NATIONAL TILLAGE CONFERENCE 2004

Published by

Crops Research Centre
Oak Park
Carlow

Wednesday, 28th January 2004

Contents

Short – Medium Term Market Prospects for Cereals

Andrée Defois
Editor in Chief
Strategie Grains
France

SUMMARY

After a very tight 2003/04 crop year in the EU and at the world level, perspectives are for a large increase in production in the EU and the FSU, weather permitting. However, the world grain balance sheet in 2004/05 is going to remain quite tight because of very low carry-in stocks, and perspectives of crop reductions (in the USA for wheat, for example, and in China). EU prices will certainly have to drop slightly from current spot levels but their decrease in euros could remain moderated by world demand and by any recovery in the dollar rate against the euro.

On the medium term basis, prospects are for an increase in world grain trade and this should sustain prices, despite the export potential which is developing in Eastern Europe and the FSU.

EMERGENCE OF THE FSU AS AN ERRATIC BUT GOOD EXPORTING POLE

Just to begin with and before thinking to the medium term prospects, it is highly instructive to go back to the last 3 crop years (2001/02, 2002/03 and the current one 2003/04).

In 2001/02, the volume of FSU crops was quite high, enabling large exports to the world market, of which nearly 4 Mt to the EU (compared to nothing in 2000/01). FSU crops were even greater in 2002/03, so exports increased again (7.1 Mt to the EU).

High levels of crops and exports from the FSU were not really a surprise (it had already happened in the past). However, the FSU wheat crop reached more than 90 Mt during these 2 consecutive years (against 60 Mt in 2000/01): the surprise was that the very good performance was repeated for 2 years.

The consequence of these very large supplies was very low prices ex-farm in the FSU because of a lack of storage space and deficient market organisation.

Table 1: FSU's grain balance sheet – Mt

	Area Harvested	Yield	Production	--Imports--	--Exports--	Domestic feed use	Domestic total use	Ending stocks
FSU-12 TOTAL								
WHEAT								
1997/98	48.2	1.7	80.6	6.7	6.3	24.5	72.1	17.2
1998/99	44.9	1.2	56.0	5.3	8.8	16.2	63.9	5.8
1999/00	41.8	1.5	64.7	9.5	9.3	17.0	64.9	5.8
2000/01	43.0	1.5	62.9	5.0	4.7	16.2	63.6	5.4
2001/02	45.7	2.0	91.3	3.6	13.8	20.5	69.3	17.1
2002/03	48.5	2.0	97.4	3.7	24.9	24.1	74.2	19.1
2003/04	40.0	1.5	61.9	7.3	10.2	17.3	66.0	12.1
COARSE GRAINS								
1997/98	38.5	1.8	68.5	0.4	3.0	37.2	56.9	12.3
1998/99	33.3	1.1	37.3	1.5	2.3	26.2	44.4	4.5
1999/00	31.8	1.3	40.5	2.8	2.0	26.9	42.2	3.6
2000/01	31.2	1.6	49.5	1.1	2.5	29.1	45.7	5.9
2001/02	32.7	1.9	62.3	1.0	6.6	33.7	51.4	11.3
2002/03	31.4	1.9	60.8	0.7	8.1	35.3	53.0	11.7
2003/04	33.1	1.7	56.6	1.4	6.1	40.1	58.4	5.1

Source: USDA

In 2003/04, the FSU story is completely different: the FSU wheat crop has reduced back down to 60 Mt and the exportable surplus has shrunk to 10 Mt against 25 Mt in 2002/03 (and of the 10 Mt, at least 3 Mt account for intra-FSU business).

