# Food, Fuel and Volatility – a UK perspective on the world grain market.

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## SUMMARY

The fundamentals of wheat supply and demand cannot be assessed alone. The price of wheat is based on a matrix of other grain market drivers as well as its own. Whilst wheat cannot be replaced by another grain to make bread or biscuits, grain for livestock feed is partially interchangeable.

Land on which wheat is grown can, in most cases be used to grow other crops if price relationships indicate a greater return to farmers. For this reason, much of the global fundamentals are considered as ‘all-grains’. This excludes rice as it is grown on land that does not overlap wheat area, and consumption does not noticeably switch between the two grains.

Production of any grain is demand led. Over the last 8 years, wheat demand has outstripped production but prices did not rise on a sustained basis as draw down of high global stock levels met the balance. Now, these stocks are far lower and demand can only be met by increasing wheat production. If this is achieved by next harvest, prices would be expected to fall, but with low existing stock levels, any shortfall could place upward pressure on prices. Such volatility would be expected to remain in the market until some stock levels return to ‘buffer’ the demand and production boundary.

> *To this extent, one would expect lower grain prices when stocks are on a rising plain, even if they are still historically low .It is yet to be seen how much ‘comfort’ stocks, the world is prepared to pay for.*

It is noteworthy that whilst wheat stocks fell considerably in 2006/07, wheat price rose considerably less than they already have done in 2007/08, despite much smaller reductions in stocks. Year-end stock levels are not the fundamental market driver, it’s their availability to the consumers that affects price. Stock levels provide a benchmark indication of this availability.

Over the last decade, new management systems have facilitated this availability of stocks so lower stocks can now be kept before grain prices rise.

The one certainty going forward is volatility. Daily price moves of above £10 per mt and yearly moves of £100 per mt could become the 'norm'. For the grain grower and consumer alike risk management strategies will become much more important. Margins wins for some will become a margin squeeze for others. Higher production costs will have to find their way to the ultimate consumer at some stage whether that be in the form of higher food or fuel prices.

# Wheat Price

The price of any commodity is the messenger between demand and supply in a free and open market. If demand is higher than supply, prices rise, acting as an indicator to two market participants; the consumer to use less and the producer to produce more. Conversely if demand falls beneath supply leaving a surplus, prices will fall, consumers will increase consumption and production will fall.

Production of wheat takes at least a year to respond to such signals. Even then, much of the production response may depend on weather patterns that season. Although adjustments to consumption are faster, their response tends to be smaller. Wheat consumption changes are therefore less volatile from year to year.

*There is nothing more bearish than a high price or bullish than a low price*

For long-term consideration of wheat price, we should ignore market peaks and troughs, as over time, the market will compensate.

## GLOBAL PRICES

Wheat, maize and all other grains being commodities are tradable internationally. Their quality and condition can be easily described and quantified. Trading grain from a surplus region to one of deficit is thus relatively straightforward. This brings prices of both regions closer together. Thus a world market operates and underlying prices are set at a global level. The price for a grain anywhere within reach of global trade (e.g. east coast UK) is based on the global price of grain, then with regional influences affecting the price. There will then also be local factors affecting that price.

## THE GRAIN PRICE MATRIX

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## TODAY'S WHEAT MARKET POSITION

Since the recent harvest, wheat has been trading at prices higher than ever before in all areas of the world that trade globally. Benchmark world prices for 'nearby positions' have doubled since early April 2007 and tripled since the lows of 1998 to 2002 as Chart 1 shows. The price history in the UK is similar. The high grain price is a global phenomenon, not just local. However, futures contracts scheduled to close after 2008 harvest or after the 2009 harvest are considerably cheaper, implying the market sees the tight supply situation to have eased somewhat by then. This is illustrated in

Chart 2 showing UK futures values.

**Chart 1:** Global Wheat Price History (CBOT)

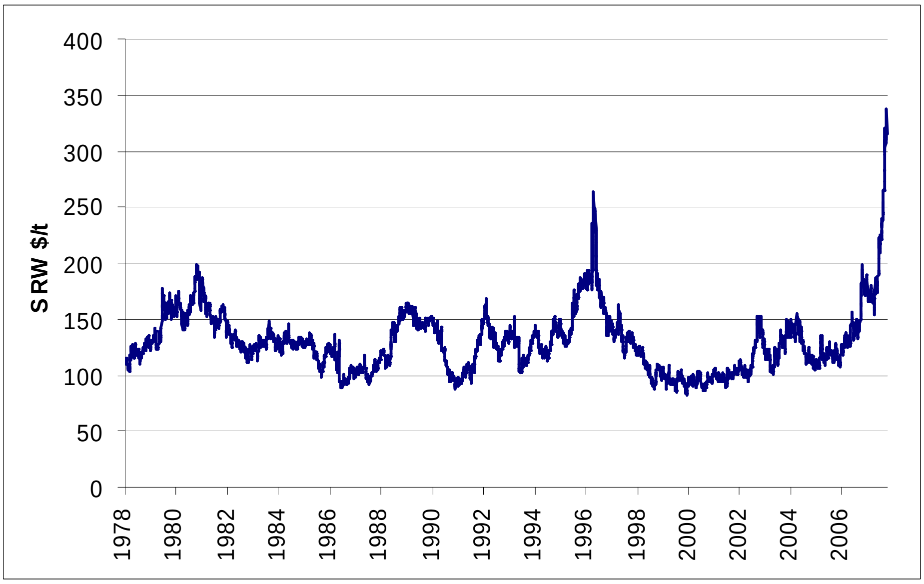
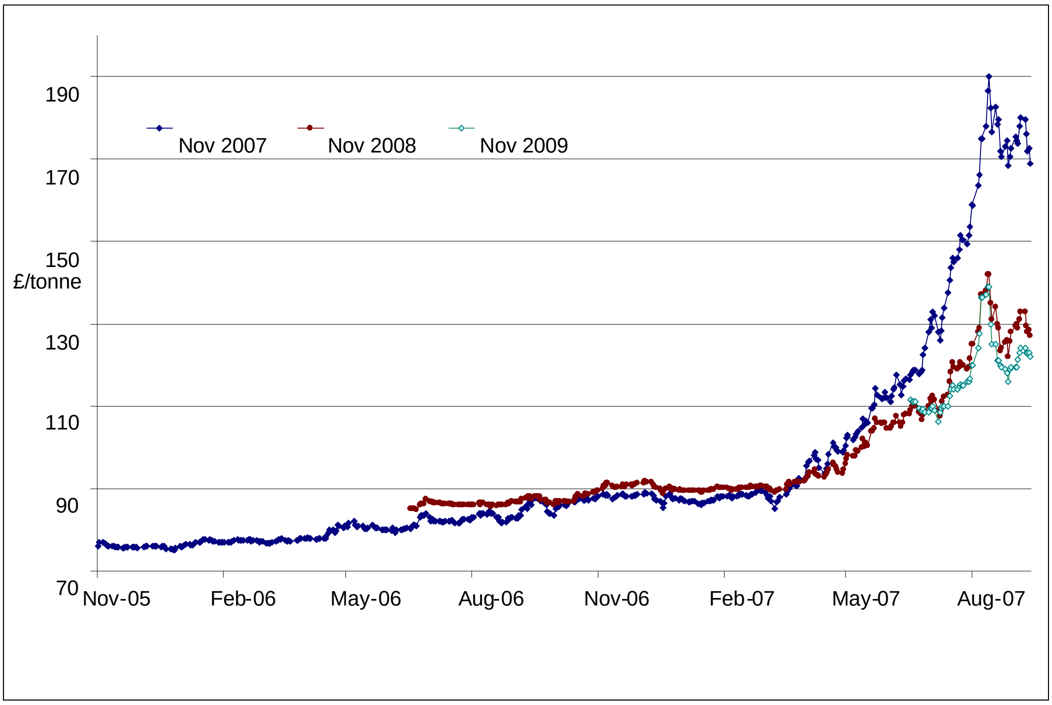


**Chart 2:** UK Wheat Futures Prices for Three Successive Crops




# Grain Stocks

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## GLOBAL WHEAT AND OTHER GRAIN STOCKS

Since 1999, countries (including importing nations) became increasingly comfortable with lower strategic reserves, processing companies became more accustomed to shorter delivery periods and ‘just in time’ supply chain management and the world as a whole, became relaxed (even complacent) that grain availability was not a problem. Stocks for wheat and coarse (feed) grains fell by 45% over this period.

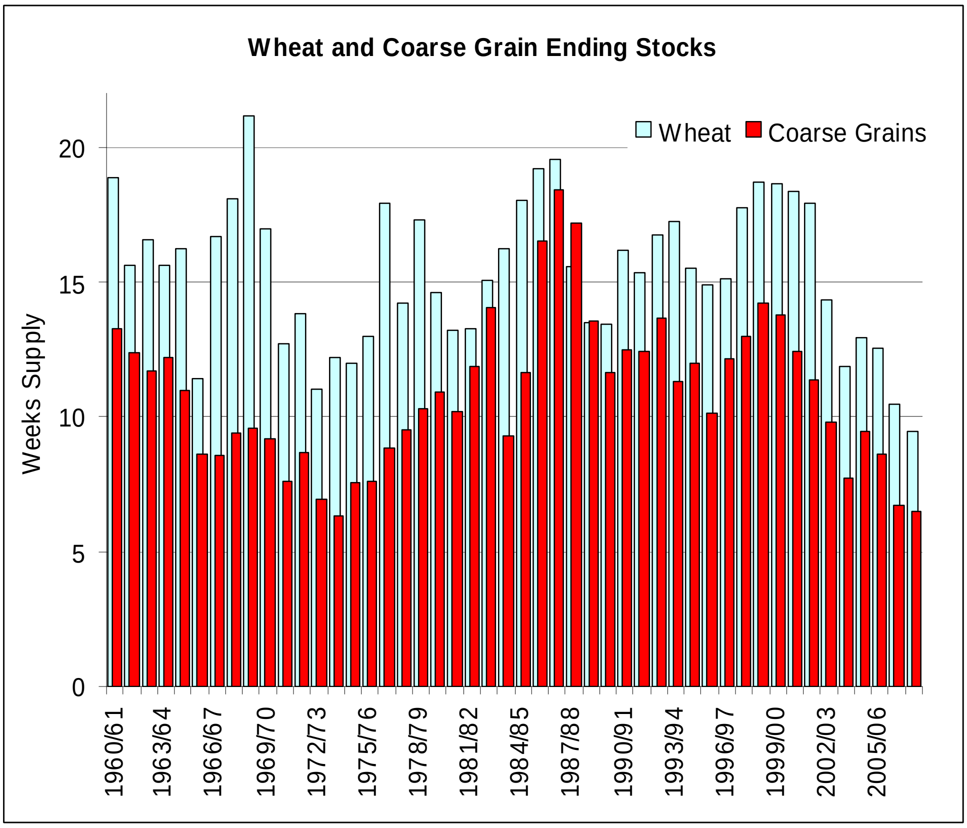
Throughout the marketing year 2006/07, global grain stocks fell by 57 million tonnes, this year (2007/08) they are forecast to drop another 11 million (all from wheat). Last year, total grain production fell by 28 million tonnes compared with the previous year, this year they are forecast to rise by 95 million (even with severe droughts and adverse weather conditions throughout the world). Global grain consumption is forecast to rise by 48 million tonnes.

*It is not just the poor weather conditions alone that have led to high grain values.*

It need only be a marginal change for supply to become difficult to secure. When this happens, prices rise. Global grain stocks have not been this low since 1977. Since then, demand for grain has risen by 56%. Chart 3 incorporates this factor by illustrating grain stocks in terms of weeks supply remaining at the current rate of consumption. As a proportion of demand, grain stocks have not been this low for the data available.

Highest prices are presently for wheat rather than coarse grains. Wheat cannot be replaced with anything else in a loaf of bread, whereas coarse grains are considerably more interchangeable. Secondly, the bulk of the coarse grains are US maize (which is presently being harvested). It is a bumper crop, 70 million tonnes greater than last year’s.

**Chart 3:** The Root of Recent Price Highs




## LOCAL WHEAT STOCKS

In recent years, both the UK and the EU have been net wheat exporting regions. The UK has typically produced a surplus beyond domestic requirement of about 3 million tonnes and the EU has produced about ***10*** million tonnes more than required. Stocks have therefore not been a major market or political issue. Indeed, it has been more of a focus to achieve sufficient export sales to remove carry-over stock to keep domestic prices buoyant. With expected changes in demand throughout both the UK and EU, this trade pattern might change in the coming decade. This is discussed in paragraph 0.

## Demand

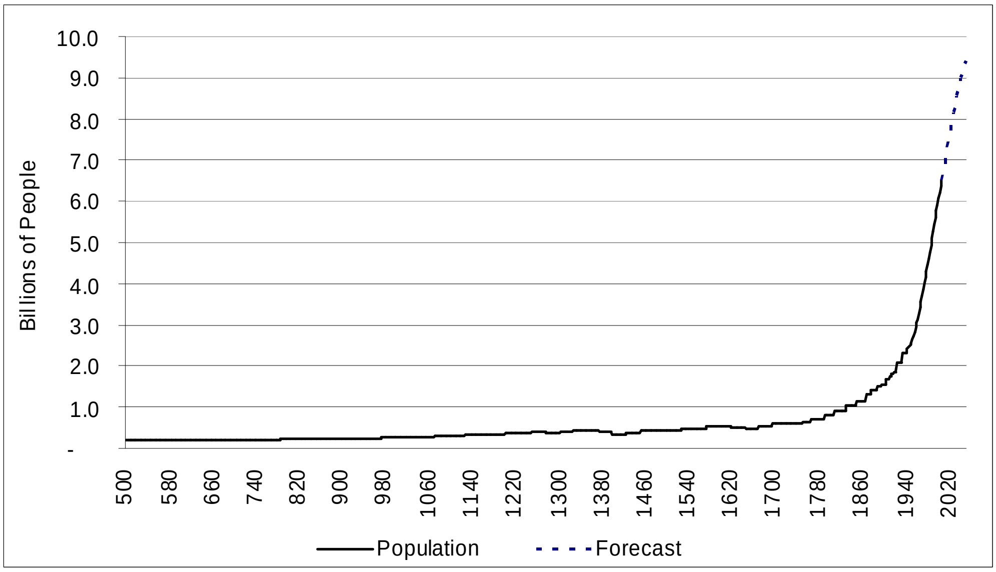
Until recently, all significant grain consumption was based on human food requirements, whether consumed directly or indirectly through feeding to livestock. This is changing and a new layer of consumption is emerging for agricultural products.

Global demand for wheat is approximately 615 million tonnes per year. Over the last 10 years, this has increased at an annual rate of 4 million tonnes per year, albeit in an uneven manner. As prices peaked over this period, demand fell (such as in 2003/4 and 1995/6) only to rebound strongly when prices later fell. To this extent, the USDA forecasts 2007/08 demand will fall by 2 million tonnes from last year (which was 6.5 million tonnes lower than 2005/06). Furthermore, since May, when the USDA first published their 2007/08 grain forecasts, their global usage expectation has fallen by 7.65 million tonnes. Learning from history, we might expect a strong rebound in demand in 2008/09 assuming prices for new crop remain lower. One would expect this to slow the rate of wheat price falls.

## POPULATION GROWTH

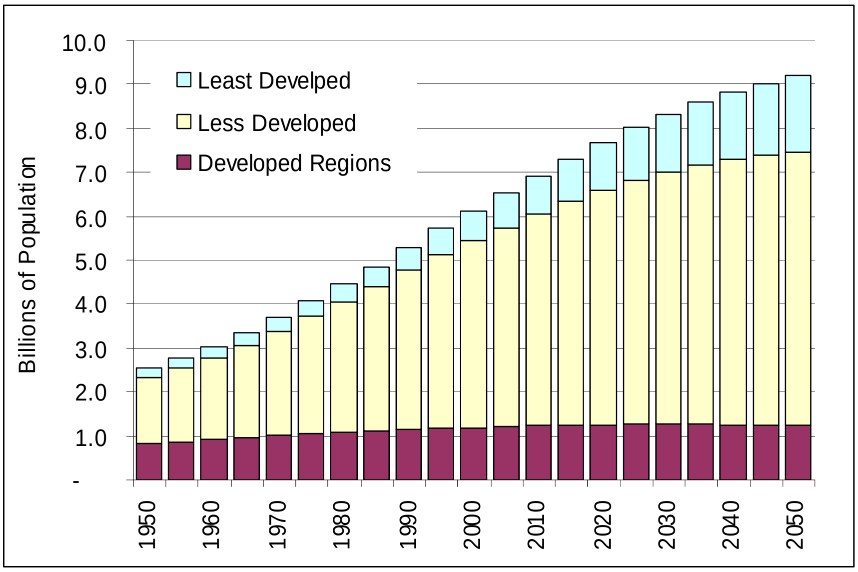
Our industry is charged with feeding an additional 75 million people per year and until recently (1960's), population has been increasing exponentially (accelerating) as Chart 4 shows. However, care is required interpreting this chart. In 1798, when Thomas Malthus made his famous (erroneous) comment that agriculture could not feed the population for another 50 years, he was looking at a chart the same shape as this, even though population had only just eclipsed 1 billion. If infinity is not an option, a chart like this has a peak, but from the chart alone, its timing cannot be forecast. We should be wary not to make another equally inaccurate forecast, underestimating the ability of agriculture to meet the demands of the market.

**Chart 4:** Population Explosion ?




Global population is rising at 1.2% per annum, but that rate is now falling. However, population growth is fastest in the poorest nations as shown in Chart 5

**Chart 5:** Regional Population Growth Forecast




## ECONOMIC GROWTH

Wealth is consumption. As people in emerging economies become wealthier, they consume more or higher value products. This is coupled with the trend towards urbanisation in such countries. However, this doesn't mean they are consuming more wheat or wheat-fed products. China is the prime example. Its traditional subsistence diet of noodles (wheat) and rice is being shed in place of a more sophisticated diet of meat and fresh produce such as vegetables. Urbanisation links people with fresh food markets and electricity, meaning fridges and cookers are more common in cities in developing countries. Meat from grass and foraging is important in many countries and grain based animal feed is normally a coarse grain. In fact, wheat consumption per capita in China is falling by about 1½ kg per head per year as shown in Chart 6. Note also the strong increase of coarse grain consumption indicating the rise of grain-fed livestock.

**Chart 6:** Grain Consumption per Capita in China

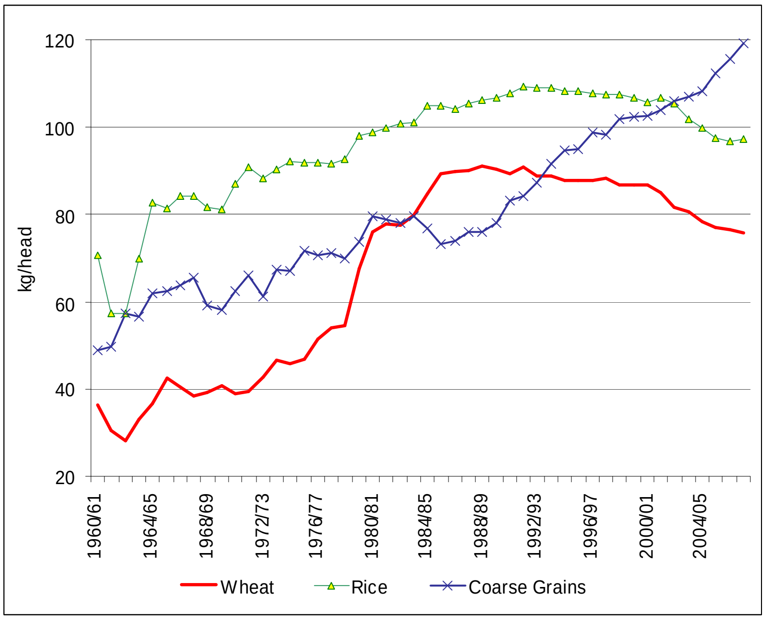



**Chart 7:** All Grain Consumption Per Capita (& Forecast)[1]

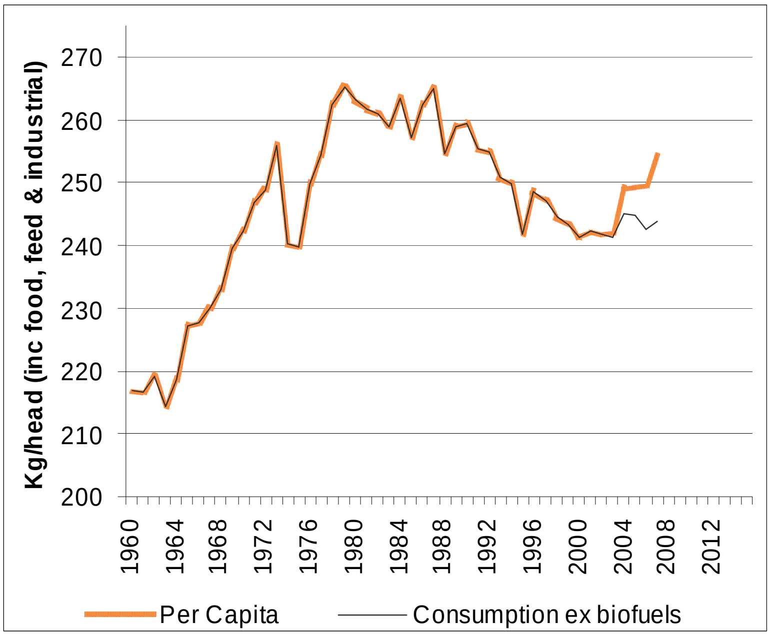



Chart 7 illustrates there is evidence that consumption per head is rising once again. This rise appears to be almost solely attributable to the recent demand from the non-food sector. …

[1] *Population data from the US Census Bureau, [www.census.gov/cgi-bin/ipc/agggen](www.census.gov/cgi-bin/ipc/agggen)*

## FOOD

It is not difficult in a developed economy to switch from one food to another if that is what individuals choose. However, doubling wheat price is likely to add 6 pence per loaf of bread (plus some 'supply-chain' inflation so say 12pence. However, in a wealthy environment like ours, few consumers will make noticeable changes to affect national consumption patterns.

In the least developed nations, where people the majority of their disposable income on basic foodstuffs such as wheat, the impact of high prices could be severe. However, in these situations, there may be little choice to switch from one basic food into another cheaper option. Furthermore, many of these countries do not play a noticeable part in the grain trade.

For these reasons, food consumption will not change dramatically in response to price change.

## BIOFUELS

It is commonly recognised that biofuels would not commercially operate in any country if there was not government support for the sector. We also recognise that government support for all energy sectors is high. However, it is prudent to consider the possibility of some global regions not achieving their quantified policy goal in terms of volume by 2010 or later. The EU for example has not reached its target up to date (but we recognise the more formal structure of the targets in place now).

In 2006, the OECD calculated that if the US and Canada were to incorporate biofuels into road traffic fuels at a 10% rate, the land requirement would be about a third of their total area currently in combinable cropping. In the EU, this figure would be nearer to three quarters[2]. This is not to say that there would be no trade to procure these tonnages, indeed the Commission has accepted the EU cannot supply this feedstock itself. Nevertheless, this is the long term objective of the Commission.

Second generation biofuels technology, the production of fuel from lingo-cellulosic materials is a well developed and researched process. However the cost of such a procedure is highly expensive involving high temperatures and pressure. It seems unlikely that this technology will become competitive in the medium term without substantial government support. Even then, its commercial application is unlikely to replace first generation biofuels rather co-exist adopting incremental opportunity.

[2] *Agricultural Market Impacts of Future Growth in the Production of Biofuels. AGR/CA/APM(2005)24/FINAL*

## DOMESTIC WHEAT DEMAND

Demand for wheat in the UK has been around 12-13 million tonnes in recent years. This is forecast to rise throughout the project period. This is based on a switch from the Cerestar starch and sweetener processing facility in Manchester from using (French) maize as its base feedstock. This transition will be taking place from this marketing year, building up to full capacity (using 750,000 tonnes of wheat) from the 2008 harvest.

Furthermore, depending on the success of the fledgling bioethanol industry throughout the UK coupled with the ability of other established grain processing businesses to compete with the new demand, this could increase demand for domestic grain beyond the normal national crop production level.. Examples are Bioethanol Limited and Green Spirit Fuels. If all publicly announced bioethanol plans are successful and existing wheat consumers remain in the UK, wheat demand would rise by over 4 million tonnes.

## FOOD SECURITY

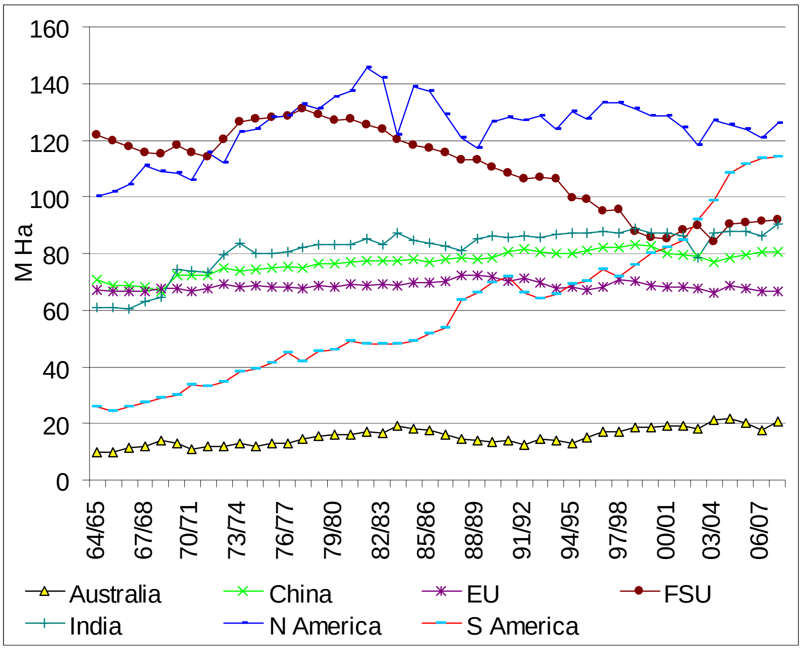
Food security is an issue that does not appear to bother DEFRA. The government's attitude is if food supply becomes strategically threatened, the UK population can easily consume sufficient calories through eating grain and pulses rather than feeding it to livestock. The meat we would eat in this situation would be grass and forage fed.

## FERAL LAND - ONCE FARMED, BUT NOW IDLED

Simply taking the land area that has once been cropped but now is idle provides us with a rough indication of land that could, with probably relatively straightforward infrastructural development become available for cropping within a few years. Chart 8 takes the major grain growing regions of the world and shows how areas have changed since 1960. The difference between the areas cropped today and the peak areas in each region total almost 70 million hectares. The bulk of this fall is in the Former Soviet Union. Here there will be infrastructural issues to overcome such as creating supply chain operations, routes for passage of grain, supply of inputs and so on. These sorts of problems are overcome with money when sufficient is available. Also, this region having a continental climate means that variable weather conditions give it highly variable grain yields. This is a very difficult situation in which to build a business. However, once again, high grain prices will help businessmen afford this risk. Large amounts of city investment are being directed into the agricultural sector of some of these countries and it appears that some of this infrastructure in being put into place. It is not clear how many seasons it will take before large increases in area are noticed in the region.

