive and practical approach to agriculture. In my opinion, the inspectorate needs to stand their ground and defend good farming practice in Ireland to Europe.

There is a need to evaluate our tillage industry from production to end user. Capital investment needs to be targeted to areas of need. There has been a reduction in our grain handling infrastructure over many years. Crop production and usage also requires evaluation. Efficient evaluation of the grain industry would facilitate the matching of crop production with local markets and would lead to lower transport and higher efficiencies. Grant-aided or tax incentivized slurry holding facilities in suitable tillage locations would greatly assist the nutrient cycle and reduce fertilizer costs. This proposal would allow the growth of the dairy and pig sectors without the requirements of extra land to deal with their slurry waste. It would also greatly reduce soil compaction on tillage farms as slurry application would only occur during optimal soil conditions.

The future of the tillage industry lies in research and development. Teagasc plays a pivotal role here in both its research and advisory capacity. Straw, a waste product of grain production, is a proven energy source which has huge potential if properly exploited.

The challenges to Irish tillage farming are very real and are constantly changing. We need to be knowledgeable and flexible in our approach to deal with these issues as they arise.

INTRODUCTION

Tillage farming in Ireland is a specialized industry. The fragmentation of our rural landscape and small farm size coupled with high disease pressure make tillage farming in Ireland a constant challenge. Our climate, which so often challenges us, also provides us with the highest yields in Europe. Irish tillage farmers have always embraced technology and, year in year out, produce highly traceable, consistent quality grain. Coupled and intertwined with our tillage industry are our dairy, beef, sheep, pig and poultry industries which combined can utilize all our national tillage produce.

This paper will address the following topics:-

- Whole farm analysis and cost reduction
- Alternative enterprise: opportunities and pitfalls
- New ways to market grain
- Value for money - Modulation and Regulation
- Evaluation of our industry and nutrient recycling
- Practical biofuels and research

Whole Farm Analysis and Cost Reduction

Whole Farm Analysis

Whole farm analysis is an important task for all farmers, not just tillage farmers. All lands owned should be appraised to evaluate their yield potential or otherwise. The simple way to put it is ‘every acre must earn’. All inaccessible or wet ground not suitable for tillage should be identified and either converted to grass, forestry or linnet. Whichever use is chosen, this must fit the farming schedule and return profit. Too often, bad portions of land are returned to tillage only to loose money on an annual basis. With regard to conacre, the analysis is quite simple: only take land which has the potential to yield a profit.

For every acre farmed, it is essential to maximize farm payments. Consolidation of entitlements may reduce the need for expensive conacre. REPS (Rural Environmental Protection Scheme) is a valuable source of income which should also be considered.

Cost Reduction

Cost reduction is a difficult task for most businesses. Tillage farming is no exception. Low input production techniques are often not favored by progressive farmers who strive for high yields. Some cost reductions are simply prudent behaviour while others, such as sharing of equipment, require good inter-personnel skills. Budgeting is essential. Prior to setting a crop, a farmer needs to decide his acceptable profit per acre. This means that the farmer needs to deduct his profit from the estimated turnover, and determine if it is possible to produce a crop with the remaining money. If the farmer cannot produce the crop within this budget, then in my opinion, the crop should not be sown. A farmer receives the SFP (Single Farm Payment) irrespective of whether he works the land or not. For example, spring barley with an average yield of 2.5 tonnes per acre, will produce sales of 300Euro per acre (allowing for a green grain price of 100Euro per tonne and a value of 50Euro per acre for straw). With a turnover of 300Euro per acre, allowing for a profit of 60Euro per acre, the costs of crop production must fall under 240Euro per acre.

It could be said that the difference between a good and an average yield is a half tonne per acre. At a possible green grain price of 100Euro per tonne, this equates to 50Euro per acre. Spending extra on inputs this year, may only help turnover.