Impact

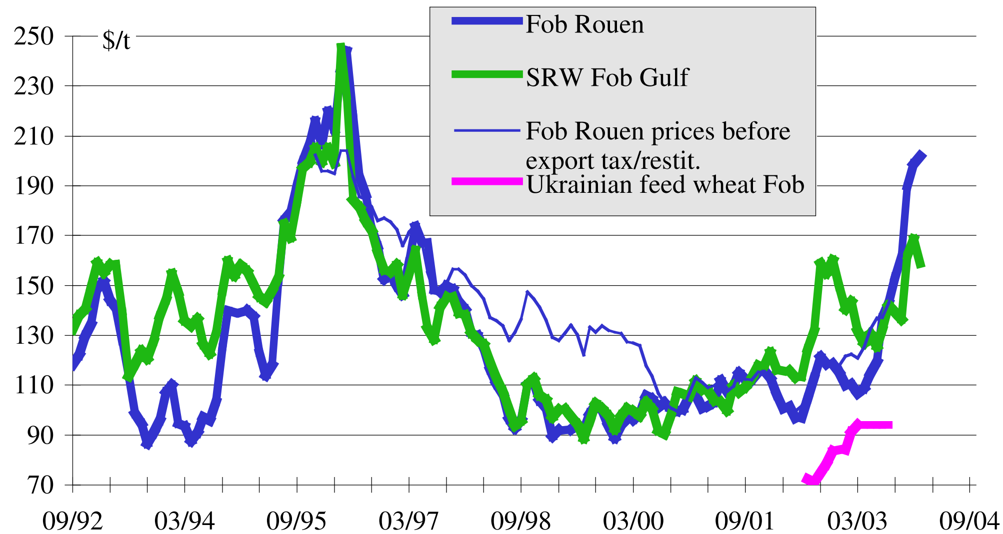
- The world market knows now that there is a great production potential in that region. Of course, this region's production potential is subject to weather conditions, which have a larger impact on crops than in the EU (harsher climate).

- The world market has learned about the quality of Ukrainian, Russian and Kazakh grains.

- Russian and Ukrainian market organisation has improved. For example, storage capacities have been built and internal transport infrastructures have been improved. To prevent new big price dips in case of renewed high crop levels, these countries have tried to set up intervention authorities.

DIFFICULT NOW TO SPEAK OF ONE WORLD WHEAT PRICE

Another consequence of the large FSU supplies is that it was impossible to speak of ONE world wheat price during the 2002/03 crop year. Usually, when there is a price gap for one commodity between different geographical locations, the job of the market is to narrow the gap through increases in demand or exports from the cheap areas and reductions in demand or increases in imports in deficit areas.



Source: Tallage

Fig. 1: World wheat prices

It did not work last year: FSU wheat remains really cheap all the crop year long (from 70 $/t Fob at the beginning to about 100 $/t at the end of the crop year). US SRW prices went up from 110 $/t Fob to 170 $/t before declining in the last part of the crop year. In the meantime, EU prices remained quite low at about 110 $/t Fob. EU prices were kept in check by wheat and barley imports from the FSU, while prices increased in the US because of very low crop levels in three of the biggest wheat exporting countries, i.e. the US, Australia and Canada. While imports from Russia or Ukraine should have been attractive in the US market and thus reduce the US internal prices, the US market protected itself from cheap FSU wheat through sanitary rules.

Following the very large imports from the FSU, the EU has changed its importing rules so that imports of barley and medium and low quality wheat are now limited by import quotas.

2003/04: THE TIGHTEST CEREAL CROP YEAR IN THE EU OVER THE LAST 15 YEARS

The current crop year is characterized by very low crop levels in the EU, the FSU and in Eastern European countries.

The story is thus completely different from last year: despite a sharp reduction in animal feed demand to the benefit of tapioca, feed peas and oilmeals, the EU still needs to import quite large amounts of cereals.