Reports also suggest large amounts of savannah land in Brazil, which sits on the world's largest fresh water aquifer. Just as the Canadian oil sands have become exploited for oil since crude oil price have been high, so this land will surely be developed as grain and sugar prices increase. How quickly is difficult to tell.

**Chart 8:** Major Combinable Cropping Regions. Hectares of all Grain and Oilseeds




*Land availability is not likely to be a limiting factor for grain production globally for the forthcoming 15 years.*

There may well be political tensions regarding ploughing some of the land, but when grain values are at unprecedented levels, this may be the least politically sensitive option if high food price is the other option.

# CONCLUSIONS

The one certainty going forward is volatility. Daily price moves of above £10 per mt and yearly moves of £100 per mt could become the 'norm'. For the grain grower and consumer alike risk management strategies will become much more important. Margins wins for some will become a margin squeeze for others. Higher production costs will have to find their way to the ultimate consumer at some stage whether that be in the form of higher food or fuel prices.

# Developments in Feed Grain Markets

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## SUMMARY

Ireland is very reliant on imported raw materials, we produce 2m tonnes of Cereals and import another 3m tonnes. We are 52% reliant on imports while the UK are only 36% dependent, France 19% dependent, and Germany 26% dependent. Sourcing our imports is becoming more difficult and expensive due to factors such as weather, freight, currency, energy debate, GM influence, funds activity and a global tightening of wheat stocks.

In 2007 we saw commodity prices increase significantly, wheat on CBOT increased by 86%, and on LIFFE the increase was 68%. The price of Soya increased by 77%. A recent USDA report put the 2007/08 wheat ending stocks at 109.8m tonnes, this is the lowest carryover since 1977/78 which was 109.2m tonnes. The stocks-to-use ratio at 17.8% is the lowest on record since the start of the USDA's statistical database in 1960. World wheat consumption is estimated to be running at 1.7m tonnes per day. Declines in planted area and adverse weather in many of the key growing regions cut harvest output this year.

The EU policy on approval of GMO's has caused the end of imported Corn By-Products from the US. We traditionally imported 800k tonnes of these products into Ireland. Post the approval of Herculex which took almost 3 years to be approved in the EU the US have 2 new GM varieties in this years harvest. It is illegal to import material containing these varieties as they are unapproved for use in the EU.With over 100m hectares of GM crops grown in the worlds to day, it is the fastest adopted crop technology in recent years. The latest indications show that new generation of soybeans will come on stream from 2009 onwards. Again this new variety has not yet been

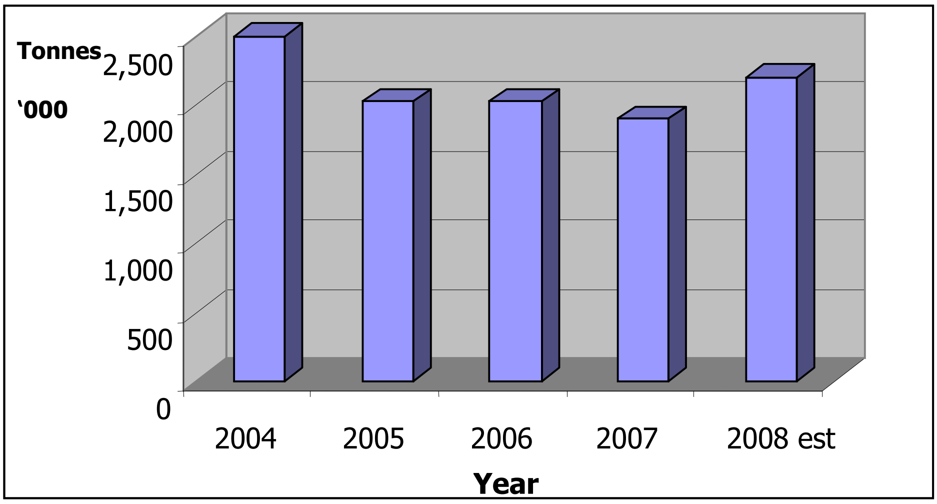
approved fro use in the EU. Submissions for approval have been made but looking at the example of the Herculex approval one would be forgiven for being concerned that the deadline will be missed in the EU. In addition the fact that not a single GM has been approved by qualified majority voting is also very concerning and adding an unnecessary time delay to the approval process. There are c40m tonnes of Soy products being imported into the EU, a slow down or halt to this supply line will have disastrous consequences for the EU Feed and Food production industries.

The cost of Ocean freight has rocketed since 2000, with greater than 100m tonnes per annum of additional demand growth, lead mainly by the growth in Iron Ore and Coal. Supply coming on stream in 2009 and 2010 should have the effect of reducing the cost.

Global economic and population growth, increased Fund activity and the ongoing food v fuel debate are all adding new variables to commodity markets. Extreme volatility in commodity markets is forecast for the coming year, the challenge ahead will be to navigate the volatility.

# INTRODUCTION

Our annual harvest generally yields about 2m tonnes of Cereals.



We are however deficit in our production of energy and protein crops and have to supplement our own production with some 3m tonnes of imported raw materials. We are 52% reliant on imported raw materials while the UK are only 36% dependent, France 19% dependent, and Germany 26% dependent.

Sourcing our import requirements is becoming more difficult and expensive, indeed over the last 12 months we have seen unprecedented price increases and a lot more volatility than we would normally expect. Traditionally commodities are influenced by items such as weather, currency movements, supply and demand, but in recent times we have seen other factors being introduced such as the energy debate, GM influence and the tightening global stocks of wheat.

Our market here is influenced more and more by Global Economic, Scientific and Environmental trends, and this is set to continue into the future.

It is worth looking at the effect these factors have had on some key commodities during 2007 (prices based on CBOT):

| | **Jan '07** | **Jan '08** | **Inc %** |
|---|---|---|---|
| **Soya Meal (CBOT)** | $187.8 | $331.5 | +77% |
| **Wheat (CBOT)** | $4.76 | $8.85 | +86% |
| **Corn (CBOT)** | $3.70 | $4.55 | +23% |
| **Wheat (LIFFE)** | £98.00 | £164.50 | +68% |

Looking at the currency movements we can see that the weakening dollar and sterling have sheltered us somewhat from the major increases in commodity prices:

| | **Jan '07** | **Jan '08** | **Inc %** |
|---|---|---|---|
| **€ v $** | 1.315 | 1.465 | (11%) |
| **€ v £** | 0.674 | 0.740 | (10%) |

# WEATHER

The impact of weather can be very dramatic on crop production. The table below shows the effect the weather had on this year's Wheat crop in the EU and Australia:

| | 2007 Expected Crop | 2007 Actual Crop | GAP |
|---|---|---|---|
| **Australia** | 26m tonnes | 13m tonnes | 13m tonnes |
| **EU 27** | 128m tonnes | 112m tonnes | 16m tonnes |

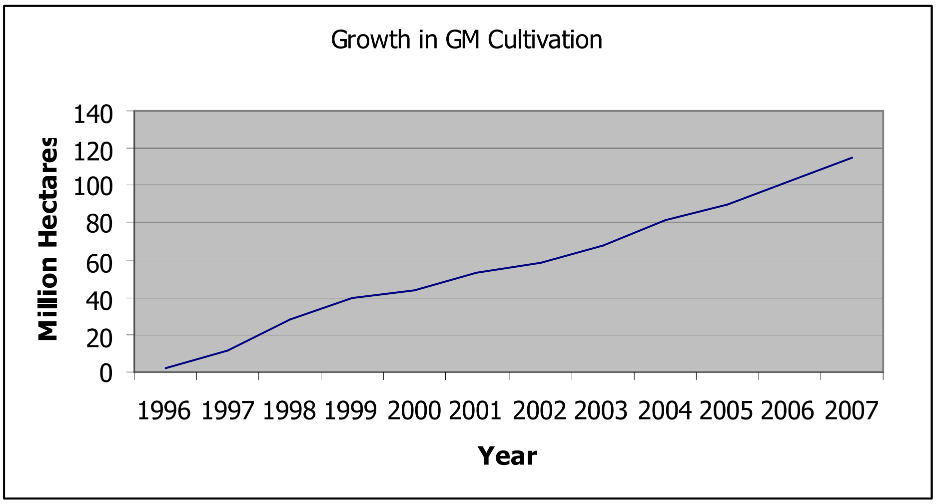
Australia's shortfall was created as a result of drought, and was the second bad year in a row, in 2006 the actual crop was 10m tonnes. Australia is generally one of the World's largest exports of Wheat.

In the EU we had the effect of heavy rains leading up to harvest time which resulted in 16m tonnes being wiped off and already tight Wheat supply and demand balance sheet.

In Ireland our annual harvest was expected to produce 2.2m tonnes, due to poor weather leading up to harvest time our final production was 1.9m tonnes, some 4% back on last year's figure and 16% behind expectations.

# GM LEGISLATION AND THE IMPACT ON IRELAND / EU

The feed industry is a large user of the by-products derived from the Maize and Oilseeds processing industries. The growth in the planting of GM varieties of these crops has increased significantly in the past few years. The year on year increase from 2005 to 2006 was 12m hectares. GM is the fastest adopted crop technology in recent history. Accumulated hectares stands at 577m hectares since their commercialisation in 1996. There are now in excess of 100m hectares of GM crops sown annually, in more than 22 countries and by more than 10m farmers.




The newer GM varieties of Corn and Soybean in particular are providing farmers with solutions to agronomic problems combined with increased yield. These two factors are a powerful driver for the uptake of this technology and the growth of GM varieties in the major Soya and Corn growing areas will continue. Unfortunately for the European feed industry the EU approval system is unable to keep pace with the development and planting of these crops.

## EXAMPLE - HERCULEX

Part of the basket of commodities that Ireland has imported over the last 30 years has been US Corn By-Products. Corn Gluten Meal and Corn Distillers traditionally have accounted for 800,000 tonnes of our imported raw materials, or c25% of our annual import requirements.

Herculex RW Maize is a GM seed variety that is sown in the US. By Spring of 2006, Herculex RW maize was approved to grow in the US and Canada, and was also approved for import, food and feed use in Japan, Mexico, Korea, Taiwan, Australia and New Zealand. Approval in these countries took between 7 and 24 months. Approval was sought in the EU during January 2005, the dossier completeness check was completed in September 2005. European Food Safety Authority ("EFSA") gave a positive opinion in March 2007 stating that Herculex was as safe as its non genetically modified counterparts. Final EU approval was published in the Official Journal on 31st October 2007. The approval process took 33 months, or just short of 3 years.

Under Regulation 1829/2003 it is illegal in the EU to import un approved GM varieties.

Although Herculex is now approved in the EU, we are now dealing with a similar set of circumstances with the next crop. Two new GM varieties were sown and harvested in the US for the 2007 crop, thus removing the possibility of importing Corn By-Products in 2008.

# SOYA

Latest indications on Soya are that the new generation of soybeans will come on stream from 2009 onwards. The planned release for these varieties will be the USA and Brazil. Once again there are strong drivers for the farmers to choose these new varieties and yield improvements are expected to be in the region of 5-8 %.

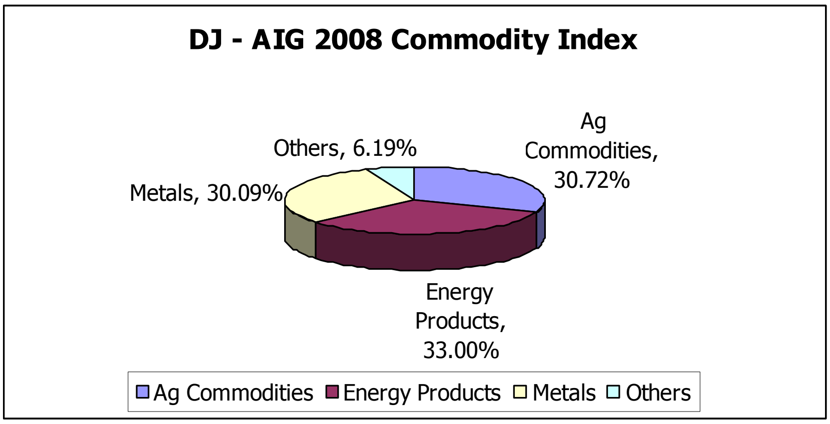
Submissions for approval have been made and are expected in Japan and China before the planned planting. It is unknown if the EU will approve these varieties within this time frame, but one would be forgiven for being very doubtful if we take the Herculex approval as our example. Furthermore fast approval of new GM's that have received clearance from EFSA can not be guaranteed in the EU, given the persistent disagreement among Member States in the respective Regulatory Committees and in the Council. So far, not a single GM has been approved by qualified majority. Authorisations have been approved by the Commission in line with comitology procedures.

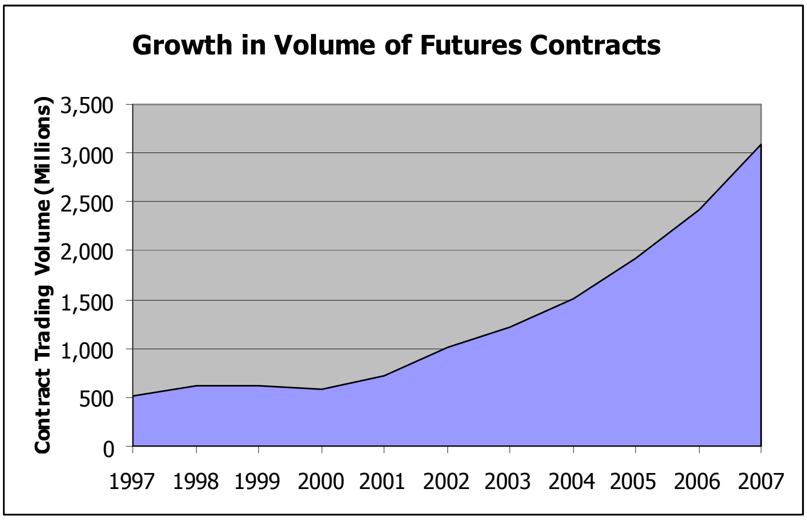
The EU import c35m tonnes of Soy products annually. The import of these essential raw material will slow down or halt if the approval system is not improved.

# FUNDS

In recent years, commodity futures have grown to be a trillion dollar market with massive economic force, having grown faster than any other asset class. Futures contracts for agricultural commodities have been traded in the United States for more than 150 years. Traders have used the futures market to hedge risk due to the volatile nature of commodity pricing. The Index Funds have always had some investment in Commodities Futures, however they now more than ever view commodity futures as a key part of their portfolio.

For example in 1990 for every one barrel of Oil used there were four barrels traded, while in 2007 this figure has increased to thirteen barrels traded for every one used. The Funds now view Agricultural Commodities in the same way thus increasing volatility in the market place.

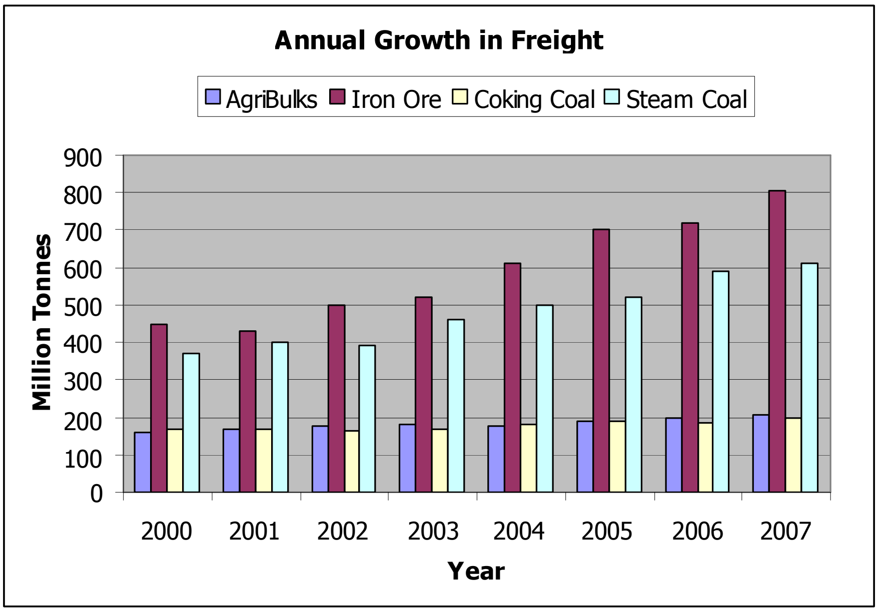



# FREIGHT

The cost of Ocean freight has rocketed since 2000, with demand outstripping supply. The key driver being demand led growth for Iron Ore and Coal. There has been an average growth of +100m tonnes per annum since 2000. Another contributor to the massive cost increase has been port congestion. At times 15% of the World's Capesize fleet has been removed from the market due to port congestion.

It is envisaged that new supply will enter the market in 2008 +8%, 2009 +12% and 2010 +16%, but this probably won't have a price effect until 2009.




## GLOBAL ECONOMIC AND POPULATION GROWTH

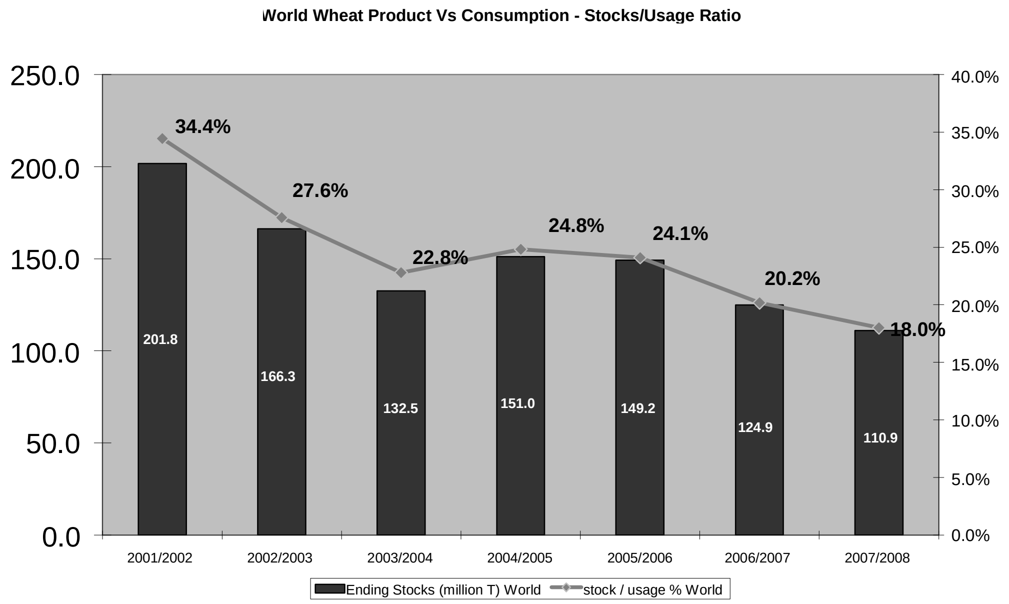
Global population doubled from 1950 to 2005 and today stands at 6.4bn people. The growth is set to continue with an estimated increase of 40% by 2050 to 9bn people. This increase is equivalent to the size that the world population had in 1950 and it will be absorbed mostly by the less developed regions, whose population is projected to rise from 5.4bn in 2007 to 7.9bn in 2050. In contrast, the population of the more developed regions is expected to remain largely unchanged at 1.2bn.

According to some projections, World food demand could double by the year 2050, they estimates that 50% will be due to the increase in population and 50% will be due increasing economic growth in lower income countries.

The IMF, in its World Economic Outlook September 2007 projects that growth in the international economy will slow slightly to 4.8% in 2008, down from 5% in 2007. The past 5-year period of growth sustained at above 5% represents the longest boom since the 1950's. Half of the current global growth is taking place in China, India and Russia.

Economic and population growth is driving the annual demand for more Agricultural products. Asia and the Middle East cannot be self sufficient in food.

Grain production is not keeping pace with consumption. World Wheat stocks at 110m tonnes is a 30 year low.




# ENERGY – FOOD V FUEL

Traditionally we had 2 options for our agricultural output, feed for livestock production and ingredients for the food chain. However, today we now have an alternative output which is for the energy market. Bio-fuels are growing rapidly world wide and are impacting on the commodity prices. The growth in the US ethanol production is resulting in an annual battle for acres between Soybeans and Corn.

In 2000 the US produced 1.6bn gallons of ethanol which used 6% of the US corn harvest, and in 2006 the US produced 5.0bn gallons of ethanol which used 20% of the US corn harvest. Today there are 110 operating ethanol plants with 5.4bn gallons of capacity, 73 more under construction and 8 more expanding capacity.

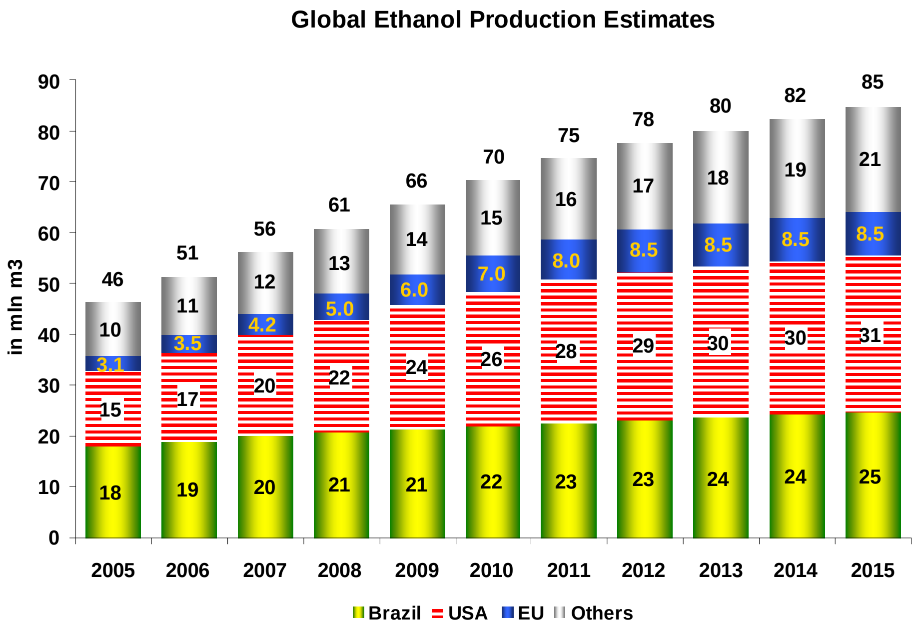
Due to the increase in ethanol production in the US there is a large increase in the production of Corn Distillers. These Distillers are being exported to new market such as Latin America and Turkey. The Distillers are currently prohibited from import in the EU due to unapproved GM varieties.

On December 19th, 2007 President Bush signed into law the “Energy Independence and Security Act”, which includes a historic Renewable Fuels Standard (RFS) calling for a minimum of 9bn gallons of ethanol to be used in 2008, 20.5bn gallons by 2015 and a total of 36bn gallons by 2022.

The US hope that this long term plan for ethanol will spur its commercialisation from cellulose feedstock’s such as native grasses, crop residues forestry waste and many other materials.

However the new technology required to produce this ethanol is lagging far behind and some industry experts believe that it may not be a long term viable option.

In the EU only 2% of our Grain production is used for ethanol production. In Brazil ethanol is produced using Sugar Cane.



# Wheat – securing a new 'Green Revolution'

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## SUMMARY

The demands for wheat are increasing as countries such as China and India look to import higher quantities of grain to not only feed their populations but also move towards a meat based (and hence grain fed) diet. There are also higher demands for starch based products to meet the increasing demands of the biofuels industry. This increased demand can only be met by exploiting the technologies currently available and well as introducing newer ones when appropriate. As for the first 'Green Revolution' plant genetics and the role of the plant breeder will be pivotal. New varieties will need to be developed which will demand lower inputs, whether these be fertiliser, fungicides or plant growth regulators, in order that they will respond to the agronomic inputs available.

There is a growing awareness that targets being set now are far more complex and difficult to achieve than those established at the dawn of the first 'Green Revolution' where yield was of prime importance. In order to meet these challenges wheat breeders are working closely together and have established a more interactive dialogue with the agrochemical supply industry. The output from these initiatives can only be fully exploited with detailed agronomic support from the participants as well as the extension services. A second 'Green Revolution' must capitalise on the wide range of technologies, some controversial, available if the world is required to continue to increase food output for an increasing demand.

# INTRODUCTION

The term 'Green Revolution' was first used in 1968 by USAID Director William Gaud to describe the means by which world output of grain had increased over the previous 20 years. Using the example of India in 1968 wheat production was just 18 million tonnes – it is now 73 million tonnes. Pakistan, a much smaller country, saw yields rise from 4.6 million tonnes of wheat in 1965 to 8.4 million tonnes in 1970. Even in western economies yields increased with the UK doubling wheat output from 4 tonnes per hectare in 1970 to 8 tonnes per hectare in 2000.

The term 'Green Revolution' referred not just to improved varieties but also the uptake of novel technologies – whether this be irrigation and fertiliser use in the third world or 'tramlines' and fungicides in the 'developed world'.

With current demands for cereal grains increasing, as population growth continues unabated and the demand for biofuel raw ingredients grows, there will need to be a re-newed commitment to agriculture to meet these demands. However in contrast to the first 'Green Revolution' there are now significant constraints being placed on growers which will impact upon their abilities to deliver the output required. In addition to environmental concerns there will be a need to deliver output against a background of higher energy costs and competition for oil based products for industrial use.

This paper illustrates the means by which plant breeders have utilised genetic resources to meet current demands and will cast light upon how they intend to meet the requirements for grain production for the 21st century.

## HISTORICAL PERSPECTIVE

The UK has seen wheat yields increase significantly over the last forty years. The 'driver' for this improvement in performance was the utilisation of genetic resources from around the world through the activities of the Plant Breeding Institute in Cambridge, England.

Of most significance was the introduction of the dwarfing genes from material originally sourced from Japan. American breeders at Washington State University transferred dwarf genes from the Japanese source into agronomically superior lines. These were then used as the basis for a breeding activity in the UK which went on to develop the now very successful dwarf varieties grown today (Gale M D, 1978). From just three varieties (Hobbit, Bilbo and Durin) a succession of high yield potential varieties has been developed. These varieties enhanced grain production by're-directing' photosynthates from wasteful straw production to grain. In order to optimise their performance higher inputs were applied and a new generation of agronomy involving fertilisers, fungicides and plant growth regulators emerged.

In the Irish environment these varieties found immediate favour, particularly as grain quality was not a serious issue. The high rainfall environment combined with the high yield potential of these varieties to produce significant benefits.

Yield improvements continue to accrue but the rate of increase is now somewhat lower than previously. This is not surprising bearing in mind the considerable utilisation of genetic resources and the intensity of highly efficient breeding programmes.

## CURRENT MARKET DEMANDS AND FUTURE PROSPECTS

Grain prices have risen as a consequence of demand within the US and the Far East for starch based products – in the case of the US for biofuel production and in the Far East as a consequence of dietary changes towards more 'western diets' based on animal products as well as the requirement for transformed wheat products. This trend is unlikely to decline and high grain prices are likely to be a feature for the foreseeable future (Marathee, J-P and Gomez-Macpherson, H. 2000). Thus wheat growers in high yield potential climates such as Ireland look set to benefit from this demand as yield will once again be the number one priority.

In the light of lower genetic yield 'potential' increases growers must look to take advantage of every aspect of a range of technologies to ensure that yields are maximised in 'on farm' situations.