Cost reduction should include critical assessment of the following:

- ***Inputs***

Seed, fertilizer, spray, diesel and insurance are often purchased competitively though ‘purchasing groups’. Nevertheless, mistakes are often made due to lack of preparation at individual level. Accurate assessment of input requirements by each group member is essential. Under or over purchasing can increase costs. However, some flexibility in purchasing is also required as input levels vary each year. In 2008, there was low disease pressure early in the growing season. Less spray was required as many winter wheat crops yielded very well with a two spray program. The days of blanket T 0, T 1, T 2 and T 3 preventative disease control are gone.

- ***Conacre / leased land***

In 2008, very little conacre made profit. Only conacre which was required for consolidated single farm payment was justified. Decisions on conacre need to be assessed on a three-yearly basis. Gambling on conacre is an expensive game. A more sustainable rental needs to be based on the crop yield. Potential pitfalls of shared farming need to be addressed. The situation where the land owner received the SFP on the basis of his area aid form and the actual farmer was disenfranchised cannot be ignored in the future.

- ***Machinery***

Minimum tillage and machinery sharing can both offer substantial savings. In my experience, minimum tillage can produce real cost savings. However, it is essential to keep the costs of the cultivation equipment to a minimum. There is a case for using conventional and minimum tillage in tandem as they compensate for the weaknesses of each other. Machinery sharing allows the tillage farmer to have new, reliable equipment at minimum cost. In my own case, I am one of three joint owners of a combine harvester. This allows us to purchase a new high output machine every three to four years, with a payment per acre of 25Euro.

- ***Soil and plant tissue analysis***

Tillage farmers need to know the inherent strengths and weaknesses of each field. Soil analysis allows a farmer to anticipate problems and act on them prior to manifestation during plant growth. Soil analysis also allows cost savings as fields with high phosphate and potash indices can be targeted for nitrogen only application. In my experience, plant tissue analysis has proven valuable, especially when a crop comes under pressure mid-season. Following liquid nitrogen and targeted trace element application, I have seen crops recover and yield well with little expense.

- ***Straw Management***

The straw market is highly variable. Every year, it is labour intensive while only some years, delivers a profit. Having baled straw for many years, I recently changed my approach to either selling straw on the flat or chopping the straw at harvest, where nutrients are returned to the soil. One important advantage of removing the straw crop is that fields are available for early planting and compaction is minimized. This ensures optimal crop establishment.

Alternative Enterprise: Opportunities and Pitfalls

Farming needs to embrace business with a clinical approach. I have seen farmers purchase equipment on the basis of colour rather than cost and performance. There are still farmers who purchase sprays on the word of a sales person rather than assessing products themselves on a yearly basis. It would be wrong to give the impression that all spending is bad. However, in my opinion, spending must be knowledge based, clearly demonstrating additional profit return to the business.

This is the approach a farmer needs to adopt if he is to have a reasonable chance of succeeding in an alternate enterprise. Ideally, an alternative enterprise should have common links with the farm. This will permit fixed costs to be diluted across two businesses and helps to reduce startup costs. I have used this approach to establish a grain drying and warehousing business in 1995: 'TBWarehousing'. Today, this business dries and stores 35,000 tonnes per annum. This alternative enterprise has worked in tandem with the farm and provides additional income and employment. Storage, like farming, is hugely capital intensive. Therefore, each investment must be monitored critically.

Be warned that setting up a new business is a gamble. Banks will require security for additional loans pertaining to the business. In the case of farmers, land is frequently offered as security. Failure of a new business may result in the loss of some, or all, of the family farm. This needs to be discussed thoroughly beforehand with relevant family members.

In my experience, it is very easy to become reliant on one customer. As the saying goes, 'Don't put all your eggs in one basket'. Always be on the lookout for new customers and be flexible in ones approach. Customer care is a term often used and seldom practiced. However, it is crucial that a business works with its customers and understands their requirements.