Table 2: Changes in raw material incorporation rates in compound feeds 2003/04

EU 15	2002/03		2003/04	
Consumption in industrial feeds				
	inc. %	Mt	*inc.* %	Mt
Cereals	**59.2%**	**68.2**	**55.6%**	**66.4**
of which wheat	*25.9%*	*29.8*	*21.1%*	*24.0*
maize	*18.0%*	*20.8*	*15.9%*	*19.0*
barley	*10.6%*	*12.2*	*11.8%*	*14.6*
rye	*1.2%*	*1.4*	*2.6%*	*3.0*
sorghum	*0.4%*	*0.5*	*1.4%*	*1.6*
Feed peas	**1.6%**	**1.9**	**2.5%**	**2.7**
Sunflower and rape seeds	**1.0%**	**1.2**	**1.1%**	**1.3**
Oilmeals and CGF	**32.3%**	**37.2**	**34.6%**	**39.9**
of which soymeal	*15.5%*	*17.9*	*17.4%*	*20.6*
Tapioca	**1.1%**	**1.2**	**2.4%**	**2.8**
Distillers	**0.6%**	**0.7**	**0.7%**	**0.8**
Citrus pulp	**1.1%**	**1.2**	**1.1%**	**1.2**
Other raw materials	**3.1%**	**3.7**	**2.1%**	**1.1**
Pig, cattle, poultry compound feed production	*100.0%*	*115.3*	*100.0%*	*116.2*
On-farm consumption				
Soymeal		12.2		11.6
Cereals		57.0		53.7
Total consumption				
Soymeal		**30.2**		**32.1**
Cereals		**125.2**		**120.1**

Source: Strategie Grains

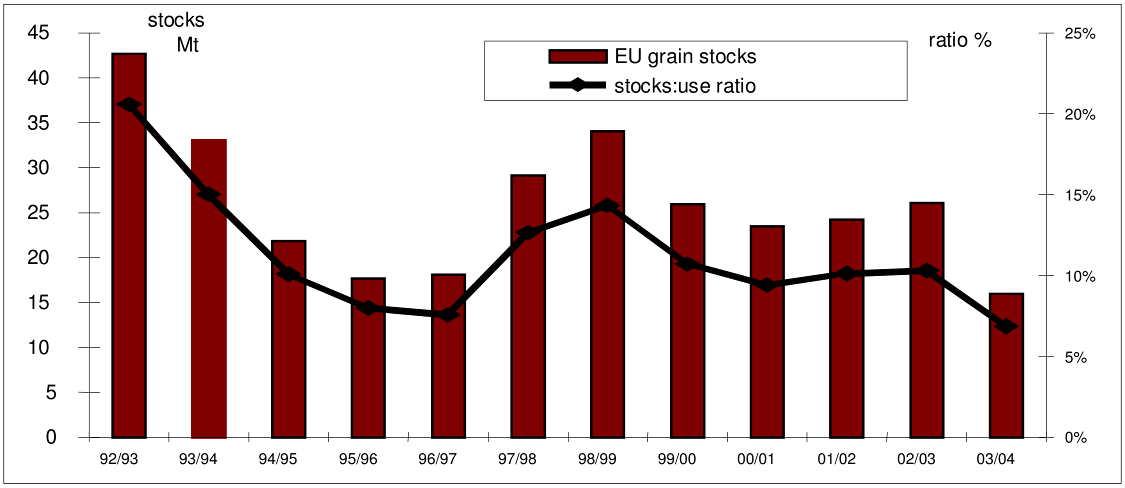
While the EU would need to import FSU grains if available, it can not because imports have been capped and because FSU supplies do not allow for it now.