Growers will continue to be under the 'environmental spotlight' as politicians lobby for the so called 'green vote'. It is imperative therefore that growers take heed of these concerns and take appropriate action to mitigate any potential losses in yield. Some of these constraints are listed below.

1. Water use – grain yield is influenced very strongly by the availability of water – and in this respect Ireland is well placed. However in the UK there are now pressures to reduce levels of water contamination from the use of applied fertilisers. There is therefore a school of thought that growers somehow should be able to maintain yield and yet reduce nitrogen inputs at the same time. Plant breeders have been asked to select varieties with improved 'nitrogen use efficiencies' (NUEs).

2. Fungicide use – the demise of strobilurin chemistry and the gradual erosion of the efficacy of triazole chemistry has highlighted the benefits of utilising genetic resistance for *Septoria tritici*. This disease is by far the most damaging of all the foliar diseases and even low levels of the disease in commercial crops will result in significant yield loss and grain degradation. At present there is no new chemistry on the horizon so breeding for resistance will command a high priority in breeding programmes.

3. Political considerations – food supply will become a major issue in the future as the world population increase and supplies become 'tighter'. Current UK expenditure on food of 10% of disposable income is very low and is likely to increase over the next ten years as supply/ use balance tightens in the world arena. This will give greater emphasis to high yield production. However conversely the European community have made commitments to reduce the impact of agriculture on global warming which could impede the development of a truly sustainable agricultural market.

## THE POTENTIAL FOR WHEAT BREEDING TO CONTRIBUTE TO IRISH AGRICULTURE

Within the framework outlined above it is clear that cereal growers will be expected to be able to produce grain in a more sustainable manner. The need for water use efficiency (WUE) is less than in other more arid parts of Europe and certainly there are no indications that water supply will be yield limiting in the foreseeable future.

There will however be concerns about any reduced inputs in nitrogen. The Irish grower is better placed than many of his/ her European counterparts in having a higher proportion of mixed stocking and hence able to take advantage of effluents produced by stock. However careful monitoring of nitrogen inputs will be required and different strategies employed according to rotational position of crops. There has been little work on the efficiency of different wheat varieties in terms of nitrogen use. The history of breeding higher protein quality wheats does not bode well as little genetic variability has been identified with just a few varieties now accepted as having marginally better grain protein contents (in the region of 0.5%). However there is active work within the UK to seek out variability but this is a long term proposition. In the short term agronomic practices will need to be modified – including utilising nitrogen later in the spring than currently. This will have a number of benefits:

1. reduced levels of losses through the water courses
2. reduced extension of the first internode – hence reducing the threat of lodging
3. reduced disease pressure

The opportunities for disease control are significant and will be realised in a very short time scale. Resistance to *Septoria tritici* is of very high importance in Ireland with even low levels of the disease resulting in reduced yields and grain quality. Significant progress continues to be made using conventional plant breeding strategies. Screening within the Irish environment now takes place and is a regular feature of the Nickerson wheat breeding programme. This has highlighted a very high number of varieties with improved levels of resistance. Table 1 gives a summary of progress made to date. Contrary to views previously held by the scientific community yield performance has not been compromised by these higher levels of Septoria resistance. A number of breeders are now entering varieties with very high levels of resistance. This bodes well in an environment, such as Ireland, where this disease is so prevalent.

**Table 1:** *Septoria tritici* disease ratings over time

| Variety | Year added to UK RL | Sept tritici rating | Septoria nodorum rating |
|---|---|---|---|
| Longbow | 1983 | 3 | 4 |
| Riband | 1989 | 3 (2.8) | 4 |
| Consort | 1995 | 4 (3.6) | 4 |
| Claire | 1999 | 6 (5.7) | 8 |
| Alchemy | 2006 | 6 (6.4) | 9 |
| Lear | ?? | 7 (7.3) | * |

* No rating available Source CEL/ NIAB

The major root disease, apart from the intractable disease 'Take all' is eyespot, *Tapesia acuformis* (R type) and *Tapesia yallundae* (W type) which can have a very significant effect both on grain yield and quality. Results reported at the National tillage Conference in 2007 (O'Sullivan et al) showed that resistance to MBC fungicides was still very high and that reduced sensitivity to prochloraz had increased. There was also an indication that there was an increase in the number of isolates which were insensitive to cyprodinil (Unix) although this latter observation was based on a relatively small sample size.

There are however clear indications of increased levels of reduced sensitivity to chemistry in use and although new chemistry is available through products such as Tracker (BASF = epoxiconazole + boscalid) and Proline (Bayercropscience = prothioconazole)

Breeding varieties with high levels of resistance to eyespot has been a priority for UK breeders for many years. Eyespot resistance derived from Cappelle Desprez has been exploited through a range of varieties over the years from Maris Huntsman, via Norman and Riband to present day varieties such as Claire. However newer and higher levels of resistance were sourced from *Aegilops ventricosa* (VPM) and these are now coming to the fore in advanced varieties (Koener, R.M.D. and Martin, P.K. (1990). Whilst the combination of the Cappelle resistance and the VPM resistance does not confer immunity it does offer growers the opportunity to exclude a specific eyespot spray in situations other than very high risk. Again though a combination of genetic resistance and chemical control will be required for optimal control.

## AGRONOMIC TARGETS

Whilst diseases such as *Septoria tritici* and Eyespot represent significant threats for the Irish grower, standing power and the ability to withstand wet weather at harvest are two major concerns.

With regard to straw strength, breeders are well aware of the needs of the grower and this trait is considered second only to yield. Unfortunately the genetics of this character are complex and there appears to be no short cut to developing varieties with improved standing power. However the success of breeders to produce varieties to date and the large scale of current breeding programmes promises to deliver varieties with stiff straw and many of the disease resistance attributes required by Irish growers. Alchemy is a good example of the output from conventional breeding strategies and this variety, successful in its own right as a variety, will feature in the pedigrees of newer varieties to come.

Sprouting resistance is so complex that breeders have combined together to tackle the problem. This in itself is a significant advance as historically breeders have attempted to resolve this problem individually. A consortium of Nickerson-Advanta, RAGT (formerly PBIC) and CPBTwyford are working with the John Innes Centre and others to resolve this complex issue.

## DEVELOPING A STRATEGY TO PRODUCE WHEAT IN THE 21ST CENTURY

With environmental issues now uppermost in the deliberations of politicians it is difficult to see a return to the ‘spray it then weigh it’ philosophy of the 1970/80s – certainly in the short term. Thus selective use of technology will be the focus for the future – just as it was for the first ‘Green Revolution’. This time however we will need to see a more interactive process develop between agrochemical manufacturers, plant breeders and the ‘extension’ services. In many respects this has been happening within the Nickerson programme as the company has developed its own ‘in house’ agronomy work with key manufacturers such as BASF, Monsanto, Syngenta and Bayercropscience. The mechanism for this has been an understanding that products will be used selectively and information supplied to growers to advance their knowledge on optimising their use. Nickerson still retain their independence and receive no payment from these companies, other than to offset costs incurred.

It is unlikely that ‘blueprints’ can be developed for individual varieties but strategies can be developed to ensure that growers sow the most appropriate variety, in the quality class required, in the correct rotational position.

This strategy will be developed further as new markets develop. Already Nickerson have invested in selecting varieties for animal feed needs and the biofuel market.

## DEVELOPING VARIETIES FOR END USE

### *Animal Feed*

Work carried out ten years ago by Nickerson identified varietal differences which would be of benefit to poultry producers (Short *et al*, 2000). This has resulted in the exclusion of certain varieties (which carry the 1B/1R wheat/rye translocation) from certain feed producers buying programmes. The problems associated with this undesirable trait have been resolved by the use of enzymes but these additions may come under greater scrutiny as animal pressure grows to reduce additives.

Again there is an increased level of coordination between the various supply chain companies as breeders have combined with academics and commercial poultry producers to tackle issues relating to efficient but environmentally ‘friendly’ means of poultry production taking full cognisance of animal health issues. This work is being funded under the auspices of the Defra LINK sustainable agriculture programme.

### *Biofuel*

Fortunately there has been an increasing awareness of differences between wheat varieties in their potential use for potable alcohol production. The requirements for alcohol yield from wheat are likely to be similar for traditional alcohol production or industrial alcohol production. The UK and Ireland are well positioned to take advantage of demand for wheat to meet these end uses. Of primary interest for this market is high starch content, ie low protein content, and this fits well with the output from UK and Irish farms. The maritime climate prevalent across the UK and Ireland lends itself to high rainfall, low sunshine levels and therefore high grain yields of low protein wheats. Breeders are conscious of these needs and high alcohol output varieties are already available with varieties such as Riband, Istabraq and Alchemy.

## THE ROLE OF NEW TECHNOLOGY

One of the technologies unavailable during the first 'Green Revolution' is biotechnology. This, potentially very exciting technology, is available to plant breeders in two different but often complementary disciplines.

### *Marker Assisted selection (MAS)*

Prior to the development of markers associated with genes of known interest plant breeders were able to select primarily on phenotype – what one can observe, usually in the field. The example of a marker associated with a disease of high value was first used on a large scale with the development of varieties known to carry resistance for eyespot from *Aegilops ventricosa* (VPM). *Without* field selection it is now possible to select lines from segregating populations in the laboratory which carry this valuable trait. A 'library' of valuable markers associated with known valuable traits is now being collated. These markers can then be used in combination to increase the efficiency of selection for valuable characters. Already physiology, quality, disease and pest traits are being assessed in breeding programmes. Whilst this technology is still in its infancy the potential is high. Working with the agrochemical industry varieties could be selected to avoid sensitivity to herbicides designated as being more benign or less environmentally damaging. The example served by the selection for varieties resistant to wheat orange blossom midge is an example whereby varieties known to exercise their own form of biological control can be developed, rather than a reliance of insecticide use.

### *Genetic Modification (GM)*

Investment in this process has 'migrated' to crops of high value and which are often hybrids. Work on wheat has been much reduced but it is likely to be re-considered in the near future. There are still major issues about public acceptance but the science does have some environmental benefits. Crops so produced could lend themselves to lower inputs and more targeted use of agrochemicals. If production can be increased in the most fertile soils this could lead to a reduction in the cultivation of more marginal soils – these becoming free for other recreational or other environmentally valuable uses.

The technology behind the development of GM wheats is now mature. However there is still a need to monitor the potential outcomes from the introduction of such material and, as the plant breeding industry has always recognised, this will be and should be a long and exhaustive process.

## HYBRID WHEAT

This subject of hybrid wheat has been the 'Holy Grail' for wheat breeders over the last century. Whilst opportunities to develop this technology do exist this is likely to be focussed on areas of the world where drought is a limiting factor with regard to capturing high grain yield. It is this unlikely to figure within the wetter climate of Ireland.

# SUMMARY

The demands for wheat are increasing as countries such as China and India look to import higher quantities of grain to not only feed their populations but also move towards a meat based (and hence grain fed) diet. There are also higher demands for starch based products to meet the increasing demands of the biofuels industry. This increased demand can only be met by exploiting the technologies currently available and well as introducing newer ones when appropriate. As for the first 'Green Revolution' plant genetics and the role of the plant breeder will be pivotal. New varieties will need to be developed which will demand lower inputs, whether these be fertiliser, fungicides or plant growth regulators, in order that they will respond to the agronomic inputs available.

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# REFERENCES


- Gale, M.D. (1978) The effects of Norin 10 dwarfing genes on yield. Proc. 5th Int Wheat Genetics Symposium, pp 978-987
- HGCA Recommended Lists for Cereals and Oilseeds (various)
- Koener, R.M.D. and Martin, P.K. (1990) Association of eyespot resistance in wheat cv. 'Cappelle Desprez' with endopeptidase profile. Plant Breed. 104: pp 312-317
- Marathee, J-P and Gomez-Macpherson, H (2000) Future World Supply and Demand World Wheat Book (Edited Bonjean and Angus) Ch 43 pp 1107-1116
- NIAB Recommended Varieties of Cereals (various)
- O'Sullivan et al (2007) Fungicide Resistance – an increasing problem. National Tillage Conference pp 43-56
- Short, F.J. Wiseman, J and Boorman, K.N. (2000) The effect of the 1B/1R translocation and endosperm texture on amino acid digestibility in near iso-genic lines of wheat for broilers. Journal of Agricultural Science, Camb. 134, 69-76

# Reducing Fuel Costs for Tillage farmers

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## SUMMARY

The increase in oil price, which is likely to be sustained, has an impact on production costs on tillage farms. All input prices are likely to be affected, but the cost of fuel used in farm machinery is directly affected, and is one of the few areas that growers can influence. To remain competitive, growers must strive to reduce costs and fuel use should be targeted. There are many factors which influence fuel use which vary in scope and opportunity for cost reduction. The selection of machinery system and choice of tractors are considered in this paper. Minimum tillage establishment systems offer considerable scope for fuel saving as the shallower cultivation system requires much less energy input per hectare. With a primary cultivation energy requirement of approximately 37% of that required by ploughing, the overall fuel use of the min-till establishment system is just 50% of that of conventional systems. This can result in a fuel saving of between €13 and €16 per hectare, with additional depreciation and repair cost savings also accruing. There are significant differences in fuel consumption rates between tractors. Data from the OECD tractor tests allow valid comparisons to be made. Ironically the introduction of emissions regulations in recent years has increased fuel consumption by up to 30%. Differences between tractor models can also be significant with substantial cost implications for tractors with high annual use rates. Overall the choice of tractor could easily account for fuel cost differences of up to €8/ha. The choice and use of machinery can have a significant impact on fuel use and cost. .

# INTRODUCTION

With crude oil prices having touched the threshold figure of $100 / barrel recently, there is a strong focus on fuel cost and it's effect on production. In real terms, current oil prices may be no higher than those experienced during the crises of the 1970s and early 80s, but past price peaks were precipitated by wars in oil producing areas, whereas today's prices are a reflection of supply and demand. While prices of oil will always fluctuate, there is general agreement that the era of low oil prices has passed and that the increase in energy demand due to the growth of eastern economies, coupled with dwindling resources and more expensive oil extraction, will resulted in relatively sustained high and increasing oil prices.

The increased oil / energy prices impact on agriculture in many ways. Fuel cost increases directly affect machinery operating costs and crop drying and transport charges. However the effects on fertilizer costs (particular nitrogen), plant protection products, and indeed manufacturing and transport costs for all inputs, also impact on growers production costs. The impact on farmers' net income depends not only on costs but on the market responses to these price increases. Can the extra costs be recouped when produce is sold, is there a time lag, or, do these same energy prices increases reduce demand by steering economies towards recession? These questions are difficult to answer. An additional factor in the current era is the ability of agriculture to produce energy crops and the consequent positive impact on commodity prices for produce competing for the same land resource as biofuel production.

As producers, we must always seek to reduce the costs of production. The measures we take to reduce costs are influenced by: 1) research, which determines the scope for cost reduction and quantifies the response to changes in inputs and costs and; 2) the relationship between input costs and output prices at the time of consideration.

There was a positive agricultural research response to the oil crises of the 1970s / early 1980s with work focused on energy reduction and the commencement of a biofuels programme. However this response was not sustained following the reduction in oil prices in the mid 1980s with cessation/reduction of this research and much less interest in these areas by end-users and other stakeholders. This time round, it is important that research, development and promotion efforts in the area of reduced energy use and bio-fuel production are sustained to ensure that we maximize the benefits from this work. This is more likely now than in the 70s/80s because of the likely sustained higher oil prices, but also particularly because of the need to reduce fossil fuel combustion in an effort to reduce our impact on climate change.

# FUEL USED ON TILLAGE FARMS

While the impact of increased energy costs on agriculture is wide-ranging, this paper will focus on the direct use of fuel on arable farms, or more specifically, the consumption of diesel by farm machinery. Fuel used in the production or transport of inputs or in the drying of grain is not considered here. Irish research on fuel use and factors affecting use on Irish tillage farms is very limited, however we can build on some Irish data sources and draw on other data to give a useful indication of where fuel and cost savings can be made at farm level and also to indicate where we should target our future research efforts.

## Fuel used to produce tillage crops

There are many sources of data relating directly or indirectly to the fuel or energy required to produce arable crops, but few of these relate directly to Irish conditions. In the early 1990s, a detailed machinery cost survey of 40 tillage farms indicated that cereal production required approximately 85 litres of fuel per hectare (7.5gals/acre), but this varied considerably from farm to farm. Research in the UK which examined individual field operations is outlined in table 1.

**Table 1:** Typical fuel requirements for field operations in UK (from Witney, B.D. 1988)

| Operation | Fuel consumption (l/ha) |
|---|---|
| Subsoiling | 15 |
| Ploughing | 21 |
| Heavy Cultivation | 13 |
| Light Cultivation | 8 |
| Rotary Cultivation | 13 |
| Fertiliser Distribution | 3 |
| Grain Drilling | 4 |
| Rolling | 4 |
| Spraying | 1 |
| Combine harvesting | 11 |

While this data is quite old, and some of the machine operations have changed considerably (e.g. fertilizer spreading, cultivator-type drill not included etc), it is still a useful resource. If the operations that would typify an Irish cereal crop growing situation are summed from this table, a figure of 64 liters per hectare is produced. To compare this to an overall tillage crop production figure on farms, transport of grain to a merchant and machine transport to/from field would need to be included. Grain transport could add 5 to 10 litres/ha while machine operation between fields etc could add another 10% resulting in a total figure similar to that noted from the Irish machinery cost survey. While these figures give an approximation of the average fuel consumption on tillage farms, it is important to note that there are many factors which influence consumption resulting in much variation in individual farm circumstances.

## Importance of fuel costs

The importance of fuel as a cost depends on how much is used per unit of production and the price of the fuel. In this paper, where mechanisation systems are compared, fuel use per hectare is considered rather than per unit of produce (per tonne). The price of fuel has a large impact on costs, and its current relatively high price has focused our attention.

If we take the data from the machinery cost survey of the 1990s, updated to take into account inflation to give an overall machinery cost of €314/ha and then factor in the effect of changing fuel prices from €0.25 to €1.00 per litre, we can see the effect on machinery cost components (Fig 1). Costs increase by €67/ha and move in importance from being just 8% of total machinery costs to 25%, as fuel costs increase (Fig 1).

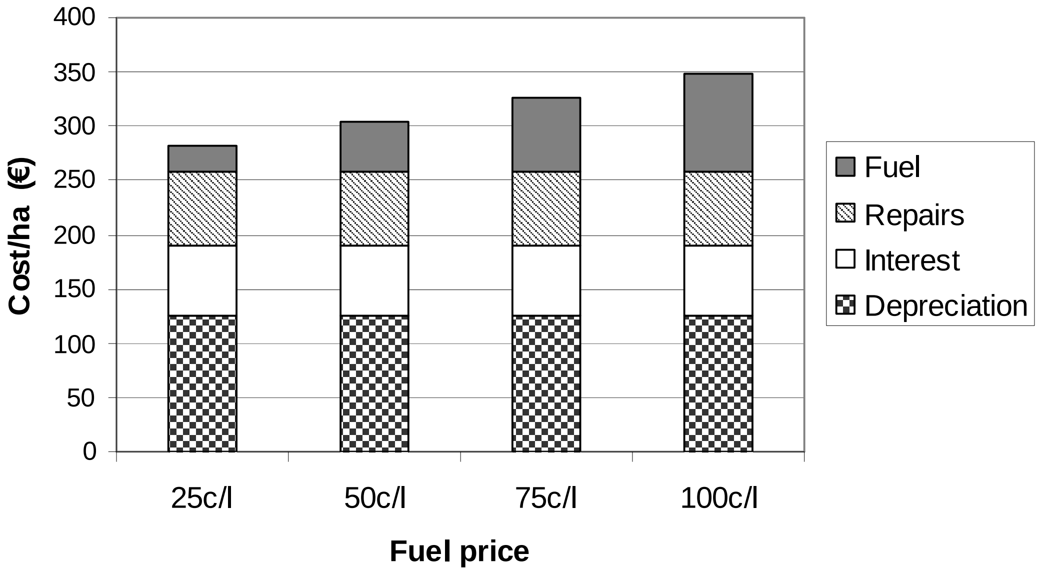


**Fig 1:** The increasing effect of fuel price on machinery cost elements

## Factors influencing fuel costs

While we have no control over the price of fuel, we are to some extent able to influence the quantities that we use. It was stated earlier that there is considerable variation in fuel use from farm to farm – some of this may be under the control of the grower and be determined by machines or systems used. There factors which influence fuel use on tillage farms are outlined in Table 2:

**Table 2:** Factors influencing fuel use on tillage farms

| Factor | Impact | Scope for saving |
|---|---|---|
| **Crop grown** | Root crops require intensive cultivation and fuel | ***Little:*** Crop choice must be determined by overall profitability and not fuel use alone |
| **Soil type** | Heavier soils can require more intensive cultivation. | ***Some:*** Match cultivation system to soil type |
| **Field size, distance** | Inefficient use of machinery | ***Some:*** Over long term adjacent land blocks should be farmed together. |
| **Weather** | Soil damage requiring remediation | ***None*** |
| **Machine systems** | Shallower less intensive cultivation and less fuel | ***Good:*** However costs and benefits of overall system must be compared |
| **Machine type** | Potentially improved efficiency | ***Some:*** In certain situations |
| **Machine operation** | Improved efficiency | ***Some*** |

While many of these factors are to a greater or lesser extent outside of our control, others are not and growers' decisions can influence costs. The choice and use of machinery is in this category.

### Choice and use of machinery

The choice and use of machinery and it's impact on fuel consumption can be considered at many levels.

1. The choice of basic machinery system
2. The choice of machines within a system
3. The selection of efficient prime movers (tractors and other machines with engines)

4. Machine matching and suitable machine specification
5. Efficient machine operation

The basic system that is used can have the biggest impact on fuel use, but not every mechanised operation offers scope for savings here. The use of crop establishment systems such as minimum tillage or direct drilling in place of conventional plough-based tillage offers significant scope for fuel saving and will be considered further here. Other machinery operations offer much more limited scope for fuel savings. There are no radically different ways of harvesting a cereal crop or applying herbicide/fungicides, for example, which will save fuel.

The choice of machines within a system may also impact on fuel. Particular plough mould-boards for example or cultivator types may be more fuel efficient than others. Coming from an era of cheap energy, manufacturers may now need to refocus their attention on fuel efficient design.

Within prime-movers like tractors, there can be significant differences between models even though the overall design and specification are similar. These engine efficiency differences are important and should be pursued as a possible route to fuel saving. This will be considered further here.

Machine capacity or size needs to be carefully matched with other machines to be worked on the farm to allow them work efficiently e.g. it is inefficient to own a very high powered tractor for just one short power-demanding task in a season. Similarly the specification of the machine, such as the choice of tyres and ballast, can have a significant impact on fuel efficiency.

Efficient machine operation in the field can also impact on fuel efficiency. Correct adjustment and maintenance of implements in addition to correct driving technique can reduce fuel use.

## MINIMUM TILLAGE FOR REDUCED FUEL COSTS

Minimum tillage systems offer scope for fuel saving. The source of this potential is primarily the shallower cultivation depth compared to ploughing (typically 75mm compared to 200+mm), and occasionally some reduction in the intensity of cultivation. While the energy requirement and fuel use of cultivation systems was researched in the past in other countries, there has been little research into the power requirement of the systems which have currently evolved and particularly of those working in Irish conditions. Data from the Teagasc research programme evaluating machinery work rates (Forristal 2006), can be used to estimate fuel and energy inputs of different machinery operations. In this project, machine work rates were recorded and the available power (tractor size) for each operation was noted.

## Fuel use for machine operations

For the cultivation operations recorded, most operators would seek to load the tractors optimally to maximise work rate, allowing estimates of the power input to be made (Table 3). In this table two factors: the proportion of engine power utilized and; the specific fuel consumption are used to estimate fuel use for each operation.

**Table 3:** Estimated power input and fuel consumption of different tillage operations

| Operation | | Power input (kWh/ha) | Power used (prop) | Energy input (kwh/ha) | SFC[1] (kg/kWh) | Fuel use (kg/ha) | Fuel use (Litre/ha) |
|---|---|---|---|---|---|---|---|
| **Plough** | ***Mean*** | ***82*** | **0.80** | **59.04** | **0.30** | **17.71** | **21.61** |
| (26) | High[2] | 92 | 0.80 | 66.24 | 0.30 | 19.87 | 24.24 |
| | Low | 72 | 0.80 | 51.84 | 0.30 | 15.55 | 18.97 |
| **One Pass** | ***Mean*** | ***44.7*** | **0.85** | **34.20** | **0.33** | **11.11** | **13.56** |
| (23) | High | 50 | 0.85 | 38.25 | **0.33** | 12.43 | 15.17 |
| | Low | 39 | 0.85 | 29.84 | **0.33** | 9.70 | 11.83 |
| **Roll** | ***Mean*** | ***15.6*** | **0.50** | **7.02** | **0.35** | **2.46** | **3.00** |
| (6) | High | 22 | 0.50 | 9.90 | **0.35** | 3.47 | 4.23 |
| | Low | 10 | 0.50 | 4.50 | **0.35** | 1.58 | 1.92 |
| **MT cult**[3] | ***Mean*** | ***21.3*** | **0.85** | **16.29** | **0.30** | **4.89** | **5.96** |
| (10) | High | 24 | 0.85 | 18.36 | 0.30 | 5.51 | 6.72 |
| | Low | 18 | 0.85 | 13.77 | 0.30 | 4.13 | 5.04 |
| **MT drill**[4] | ***Mean*** | ***29.9*** | **0.70** | **18.84** | **0.30** | **5.65** | **6.89** |
| (9) | High | 35 | 0.70 | 22.05 | 0.30 | 6.62 | 8.07 |
| | Low | 25 | 0.70 | 15.75 | 0.30 | 4.73 | 5.76 |

Notes: [1] Specific Fuel Consumption

[2] High and Low refer to the 95% confidence intervals about the mean

[3] Minimum tillage cultivator

[4] Minimum tillage drill

The calculated fuel consumption figures correlate quite well with those presented earlier (Witney) where comparable operations are available. However this calculated data must still be treated with caution as both correction factors used (proportion power and SFC) are estimates only. The fuel consumption data is presented graphically in Fig 2.