Efficient bookwork is the engine that keeps the business moving. Issuing invoices on a weekly basis and statements on a monthly basis is essential. Enforcing credit limits on customers is also necessary, as one large bad debt can ruin a business. Keeping the bank up to date by providing monthly reports and using budget planners, is good practice and necessary for approval of additional funding as the business grows. There is a large, flexible workforce available in rural Ireland. If bookwork is not ones strength, then part-time administrative staff are essential.

Once involved in an alternative enterprise, a farmer will have less free time and less flexibility with regard to farm work.

New ways to Market Grain

The traditional model of grain marketing in Ireland, where a merchant or co-op purchased green grain at harvest and speculated on price, may not be feasible in these volatile times. This model tied up substantial working capital for merchants and brought substantial risk for relatively low gain. Low profits resulted in many small merchants failing to reinvest in their business and finally leaving the industry. There is also the possibility that, in the future, banks may decide not to finance businesses in the speculative purchase of green grain. The Irish tillage industry needs to recognize this possibility and be ready to deal with such a scenario.

Three years ago, I pioneered a system where farmers brought their grain to my facility to be dried and stored. We refer to this as 'B & B'. This offered farmers the advantage of selling their produce throughout the year and receiving the benefits of any uplift which may occur. The price received for grain would reflect a good average for the whole year, not just a distorted price at harvest.

This paves the way for forward selling of grain and also farmer to farmer trade. At present, when buyers of native grain come to the market, if product is not available on the day, then imports are likely. In 2007, farmers profited greatly from 'B & B' but in 2008, the opposite was true. The difficult market in 2008 motivated many ‘B & B’ farmers to search for markets for their grain and offer rolled grain to the market. Tillage farmers began to realize that many of their existing costumers for beet, straw and contracting would also be valuable customers for their grain. This stimulated huge interest in farm to farm trade, where grain margins have been stabilized. A much more sustainable business relationship is gradually being forged between tillage farmers and end users. This will help to establish a fair pricing structure, which all sectors can live with.

The 2008-2009 grain year has left us in a very serious situation. Native grain remains stock piled in stores while large quantities of foreign grain are imported. All sides have lost out here - those who imported early have paid higher prices, while the Irish tillage farmer cannot find a market. All players have the responsibility to protect our native industry. There is a need to introduce forward selling, perhaps initially by tillage farmers agreeing to supply the market throughout the year at a fair market price and not waiting in anticipation of market peaks. We all know the importance of guaranteed Irish and it is the duty of all concerned to purchase native grain firstly and if more is required, to source grain only from reliable, traceable producers within Europe. The dairy, beef, pig, sheep and poultry industries all require traceable, quality assured grain at prices that keep all sectors in business.

Analysts view the agricultural production within Europe as being stable. However, this may change with milk prices lowering, pigs in transition and grain prices down to 125Euro per tonne dried. Irish tillage farmers cannot continue producing high quality grain at a loss. An exodus from the tillage industry will not be seen as dramatically as in other businesses which can shut down over night. The winding down of a tillage operation is usually a phased response over two to three years, as machinery leasing and other commitments are divested. This delay can lead to a false sense of security by both government and other interested parties. If we loose a substantial section of our tillage industry to imports, this will eventually lead to end users being subject to costs over which they have no control or influence. This situation occurred with the loss of the Irish Fertilizer Industry (IFI). The absence of native fertilizer production was followed by a dependence on expensive imports and huge profiteering on the back of our farming industry.

Irish tillage farming is the prime model of ‘buy Irish’ as most of us conduct our business within twenty miles of home. All players in the industry, including government, need to recognize that our industry must be protected and nurtured. Without doubt, this is a fragile industry. This was displayed clearly before Christmas 2008 with the pork and beef crisis. The tillage industry has paid the price and will continue to pay dearly for the so-called cheap ingredients. The use of recycled waste produce such as bread meal is wrong. One could argue its safety but all that is needed to cripple the industry is one mistake. The blind importation of untraceable grain, with lax or no production standards, has to stop. It is inevitable that at some stage a suspect shipment of grain will arrive and the consequences to the food industry will be devastating. Lowest cost animal feed formulation and the acceptance of grain with traceability standards below Irish levels may be the rock we perish on.