Table 3: The EU grain deficit (000 t) in 2003/04

Mt		Carry-in stock	Production	Imports	Total supply	Animal demand	Other usages	Exports	Total demand	Carry-out stocks of which:	*Intervention*	*Free-market*	Free carry-out requirement (FCO)	Difference between FCO and free carry-out stocks
Wheat	2003/04	10386	82392	4289	97067	39605	44231	5376	89211	7856	*1164*	*6692*	7835	-1143
	2002/03	8707	93830	11161	113699	46991	44867	11454	103313	10386	*1182*	*9204*	7835	1369
Barley	2003/04	6609	46643	276	53528	34471	12105	3474	50050	3478	*118*	*3360*	4560	-1200
	2002/03	7546	47623	801	55970	32469	11986	4905	49361	6609	*936*	*5673*	4560	1113
Maize	2003/04	8581	31020	5739	45339	29805	9462	35	39302	6037	*1*	*6036*	6913	-877
	2002/03	7370	40076	2842	50288	32259	9297	151	41708	8581	*17*	*8563*	7301	1262
Rye	2003/04	5508	3198	50	8756	4231	1725	439	6395	2360	*3671*	*-1311*	600	-1911
	2002/03	5626	4708	324	10658	2629	1824	697	5150	5508	*5092*	*415*	600	-185
Triticale	2003/04	124	4658	0	4782	4400	247	0	4647	135	*0*	*135*	130	0
	2002/03	142	5329	0	5471	5100	247	0	5347	124	*0*	*124*	130	-6
Sorghum	2003/04	126	517	1100	1743	1658	27	0	1685	58	*0*	*58*	60	0
	2002/03	202	600	13	815	654	22	13	689	126	*14*	*112*	60	52
Oats	2003/04	1147	6796	0	7943	5190	1075	900	7165	778	*0*	*778*	750	0
	2002/03	805	7189	2	7996	4819	1075	955	6849	1147	*0*	*1147*	750	397
Durum	2003/04	634	8048	1600	10282	750	8126	700	9576	706	*0*	*706*	700	0
	2002/03	494	8949	591	10034	250	8126	1025	9401	634	*0*	*634*	700	-66
Total	2003/04	33115	183271	13053	229439	120110	76999	10924	208032	21407	*4954*	*16454*	21548	-5130
	2002/03	30893	208306	15733	254932	125172	77444	19200	221817	33115	*7242*	*25873*	21936	3937

Source: Strategie Grains

The EU has to import North and South American wheat instead and large quantities of Brazilian maize to compensate for its grain deficit.



Source: Tallage

Fig. 2: EU grain stocks at a very low level

This situation sent EU grain prices sky-rocketing during the first part of the crop year and the exploding level of freight costs did not do anything at all to help.

WHAT IS THE PERSPECTIVE FOR THE END OF THE CURRENT CROP YEAR?

The mechanisms for eliminating the grain deficit in the EU are now in place and therefore cereal prices should no longer be subject to a new additional bullish pressure. In the short term, wheat and maize prices could actually ease. Nevertheless, the situation is extremely precarious: the European internal market must continue to draw in maize and wheat from third countries and rye from intervention. This will keep any large potential decrease pressure in check. The precarious situation on the European market is heightened by the fact that the world wheat and maize balances are also exceptionally tight. Any increase in the price of imported wheat (i.e. through an increase in dollar prices or an appreciation of the dollar against the euro) would automatically reduce the volume of imports to the EU. In the case of maize, any increase in the world price would be partially compensated for by a reduction in the rate of import duty on entry to the EU (assuming the increase did not exceed the actual rate of duty). Any factor which delayed the arrival of third country maize into the EU – such as a reduction in Brazilian maize availability or a worsening of the current scarcity of transatlantic shipping – would immediately cause the EU maize balance to tighten again. The uncertainty surrounding weather conditions over the next six months is another contributor to the precarious atmosphere: the level of stock we forecast at the end of the crop year in the EU will be adequate only if the 2004 harvest registers a significant increase on the 2003 harvest.

Malting barley is the only grain which is not concerned by the tight situation. The EU malting barley production has increased by 1 Mt from the 2002/03 level, following yield improvement in the northern part of the EU and a switch from winter to spring areas because of the very harsh climate conditions during the winter. In the meantime, Canadian and Australian crops have recovered to normal levels after large reductions in 2002/03. Also, while still on a long term increasing trend, world malting barley demand has been quite sluggish recently because of high freight rates, a reduction in beer sales in Brazil and Japan and a downturn in South American economies. In the EU, malting barley usage has been reduced in Germany following the new rules about beer cans.

Malting barley prices have thus come down from last year's level in a first stage. Then they recovered slightly because the very low premiums on feed barley prices led to the usage of malting barley in animal feeds.