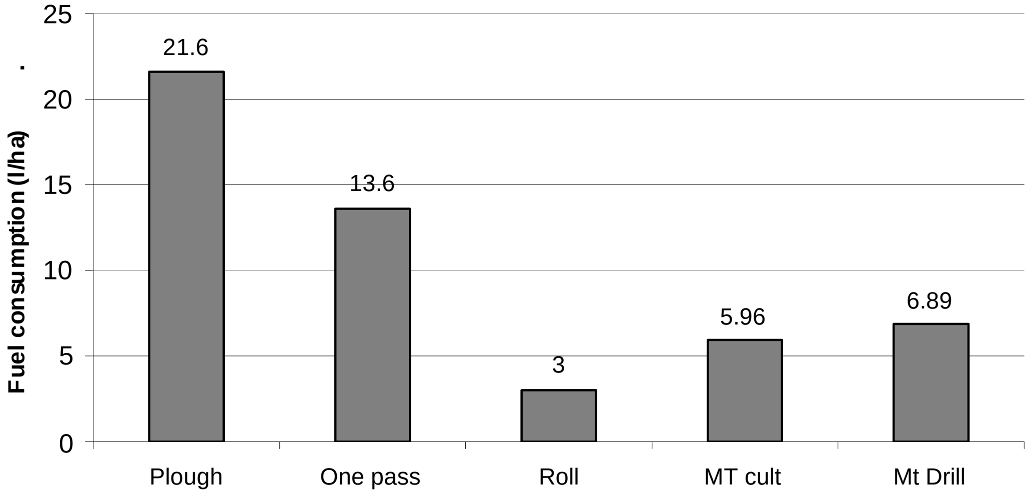


**Fig 2:** Estimated fuel consumption for different cultivation operations.

## Cultivation system fuel requirements

The estimated fuel consumption figures can be compiled to allow us to compare the fuel efficiency of different crop establishment systems. Two plough-based systems and two minimum tillage systems are compared in Fig 3. A plough system which uses a power harrow and mounted drill (one-pass) has a similar fuel use rate as that using a furrow press and a cultivator-drill (plough/ drill). The minimum tillage systems have a much lower fuel demand at approximately 50% of that of the plough-based system, depending on whether one (Min till1) or two passes (Min Till 2) of the stubble cultivator are used.

Using a fuel cost figure of €0.70/litre, minimum cultivation systems save between €12.64 and €15.65 / ha. The difference in total machinery cost between the two systems is much greater, as the lower energy consumption of the minimum tillage system requires a lesser power input, which results in a similar reduction in machine capital (depreciation and interest) costs and wear / repair rates. The relative benefits, in fuel and machinery costs, of adopting minimum tillage will vary in individual farm situations. Heavy soil farms are likely to gain bigger savings from adopting min-till. Costs may also vary if occasional changes in working depth are needed to overcome soil pan formation or surface compaction.

While fuel and machinery costs of the minimum tillage system cannot be considered in isolation, they are one of the key advantages of reduced cultivation systems. Minimum tillage needs to be considered as a cost reduction strategy on many farms.

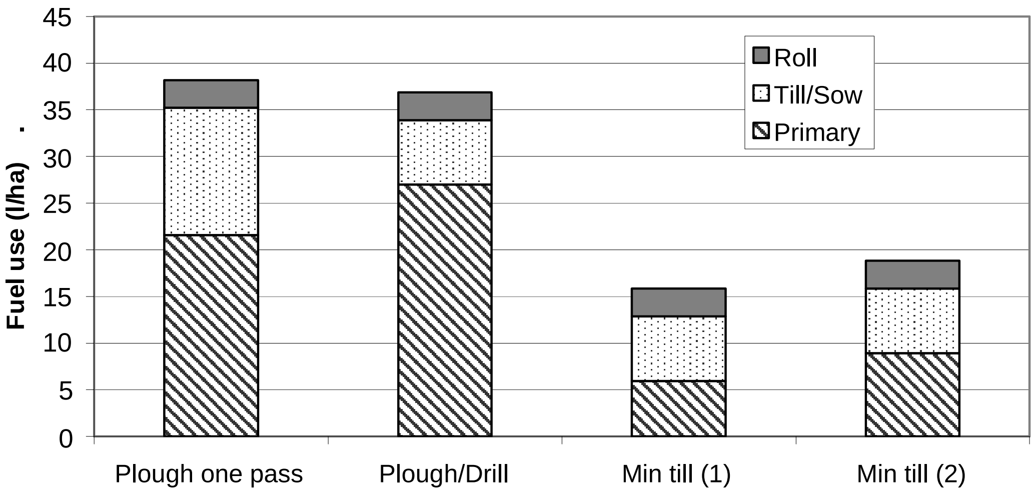


**Fig 3:** Estimated fuel consumption for different establishment systems

# TRACTOR FUEL CONSUMPTION

From the late 1980s until quite recently, the fuel consumption characteristics of tractors were considered relatively unimportant as fuel prices were low, and it was believed that there was little difference in fuel consumption between tractor makes and models. Most tractor purchasers would also have believed that the fuel efficiency of modern tractors would be superior to that of older models and that newer emissions legislation, that tractors must comply with, has improved fuel efficiency. But today, differences in fuel consumption are common and are important. Perhaps surprisingly the emissions legislation has generally resulted in higher fuel use rates and today's tractors often use more fuel than those of 15 years ago.

## Emissions legislation

Agricultural tractors must comply with EU emissions legislation which stipulates that new tractors must produce less than set threshold levels of pollutants. These standards, which are becoming more stringent over time, are referred to as EU 'stages' 1 to 4 which are analogous to the US 'tiers' 1 to 4. The pollutants included are: oxides of nitrogen (NOX); hydrocarbons (unburned fuel); carbon monoxide and; particulate matter (smoke). They do not refer to fuel consumption or $CO^2$ production, which are both fuel efficiency factors. Consequently compliance with these regulations does not indicate fuel efficiency. In fact many of the engine adjustments that will reduce pollutants (e.g. NOX) will actually cause fuel consumption to detiorate. The challenge for manufacturers is to design and build engines that meet future stringent emissions regulations while maintaining fuel efficiency.

## Comparing fuel consumption

To compare tractor fuel consumption, the fuel use rate must be expressed as a function of the quantity of power produced. This specific fuel consumption figure allows tractors of differing power outputs to be compared. Specific fuel consumption is usually given as the weight of fuel per kWh of energy (e.g 0.256kg/kWh). There are a number of sources of fuel consumption data. Manufacturers generally rely on engine tests where power output is measured to DIN, ECER 24, ISO 14396, or similar standards and fuel use is recorded simultaneously. Unfortunately these different test standards specify different test conditions and consequently, if the same engine was tested under different standards, different power outputs and consequently specific fuel consumption rates would be recorded. The move to using ISO 14396 rather than DIN over recent years allows the manufacturer to quote higher power outputs and lower specific fuel consumption data from the same engine.

The OECD pto power test is a more useful guide, as the tractor is tested with all normal ancillaries such as cooling system, hydraulic systems etc in place. The OECD code is a voluntary independent test that not all tractor manufacturers choose to use, however for the tractor purchaser and indeed as a means of controlling the claims of manufacturers, it is extremely valuable. During the test the tractor is fully loaded to determine the tractors power and torque delivery characteristics and it’s fuel consumption. Teagasc has access to the full test reports while a summary of the reports is available on the OECD website. Unfortunately not all tractor models data are available and there is often a significant time delay between the introduction of a new model and the publishing of test data. In this paper the OECD test data is used to examine the difference in fuel consumption between tractors

## Are newer tractors more fuel efficient?

Two comparisons are chosen to illustrate the reduction in efficiency that tractors of recent years have compared to previous generation models. Models from John Deere and New Holland tractor ranges are chosen. The fuel data in Fig 4 and Fig 5 are corrected using the specific fuel consumption figures, for a mean pto power output of 80kW.

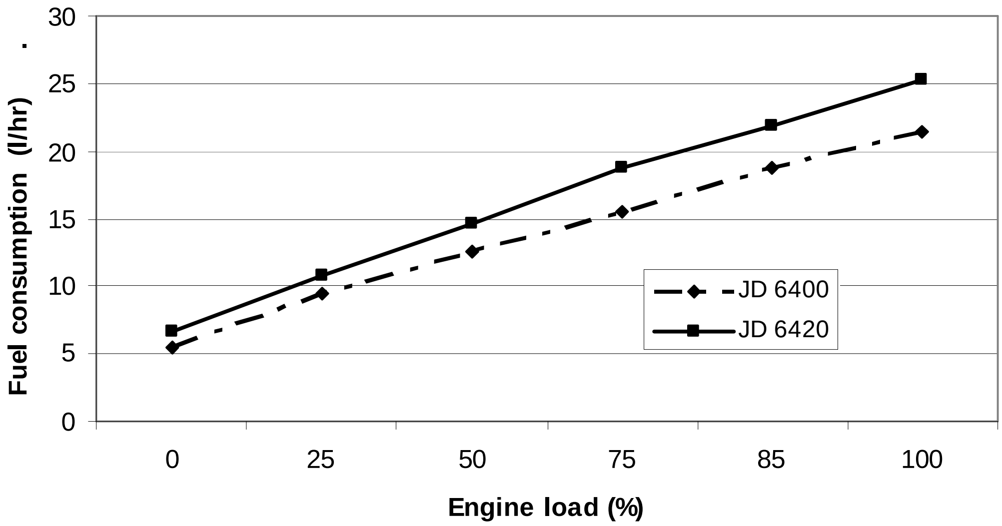


**Fig 4:** Tractor fuel consumption for newer and older tractor models at 80kW power output

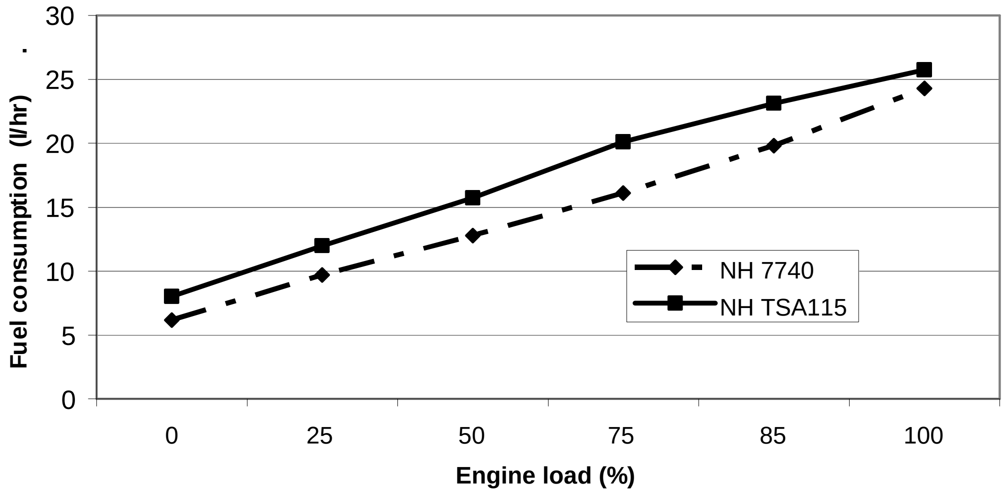


**Fig 5:** Tractor fuel consumption for newer and older tractor models at 80kW power output

The data in both cases clearly shows that the older models are more efficient at all engine loadings. The older John Deere model used between 14 and 21% less fuel, depending on the load on the engine, for the same power output as the newer model. Similarly the older New Holland model was between 6 and 30% more fuel efficient.

The impact of these difference on annual fuel costs depends on the amount and type of work load the tractor would have and on the cost of fuel. The load on a tractors engine varies continuously depending on the work being carried out. An 80kW tractor under full test load could use up to 25litres of fuel per hour for example, which it would realise in farm work. If an 80kW pto power output (approx 115hp engine power) tractor was used continually at heavy work during every hour worked for example, the overall difference in fuel consumption could be 2.7 litres per hour (18 rather than 15.3 litres / hr). The potential impact of this on annual fuel costs is shown in the matrix in Table 5.

**Table 5:** The effect of a 2.7 litres/hr fuel consumption difference on annual fuel costs (€/year)

| | **Fuel prices € / litre** | | |
|---|---|---|---|
| **Hrs /year** | **0.3** | **0.55** | **0.7** |
| **500** | 405 | 743 | 945 |
| **1000** | 810 | 1485 | 1890 |
| **1500** | 1215 | 2228 | 2835 |
| **2000** | 1620 | 2970 | 3780 |

The ‘newer’ tractor models used in this illustration have also now been replaced. While OECD figures are not available for comparison, indications are that manufacturers are succeeding in improving tractors fuel consumption somewhat although not achieving the economy of the 1990 models above.

## Differences between tractor models

There are also substantial differences in fuel consumption between different makes and models. To illustrate this OECD test data from tractor models in the 80 to 85kW pto output category, from three leading tractor manufacturers, were compared. The manufacturers are not identified here as the differences are model specific. For example manufacturer A may have a tractor with the poorest fuel efficiency in the 80kW power category, but its model in the 120kW category could have the best fuel efficiency.

In Fig 6, the OECD fuel consumption for the three models is normalized for a pto power output of 80kW, to allow valid comparison. The differences in fuel consumption rate, between the three models, varies from 0 to 18%, depending on engine loading.

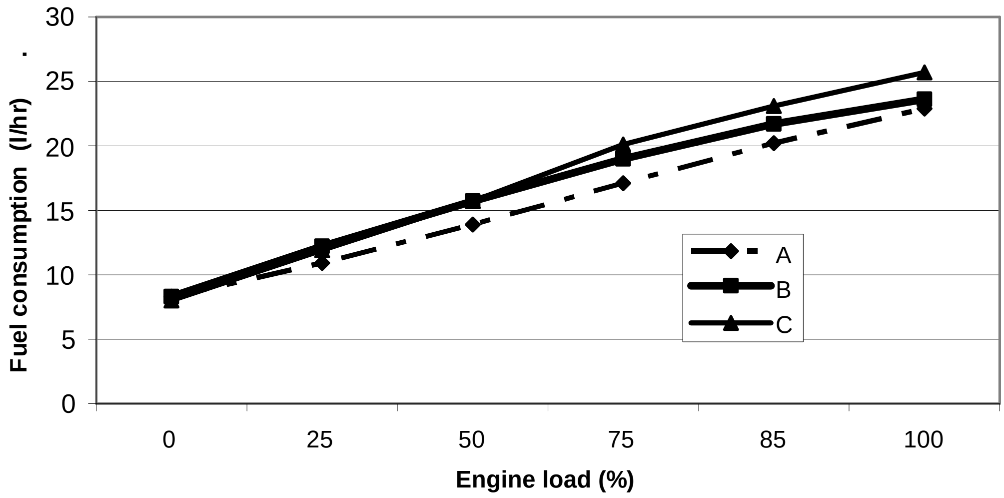


**Fig 6:** Tractor fuel consumption for newer and older tractor models at 80kW power output

The effect of this on annual fuel costs depends on work load. For example if the tractor was used for very heavy work, there could be a fuel use difference of 2.25 litres per hour between the best and worst of the three models tested. A mixed light-load pattern where the tractor is rarely loaded to deliver full power was also modeled using the OECD data. This resulted in a fuel use difference of 1.17 litres per hour between the best and worst models in the three-way comparison. The impact of these work patterns on annual fuel cost depending on fuel price and annual work load are given in table 6.

**Table 6:** The effect of a 2.3 l/hr (heavy work) and 1.2 l/hr (light load) fuel consumption difference on annual fuel costs (€/year)

| | **Heavy work** | | | **Light Work** | | |
|---|---|---|---|---|---|---|
| **Fuel price (€/l)** | **0.3** | **0.55** | **0.7** | **0.3** | **0.55** | **0.7** |
| **Hrs /year** | | | | | | |
| **500** | 339 | 620 | 790 | 175 | 321 | 409 |
| **1000** | 677 | 1241 | 1580 | 351 | 643 | 819 |
| **1500** | 1016 | 1862 | 2370 | 526 | 965 | 1228 |
| **2000** | 1354 | 2483 | 3161 | 702 | 1287 | 1638 |

It is clear from this analysis of the OECD tractor data that there are substantial differences in fuel consumption between tractor models. The importance of these differences depends on tractor use level. Many tractors on tillage farms are worked relatively few annual work hours thereby limiting the impact of fuel consumption on individual tractor costs. However a difference of 2 liters per hour in fuel consumption with an 80kW tractor would at least amount to 11 litres per hectare worked in a season, which at €0.70 / litre would cost €7.70/ha. Fuel consumption should be an important consideration in tractor selection. Active selection of fuel efficient tractors will reduce fuel costs and carbon emissions.

# CONCLUSIONS

1. The increased price of oil, which is likely to be sustained over the longer term, increases the costs of many inputs on tillage farms, but particularly fuel.

2. Growers must seek to control or reduce all costs to remain competitive. Fuel costs must be targeted, as growers in competing grain producing countries frequently use low-energy crop establishment systems.

3. Many factors influence fuel consumption with varying scope and opportunities for cost reduction.

4. Minimum tillage offers considerable scope for cost reduction as the shallow primary cultivation operation requires just 37% of the energy input of ploughing.

5. Minimum tillage crop establishment systems requires just 50% of the fuel input of plough-based systems saving €13 to €16 /ha in direct costs. It's adoption would also reduce machinery depreciation and repair costs.

6. The availability of specific fuel consumption data from OECD tests allows tractor fuel consumption comparisons to be made.

7. Necessary compliance with fuel emissions regulations has increased fuel tractor fuel consumption.

8. There are considerable differences in fuel consumption between tractors which could account for operating cost differences of €8 /ha in operating costs.

# REFERENCES

Forristal, D., (2006): Workrates of high capacity machinery systems.

In proceedings of the National Tillage Conference 2006, Teagasc, Oak Park, Carlow.

Witney B.D., (1988): In: Choosing and using farm machines.

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# Maximising Returns from Fungicide Use in Cereals

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## SUMMARY

Fungicide trials carried out in 2006 and 2007 on wheat and barley showed economic yield responses to a number of fungicide programmes. Yield responses were higher in both wheat and spring barley in 2007 than 2006 due to the different disease pattern in each season. Yield responses in winter barley were similar in both years.

Routine spraying of winter wheat based on crop growth stage is the common practice. Results from trials have shown that Margin Over Fungicide Costs (MOFC) from three-spray programmes on crop growth stages have been positive ranging from €35/ha in 2004 to over €200/ha in 2007.

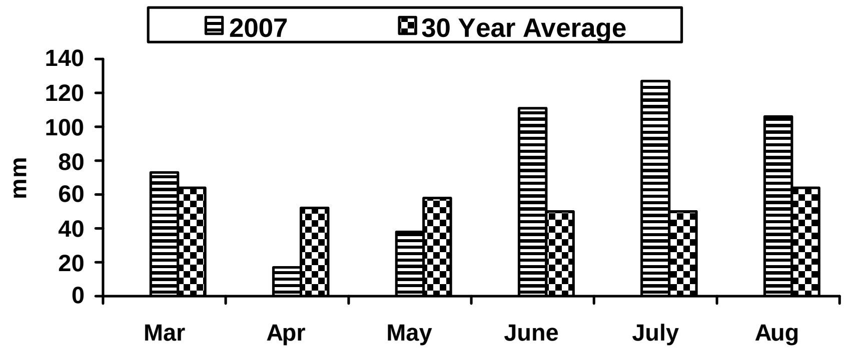
Similar trials in spring barley have also given positive results.

Decision Support Systems (DSS) offer an alternative to routine spraying. They take into account factors such as disease pressure, varietal resistance, fungicide dose response and weather information. An evaluation of a number of DSS systems showed that while some reduced the number of sprays orates of fungicides in some seasons, they rarely increased MOFCs over those obtained from routine three-spray programmes.

# INTRODUCTION

The yield of cereals in 2007 were close to the average of those of the previous six years with the exception of winter wheat yields which were below average. The weather pattern over the growing season of 2007 was somewhat abnormal. March was warmer than normal with normal rainfall. April was the warmest and sunniest on record and it was dry for most of the month. May was slightly warmer than normal with rainfall below normal. June temperatures were below normal while rainfall was more than twice normal. July temperatures were a little below normal, rainfall twice or three times normal. Rainfall data for the growing season is shown in Figure 1..

**Fig. 1: Rainfall Oak Park**




In early April Septoria was prevalent on wheat crops. The long dry spell 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 high levels of Septoria by early July, as well as facilitating the spread of ear blight caused by *Fusarium spp.* This latter disease was very prevalent in 2007 in contrast to previous years.

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

Many spring barley crops were infected by net blotch shortly after emergence and net blotch was the dominant disease on spring barley in 2007. It was well controlled by early fungicide treatments and consequently its overall effect on final yield was minimal. Ramularia was at lower than usual levels in 2007.

## DISEASE CONTROL IN WINTER WHEAT

## PROGRAMME TRIALS

Programme trials were carried out at three locations in 2006 and 2007. Results of the more conventional programmes are shown in Table 1. In 2007 due to the dry period in April and May it was decide to omit the T3 spray from most of the programmes. In treatments were a T3 spray was included the yield response to it was small.

2006 was a season with low foliar disease levels and yield response to fungicide treatment were lower than in 2007.

In both years there were only small differences between the various programmes especially in 2006.

## TIMING OF FUNGICIDE APPLICATIONS

In order to maximise yields from winter wheat the timing of fungicide applications is important. The main timing of sprays to control Septoria, the most important disease of winter wheat, has been established as growth stages 32, 39 and 59/65. These timings aim to afford maximum protection to the three most important yield producing leaves. At growth stage 32 the third leaf is almost emerged and will be fully protected. At growth stage 39 the flag leaf is just emerged. At this timing the second leaf may be infected but the disease will still be in a latent period and controllable. The final spray protects the ear and also gives added protection to the flag leaf.

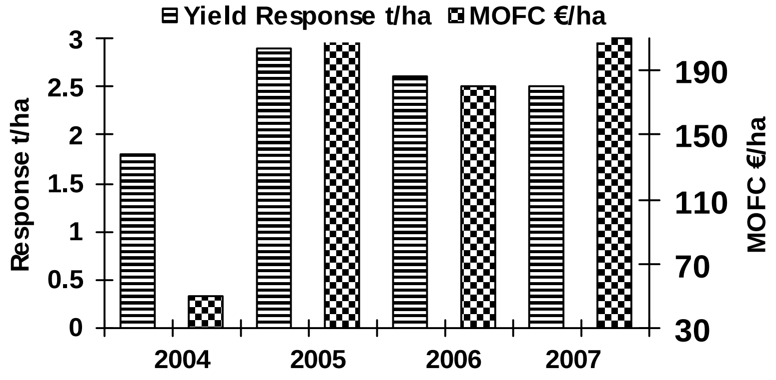
Ideally these spray timings should be targeted to leaf emergence rather than growth stage as the growth stage at which leaves emerge varies between crops depending on sowing date. Identifying leaf emergence is be done by close examination of the plants and when learned can be carried out in the field. Growth stages provide an acceptable spray timing guide but are not as precise as leaf identification.

However, the response from fungicide programmes applied to winter wheat based on growth stage has been usually positive. Figure 2 shows the average response to fungicide spraying on winter wheat for the past four years 2004 to 2007. This average is taken over a number of trials which were located in various parts of the main wheat growing areas, Oak Park, County Carlow, Kildalton Co. Kilkenny as well as County Meath and County Cork. The trials consisted of a various three-spray fungicide programmes and many fungicide products were included.

**Table 1:** Winter Wheat Programme Trials. Yield and % Disease.

| **2007** | | | **2006** | | |
|---|---|---|---|---|---|
| **Programme** | **% Septoria 2nd Leaf** | **t/ha @ 15%** | **Programme** | **% Septoria 3rd Leaf** | **t/ha @ 15%** |
| Opus + Bravo<br>Opus | 15 | 10.4 | Opus + Bravo<br>Opus<br>Caramba | 74 | 10.0 |
| Opus + Bravo<br>Opus + Bravo | 8 | 10.5 | Venture + Bravo<br>Opus<br>Caramba | 65 | 9.9 |
| Proline + Bravo<br>Opus | 25 | 9.8 | Proline + Bravo<br>Opus<br>Caramba | 68 | 9.9 |
| Venture + Bravo<br>Opus | 13 | 10.9 | Fandango + Bravo<br>Opus<br>Caramba | 58 | 9.8 |
| Opus + Bravo<br>Proline | 21 | 10.8 | Opus + Bravo<br>Prosaro<br>Caramba | 65 | 10.0 |
| Opus + Bravo<br>Venture | 11 | 10.5 | Opus + Bravo<br>Opus + Modem<br>Caramba | 51 | 10.4 |
| Opus<br>Venture + Opus | 14 | 10.1 | Opus + Bravo<br>Opus + Venture<br>Caramba | 60 | 10.3 |
| Opus + Bravo<br>Venture + Bravo | 11 | 10.9 | Opus + Bravo<br>Opus<br>Caramba + Amistar | 65 | 10.3 |
| Opus + Bravo<br>Opus<br>Caramba + Amistar | 8 | 11.0 | Unsprayed | 100 | 8.6 |
| Unsprayed | 100 | 7.9 | | | |

**Fig. 2 Fungicide Response in Winter Wheat**




The lowest yield and economic response was in 2004 which was a season of low disease. The highest yield response was in 2005 and the highest margin over fungicide costs (MOFC) was in 2007. The high MOFC in 2007 is a reflection of the high grain prices prevailing in 2007. However across all seasons there was an economic response from the use of disease control measures. As septoria is a problem every season in Ireland it is not surprising that there is always a positive response from the use of fungicides in winter wheat.

The contributions of the components of the spray programmes applied at the different timings are shown in Table 2.

**Table 2:** Yield and Disease Response to Spray Timings

| Spray Timing | % Septoria 2nd Leaf | Yield t/ha @ 15% |
|---|---|---|
| T1 | 72 | 10.5 |
| T2 | 68 | 10.3 |
| T3 | 99 | 8.3 |
| T1 + T2 | 32 | 11.5 |
| T1 + T3 | 55 | 10.8 |
| T2 + T3 | 60 | 10.5 |
| T1 + T2 + T3 | 12 | 11.5 |
| Unsprayed | 100 | 7.7 |

The figures in Table 3 are an average from trials over a number of seasons.

T1 and T2 single applications gave similar yield responses while a single spray at T3 gave a much lower response than the earlier timings. Similarly when T1 and T2 are applied the extra response from the addition of a T3 fungicide is small. However in some years, as in 2007, when ear diseases are prevalent the T3 spray gives a more substantial yield response and reduces fusarium on the ear.

Yield response to fungicide treatment varies between varieties with predictably the more resistant varieties giving a lower yield response than the susceptible one. This has implications for the fungicide dose to be used as where yield responses are large a greater input is needed to achieve yield potential.

## DECISION SUPPORT SYSTEMS

Disease is a major factor in reducing yields and as outlined already cereal farmers have developed the practice of spraying their crops on a routine basis. This method of fungicide application is an insurance approach, the timing of the spray applications being determined by critical crop development stages. Little or no account is taken of infection levels, weather conditions, fungicide dose or varietal resistance. This approach has been successful as a practical disease control strategy. However, in certain years it is evident both from trial work, and from farmers' own observations of disease in their crops, that in many situations one of the spray applications could have been omitted or would have been more beneficial if applied at a different timing. Results from trials carried out in the 1990s showed that in some years using reduced rates of fungicides were as effective in controlling disease and maintaining yield potential as were full rates. However it is impossible to predict the seasons when growers could benefit form using reduced rates. Cereal growers realise that with more precise information they might be able save the cost of a spray or use a fungicide more effectively.

One system of maximising the returns from fungicide use in cereals is by the use of a DSS (Decision Support System). Most DSSs are PC or internet based but there are also simpler systems in use.

The extent and severity of cereal disease incidence, in common with diseases of other crops, is very much influenced by local weather conditions. Many years of research has provided information on the precise weather factors controlling the build-up and severity of epidemics of the various cereal diseases. Similarly there is a wealth of data on the yield losses and economic losses caused by various levels of disease as well as the yield responses to dose rates of fungicides. There is also data available on the effect of variety, crop density, nutrient levels, sowing date and many other parameters on disease epidemiology. If all these separate pieces of information are put together and combined with good weather data and forecasts it should be possible to develop a system that suggests an optimal disease control programme for a crop. The development and universal availability of PC's, to perform the numerous calculations required when combining all these factors, has made it possible to develop systems that help in planning cereal disease control strategies. In theory, these Decision

Support Systems should provide appropriate information 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 were PC or internet and one was an in-crop instrument, the Theis Septoria Timer. This device consists of two parts, a sensor which measures the duration of leaf wetness and a datalogger. The septoria timer records the occurrence of weather patterns conducive to the development and spread of septoria and thus indicates when a fungicide spray might be benefical.