Value for Money – Modulation and Regulation

Modulation

As a farming sector, we accepted lower product prices in lieu of area aid which subsequently evolved into the SFP. The SFP is not indexed linked and is costing more in regulation year on year. Decoupling arrived and it was aptly named, as it decoupled farmers even further from their payments through a tax called modulation. This tax is currently approaching 10% of ones original SFP. What is the benefit of modulation to commercial tillage farmers? Very little, I would suggest. We need value for money from this tax. Modulation comes with no tax allowances and could be regarded as an income levy. In my opinion, a portion of modulation should be allocated to establish an emergency fund for the farming industry. From the modulation monies, I would suggest that we need at least 20% of national modulation money and an additional 5% across the E.U. modulation money to be used for this emergency fund. This insurance fund could assist the compensation across the industry in the event of situations such as the recent pork crisis. During this crisis, there was a stalemate over compensation while the Irish pork industry faltered. Meanwhile, other taxpayers wondered why they should bail out the farming industry. These bailout senarios do little to enhance the image of the farming industry with the general public, especially in these difficult financial times.

Regulation

European law is very forthright and sets an example for the world to follow. The difficulty in Ireland, it seems, is the over zealous approach to the interpretation of European law. We have seen a monster called regulation grow in the last number of years. This has led to the closure in Ireland of many local industries, such as abattoirs and cheese production units, which provided a valuable outlet for specialist products. These micro-industries develop new specialized markets with the potential to grow and add value to our industry.

The poor interpretation of European law is sullying the waters of opinion of the Irish farming community towards Europe. The number of time consuming inspections by numerous cross compliance agencies has increased dramatically to the point that they have become a new boom industry in themselves. The inspection industry, whose lifeline is agriculture, should have a positive, constructive and practical approach to agriculture. In my opinion, the inspectorate needs to stand their ground and defend good farming practice in Ireland to Europe.

The abolition of winter ploughing, which was good farming practice in Ireland for many generations, is an example of poor decision making with regards to Ireland. The beautiful Irish countryside which we have today did not appear by accident but is the result of generations of good farming practice. Ireland should have vehemently opposed the abolition of winter ploughing, as it was introduced without sound scientific data. However, we are now in a situation where overturning this decision would require considerable research time and money which may not be available. There is a constant need to critically evaluate all consequences of proposed European law with regards to farming. An expert group representing the farming industry needs to be established to prevent a recurrence of this type of situation. The proposed pesticide ban, in its current form, is another serious threat to the Irish tillage industry and needs to be addressed urgently.

Evaluation of our Industry and Nutrient Recycling

Evaluation of our Industry

There is a need to evaluate our tillage industry from production to end user. As it stands, not enough is known about our storage and grain drying capacities. It is necessary to make an inventory of all storage and grain handling facilities in the country and access the condition of same. The reason for this is that grain production should be matched by adequate grain handling facilities. In 2008, with favorable weather conditions, we would have had a situation where grain production would have exceeded storage capacity. This was averted by the very poor weather conditions leading to lower yields. However, another problem arose with a lack of drying facilities to cope with the very wet grain. This wet grain slowed up drying facilities, choked up intake depots and led to farmers being unable to deliver grain to merchants' yards. Inadequate grain handling capability has resulted from the closure of many facilities over the last number of years. Many closures were as a result of proximity to urban areas, lack of expansion potential, inefficient practices and an unwillingness to re-invest in a low profit business. We need to examine this with a knowledge-based approach and identify geographical areas that need capital investment. Grant aid or investment should be targeted only where grain facilities are required, in contrast to the last grant-aided investment scheme where monies for tillage infrastructure ended up as storage for other industries. It is not efficient to grant aid multiple small grain drying units, which will never achieve the scale necessary for economic survival. There is more to storing and drying grain than just the basic equipment. Poorly stored and marketed grain is of little value to the industry.

Crop production and usage also requires evaluation. Efficient evaluation of the grain industry can identify, prior to sowing, the market requirements of particular crops within local areas. Matching crop production with local markets would lead to lower transport and higher efficiencies.

Nutrient Recycling

Grant-aided or tax incentivized slurry holding facilities in suitable tillage locations would greatly assist the nutrient cycle. An opportunity was lost in the last pollution scheme to address this issue. It is still not too late to consider this, as the expansion of our dairy and pig industries could still avail of this. Simply put, excess slurry could be imported by local tillage farmers during the winter months, stored and utilized when conditions are optimal. This benefits both parties, as what is waste for one, is a valuable resource for the other. Refining this scheme would undoubtedly need to focus on the actual nitrogen and phosphate content of each slurry delivery, as each is unique. This proposal would also greatly reduce soil compaction as slurry application would only occur during optimal soil conditions. I have spread slurry on standing crops of wheat and the results were highly beneficial and cost effective.

Research and Practical Biofuels

The future of the tillage industry lies in research and development. Teagasc plays a pivotal role here in both its research and advisory capacity. Teagasc works with all sectors of the farming industry and as all farming sectors are interdependent, this allows Teagasc to develop a holistic approach to the development of Irish agriculture. The quality of tillage research in Ireland is very high and therein lies the future of our industry. Research and development is an important way to distinguish ourselves from other grain producing nations. Quality assurance and quality product strengthens our hand when the end products such as, beef, pork and milk, are sold. There is also potential, in areas such as nitrogen fixation, for development of crops to increase production.

The development of biofuels has been hap-hazard with mixed signals from government with regards to their potential. The abolition of aid for energy crops and the lack of a coherent plan have led farmers to become disillusioned with biofuels. In Denmark, I have seen whole towns, the size of Carlow, run their heating and hot water from straw fuelled boilers. This system is very simple and one town I visited had been fuelled by straw for twenty years, with only one day of breakdown. This provided a huge boost to the local farming community and also provided the general public with cheap, reliable and green energy. This security of energy cannot be underestimated as is displayed by the current gas supply situation in the Ukraine. In the UK, there is a power station is fuelled by straw. Straw has one third the calorific value of oil. So, to put it into prospective, when a farmer looks at his field of straw bales, each bale of straw with a weight of 210kg is equivalent to approximately 70 litres of oil, the value of which we have seen to rise to 60Euro last summer. Other crops such as miscanthus and hay, would also suitable for heat systems.

Drying grain from straw is also an exciting new concept with I am working on. This is achievable and offers a practical biofuel, especially given the costs of grain drying in Ireland. Such units could also be adapted to provide heat for other sources on a twelve month basis. What is essentially a waste product from grain production, is also very important carbon neutral heat source.

The ten million budget cut for Teagasc has to be addressed as this will severely hinder the growth of our industry. Teagasc is the sole provider of primary research without which we face the future without cutting-edge knowledge – a dangerous place to be.

CONCLUSION

The challenges to Irish tillage farming are very real and are constantly changing. We need to be knowledgeable and flexible in our approach to deal with these issues as they arise. Some of the external pressures on our industry require preventative rather than curative action. As an industry we need to become more organized and focused. A strong industry based on partnership and mutual gain will provide the tide which will raise all boats. The opportunities for a country the size of Ireland is enormous. If our high quality produce from this unique location is properly marketed and developed, we can compete at the higher end of the value chain. The French achieved this many years ago with wine. The classification system introduced by them allowed the champagne region to distinguish itself from all other sparkling white wine producing areas and gain an exclusive market. We must emulate this here. More than ever, we need dedicated leadership from representative stakeholders within farming industry of which the tillage sector plays a pivotal role.