Five interactive DSSs were selected for evaluation. DESSAC, a PC-based system from U.K., Crop Protection Online (CPO) from Denmark, CerDis (Opticrop) and Decom PLANT-Plus from the Netherlands and proPLANT expert from Germany. The latter four are accessed over the internet. These various DSSs were compared with the standard three-spray programme and a two-spray programme for the control of septoria in winter wheat.

The results from the three years of trials are shown in Table 3.

**Table 3**: Decision Support System Trial Results

| Treatment | No. of Sprays | | | Yield t/ha | | | MOFC €/ha | | |
|---|---|---|---|---|---|---|---|---|---|
| | 2003 | 2004 | 2005 | 2003 | 2004 | 2005 | 2003 | 2004 | 2005 |
| Standard 3-spray | 3 | 3 | 3 | 10.1 | 13.5 | 10.9 | 316 | 184 | 288 |
| Standard 2-spray | 2 | 2 | 2 | 8.0 | 12.2 | 10.0 | 99 | 80 | 213 |
| Septoria Timer | 3 | 2 | 2 | 11.1 | 12.8 | 10.2 | 420 | 148 | 255 |
| DESSAC | 3 | 3 | 3 | 9.6 | 12.6 | 10.7 | 288 | 91 | 287 |
| DACOM | 4 | 4 | 4 | 9.0 | 12.9 | 10.3 | 243 | 79 | 180 |
| ProPlant | 3 | 3 | 3 | 8.8 | 13.4 | 10.5 | 228 | 258 | 258 |
| Opticrop | 2 | 3 | 4 | 8.4 | 12.8 | 10.6 | 160 | 75 | 250 |
| Crop Protection | 3 | 2 | 2 | 7.3 | 12.2 | 10.4 | 61 | 66 | 257 |
| Unsprayed | | | | 6.3 | 10.8 | 7.7 | | | |

A successful DSS should improve the timing of fungicide application and where conditions warrant, should reduce both the frequency of applications and the rate of active ingredient, while maintaining similar economic returns

There were differences in the number of spray applications recommended by the DSSs in various years. Over the three years of the trial there were nine spray applications in the standard three-spray treatment compared with twelve in the DACOM DSS and seven in both the Septoria Timer and Crop Protection treatments.

The two latter systems therefore saved both spraying operations and fungicide.

The standard three-spray programme used by all winter wheat growers proved robust and gave consistently good results proving its value as a disease control strategy.

Scheduling fungicide applications according to the Theis Septoria Timer however gave similar returns with lower fungicide input.

Decision Support Systems are now well developed and are used by cereals farmers and growers of many other crops across Europe. They have the ability to schedule precisely the timing of spraying operations against pests and diseases as well as recommending the minimum amount of pesticide necessary thereby being more economical and having a lower environmental input than routine prophylactic programmes.

It is important to stress that these programmes will not make the management decisions. They are not designed to make absolute decisions but to process a range of suitable options to be considered making management decisions and are not intended to take the decision making process away from the grower.

The differences between the different DSSs can be ascribed to two factors 1) spray timing and 2) product choice. For instance, in 2003 both the Septoria Timer and the standard three-spray programme treatments received three fungicide applications using similar products. In 2003 the Septoria Timer gave a higher yield and MOFC than the standard three-spray programme. The difference between these two treatments was the timing of the T2 spray. Using the Septoria Timer delayed the T2 until May 30th whereas the standard treatment was sprayed five days earlier.

This emphasises the importance of spray timing in relation to control of cereal diseases.

The spray window for optimum disease control on any particular leaf is fairly narrow. The optimum timing is when the leaf is just fully emerged. Too early and not enough of the leaf is present to get an overall covering of fungicide and if too late the leaf may already be infected resulting in poor control.

## DISEASE CONTROL IN BARLEY

## FUNGICIDE PROGRAMMES IN BARLEY

Fungicide programme trials carried out in 2006 and 2007 are shown in Table 4.

Treatments using standard products are shown. 2006 was a season of low disease as shown by the high yield of the unsprayed treatment. Nevertheless yield responses were satisfactory. There were high levels of net blotch at the trial sites in 2007.

Winter barley fungicide trials were located at Oak Park in 2006 and 2007. Disease levels were low in both seasons at Oak Park and yield responses averaged approximately 1.0 t/ha. Results of programmes are shown in Table 5. There was a high degree of consistency between the two seasons both in terms of overall yield reponse and in performance of the individual programmes.

**Table 4**: Yield Response to Fungicide Programmes in Spring Barley

| **2006** | | **2007** | |
|---|---|---|---|
| Programme | t/ha @ 15% | Programme | t/ha @15% |
| Proline | 7.0 | Stereo | 5.6 |
| Mantra + Bravo | | Bravo | |
| Stereo | 6.7 | Proline | 6.2 |
| Mantra + Bravo | | Bravo | |
| Stereo | 6.5 | Stereo | 6.5 |
| Fandango + Bravo | | Amistar Opti + Proline | |
| Fandango | 7.0 | Stereo | 6.2 |
| Mantra + Bravo | | Amistar Opti + Stereo | |
| Opus Team | 6.6 | Proline + Modem | 6.2 |
| Fandango + Bravo | | Bravo | |
| Opus Team | 6.4 | Fandango | 6.5 |
| Proline + Bravo | | Fandango + Bravo | |
| Proline | 7.3 | Stereo | 6.1 |
| Fandango + Bravo | | Fandango + Bravo | |
| Unsprayed | 6.1 | Unsprayed | 5.1 |

**Table 5:** Yield Response to Fungicide Programmes in Winter Barley

| | **2006** | **2007** |
|---|---|---|
| Programme | t/ha @ 15% | t/ha @15% |
| Fandango | 10.3 | 10.2 |
| Fandango + Bravo | | |
| Mantra | 9.9 | 10.2 |
| Mantra + Bravo | | |
| Stereo | 10.2 | 9.8 |
| Fandango + Bravo | | |
| Stereo | 9.9 | 9.3 |
| Venture + Bravo | | |
| Bravo | - | 10.0 |
| Fandango + Bravo | | |
| Venture | 10.1 | - |
| Venture + Bravo | | |
| Punch C | 9.9 | 10.1 |
| Fandango + Bravo | | |
| Unsprayed | 8.8 | 8.9 |

## SPRAY TIMING ON BARLEY

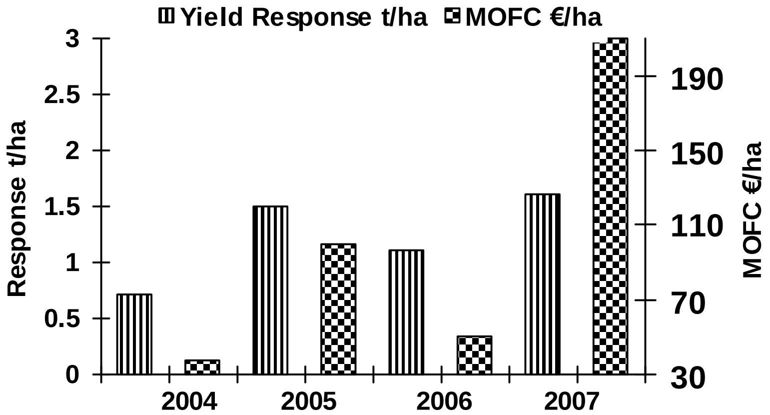
Winter and spring barley crops generally require two fungicide applications. Growth stages are used as a guide but the timings are not as critical as in wheat. Fungicide timings for winter barley are growth stages 32 and 45/59 while for spring barley 30/31 and 45.

These timings are flexible and fungicide applications in barley crops should be targeted at these growth stages taking cognisance of disease prevalence in the crops. Often disease can develop early in the growth cycle. In such situations fungicides may need to be applied earlier than growth stage 32. Winter barley can frequently have high levels of rhynchosporium in early spring and thus would require an early fungicide. In 2007 for example spring barley crops had net blotch present from emergence and again early sprays were required.

Yield responses to fungicides are generally not as high in barley as in wheat.

The responses from spring barley is shown in Fig. 3

**Fig. 3 Fungicide Response in Spring Barley**




Yield responses to fungicides and MOFCs are lower in spring barley than in winter wheat. Nevertheless again when averaged over many sites and seasons even in low disease years the economic response to fungicide treatment in spring barley has been positive. As in the case of winter wheat the high grain price pertaining in 2007 give the MOFC an exaggerated high figure.

Yield response to winter barley fungicide treatment over the same seasons varied from 0.75 t/ha in 2005 to 1.3 t/ha in 2006. These trials were only located at Oak Park and therefore there would not cover the range of variation in disease levels that pertained in the wheat and spring barley trials.

The results shown in Figures 1 & 2 for both wheat and barley include many trials and encompass many fungicide programmes. It is important to remember that they are average figures and such averages cover both the high and the low responses and mask the extremes. There were some treatments in both crops which did not give an economic return. Choice of products has a major effect on the profitability of disease control measures.

The higher the price of grain then the greater the profitability of fungicide treatments as is evidenced by the huge MOFCs in 2007.

# CONCLUSION

- Septoria levels on Winter wheat were high in 2007 despite the dry early summer.
- Response to fungicide programmes was higher than in 2006.
- Three spray fungicide programmes in winter wheat over a number of seasons have given good yield responses and positive MOFCs.
- Fungicide programmes in spring barley have given positive yield responses but MOFC's have been low in some years.
- T1 and T2 individual spray timings in winter wheat give similar yield responses. The T3 timing gives a lower response than T1 or T2.
- No DSS outperformed the standard three-spray programme in years of high disease pressure.
- Two Decision Support Systems gave a lower number of spray applications and reduced fungicide use in winter wheat over three seasons compared with the standard programme.

# REFERENCES

Burke, J.J. and Dunne, B. 2008. . Field testing of six decision support systemsfor scheduling fungicide applications to control *Mycosphaerella graminicola* on winterwheat crops in Ireland Journal of Agricultural Science (2008), 146, 1–14.

Burke, J.J. and Dunne, B. 2008. Investigating the effectiveness of the Thies Clima "Septoria Timer" to schedule fungicide applications to control *Mycosphaerella graminicola* on winter wheat in Ireland Crop Protection (2008) (in press).

The Wheat Disease Management Guide. Spring 2007. HGCA Publications.

Oxley, Simon. 2007. Barley Disease Control. TN 583 Scottish Agricultural College, Edinburgh.

# Cost Effective Management of Take-All

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## SUMMARY

Despite many years of research take-all caused by *Gaeumannomyces graminis var tritici* can still cause significant yield loss in Irish cereal crops, particularly winter wheat. Such losses were experienced by a number of growers in 2007. Good rotational practice remains the best method of controlling the disease but will only be cost effective where the non-host break crops used in the rotation provide viable margins. Factors such as sowing date, seed rate and fertiliser strategy can also have an important role to play in cost effective management of take-all. The phenomenon of take-all decline, whereby the risk of severe outbreaks of the disease is considerably reduced following a sequence of susceptible cereals, allows continuous wheat and barley crops to be grown. However, even within these systems relatively severe take-all can occasionally, and unpredictably, occur.

The advent of effective seed treatments for take-all has enabled growers to produce acceptable crops in take-all risk situations. However even where seed treatment is used growers should not abandon good cultural practices that reduce the risk of take-all, such as delayed sowing. Latitude, the most effective of the seed treatments, does not give complete control of take-all and take-all will still occur even where it is used. Latitude will give the best economic returns when used on second wheat (and triticale) crops. It can also give economic returns on third to fifth wheats but these returns are likely to be lower and less consistent than in second wheats. Economic returns from Latitude in continuous wheat are likely to be dependent on the grain price relative to the seed treatment cost but in many instances will at best be break-even. Use of Latitude on winter barley is unlikely to give consistent economic returns. Azoxystrobin (Amistar) can give some control of take-all but its effect on take-all is inconsistent.

# INTRODUCTION

Take-all is the most important root disease of cereals in many areas of the world and can cause significant yield losses where it occurs. Since it was first identified in the latter half of the nineteenth century a considerable amount of research effort has been devoted to studying the disease and developing strategies to mitigate its effects. Despite the considerable advances in our understanding of the disease, significant yield losses as a result of the disease still occur. High levels of take-all can reduce wheat yields by up to 50 % and barley yields by about 25%. Minimising these losses is a key requirement of profitable cereal production.

Crop rotation is the oldest and the key strategy in the management of take-all. Garret (1946) wrote that *'the only permanent and satisfactory method of controlling take-all is by means of a sound rotation, which should only be abandoned in periods of serious emergency'* and this, despite the advances in fungicidal control, is still largely the case today. However using rotations to reduce take-all is not always a viable economic option and often economics will dictate that cereal crops will be grown in situations where there is a risk of take-all. In these cases judicious use of fungicides effective against take-all coupled with good husbandry techniques can significantly reduce the risk of severe epidemics of take-all occurring. In this paper we will discuss the various husbandry techniques and fungicidal control strategies that can be used to reduce the risk of severe take-all occurring and/or mitigate its effects if it does occur.

# PATHOGEN BIOLOGY AND EFFECTS ON THE CROP

As with all diseases knowledge of the biology of the pathogen involved is helpful in deciding how to best reduce its effects. The main pathogen involved in take-all is *Gaeumannomyces graminis var tritici* (Ggt) which infects wheat, barley, triticale and grasses. *Gaeumannomyces graminis var avenae* which infects oats can also infect wheat, barley, triticale and grasses. This paper will focus largely on Ggt which is the main cause of take-all on wheat and barley.

When there is no living host (ie wheat, barley or grass plant) Ggt survives on dead host tissue (e.g crop residues) in the soil and levels of the fungus will decline over time as host tissue decays. Ggt on crop residues, along with Ggt on volunteers growing in the field, provides the inoculum to infect a newly emerging cereal crop. The initial infection of the plant roots is often referred to as the primary infection. In winter crops primary infection occurs in the autumn and generally there is little spread of the disease between roots over the winter period. In the spring the disease spreads between roots and this is referred to as secondary infection. A number of factors such as soil temperature, wetness and the number of roots can affect the extent to which secondary infection occurs.

In terms of environmental effects take-all can develop where soil pH is between 5.5 and 8.5, soil temperature between 5-30$^{o}$C (severe take-all is thought to be favoured by temperatures of 5-20$^{o}$C) the soil water content is near field capacity (moist) and aeration is good. Weather conditions during crop growth can have an effect on yield loss due to take-all, either by favouring growth of the fungus or by reducing the ability of the crop to tolerate root loss caused by take-all. Generally warm and wet conditions in autumn and spring encourage higher levels of take-all. Dry weather during grain fill will exacerbate the effects of take-all as the already damaged roots will not be able to absorb moisture efficiently. Work in the UK suggests that the greatest yield reductions in a take-all situation will occur where a wet spring is followed by a dry summer while the lowest reductions will occur where a dry spring is followed by a wet summer. Wet winters have been associated with severe take-all outbreaks also.

The susceptibility of the different crop species to take-all is generally given as wheat>triticale>barley>rye (Gutteridge *et a*l,. 1993; Rothrock, 1988). Within species there is no consistent evidence that cultivars differ in their susceptibility to the take-all fungus. In studies where differences have been suggested these differences have been small and often variable (Hollins et al., 1986). This has again been confirmed in recent trials in the UK where a range of wheat cultivars known to perform differently as second wheats showed no differences in susceptibility to take-all. However this recent research has indicated that there may be differences between cultivars in terms of how much inoculum is built up by these cultivars when sown as a first wheat and therefore choice of first wheat cultivar may influence the amount of take-all occurring in the following second wheat. There is limited evidence that cultivars may differ in their ability to tolerate take-all. Spink *et al.*, (1996) suggested that the possession of characteristics such as early flowering date, economic tillering (low ratio of maximum to final shoot number), low canopy N requirement and high levels of soluble stem reserves, can lead to a reduction in effects of take-all on a cultivar.

Winter sown crops are usually more affected by take-all than spring crops. Under Irish conditions winter wheat will be the crop most at risk of yield loss as a result of take-all. Spring wheat can also suffer significant yield loss from take-all when sown in a risk situation. Winter and spring barley are also at risk from take-all but yield reductions will usually be lower than for wheat.

An important feature of take-all is the phenomenon of take-all decline (TAD). This is a type of natural biological control mechanism which develops after consecutive susceptible cereals are grown, but usually only after a severe outbreak of the disease has occurred. TAD is generally accepted to occur after the fourth or fifth successive cereal crop. However, even when TAD has become established, severe outbreaks of take-all can occur unpredictably which can lead to significant yield loss. It should also be noted that take-all usually occurs in patches within fields. Therefore even where successive susceptible crops are grown in a field it is possible that different areas in that field will be at different stages of TAD due to the patchiness of the disease. Gutteridge and Hornby (2003) suggested that where the aim was to take advantage of take-all decline sowing crops early may encourage strong take-all decline but that as strong take-all decline requires a preceding severe attack of take-all this strategy will be prone to at least one crop that will suffer severe take-all.

# CULTURAL STRATEGIES TO REDUCE TAKE-ALL

## CROP SEQUENCE

Crops grown after a non-susceptible break crop will normally not suffer significant yield loss as a result of take-all. Suitable break crops include non-cereal crops such as oilseed rape, peas, beans and beet. Scutch grass and other grass weeds can harbour take-all during a break crop and lead to take-all outbreaks in the following wheat or barley crop; therefore good control of grass weeds should be achieved in these break crops. Oats and maize are not affected by the same strain of the take-all fungus as wheat and barley and therefore these crops will act as a break crop for take-all control in wheat and barley.

Growing barley in the years of high risk take-all (years 3-5 after a break) has traditionally been put forward as a means of avoiding severe yield loss as a result of take-all. However work in the UK would appear to contradict this. Summarising the results of a long term trial where different crop sequences were examined Hornby (1998) reported that wheat crops following barley could suffer severe take-all and that introducing barley into cereal sequences often resulted in severe disease in more years than occurred in wheat monoculture i.e. where there was no barley in the crop sequence.

The main effect of break crops is achieved by ensuring there is no host for the fungus to survive on. A similar, but probably reduced, effect can be achieved by ensuring that there are no hosts of the take-all fungus present during the period between successive crops. Some work in France examined the effect of different vegetation covers during the fallow period between successive wheat crops i.e between harvest of one crop and sowing of the next wheat crop (Ennaïfer et al., 2005). They reported a high risk of take-all where wheat volunteers were present during the fallow period. The lowest levels of take-all were found where the soil was bare during the fallow period. Levels of take-all were intermediate where crops such as oats, mustard and ryegrass were sown during the fallow period. The effects of these crops were only found when using conventional tillage. Gutteridge and Hornby (2003) also reported that reductions in take-all levels due to delayed sowing were reduced where wheat volunteers were maintained between crops compared to where the soil was maintained vegetation free between crops.

## Cultivation

Work in the UK has general failed to find consistent large differences between plough-based and tine-based cultivations in terms of take-all (Jenkyn et al., 1988). The reduced cultivation experiments on winter wheat at Knockbeg have also generally found no consistent differences in take-all levels between a plough-based system and a reduced cultivation system. Consolidation of the seed bed after sowing is important as it has been shown that light fluffy seedbeds increase the risk of severe take-all. Therefore post-sowing rolling should be considered where soil conditions allow.

## Fertiliser strategy

Crops infected with take-all have damaged root systems and therefore cannot absorb nutrients efficiently, particularly nitrogen. Generally the advice given for wheat crops growing in a high take-all risk situation is to apply a greater proportion of the total nitrogen earlier in the growing season since the root function will be reduced as the season goes on and take-all levels increase. There has also been advice given to increase the total amount of nitrogen, however current legislative restrictions essentially rule this out as an option.

There is also evidence that use of ammoniacal nitrogen rather than nitrate nitrogen can reduce the severity of take-all. However, Hornby et al. (1998) summarising results from a number of studies suggested that this may not be of significance under UK conditions which would suggest that it may not be of significance in Ireland either.

Since alkaline conditions can exacerbate take-all liming should be carried out before a break crop or before a first wheat rather than before a crop grown in a high risk situation.

## Sowing date and seed rate

Take-all levels on roots tend to increase as seeding rate increases. However work in the UK looking at the effect of high and low seed rates, with and without Latitude seed treatment, found no effect on yield of higher seed rates even though take-all levels were higher.

Early sowing of winter wheat effectively leaves a greater window favourable for primary infection of the crop in the autumn. It also reduces the length of time between successive crops which means that inoculum levels built up during the previous crop will have less time to decline than would be the case if sowing was delayed. Additionally early sowing of a first wheat will tend to increase the risk of severe take-all in a succeeding crop (Gutteridge and Hornby, 2003). Therefore sowing date of a crop can affect the amount of take-all not only of that crop but of the succeeding crop also.

While effects of sowing date on root take-all levels are relatively consistent the effects of sowing date on yield in take-all situations can be variable. In the UK, Gutteridge and Hornby (2003) found that early sown wheat could out-yield later sown wheat in a take-all situation. However Bateman et al (1990) reported lower yield from early sown third wheats than from later sown crops.

Work at Oak Park over four years (2003-2006) comparing early (mid-late September) and late (late October) sown wheat grown as a second wheat, where the risk of take-all was high, indicated that take-all levels on the roots were significantly higher on earlier sown wheat sampled in June at the beginning of grain fill (Table 1). Despite this, yields were generally higher from the earlier sown wheat reflecting the fact that factors other than take-all, influence the effect of sowing date on yield (Table 2). In these trials it is probable that the lower yields from the later sown crops were due to the normal decline in yields that would occur from later sowings, even in the absence of take-all. It should also be noted that there was a significant effect of Latitude at both sowing dates, the effect being greatest for the early sowing. This indicates that while later sowing will reduce take-all levels Latitude seed treatment should still be considered on these later sown crops when in a high risk take-all situation. Spink et al. (2002) also found a consistent effect of Latitude over a range of sowing dates. Generally it is recommended in Ireland that if sowing winter wheat in a high take-all risk situation sowing in September should be avoided and that sowing should where possible be delayed until the second week of October. This will reduce the risk of severe take-all occurring while avoiding yield penalties which can be associated with late sowing i.e. November or December sowing.

**Table 1:** Effect of sowing date and Latitude treatment on take-all levels in June of winter wheat (cv. Savannah) over four seasons at Oak Park. Data are given as take-all index (TAI) which is a measure of disease intensity.

| | **Late -September sown** | | **Late-October sown** | |
|---|---|---|---|---|
| Year | **- Latitude** | **+ Latitude** | **- Latitude** | **+ Latitude** |
| 2003 | 42.7 | 27.6 | 30.9 | 21.3 |
| 2004 | 33.5 | 19.3 | 14.7 | 10.0 |
| 2005 | 32.4 | 21.7 | 23.6 | 15.3 |
| 2006 | 11.3 | 6.6 | 6.3 | 4.2 |
| 4 year mean | 30.0 | 18.8 | 18.9 | 12.7 |

**Table 2:** Effect of sowing date and Latitude treatment on yield (t/ha) of winter wheat (cv. Savannah) over four seasons at Oak Park.

| | **Late -September sown** | | **Late-October sown** | |
|---|---|---|---|---|
| Year | **- Latitude** | **+ Latitude** | **- Latitude** | **+ Latitude** |
| 2003 | 8.91 | 9.50 | 8.36 | 9.10 |
| 2004 | 9.56 | 10.84 | 11.91 | 12.17 |
| 2005 | 9.04 | 9.63 | 8.49 | 8.96 |
| 2006 | 10.40 | 10.42 | 9.64 | 9.79 |
| 4 year mean | 9.48 | 10.10 | 9.60 | 10.01 |

# FUNGICIDAL CONTROL

## Seed treatment

In recent years two fungicidal seed treatments have come on the market with activity against take-all. These are silthiofam (Latitude) and fluquinconazole (Jockey). Latitude is specific for Ggt whereas Jockey has the advantage of giving control of other seed bome diseases. In terms of effectiveness against take-all alone and yield response Latitude has generally given better results (Figure 1).


**Fig. 1:** Effect of Latitude and Jockey seed treatments on take-all levels on winter wheat (cv. Madrigal) at Oak Park in 2001.

Economic use of Latitude requires that the value of any yield (or quality) benefits achieved is at least equal to the cost of the seed treatment. Therefore the yield response required to justify use of Latitude will vary depending on the cost of seed treatment and the price achieved for the grain. It will also depend on the seed rate used. The economics of Latitude use have changed somewhat with the current increased grain prices. Taking the cost of Latitude seed treatment at €250/t, the value of grain at €160/t and a seeding rate of 125 kg/ha (~ 8 st/ac) a yield response of 0.2 t/ha is required to justify the use of Latitude. When grain prices were €100/t the equivalent yield response required to justify Latitude use was 0.3 t/ha.

Response of winter barley to Latitude is generally smaller than that achieved with wheat. In Oak Park trials where barley was grown as a third or fourth cereal there was, on average, no significant response to Latitude treatment achieved across a range of varieties over four seasons although a significant and economic response was obtained in one season (Table 3). The average yield response across years and varieties was 0.12 t/ha which would not justify Latitude use. Similar findings have been reported from the UK (Bateman et al., 2006). Barley is thought to suffer less yield reduction as a result of take-all than wheat due to the fact that it goes through its growth stages at an earlier stage in the season when take-all levels tend to be lower (Hornby et al., 1998).

Work at Oak Park has indicated consistent responses to seed treatment with Latitude in second wheats where take-all occurs (Figure 2). Responses have also been achieved with triticale. The response to Latitude in second wheats is typically 0.5-0.8 t/ha on average, although yield responses of up to 1.5 t/ha have been recorded at Oak Park. As would be expected responses will be highest in years when take-all is most severe (Table 4).

**Table 3:** Effect of Latitude on grain yield (t/ha) of five winter barley over four seasons at Oak Park.

| | **2001** | | **2002** | | **2003** | | **2004** | | **4 year mean** | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Latitude | | Latitude | | Latitude | | Latitude | | Latitude | |
| | - | + | - | + | - | + | - | + | - | + |
| Antigua | 9.6 | 9.6 | 8.6 | 8.8 | 9.2 | 9.1 | 8.2 | 9.2 | 8.91 | 9.18 |
| Cleopatra | 10.2 | 10.1 | 8.7 | 8.9 | 9.9 | 10.0 | 8.3 | 8.9 | 9.24 | 9.47 |
| Opal | 9.7 | 9.8 | 8.7 | 9.0 | 9.3 | 9.4 | 8.1 | 8.7 | 8.94 | 9.20 |
| Regina | 8.5 | 8.2 | 9.1 | 8.5 | 9.1 | 8.9 | 8.9 | 9.7 | 8.92 | 8.81 |
| Siberia | 10.9 | 11.1 | 10.1 | 10.0 | 9.9 | 9.8 | 9.9 | 9.6 | 10.19 | 10.12 |
| *Mean* | *9.8* | *9.7* | *9.0* | *9.0* | *9.5* | *9.4* | *8.7* | *9.2* | *9.24* | *9.36* |
| Latitude effect | ns | | ns | | ns | | * | | ns | |
| Variety x Latitude | ns | | ns | | ns | | ns | | ns | |

ns = not significant * = significant at 5% level

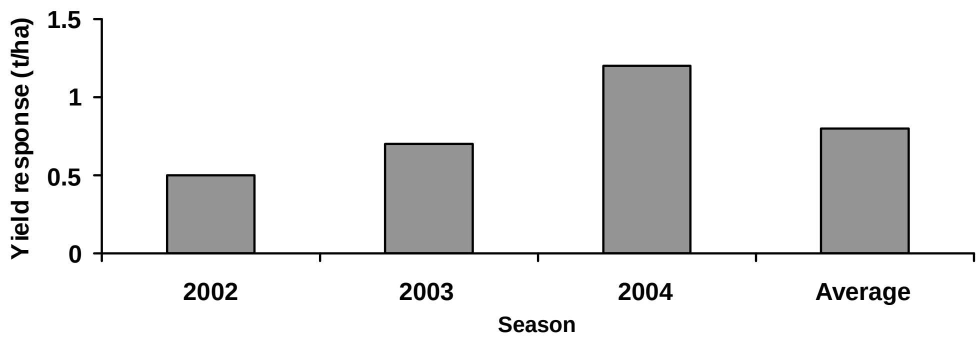


**Fig. 2:** Yield response of winter wheat to Latitude seed treatment grown as a second wheat over four seasons. Data are the mean response of ten varieties in each season.

Spink et al. (2004) and Bateman et al (2006) also reported consistent benefits from Latitude applied to second wheats. However the benefits of Latitude applied to third and subsequent wheats were much less consistent and often uneconomic (Spink et al., 2004). They also reported little or no effect of Latitude on development of take-all decline which they postulated may be due to the fact that the main effect of Latitude is to delay the take-all epidemic (it affects primary infection) and that there may be sufficient take-all present late in the season to stimulate take-all decline. They also indicated that including winter barley as the third cereal led to higher take-all levels in the subsequent winter wheat crop compared to where four wheat crops were grown in succession. Bateman et al. (2006) suggested that Latitude should only be applied to a third wheat where levels of take-all in the previous second wheat crop treated with Latitude were low. Where take-all levels in the treated second wheat were high they recommended growing barley, as even a Latitude treated wheat crop was unlikely to give an acceptable yield.

**Table 4:** Effects of Latitude and Amistar on take-all levels at early grain fill and yield response (t/ha) on a second wheat (cv. Savannah) over four seasons at Oak Park. Data are averages of two sowing dates (late September and two sowing dates. Disease data are given as take-all index (TAI) which is a measure of disease intensity.

| | | | | | | |
|---|---|---|---|---|---|---|
| | | | ***Latitude effect*** | | | |
| | | **2003** | **2004** | **2005** | **2006** | **mean** |
| Yield response | | 0.67 | 0.77 | 0.53 | 0.09 | 0.51 |
| | | *** | *** | *** | ns | *** |
| Take-all | +Latitude | 24.4 | 14.6 | 18.5 | 5.4 | 15.7 |
| | - Latitude | 36.8 | 24.1 | 28.0 | 8.8 | 24.4 |
| | | ** | ** | *** | ** | *** |
| | | | ***Amistar effect*** | | | |
| Yield response | | 0.62 | 0.22 | 0.37 | 0.16 | 0.34 |
| | | *** | ns | ** | ns | *** |
| Take-all | + Amistar | 24.5 | 18.6 | 21.4 | 6.5 | 17.8 |
| | - Amistar | 36.7 | 20.2 | 25.1 | 7.6 | 22.4 |
| | | ** | ns | ns | ns | *** |

The benefits of using Latitude in continuous wheat have generally been found to be much smaller than achieved with second wheats. Latitude can reduce take-all levels in continuous situations as was found in work at Oak Park over the last three seasons (Fig. 3). However relatively small yield benefits (~ 0.3 t/ha) of Latitude use in continuous wheat were achieved (Fig. 3). At current grain price levels this yield response just about provides an economic return. The response to Latitude in specific fields in continuous wheat may be higher than those obtained at Oak Park. Latitude insensitive strains of the take-all fungus are known to exist but it is not known whether repeated use of Latitude will lead to selection of these strains thereby reducing the effectiveness of seed treatment.

Initial indications from the Oak Park experiments would appear to confirm findings from the UK that Latitude does not affect take-all decline when used in a continuous situation but more seasons results are required before more definite conclusions can be drawn on this. The fact that Latitude may not affect the development of take-all decline suggests that where the intention is to grow continuous wheat an acceptable entry strategy may be to grow successive wheats using Latitude on the 2-5$^{th}$ crops.

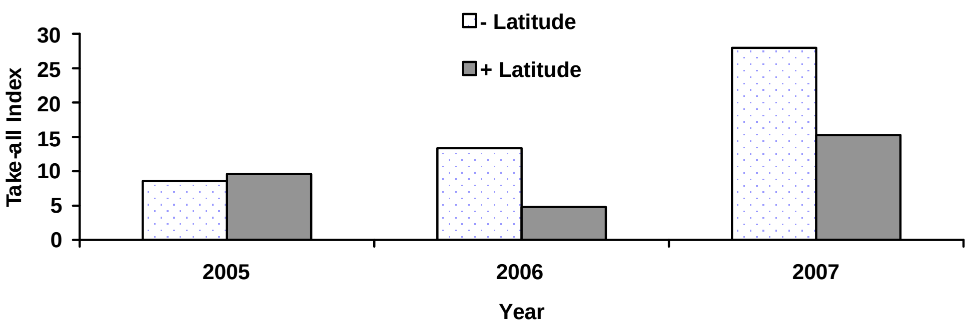


**Fig. 3:** Effect of Latitude on take-all levels in June of continuous wheat over three seasons at Oak Park.

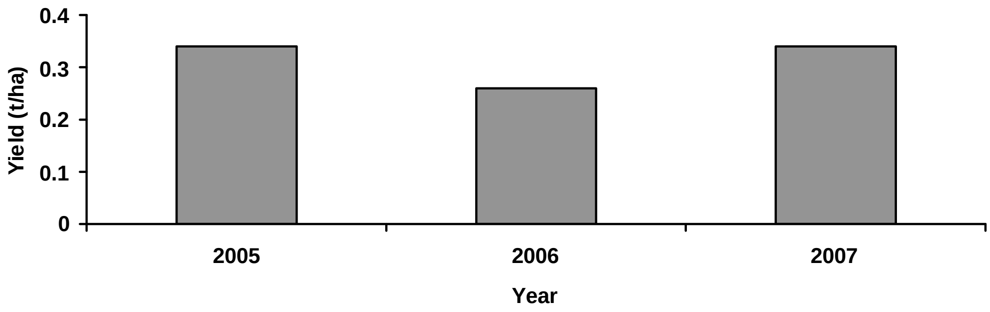


**Fig. 4:** Effect of Latitude on yield of continuous wheat over three seasons at Oak Park.

It should be remembered that Latitude does not give complete control of take-all. Studies have shown that it reduces the amount of primary infection in the autumn by about 50% with a consequent reduction in secondary infection in the spring/summer of about 25% (Bailey et al 2005). Work at Oak Park found that on average over four seasons the take-all index (a measure of disease intensity) in June on second wheats was reduced by about 35% by Latitude treatment. Environmental factors such as weather and rainfall will have a large affect as the amount of secondary infection which can have a big effect on the level of control achieved with Latitude. Therefore relying solely on Latitude as a means of take-all control is not to be advised; it should be used as part of an overall management package aimed at reducing the effects of the disease. Latitude will not raise the yield of winter wheat grown in a high risk take-all situation to a level that would be achieved where the risk of take-all is low i.e. a first wheat.

Some foliar applied fungicides have been found to have an effect on take-all. Of these most interest has been focused on azoxystrobin (Amistar). However, while effects of Amistar on take-all in cereals have been demonstrated it would appear that these effect are considerably less consistent than those achieved with Latitude. Jenkyn and Gutteridge (2002) demonstrated effects of Amistar on take-all, mainly when applied around GS 31-32, in the field but found the effects to be inconsistent. They suggested that effects of Amistar on take-all should be seen as a bonus achieved when it is used for normal foliar disease control rather than using it as a specific treatment for take-all. However with the advent of resistance to strobilurins in septoria Amistar would not be routinely used at GS32 for normal disease control.

In an experiment over four seasons (2003-2006) at Oak Park the effects of Amistar application (1 l/ha) at GS 32 on take-all and yield were examined in a second wheat situation. Take-all levels were numerically lower in the Amistar treatment in all four seasons and a cross-season analysis indicated a significant overall across seasons effect of Amistar on take-all levels (Table 4). However examination of individual seasons indicated that much of the average across season effect was due to a significant effect of Amistar on take-all in June in 2003, and that effects of Amistar on take-all were small and statistically not significant in the other three seasons. Yield was significantly increased by Amistar in two of the four seasons and was numerically, but not statistically, higher in the other two seasons and on average over the four seasons yield was increased by 0.3 t/ha by Amistar application (Table 4). This suggests that while Amistar may have effects on yield of wheat in take-all situation, these yield effects are unlikely to be due to effects on take-all and may be due to either foliar disease effects or physiological effects. It should be noted that while these crops received a good triazole based disease control programme, effects of Amistar on foliar disease cannot be ruled out, particularly in the early years of the experiment. Therefore use of Amistar as a means of controlling take-all is not generally recommended.

## Future prospects

In recent years take-all has not been a high priority for breeders or research organisations in many areas of the world. However it is now beginning to receive more attention. There are a number of areas where progress may be made, including the use of biotechnology.

Biotechnology may have a role to play in the battle against take-all on a number of fronts. A DNA test (Predicta B) which was originally developed in Australia and which has been successfully tested in New Zealand and is currently being evaluated in the UK may be able to determine whether a crop sown will be at risk from take-all. Introduction of novel sources of resistance/tolerance to take-all may also be possible in the future with possible sources including *Agropyron spp*. or *Haynaldia spp.*

# CONCLUSIONS

- Take-all is an unpredictable disease and effects of management strategies will vary between sites and seasons.
- Where economically viable use rotation to avoid sowing wheat in high risk take-all situations.
- Delay sowing of winter wheat in high risk situations until October.
- Ensure good husbandry techniques are followed e.g. optimum seed rate, rolling after sowing.
- Latitude will give best economic returns when used on second wheats.

- Use of Latitude in 3rd -5th wheats is likely to give less consistent yield benefits but its use may act as an entry strategy into continuous wheat.

- Use of Latitude on continuous wheat may not give economic returns over time.

- Responses to Latitude seed treatment in winter barley are rarely economic when taken over a number of years.

- Spring wheat is unlikely to give consistent economic returns to Latitude with the exception of where spring wheat is sown as a second wheat.

- Effects of azoxystrobin on take-all are inconsistent.

**Acknowledgement**: The author wishes to acknowledge the technical assistance of Pat Prior and Peter Tiernan.

# REFERENCES

Bailey, D. J., Paveley, N., Pillinger, C., Foulkes, J., Spink, J., and Gilligan, C. A. (2005). Epidemiology and chemical control of take-all on seminal and adventitious roots of wheat. Phytopathology 95:62-68.

Bateman, G.L., Gutteridge, R.J., Jenkyn, J.F., Self, M.M. and Orson, J. (2006). Optimising the performance and benefits of take-all control chemicals. Project report 396 HGCA London.

Bateman, G.L., Hornby, D., and Gutteridge, R.J., (1990). Effects of take-all on some aspects of grain quality of winter wheat. Aspects of Applied Biology 25, Cereal Quality II pp 339-348.

Ennaïfar, S., Lucas, P., Meynard, J. M., Makowski, D. (2005). Effects of summer fallow management on take-all of winter wheat caused by *Gaeumannomyces graminis* var. *tritici*. European Journal of Plant Pathology 112: 167-181

Garret, S.D. (1946.) Reduction of take-all by artificial fertilisers. Journal of the Ministry of Agriculture, L111, 223-225

Gutteridge, R.J. and Hornby, D.(2003). Effects of sowing date and volunteers on the infectivity of soil infested with *Gaeumannomyces graminis var tritici* and on take-all disease in successive crops of winter wheat. Annals of Applied Biology 143:275-282.

Gutteridge, R.J. Hornby, D., Hollins, T.W. and Prew, R.D. (1993**).** Take-all in autumn-sown wheat, barley, triticale and rye grown with high and low inputs. *Plant Pathology* 42:425-431.

Hollins, T.W., Scott, P.R. and Gregory, R.S. (1986). The relative resistance of heat, rye, and triticale to take-all caused by *Gaeumannomyces graminis*. Plant Pathology 35:93-100

Hornby, D. (1998). Interactions between cereal husbandry and take-all: background for newer methods of controlling disease. Proceedings BCPC Brighton Conference pp 67-76, Brighton UK.

Hornby, D., Bateman, G.L., Gutteridge, R.L., Lucas, P., Osbourne, A.E., Ward, E. and Yarham, D.L., (1998). Take-all disease of cereals – a regional perspective. Wallingford, UK:CABI 384pp.

Jenkyn, J.F. and Gutteridge, R.J. (2002). Effects of azoxystrobin on wheat take-all Project Report No. 285, HGCA London.

Jenkyn, J.F., Gutteridge, R.J. and Thomas, M.R. (1988). Effects of straw incorporation and cultivations on cereal diseases. Aspects of Applied Biology 17 181-189.

Rothrock, C.S. 1988**.** Relative susceptibility of small grains to take-all. Plant Disease 72:883-886.

Spink, J.H., Blake, J.J., Foulkes, J., Pillinger, C. and Paveley, N. (2002). Take-all in winter wheat: Effects of silthiofam (Latitude) and other management factors. Project report no 268 HGCALondon.

Spink, J.H., Blake, J.J. and Bounds, P (2004). Take-all control with silthiofam (Latitude); Economic implications from a six-year rotation experiment. Project report 342 HGCA London.

Spink, J.H., Foulkes, M.J., Clare, R.W., Scott, R.K., Sylvester-Bradley, R., and Wade, A.P. (1996). Physiological traits of wheat varieties conferring suitability to rotations with continuous successions of wheat. Aspects of Applied Biology, 47, 265-275.

# Profitability of Tillage in the new Pricing Scenario

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## SUMMARY

Most of the world's agricultural think-tanks (FAPRI, OCED) are predicting 40-50% average grain price rises in the next 10 years compared to the past decade but also warning of increased volatility of cereal and input prices into the future. However increases in input costs, especially fertilizer and fuel, will erode the increases in grain price. Cross-Compliance requires tillage farmers to estimate crop fertilizer requirements a the beginning of each year and also keep a detailed record of plant protection products and fertilizer use. Clients of the Teagasc Business & Technology Advisory Service have available to them two proven computer programs which can record your necessary details for Cross-Compliance and also produce a farmer-friendly set of management data to base your enterpise and cropping decisions on. The E-crops program is suitable for overall farm financial decisions. A review and action plant as a result of completing both programs on a yearly basis will result in an overall increase in farm profits. A review of two Technology and Business clients in Teagasc was completed and forward projections of different scenarios highlight similar trends. Net farm income in 2008 is predicted to increase by 40% on both farm over the baseline scenario (05-07 average). Maintaining farm income, adjusting for inflation, will require linking land rental prices to grain prices on a yearly basis and efficient use of machinery. New technology novel practices will increase net farm income on both farms in 2012 by an average of 8% relative to the baseline. A €10 increase in grain prices, assuming stated cost predictions, will increase net farm income on both farms by 43% in 2012

## INTRODUCTION

The recent rise in cereal prices has given a new impetus to tillage farming. Whereas previous tillage forums would debate the extent to which countries such as Ukraine and Russia were going to depress Irish cereal prices, political leaders in those same countries have now decreed that cereal shortages are a real threat and have imposed export restrictions on cereals.

These signals have also forced the realization in countries such as the UK that food security can no longer be left to the market place to solve and that policies may have to be put in place to ensure an adequate supply.

Past predictions of stagnant grain prices seem to be a distant memory. Indeed most of the world's agricultural think-tanks (FAPRI, OECD) are predicting 40-50% average grain price rises in the next 10 years compared to the past decade but also warning of increased volatility of cereal and input prices into the future. Input prices especially fuel and fertilizers have risen substantially in the last 6 months due to increased worldwide demand. It is against such a volatile background that Irish tillage farmers are challenged to produce quality, traceable grain while complying with ever increasing environmental and other legislation as well as onerous record-keeping.

Cropping and management decisions will need to be based on sound analysis of the farm business to exploit fully this cycle of rising cereal commodity prices. Foresight groups such as Agri-vision 2015 have concluded that there will be two distinct types of Irish farming entities in the future; one being a large scale commercial farm, the other being a smaller scale part-time farm. In the case of a full time tillage farmer, Teagasc see this person farming in excess of 200 ha using a combination of crop mix and increased machinery technology to profitably get through a large workload while maintaining an acceptable work-life balance. I will profile two such farmers in the main part of this paper and how options they are considering will affect their farming businesses.

Forward planning during the quieter times of the year will be critical to being able manage this large area of crops. For this, it will be essential to produce a specific set of management financial accounts allowing the farmer to base his short-term adjustments as well as any long-term strategic decisions. These management accounts will then be used to generate yearly crop budgets which will act as a reference to follow when an input spending decision has to be made especially during busy times.

Clients of the Teagasc Business & Technology Advisory Service have available to them two proven computer programs which can both record your necessary details for Cross-compliance and also produce a farmer-friendly set of management data to base your enterprise and cropping decisions on. The recording program is called E-Crops and the management data program is called Profit Monitor. The benefits and practicality of these two programs will also be discussed throughout this paper.

# Impact of the New Pricing Scenario at Farm Level

In order to see what affects the current high cereal and expected rises in input prices will have at farm level I have taken two full time intensive tillage farmers and analyzed their figures over the past 3 years.

# FARMER PROFILES

**Table 1:** Farmer Profiles – Summary Table

| | **Farmer A** | **Farmer B** |
|---|---|---|
| Location | Munster | Leinster |
| Owned (ha) | 81 | 102 |
| Conacre (ha) | 105 | 92 |
| Leased (ha) | 0 | 0 |
| Total Land farmed (ha) | 186 | 194 |
| Other Enterprise | None | None |
| Main Crop | Winter Wheat | Winter Wheat |
| Grain Sales | Sold Direct to Merchant | Dried & Stored 6 Months |
| Labour | Part-time at Harvest | Part-time at Harvest |
| Cultivation System | Plough & One-pass (3m) | Plough & System Drill (3m) |
| Machinery Cost | €337/ha | €351/ha |
| (Avg. ‘05-‘07) | | |
| Land Rental Cost (all land) | €130/ha | €126/ha |
| (Avg. ’05-’07) | | |
| Net Margin (excl. SFP) | €137/ha | €364/ha |
| (Avg. ’05-’07) | | |
| Discussion Group Member | Yes | Yes |
| Yearly Profit Monitor | Yes | Yes |

From first impressions they are very similar farms by comparing them on an enterprise and cropping basis. However, there is almost a threefold difference in Net Margin per Hectare between farms. Why is this so considering that both have very close machinery and land rental costs? A closer look at each individuals gross output and costs are detailed below.

**Table 2:** Farmer Profiles – Financial Details (€/ha)

| | All Crops/ha (Avg. '05-'07) | |
|---|---|---|
| | Farmer A | Farmer B |
| Total Sales/ha | 1234 | 1346 |
| Materials/ha | 484 | 392 |
| Machinery/ha | 337 | 351 |
| Land lease/ha | 130 | 126 |
| Overheads/ha | 145 | 113 |
| Net Margin/ha | 137 | 364 |

Farmer B attained a higher sales/ha relative to Farmer A due to a combination having cropped his set-aside with oilseed rape and being more in charge of his grain marketing as he stores grain through the winter. Farmer B is also using a combination of cash buying and lower input rates to lower his overall material costs. He also had a higher proportion of lower input spring cereals than Farmer A. From the above table it is clear that having a grain store paid well in the period examined and accounts for roughly €100/ha of the Net Margin/ha difference between the two farms.

This type of detail is readily available to all farmers from their tax returns. It offers a very quick and easy way to compare your farm performance on a year by year basis but is not suitable to base medium term crop or long term strategic decisions on. For that you need a more specialized type of accounts analysis.

## Can we use Cross-Compliance Records for Financial Analysis?

Since decoupling and the introduction of the Single Farm Payment (SFP), each farming enterprise has been freed farmers to crop their land as they see fit. This in theory should make it easier for farmers to see exactly how much of a contribution each facet of the farm is making towards the farm profits. In practice the majority of farmers only complete specific tax accounts each year which are not suitable for basing crop management decisions even though a substantial amount of resources and money is allocated towards completing these accounts. At the same time Cross-Compliance requires tillage farmers to estimate crop fertilizer requirements at the beginning of each year and also keep a detailed record of plant protection products and fertilizer use.

*So the challenge is to marry the obligation to keep records (for Cross-Compliance) with the need to produce functional financial data.*

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 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 screen shot of this program from Farmer B's 2007 records is in Appendix 2.

The Teagasc €Profit Monitor (€PM) is a secure web-based computer program which generates a complete set of management financial accounts on a yearly basis. 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 screenshot of this program showing multiple years data (2005-2007) from Farmer A's records is in Appendix 3.

Profit Monitor is already being used by 1200 Teagasc clients per year and acts as an anchor point for any discussions or management decisions on the farm. However, it is mainly being used by dairy farmers with tillage farmers having the lowest user numbers. This is an anomaly in my opinion as tillage farmers are, as a group, very accurate record keepers questioning the value of each input to the second decimal place in terms of yield returned.

If a tillage farmer records his spray and fertilizer Cross-Compliance records using the E-crops program, the same data can used to fill in the majority of a Profit Monitor. Only machinery and overhead costs are needed to complete the analysis. This can be done easily at the end of the year in consultation with his advisor.

## € Profit Monitor Analysis

**Farmer A**

Table 3 outlines some key financial indicators for winter wheat from the Profit Monitor analysis 2005-2007 and initial results from all Teagasc Profit Monitors 2007:

**Table 3:** Winter Wheat Multiple Year Report 2005-2007 (€/ha)

| Year | 2005 | 2006 | 2007 | 2007 Average €PM |
|---|---|---|---|---|
| Grain & Straw Sales | 1021 | 1449 | 1731 | 1959 |
| Variable Costs | 526 | 574 | 574 | 639 |
| Gross Margin | 495 | 875 | 1157 | 1320 |
| Machinery Costs | 433 | 434 | 296 | 289 |
| Land Rental | 28 | 112 | 169 | 218 |
| Other Fixed Costs | 178 | 248 | 126 | 111 |
| Net Margin | (144) | 81 | 566 | 702 |
| Green Yield (t/ha) | 8.9 | 10.5 | 8.0 | 8.9 |

**Key:**

| | |
|---|---|
| Grain & Straw Sales | = Total sales divided by wheat area |
| Variable Costs | = Pesticides, contractors and other variable costs |
| Machinery Costs | = Repayments, depreciation, fuel, tax, and repairs |
| Other fixed Costs | = Interest, car, phone, ESB, insurance, professional fees and sundry items |
| Net Margin | = Note: Does not include Single Farm Payment |

The benefit from having a number of year's data is that once-off events (e.g. a wet season with high fungicide usage) can be highlighted and explained on a crop by crop basis. This allows a grower and their advisor to see trends and plan for the coming season. In the table below I have highlighted some key agronomic traits in Farmer A's winter wheat crop that have changed significantly over the period 05-07.

**Table 4:** Winter Wheat – Key trends and budget for 2008 (€/ha)

| Year/Expense | 2005 | 2006 | 2007 | 2008 (Budget) |
|---|---|---|---|---|
| Fertilizer | 223 | 249 | **229** | 300 |
| Fungicide | 155 | 151 | **183** | 160 |
| Machinery | 433 | 434 | **296** | 303 |

## Fertilizer

Farmer A used Urea in 2007 which reduced his fertilizer bill. He accepts that prices will rise for fertilizer in 2008 but cannot afford to cut rates as yield will suffer. He is looking at importing organic fertilizers to reduce his costs.

## Fungicide

Farmer A has identified a combination of early continuous wheat and blanket fungicide treatments as the reason why his fungicide costs spiked in 2007. He will grow break crops to match his early wheat area and investigate a decision support system to aid fungicide decisions.

## Machinery

The overall machinery bill on the farm has increased as Farmer A gears up to take on the extra planned area but significantly the cost/ha is decreasing. The total machinery bill for the farm has increased significantly over the past 4 years; however, it is being used more efficiently and spread over a larger cropped area.

## Farmer B

Table 5 outlines some key financial indicators for Winter Wheat from the Profit Monitor analysis 2006 & 2007 and initial results from all Teagasc Profit Monitors 2007:

**Table 5:** Winter Wheat Multiple Year Report 2006 & 2007 (€/ha)

| Year | 2006 | 2007 | 2007<br>Average €PM |
|---|---|---|---|

| | | | |
|---|---|---|---|
| Grain & Straw Sales | 1615 | 1808 | 1959 |
| Variable Costs | 445 | 467 | 639 |
| Gross Margin | 1170 | 1341 | 1320 |
| Machinery Costs | 526 | 386 | 289 |
| Land Rental | 100 | 139 | 218 |
| Other Fixed Costs | 147 | 107 | 111 |
| Net Margin | 397 | 709 | 702 |
| Dry Yield (t/ha) | 9.2 | 7.9 | - |

Key: Grain & Straw Sales = Total sales divided by wheat area

Variable Costs = Pesticides, contractors and other variable costs

Machinery Costs = Repayments, depreciation, fuel, tax, and repairs

Other fixed Costs = Interest, car, phone, ESB, insurance, professional fees and sundry items

Net Margin = Note: Does not include Single Farm Payment

## Machinery

Machinery costs include grain and oilseed drying costs for Farmer B and were approx €80/ha for 2007. In 2005 Farmer B lost a significant block of conacre which was replaced in 2007. This had the effect of increasing all his fixed costs in 2005 and 2006. He needs his farmed area to be around 230 ha in order to utilize his machinery to its potential with a target cost of €300/ha. If he were to lose rented land an alternative option would be to take on more contracting work which is available locally.

# Farmers A & B under the New Pricing Scenario

Good financial projections are based on two key points

- reliability of the past data
- realism of the future assumptions

In both cases Farmers A & B have placed great emphasis on producing an accurate set of figures each year for their farms. This places both in the strong position that they can use 3 or more year's data to give a rolling average for their crop margins. This will be more important into the future as crop margins are set to vary from year to year. As no two farms are alike, therefore I have discussed different options with both farmers. It is clear from these discussions that cereal & input prices as well as the availability of realistically priced conacre are points that concern both farmers. Both farmers are very keen to adapt new technologies and practices that will increase their net margins.

## Price Assumptions

In order to make realistic price assumptions I have looked at a number of sources to get a broad range of where both cereal and input prices may be in 2012.

## Cereal Prices

Both the OECD/FAO and FAPRI published their predictions for world agricultural commodities during 2007. They predict that the biofuel industry will be the main driver of both the cereals and oilseed industries over the next decade to 2016 but that underlying fundamentals such as increasing population and economic growth in the developing nations will also increase the need for food. They predict nominal world wheat prices are expected to be 30-40 % higher on average over the next decade than in the previous 10 years with oilseeds expected to increase by a more modest 20% over the same period. However, both institutions warn that we are moving into an era of increasing price volatility.

Closer to home FAPRI Ireland Partnership recently published 'Baseline 2007 Outlook for EU and Irish Agriculture' in October 2007. They predict Irish wheat and barley prices in 2016 to be 9 % & 6 % higher than the 2004-2006 average. They also predict the areas of Irish wheat and barley to increase by 7 % & 10 % respectively making use a net exporter of barley and reducing our imports of wheat by 14 %.

After taking into account the above publications and more recent price trends, I have assumed the following prices for the 2008 & 2012 harvests.

**Table 6:** Cereal Price Assumptions used in the Financial Projections (€/t)

| | **2008** | **2012** |
|---|---|---|

| | | |
|---|---|---|
| Wheat Price | 170 | 160 |
| Barley Price | 160 | 150 |
| Oilseed Price | 320 | 310 |

## Input Prices

The CSO publish monthly statistics on the price of selected agricultural input items such as plant protection products, fertilizer etc. These figures are all made relative to the base year which is taken to be the year 2000. The following table is a summary of price increases in key tillage inputs in the past 5 years.

**Table 7:** Agricultural Price Index (Base year = 2000)

| Input Type | Oct 2002 | October 2007 | Diff (%) |
|---|---|---|---|
| Motor Fuel | 99.2 | 151.8 | + 52.6 |
| All Fertilizers | 108.8 | 137.4 | + 28.6 |

*Source: www.cso.ie*

FAPRI Ireland projects that fertilizer prices will be 19% higher in 2016 relative to 2006.

The base costs for the period are what each farmer has included in his crop budgets for 2008 based on input price quotes. This approach tries to take into account the expected price spikes in fuel and especially fertilizer in 2008, while allowing for more normal price increases thereafter.

**Table 8:** Input Price Assumptions used in the Financial Projections

| | **Yearly Increase** | **2012 (Total Increase)** |
|---|---|---|

| | (%) | (%) |
|---|---|---|
| Fertilizer & Fuel | 3.5 | 19 |
| Other Costs | 2 | 10.4 |

## Options Examined for Farmers A & B

**Option 1:** **(Baseline 05-07)** is the average net farm incomes on both farms over the period 2005 – 2007.

**Option 2** **(2008)** is the current real-life scenario for both farms for 2008.

Farmer A has increased his rental area by 60 ha, purchased a new tractor and combine as well as taken on a labour unit as part of his long-term strategy.

Farmer B is following a similar cropping program as heretofore.

**Option 3** **(2012 Standstill)** is the projected 2012 scenario for both farmers using the cereal and input price assumptions outlined previously.

Farmer A further increases his rental area by 40 ha.

There are no changes to Farmer B’s system or area.

**Option 4** **(2012; various)** is Option 3 but with the following changes:

Farmer A joins REPS4, purchases a Decision Support System (Septoria Timer) for winter wheat fungicides (200 ha), and also spreads organic manure on his spring crop area (40 ha).

Farmer B loses conacre (51 ha), consolidates his entitlements, increases his tillage contracting work and joins REPS4.

**Option 5** **(2012 +€10/t)** is Option 3 but with higher grain (+€10/ton) and oilseed (+€10/ton) prices.

# RESULTS

Figures 1 & 2 show the projections for both farmers under the various scenarios examined. The Net Farm Income for all future scenarios is adjusted downwards to take account of inflation at 4% p.a. and is set relative to the 'Baseline 05-07' figures. The Net Farm Income does not include SFP.

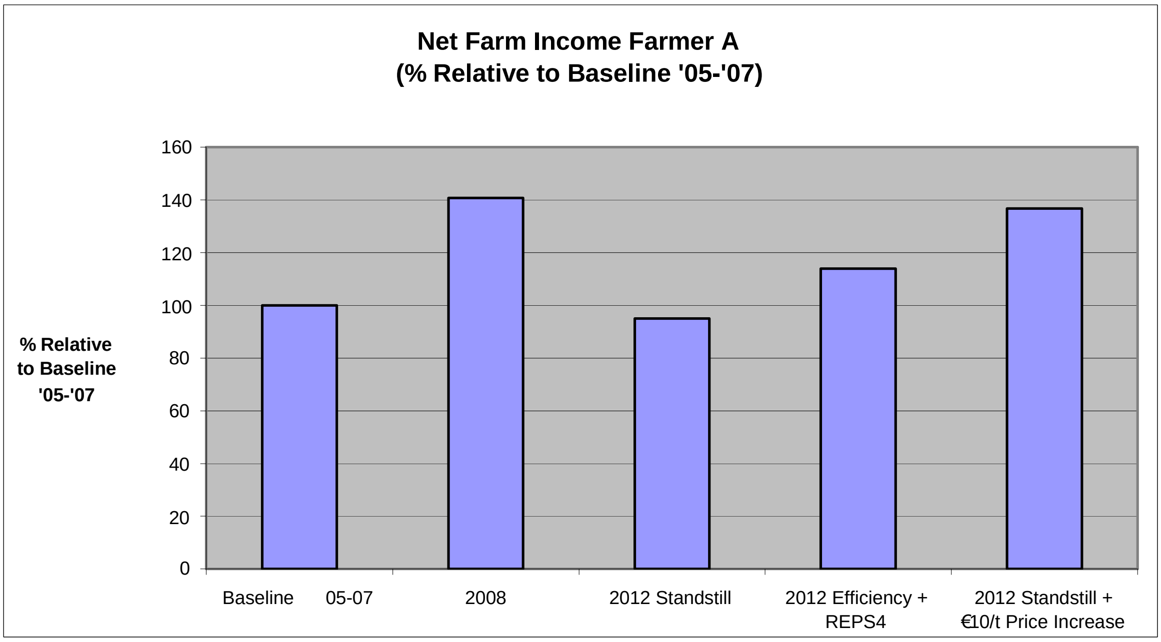



**Fig. 1:** Farmer A

Farmer A has planned to increase his area by 100 ha by 2012 with rented land. He is prepared to pay the market price to secure good land. He has also taken on a full-time labour unit and increased the capacity of his machinery. In the efficiency option he is using an Oak Park proven Decision Support System (Septoria Timer) to reduce the fungicide quantity on his wheat by 8 % and replacing a portion of his fertilizer in spring crops (40ha)

## Effect of New Pricing Scenario on Farmer A

| | |
|---|---|
| **2008:** | Income increases by 41 % relative to the Baseline. |
| **2012 (Standstill):** | Income decreases by 5 % relative to the Baseline. |
| **2012 (Effics. & REPS 4):** | Income increases by 15 % relative to the Baseline |
| **2012 (+ €10/t):** | Income increases by 37 % relative to the Baseline |

Higher grain prices in 2008 increase income by 41 %. The effect of paying too much for rented land on the strength of high grain prices is demonstrated to some effect in the case of Farmer A. Average rented land in 2008 is €380/ha rising to €403/ha in 2012. Adjustments such as using a DSS, organic manures or joining REPS4 will maintain incomes relative to the Baseline as will grain prices staying at the currently predicted 2008 levels.

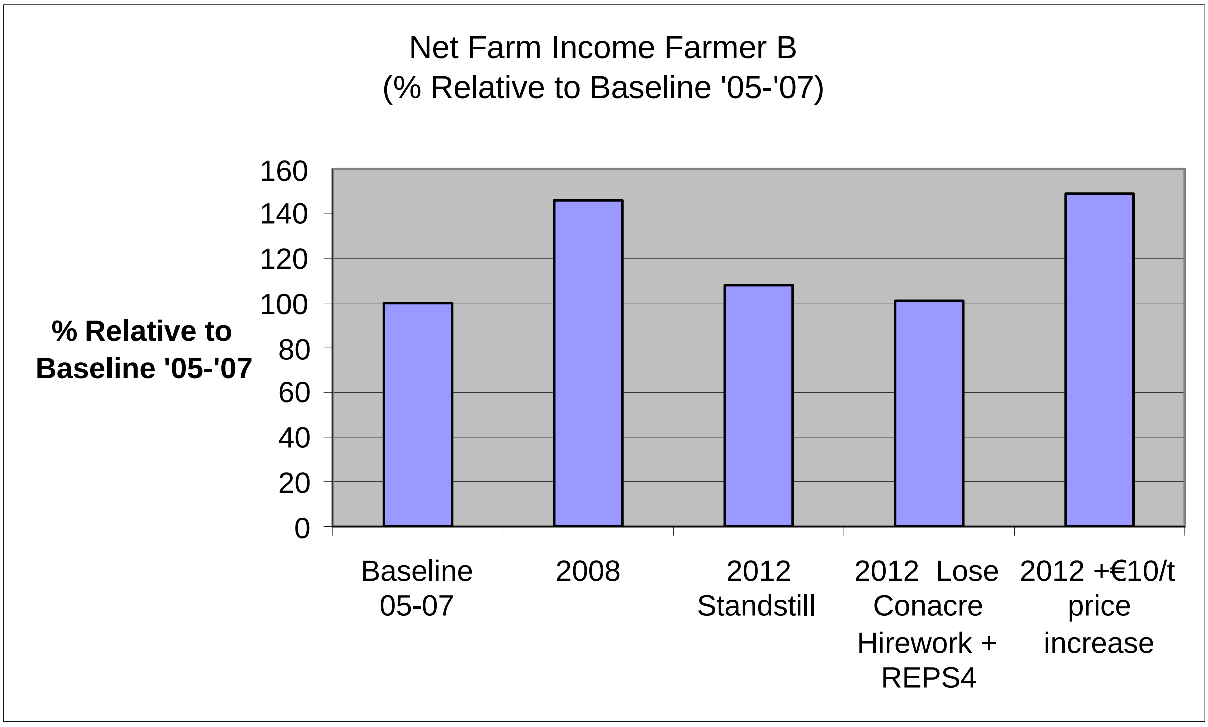



**Fig. 2:** Farmer B

Farmer B is constrained by land availability in his locality. He is not willing to pay the current market price for rented land but instead uses the value of green grain as a reference when paying for conacre. He can add value to his grain by using his grain store to give him flexibility when selling it.

## Effect of New Pricing Scenario on Farmer B

| | |
|---|---|
| **2008:** | Income increases by 46 % relative to the Baseline |
| **2012 (Standstill):** | Income increases by 8 % relative to the Baseline |
| **2012 (Stack; Hire + REPS 4):** | Income increases by 1 % relative to the Baseline |
| **2012 (+ €10/t):** | Income increases by 49 % relative to the Baseline |

The higher grain prices even with higher input prices will increase farm income in 2008 by a significant 46 %. By maintaining the cost/ha of his rented land at reasonable levels (€354/ha), Farmer B will maintain his average 2005-2007 farm income in 2012. If a significant portion of his rented land is lost, then he must replace this area with an equivalent amount of hire-work to cover his machinery costs and join REPS4 to make up for lost income on selling that amount of grain at a premium.

# CONCLUSIONS

Most of the world's agricultural think-tanks (FAPRI, OECD) are predicting 40-50% average grain price rises in the next 10 years compared to the past decade but also warning of increased volatility of cereal and input prices into the future. However increases in input costs, especially fertilizer and fuel, will erode the increases in grain price.

Cross-Compliance requires tillage farmers to estimate crop fertilizer requirements at the beginning of each year and also keep a detailed record of plant protection products and fertilizer use. Clients of the Teagasc Business & Technology Advisory Service have available to them two proven computer programs which can record your necessary details for Cross-Compliance and also produce a farmer-friendly set of management data to base your enterprise and cropping decisions on. The E-Crops program is suitable for Cross Compliance and Grain Assurance purposes. Tillage profit monitor is suitable for overall farm financial decisions. A review and action plan as a result of completing both programs on a yearly basis will result in an overall increase in farm profits. It is estimated the savings are in the region of €10 per hectare

A review of two Technology and Business clients in Teagasc was completed and forward projections of different scenarios highlight similar trends.

Net farm income in 2008 is predicted to increase by 40% on both farm over the baseline scenario (05-07 average).

Maintaining farm income, adjusting for inflation, will require linking land rental prices to grain prices on a yearly basis and efficient use of machinery.

New technology/ novel practices will increase net farm income on both farms in 2012 by and average of 8% relative to the baseline.

A €10 increase in grain prices, assuming stated cost predictions, will increase net farm income on both farms by 43% in 2012.

REPS 4 should be seriously investigated by all tillage farmers irrespectively of scale (see Appendix 1)

The tools are available to complete a financial analysis and this can be completed relatively quickly from Cross Compliance records and the review of this information will pay dividends each year. The Tillage Business and Technology advisors are equipped and willing to help you in this process.

# Appendix 1

***REPS 4***

The Department of Agriculture & Food launched the latest phase of the popular agri-environmental scheme REPS in 2007. Called REPS 4 it has a number of significant changes to its rules compared to previous versions which may make it more attractive to larger tillage farmers. Previous versions of REPS had limits on crop nitrogen rates which made the scheme unattractive to larger tillage farmers especially as the upper limit for payment was 55ha. However, in REPS 4, tillage crops are allowed the same level of nitrogen as the Nitrates Directive (SI 378 of 2006) if the applicant places 6% of their arable area (max 2.4 ha) under LINNET management. Alternatively you can avoid the LINNET option by using 70% of the Nitrates Directive nitrogen crop allowances.

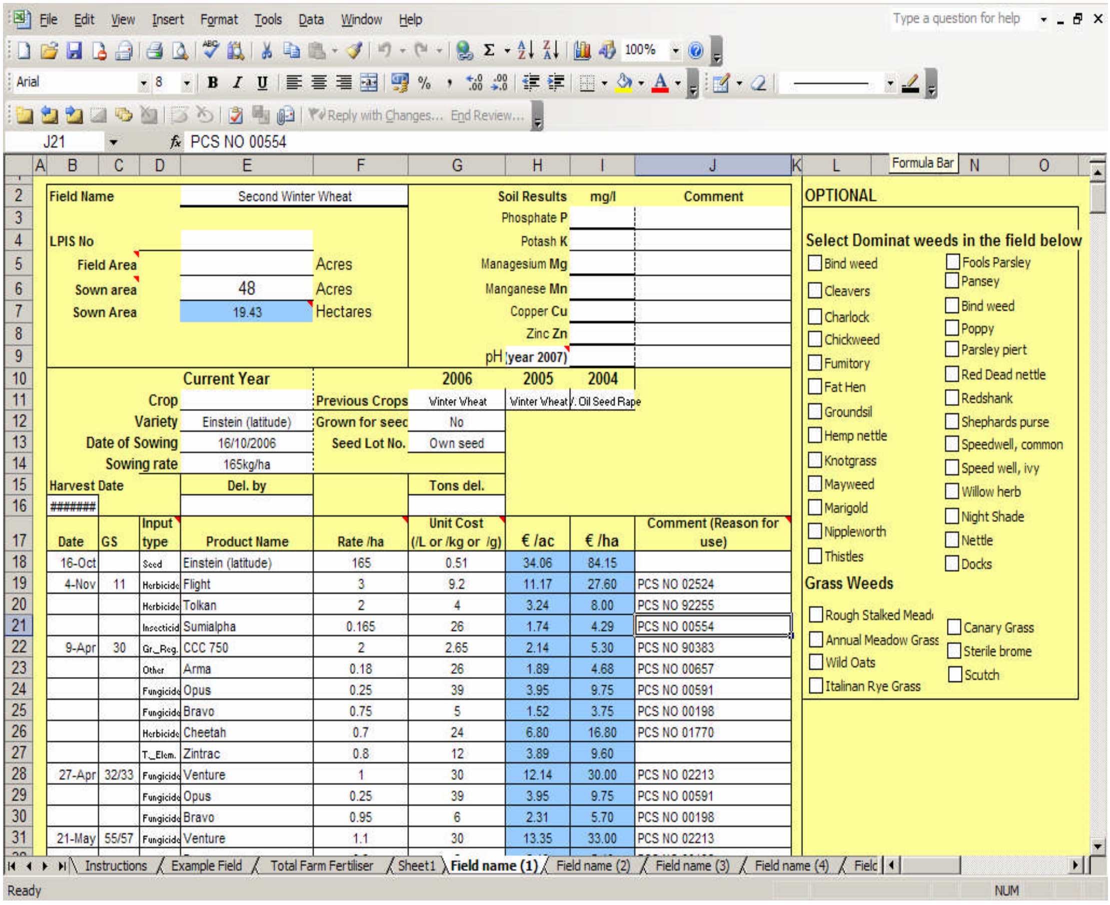
**Table 9:** REPS 4 Partial Budgets for Farmers A & B

| | **Farmer A** | | **Farmer B** | |
|---|---|---|---|---|
| REPS 4 Payments | | 10260 | | 10480 |
| Annualized Expenses: | | | | |
| Income Lost from field margins (€252/ha of margin) | 1600 | | 950 | |
| Planning Fees | 700 | | 700 | |
| Environmental Measures | 500 | | 500 | |
| LINNET costs (2.4 ha @ €280/ha) | 675 | | 675 | |
| Miscellaneous REPS compliance | 500 | 3975 | 500 | 3325 |
| Net REPS income | | 6285 | | 7155 |

In the REPS 4 analysis I have allowed for the loss of production due to increased field margins and also put costs on each of the most suitable environmental measures that these two farmers would have to undertake should they decide to enter into the scheme. Planning fees includes an initial planning fee (€1500) and a yearly fee (€400) annualized over 5 years. Miscellaneous expenses are included to account for potential stock-proofing of conacre etc.

# Appendix 2

Screenshot of Farmer B 2007 E-Crops



J21 PCS NO 00554

| | | | | | | |
|---|---|---|---|---|---|---|
| Field Name | Second Winter Wheat | | Soil Results | mg/l | Comment | |
| | | | Phosphate P | | | |
| LPIS No | | | Potash K | | | |
| Field Area | | Acres | Managesium Mg | | | |
| Sown area | 48 | Acres | Manganese Mn | | | |
| Sown Area | 19.43 | Hectares | Copper Cu | | | |
| | | | Zinc Zn | | | |
| | | | pH (year 2007) | | | |

| | Current Year | | 2006 | 2005 | 2004 |
|---|---|---|---|---|---|
| Crop | | Previous Crops | Winter Wheat | Winter Wheat | W. Oil Seed Rape |
| Variety | Einstein (latitude) | Grown for seed | No | | |
| Date of Sowing | 16/10/2006 | Seed Lot No. | Own seed | | |
| Sowing rate | 165kg/ha | | | | |
| Harvest Date | Del. by | | Tons del. | | |
| ####### | | | | | |

| Date | GS | Input type | Product Name | Rate /ha | Unit Cost (/L or /kg or /g) | € /ac | € /ha | Comment (Reason for use) |
|---|---|---|---|---|---|---|---|---|
| 16-Oct | | Seed | Einstein (latitude) | 165 | 0.51 | 34.06 | 84.15 | |
| 4-Nov | 11 | Herbicide | Flight | 3 | 9.2 | 11.17 | 27.60 | PCS NO 02524 |
| | | Herbicide | Tolkan | 2 | 4 | 3.24 | 8.00 | PCS NO 92255 |
| | | Insecticid | Sumialpha | 0.165 | 26 | 1.74 | 4.29 | PCS NO 00554 |
| 9-Apr | 30 | Gr._Reg. | CCC 750 | 2 | 2.65 | 2.14 | 5.30 | PCS NO 90383 |
| | | Other | Arma | 0.18 | 26 | 1.89 | 4.68 | PCS NO 00657 |
| | | Fungicide | Opus | 0.25 | 39 | 3.95 | 9.75 | PCS NO 00591 |
| | | Fungicide | Bravo | 0.75 | 5 | 1.52 | 3.75 | PCS NO 00198 |
| | | Herbicide | Cheetah | 0.7 | 24 | 6.80 | 16.80 | PCS NO 01770 |
| | | T._Elem. | Zintrac | 0.8 | 12 | 3.89 | 9.60 | |
| 27-Apr | 32/33 | Fungicide | Venture | 1 | 30 | 12.14 | 30.00 | PCS NO 02213 |
| | | Fungicide | Opus | 0.25 | 39 | 3.95 | 9.75 | PCS NO 00591 |
| | | Fungicide | Bravo | 0.95 | 6 | 2.31 | 5.70 | PCS NO 00198 |
| 21-May | 55/57 | Fungicide | Venture | 1.1 | 30 | 13.35 | 33.00 | PCS NO 02213 |

OPTIONAL

Select Dominat weeds in the field below

Bind weed, Cleavers, Charlock, Chickweed, Fumitory, Fat Hen, Groundsil, Hemp nettle, Knotgrass, Mayweed, Marigold, Nippleworth, Thistles, Fools Parsley, Pansey, Bind weed, Poppy, Parsley piert, Red Dead nettle, Redshank, Shephards purse, Speedwell, common, Speed well, ivy, Willow herb, Night Shade, Nettle, Docks

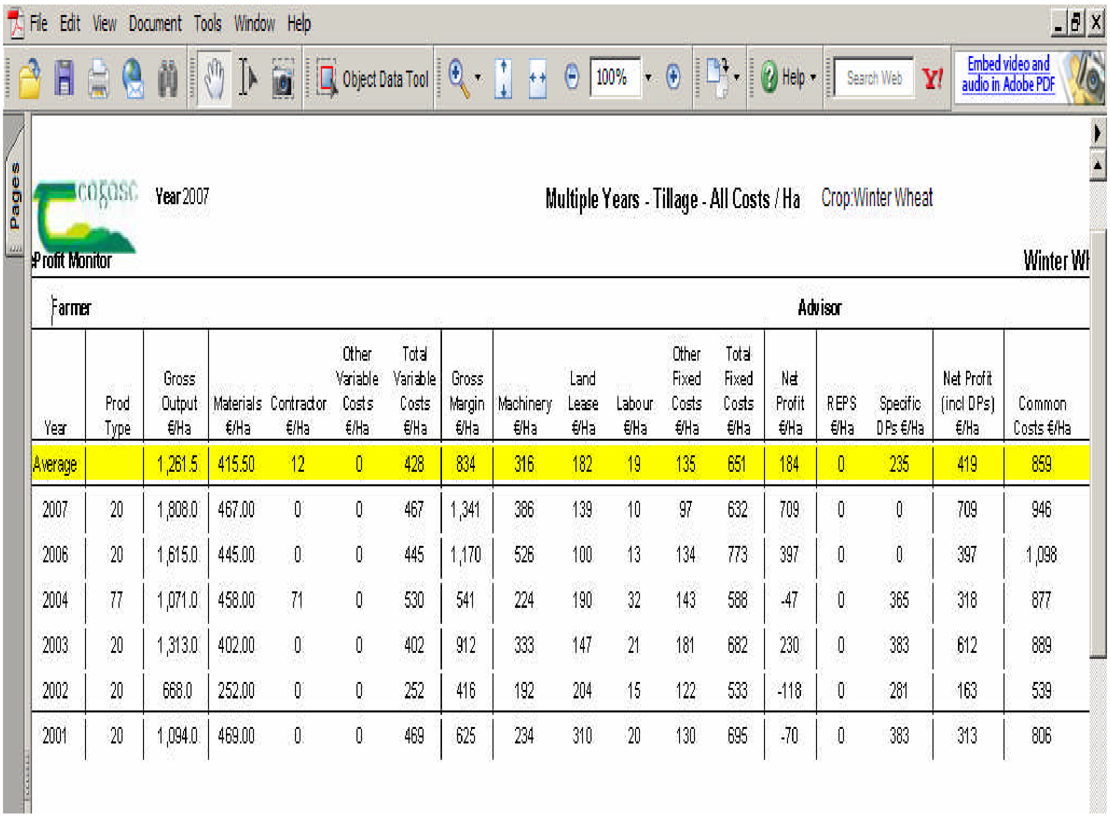
Grass Weeds

Rough Stalked Meadow, Annual Meadow Grass, Wild Oats, Italinan Rye Grass, Canary Grass, Sterile brome, Scutch

Instructions | Example Field | Total Farm Fertiliser | Sheet1 | Field name (1) | Field name (2) | Field name (3) | Field name (4)

# Appendix 3

Screenshot of Farmer A €Profit Monitor Multi Year Report



Year 2007 — Multiple Years - Tillage - All Costs / Ha — Crop:Winter Wheat

Profit Monitor — Winter Wh

Farmer — Advisor

| Year | Prod Type | Gross Output €/Ha | Materials €/Ha | Contractor €/Ha | Other Variable Costs €/Ha | Total Variable Costs €/Ha | Gross Margin €/Ha | Machinery €/Ha | Land Lease €/Ha | Labour €/Ha | Other Fixed Costs €/Ha | Total Fixed Costs €/Ha | Net Profit €/Ha | REPS €/Ha | Specific DPs €/Ha | Net Profit (incl DPs) €/Ha | Common Costs €/Ha |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Average | | 1,261.5 | 415.50 | 12 | 0 | 428 | 834 | 316 | 182 | 19 | 135 | 651 | 184 | 0 | 235 | 419 | 859 |
| 2007 | 20 | 1,808.0 | 467.00 | 0 | 0 | 467 | 1,341 | 386 | 139 | 10 | 97 | 632 | 709 | 0 | 0 | 709 | 946 |
| 2006 | 20 | 1,615.0 | 445.00 | 0 | 0 | 445 | 1,170 | 526 | 100 | 13 | 134 | 773 | 397 | 0 | 0 | 397 | 1,098 |
| 2004 | 77 | 1,071.0 | 458.00 | 71 | 0 | 530 | 541 | 224 | 190 | 32 | 143 | 588 | -47 | 0 | 365 | 318 | 877 |
| 2003 | 20 | 1,313.0 | 402.00 | 0 | 0 | 402 | 912 | 333 | 147 | 21 | 181 | 682 | 230 | 0 | 383 | 612 | 889 |
| 2002 | 20 | 668.0 | 252.00 | 0 | 0 | 252 | 416 | 192 | 204 | 15 | 122 | 533 | -118 | 0 | 281 | 163 | 539 |
| 2001 | 20 | 1,094.0 | 469.00 | 0 | 0 | 469 | 625 | 234 | 310 | 20 | 130 | 695 | -70 | 0 | 383 | 313 | 806 |

# Teagasc Business & Technology Advisory Programme and a Vision for the Future of Tillage Crops & Bio-energy Sector

***Jim O'Mahony***

***Teagasc, Oak Park, Carlow***

## SUMMARY

There is renewed interest in crop production due to the major rise in cereal prices globally and domestically in 2007. The medium term outlook for EU cereal markets is positive. World and EU stocks are very low but are likely to build and prices are likely to stabilise in a few years. Grain production is forecasted to increase stimulated by poor margins in the dry stock sector and emerging developments in the energy from biomass sector as well as our deficit in grain status. There is a growing consensus that we are facing a real trend of real food price increases driven by the onset of peak oil and a renewed interest in food for health.

Against this background Teagasc sees a bright future for agriculture particularly in the dairying and tillage crops sectors. Teagasc is in the process of completion of two visionary projects – the Sectoral Roadmaps set out our vision for the short to medium term up to 2015 for the various farming sectors and the Teagasc 2030 Foresight project is visioning what the agricultural and rural economies could look like in the longer term in 2030.

Teagasc has restructured its advisory service to enable its advisers lead and support farmers and the industry in these challenging but opportunistic times.

The Business and Technology Programme will be of most interest to commercial farmers. It will include farm planning, intensive agronomy and business appraisal reflecting renewed emphasis on farming for profit. Crop agronomy will provide a planned approach to inputs as well as time critical advice on crop husbandry and marketing opportunities. It will be delivered by means of farm visits, crop walking, news letters, texts, crop reports, emails and

website. Discussion groups, seminars, open days, field walks, events at monitor/theme farms and short courses will be used where appropriate.

The business service will provide whole farm appraisal and planning as well as crop, machinery and labour efficiencies. Profit Monitor and e-Crops will be used to benchmark and highlight potential developments. Tim O'Donovan's paper confirms the importance of business planning and achieving technical efficiencies.

The Good Farm Practice Programme provides comprehensive support service for farmers renovating farms yards and improving their farms. It is built around the REPS service.

The Rural Development Programme provides services to individuals and groups who want to evaluate business opportunities in alternative enterprises such as organic farming, rural tourism, equine, husbandry, poultry, deer and goat production and artisan foods.

The Teagasc Adult Training Programme provides an extensive range of courses to inform and train farmers in relation to business and Technology developments, the environment, animal welfare and nutrient management. Up to 9,000 farmers attend our adult courses each year. Among the courses offered are Advanced Course in Crops Management, REPS, Certificate in Farm Business, Computer Skills, Internet for farmers and farm safety courses. Many of these courses are FETAC accredited.

The Teagasc sectoral roadmap for tillage crops and bio-energy outlines the following vision for the arable sector in 2015:-

1. Increase the area devoted to tillage and energy crops by 50% by 2015.

   This will be largely driven by higher cereal prices, removal of set-aside, demand for energy crops and national and EU policies as well as lifestyle choices.
2. By 2015 the number of full time tillage farmers will be about 1,000. These will be farming in excess of 200 ha. There will be about 12,000 other part time farmers with tillage and energy crops. Many of these will be in REPS.

The major changes include:-

- an increase of 45,000 ha of wheat to reduce imports of 0.5-0.8Mt and contribute to establishing ethanol/bio-refining industry
- increase maize by 22,000 ha to support intensive dairy enterprises
- increase oilseed rape by 21,000ha to support bio-fuel expansion and high value food ingredients
- plant 70,000 ha of perennial bio-energy crops(miscanthus, willows) and establish supply chains to meet energy and climate change commitments

# INTRODUCTION

We are at the start of a new and exciting era for agriculture – the most significant since we joined the European Community in 1973. The recent major increases in agricultural commodities such as grain and dairy products signal an end to the era of cheap food. There is an increasing awareness of the importance security of supplies of food and energy. The structural shifts in consumer food preferences, e.g. food for health and environmental awareness e.g. climate change offer major opportunities for agriculture and crop production in particular.

The main challenge facing producers will be to maintain a viable income in a competitive global market situation where grain production and prices are likely to vary a lot. Environmental regulations will be a further constraint on production. Thus growers will need to adopt production systems which are environmentally acceptable and yet economically viable. Growers will need to know and compare costs and output to appropriate benchmark figures. Investments in machinery and land will need to be financially appraised before a decision on investment is made. Labour efficiency must be scrutinised.

There is new interest in the bio-economy i.e. food, feed (for animals), fuel and industrial bio-products.

Teagasc must provide the research and technology to underpin these developments and enable a competitive and sustainable crop production capability. Teagasc has undertaken two visionary processes in the last year to position itself to lead and support the agricultural and rural economies:-

1. Sectoral Roadmaps looking at the vision for the various agricultural sectors in 2015.

2. Teagasc Vision 2030 Foresight Project is designed to establish a broadly shared vision for the agrifood and rural economy in 2030 and its knowledge requirements.

Teagasc will embrace a culture of innovation based on knowledge, including knowledge creation (research), dissemination (advisory) and absorption (training). Teagasc is unique in Europe in terms of having all of these sectors in one organisation. Teagasc is keenly interested in working in partnership with relevant stakeholders to make this positive vision a reality.

This paper will address three major topics:-

- The New Business & Technology Advisory Programme
- Where Tillage Crops and Bio-energy are now
- Vision for the arable and bio-energy sector in 2015

Finally I will make some concluding remarks regarding future progress.

## Teagasc New Business and Technology Advisory Programme

Teagasc is positioning the new Advisory service to enable farmers and the agricultural industry to take advantage of the opportunities resulting from decoupling, reform of the CAP and rising commodity prices. The new emphasis is on farming for profit rather than scheme-driven income. The new service is built around four district programmes:-

- Business and Technology
- Good Farm Practice
- Rural Development
- Adult Training.

The four programmes will provide a full range of services to farmers, meeting the diverse needs of our customers.

The Business and Technology Programme will deliver cutting edge technology developed at Teagasc and other research centres as well as best practice business methods to commercial farmers.

The Good Farm Practice Programme is built around the REPS service. Teagasc is the largest provider of REPS services in the country. Over half of our clients already participate in REPS and we are geared up to assist a further 10,000 clients to join REPS 4 by 2013. A comprehensive support service for farmers renovating farms yards and improving their farms is also provided.

The Rural Development Programme provides services to individuals and groups who want to evaluate business opportunities in alternative enterprises such as organic farming, rural tourism, equine, husbandry, poultry, deer and goat production and artisan foods.

The Teagasc Adult Training Programme provides an extensive range of courses to inform and train farmers in relation to business and Technology developments, the environment, animal welfare and nutrient management. Up to 9,000 farmers attend our adult courses each year. Among the courses offered are advanced course in Crop Management, REPS, Certificate in Farm Business, Computer Skills, and Internet for farmers and farm safety courses. Many of these courses are FETAC accredited.

## 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 will be tailored to individual farmer needs. It will place 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 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 will be delivered by means of farm visits, crop walking, newsletters, leaflets, texts, emails and the web. Discussion groups, seminars, open days, field walks and short courses will be used where appropriate. The new BT Tillage Advisers will be specialised in business and agronomy. They will be challenging the status quo by introducing innovative techniques to gain efficiencies in the farming business e.g. Input planning and profit monitor and the new "theme farm" concept where selected farmers will demonstrate best practice for particular developments like soil-nutrient management, decision supports etc.

Teagasc BT advisers have the advantage of knowing the growers family goals and can deliver a complete package integrating advice on payments, financial, agronomy, mechanisation and cross compliance issues.

The Teagasc BT programme is independent and locally organised and is supported by in house research in collaboration with institutions worldwide. Advice is fully compliant with Irish/EU regulations. Access to the www.client.teagasc.ie website and Today's Farm magazine are part of the service. In addition access to REPS, farm installation and options advisers are also integral parts of the Teagasc service.

The programme is provided through a network of advisers located in all the major tillage countries.

There are 17 tillage advisers supported by 4 tillage specialists. See appendix 1 for names and contact details.

# Where Tillage Crops and Bio-energy are now

# Grain Crops

### *Structure of tillage sector*

The output at farm gate level of the tillage sector is valued at close to €600 million. Cereals occupy approximately 285,000 hectares of which over 50% is spring barley and a further 25% is winter wheat. Cereal production has been around 2M tonnes in recent years. The area devoted to maize is 18,000 hectares and has been expanding. Potatoes have stabilised around 12,000 hectares and beet is now just 5-6,000 hectares for fodder. Area sown to oilseed rape (OSR) (6,000 hectares), peas (700hectares) and beans (2-3,000 hectare) is small.

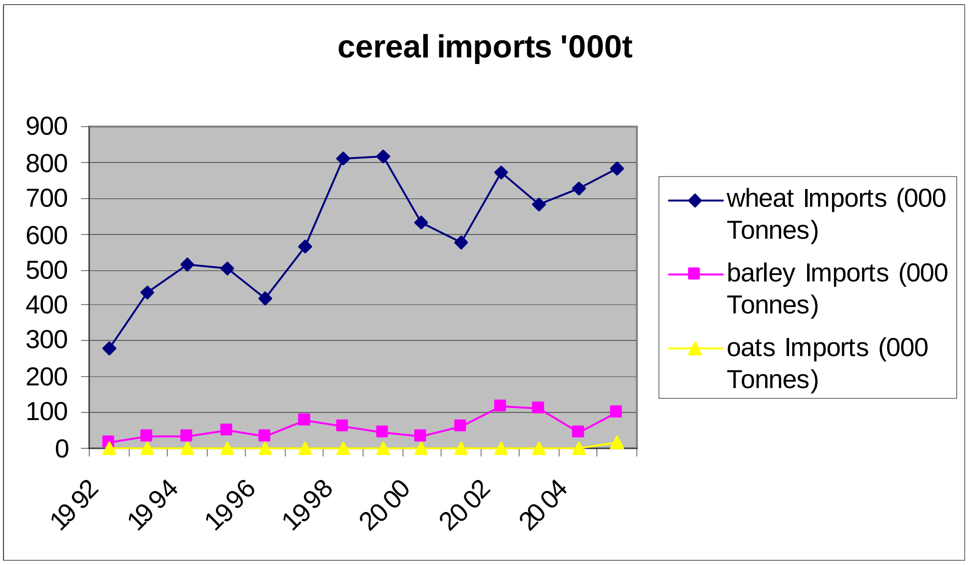
There are close on 13,000 cereal growers, 1,500 of whom grow over 50 hectares of cereals. Table 3 outlines the structure of growers by arable claim from the Single Farm Payment 2007 on a county basis. It is estimated that a further 15,000 are employed in the services and food/feed industries associated with tillage crops.

**Table 1:** Profile of Arable Growers by County 2007 – Dept Agric

| | | 0-10HA | 10-50HA | 50-100HA | 100+HA |
|---|---|---|---|---|---|
| CARLOW | | 246 | 304 | 63 | 25 |
| CAVAN | | 14 | 2 | 0 | 0 |
| CLARE | | 15 | 2 | 0 | 0 |
| CORK | | 1262 | 1042 | 148 | 61 |
| DONEGAL | | 300 | 183 | 6 | 4 |
| DUBLIN | | 61 | 132 | 50 | 35 |
| GALWAY | | 296 | 75 | 8 | 1 |
| KERRY | | 98 | 48 | 5 | 1 |
| KILDARE | | 156 | 333 | 127 | 63 |
| KILKENNY | | 493 | 394 | 47 | 20 |
| LAOIS | | 382 | 383 | 43 | 17 |
| LEITRIM | | 2 | 0 | 0 | 0 |
| LIMERICK | | 56 | 29 | 5 | 0 |
| LONGFORD | | 26 | 8 | 0 | 0 |
| LOUTH | | 212 | 262 | 54 | 43 |
| MAYO | | 49 | 6 | 0 | 0 |
| MEATH | | 232 | 339 | 96 | 66 |
| MONAGHAN | | 39 | 10 | 1 | 0 |
| OFFALY | | 380 | 226 | 23 | 10 |
| ROSCOMMON | | 27 | 9 | 3 | 0 |
| SLIGO | | 14 | 1 | 0 | 0 |
| TIPPERARY | | 482 | 431 | 81 | 33 |
| WATERFORD | | 237 | 191 | 22 | 13 |
| WESTMEATH | | 124 | 85 | 18 | 5 |
| WEXFORD | | 832 | 1127 | 180 | 47 |
| WICKLOW | | 201 | 171 | 43 | 21 |
| Total | 13517 | 6236 | 5793 | 1023 | 465 |

Over 3 million tonnes of feed ingredients including 1.5 million tonnes of proteins are imported annually. In the region of 500-750,000 tonnes of wheat are imported annually and 200,000 to 300,000 tonnes are exported mainly to Northern Ireland

**Fig 1:** Cereal Imports 1992-2005 (CSO)

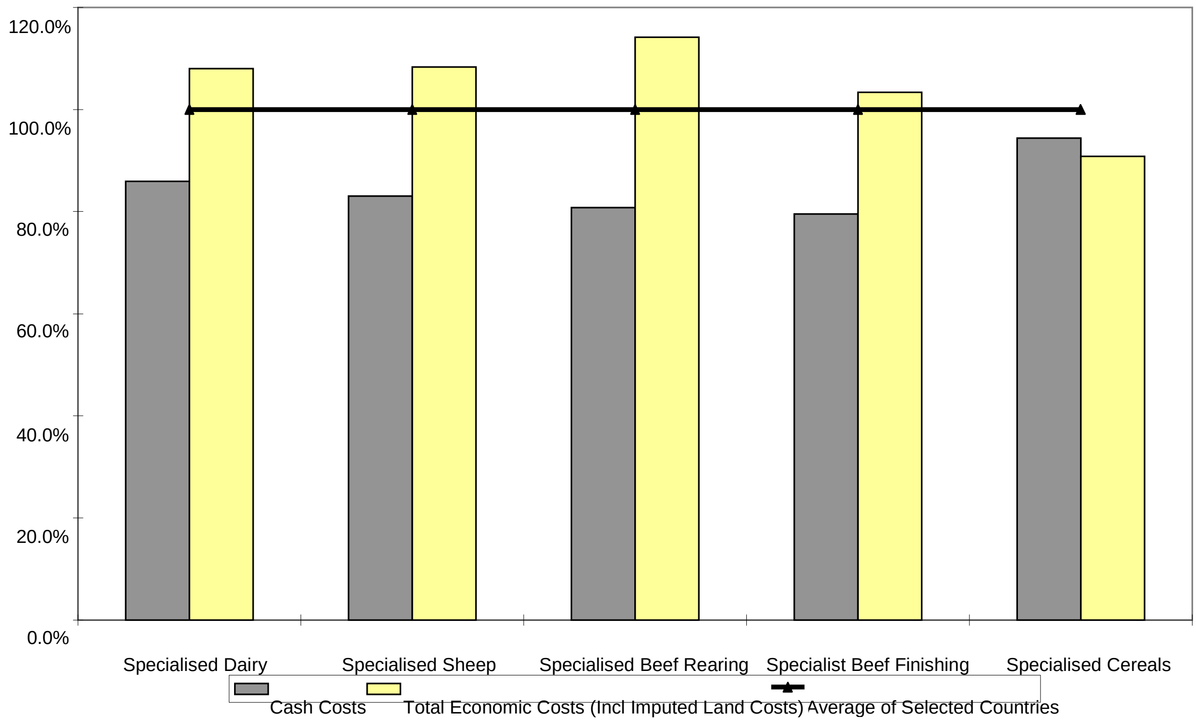



## *Competitive Performance*

Work by F.Thorne Teagasc economist shows that specialised cereal farmers performed better than dairy, beef and sheep farmers and their costs were below the average for selected EU countries in a FADN survey.

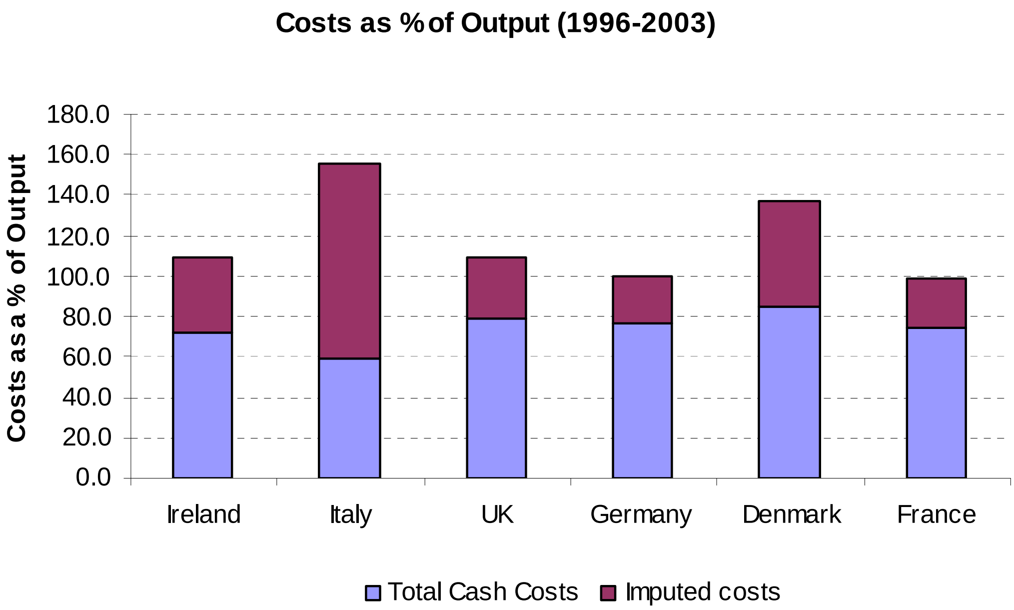
Figure 2 shows the relative competitive performance of the main sectors of Irish agriculture for the period 1996-2003. The European Commission's Farm Accountancy Data Network (FADN) was the primary source of data used in this analysis. Data analysis was confined to specialist dairy, sheep, beef finishing, beef fattening and cereal farms, as defined by FADN, on which the standard gross margin from each of the respective enterprises accounted for at least two-thirds of the farm total gross margin.

**Figure 2: Irish Cash and Economic Costs as a % of Average of Selected Countries, 1996-2003**




Moreover Ireland is an efficient cereal producer compared to our EU partners as can be seen from figure 3, imputed costs include labour and land costs.

**Figure 3:** EU Comparison of costs for cereal growing



# Biofuels

Ambitious targets are being set for the expansion of biofuel use in Ireland. It is in the national interest that these targets be met from native production, as long as this can be done sustainably and profitably and without threat to food production. To date, policy measures to promote market development (while welcome) have been mainly short-term; this has favoured imports unduly, and militates against gradual development of native feedstock production and processing. Support measures have also been sporadic in their effect; while there has been some initial development of transport fuel (driven by excise relief) and heating (Greener Homes, BioHeat and Reheat), virtually no progress has been made with the generation of electricity from biomass. Some problems have also been created by the stimulation of demand ahead of supply (e.g. wood pellets); this also favours imports.

With a set of long-term, coherent policy measures balanced between production and demand, and assuming moderate further increases in oil and gas prices, the following targets could be achieved, mainly from native production, by 2015:

| | |
|---|---|
| PPO | 25,000 tonnes/annum from 20,000 ha of rape |
| Biodiesel | 50,000t/annum, from 20,000t tallow, 15,000 t recovered vegetable oil and 15,000t rape-seed oil (12,000 ha) |
| Ethanol | One plant, capacity 300,000 t cereals (1M litres ethanol), half supplied from native crops (20,000 ha) |
| Solid biofuels | Biomass production of 1 Mt/annum from forest thinnings and residues, sawmill residues and 50,000 ha of energy plantation; also biomass in residual municipal waste of up to 0.5 Mt/annum |
| Biogas | Methane with an energy content of about 10 ktoe from pig and dairy slurry, food industry wastes and pilot amounts of crops such as grass and whole-crop cereals and maize. |

This would raise the biomass contribution to primary energy demand from 180 to 480 ktoe, with very little impact on food production potential; it would also effect a reduction in $CO_2$ emissions of about 1.5-2.0 Mt/annum. However, for these targets to be achieved, the following actions are urgently needed:

# Liquid biofuels

- A set of production and market support measures for the next ten years that is sensitive to the needs of Irish biofuel producers. These should include the phasing in over a five-year period of an inclusion obligation on oil companies, and a phasing out of excise relief over the same period. It should also include VRT and road tax rebates based on carbon emissions, and other promotion measures such as free parking.
- Substantial capital support for one large ethanol plant

# Biogas

- A ten-year schedule of increased renewable electricity prices sufficient to stimulate investment in a number of biogas digesters
- A protocol for digester operation that would allow food waste digestate to be spread on agricultural land
- A restoration of capital grants for digesters
- Pilot projects for digesters using energy crops and grass

# Solid biofuels

- A ten-year schedule of increased renewable electricity prices sufficient to initiate a supply of biomass to the peat stations
- Continuation of Greener Homes, Reheat and Crop Establishment grant schemes

In the longer term, future generations of biofuel technologies will entail the conversion of the cellulose and hemi-cellulose in a wide range of biomass materials to liquid biofuels, and the use of hydrogen as vehicle fuel. The use of celluloses will be by breakdown to fermentable sugars that can be converted to ethanol, or by gasification followed by conversion to petrol or diesel equivalents by the Fischer-Tropsch process. Attempts to reduce the cost of these fuels will tend to increase scale and reduce feedstock prices, neither of which will favour their introduction in Ireland. While they may eventually replace first-generation technologies, they are unlikely to have a commercial presence in Ireland by 2015. In the meantime we need to focus on maximum commercialisation of current opportunities, and researching post-2015 possibilities for the newly-emerging technologies.

# Potatoes

The potato sector plays an important part in the output value for the agricultural sector. Currently the industry has over 550 commercial potato growers, of which about 100 produce over 70% of production (total industry production was over 400,000 tonnes potatoes in 2006). The value of the potato sector is estimated to be €162 million at farm gate (TNS, 2006) but could be close on €250 M at retail level.

Changing trends in consumer preferences have resulted in a reduction in overall consumption and a fall in acreage and in grower numbers. Specialisation by growers has been essential to justify capital investment. Potato packers and merchants purchase well over 80% of all potatoes produced and sell them onto retail multiples. Thus packers and merchants exert substantial influence over the industry. Retail multiple outlets are demanding greater quantities of higher grades of washed potatoes in response to consumer demands. A continued expansion of the pre-packed and processing market is expected over the next ten years.

Access to quality land to grow high specification potatoes continues to be a barrier to expansion in the most intensive producing potato counties. Small growers have seen their markets (unwashed potatoes in 10-20kg bags) shrink over the past number of years and this trend is expected to continue. Many of these growers will cease potato production due to the loss of markets and an inability to supply high specification potatoes through the year. However, some specialised smaller growers will continue to fulfil niche markets in many parts of the country. Larger growers will increase acreage and yields as efficiencies of scale dictate. Overall increased acreage is not expected in the next ten years as consumption will be flat at best and increases are not predicted in the export of potato seed.

# Vision for the arable and bio-energy sector in 2015

1. Increase the area devoted to tillage and energy crops by 50% by 2015.

   This will be largely driven by higher cereal prices, removal of setaside, demand for energy crops and national and EU policies as well as lifestyle choices.

2. By 2015 the number of full time tillage farmers will be about 1,000. These will be farming in excess of 200 ha. There will be about 12,000 other part time farmers with tillage and energy crops. Many of these will be in REPS.

The table 2 outlines the estimated areas to bring about the developments outlined.

**Table2:** Estimated Areas of Crops by 2015– '000 ha

| | 2004-6 | 2015 | % change |
|---|---|---|---|
| wheat | 95.1 | 140 | 47 |
| barley | 171.7 | 180 | 5 |
| oats | 19 | 20 | 5 |
| TOTAL w,b,o | 285.8 | 340 | 19 |
| maize | 18 | 40 | 122 |
| f.beet | 5 | 5 | 0 |
| osr | 3.7 | 25 | 576 |
| beans/peas | 3.6 | 5 | 39 |
| new crops-hemp | 0.1 | 5 | 4900 |
| perennial bio-energy | 0.1 | 70 | 69900 |
| potatoes | 12.4 | 10 | -19 |
| tot non cereals | 42.9 | 160 | 273 |
| tot crops | 328.7 | 500 | 52 |

**Note**: the major changes include:-

an increase of 45,000 ha of wheat to reduce imports of 0.5-0.8Mt and contribute to establishing ethanol/biorefining industry

increase maize by 22,000 ha to support intensive dairy enterprises

increase osr by 21,000ha to support biofuel expansion and high value food ingredients

plant 70,000 ha of perennial bioenergy crops(miscanthus, willows) and establish supply chains to meet energy and climate change commitments

## Teagasc research and advisory services to support the Vision

Teagasc must provide the research and technology to underpin the development of a competitive and sustainable crop production capability. Teagasc, farmers and all involved in the tillage crops and energy sector must embrace a new culture of innovation and must continually strive to improve their skills of knowledge reconnaissance and dissemination. Farmers must use the most appropriate business methods in addition to adopting new technology to achieve viability in the future. Farmers will need to meet ever more demanding/rigorous cross compliant regulations and safety/ traceability standards in the future.

## Concluding remarks regarding future progress

- We are facing a new era in agriculture where crop production for food, energy and bio-materials offers considerable opportunities but we must embrace a culture of innovation and knowledge utilisation to realise the potential.

- Teagasc is in the process of building a vision for the medium and long term for the agriculture and rural economies and the various farming sectors. We will be looking forward to new and dynamic arrangements with our stakeholders to make this vision a reality.

- The area devoted to tillage and energy crops could increase by 50% by 2015 given a commitment from the Irish government and the EU to make bio-energy a reality.

- The new BT Advisory Programme for commercial farmers will be placing a renewed focus on farming for profit. It will be using innovative as well as tried and tested advisory techniques incorporating both business and technology aspects of development.

# Appendix 1: BT Tillage Advisers & Specialists

| Name | Address | Tel. No. |
|---|---|---|
| Bourke, Martin | Teagasc, Unit 4b,The Anchorage,North Quay,Wicklow Town | 0404-69898 |
| Caslin, Barry | Renewable Energy Specialist Teagasc, Oak Park, Carlow | 059-9183413 |
| Collins, Ciaran | Teagasc, Farranlea Rd. Cork | 021-4545055 |
| Darcy, Cyril | Teagasc, Slane Road, Drogheda, Co. Louth | 041-9833006 |
| Dobson, Conor | Teagasc, Slane Road, Drogheda, Co. Louth | 041-983306 |
| Freaney, Meadhbh | Teagasc, Carrigeen, Clonmel, Co. Tipperary | 052-21300 |
| Hennessy, Michael | Crops Specialist Teagasc, Oak Park, Carlow | 059-9183427 |
| Hickey, Ciaran | Teagasc, The Green, Tullow, Co. Carlow | 059-9151210 |
| Higgins, Michael | Teagasc, Dublin Road, Enniscorthy, Co. Wexford | 053-9233332 |
| Lynch, Eamon | Teagasc, Knockgriffen, Midleton, Co. Cork | 021-4631898 |
| Marren, Matt | Teagasc, Carnmuggagh, Letterkenny, Co. Donegal | 074-9121053 |
| McCreevy, Hugh | Teagasc, Rathstewart, Athy, Co. Kildare | 059-8631719 |
| Molloy, Matt | Teagasc, Slane Road, Drogheda, Co. Louth | 041-9833006 |
| Murphy, Larry | Teagasc, Barretts Park, New Ross, Co. Wexford | 051-421404 |
| O'Donovan, Tim | Crops Specialist Teagasc, Kildalton College, Piltown, Co. Kilkenny | 051-644401 |
| O'Mahony, Jim | Teagasc, Programme Manager, Oak Park, Carlow | 059-9183482 |
| O'Shea, Richard | Teagasc, Kells Road, Kilkenny | 056-7721153 |
| O'Sullivan, Michael | Teagasc, Advisory Office, Athenry, Co. Galway | 091-845810 |
| Pettit, John | Teagasc, Advisory Centre, Johnstown Castle, Wexford | 053-71355 |
| Phelan, Shay | Teagasc, Kinsealy Res. Centre, Malahide Road, Dublin 17 | 01-8460644 |
| Plunkett, Mark | Soil/Plant Nutrition Specialist,Teagasc, Johnstown Castle, Wexford | 053-9171294 |
| Whitten, Ivan | Teagasc, Friary Road, Naas, Co. Kildare | 045-879203 |