The surge in feed barley prices has thus pushed up malting barley prices. Any further increase potential seems limited now, however, because European barley is expensive compared to competitor origins on the world market. Also, despite the fact that EU malting barley export availability has been reduced to the benefit of animal feeds, it remains sufficient to meet export demand for malting barley addressed to the EU (currently estimated at between 1 to 1.3 Mt).

… AND FOR 2004/05?

Bullish factors

- The US winter wheat area for the 2004 harvest is estimated down by 3%. US yields were high in 2003 thanks to very good spring weather conditions: a return to the trend means a possible reduction for the 2004 wheat yield.

- Chinese grain stocks are currently being reduced by a large extent and next year's crop prospect is not fantastic.

Table 4: China's grain balance-sheet – Mt

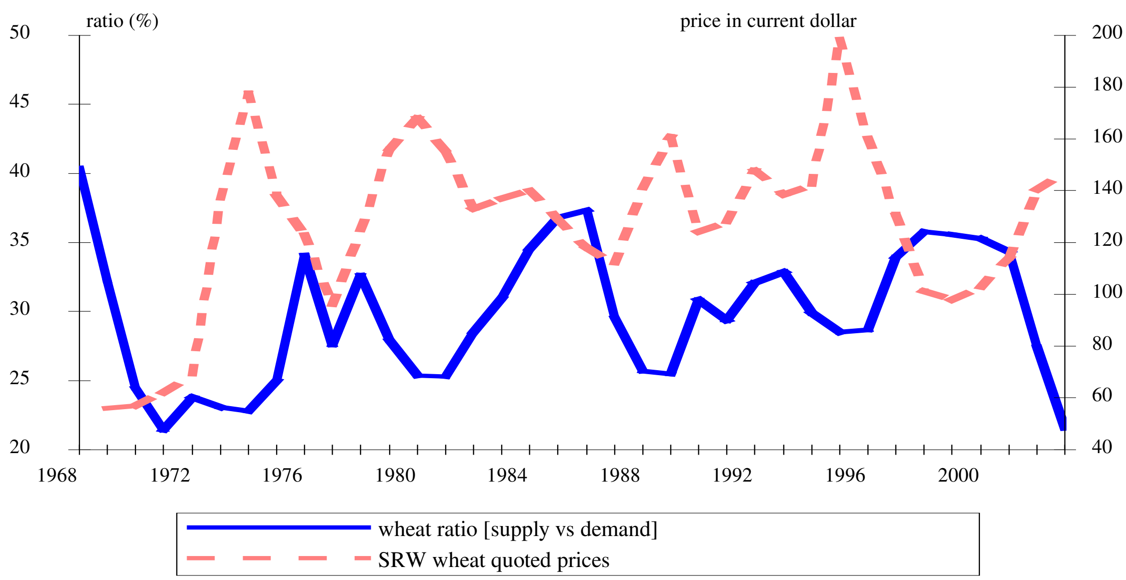
	Area harvested	Yield	Production	--Imports--	--Exports--	Domestic feed use	Domestic total use	Ending stocks
WHEAT								
1992/93	30.5	3.3	101.6	6.7	0.2	2.8	104.3	60.2
1993/94	30.2	3.5	106.4	4.3	0.6	2.7	105.3	65.0
1994/95	29.0	3.4	99.3	10.3	0.4	3.0	105.4	68.7
1995/96	28.9	3.5	102.2	12.5	0.5	3.2	106.5	76.5
1996/97	29.6	3.7	110.6	2.7	1.0	3.4	107.6	81.2
1997/98	30.1	4.1	123.3	1.9	1.2	4.9	109.1	96.2
1998/99	29.8	3.7	109.7	0.8	0.5	5.0	108.3	97.9
1999/00	28.9	3.9	113.9	1.0	0.5	6.5	109.3	102.9
2000/01	26.7	3.7	99.6	0.2	0.6	10.0	110.3	91.9
2001/02	24.7	3.8	93.9	1.1	1.5	9.0	108.7	76.6
2002/03	23.9	3.8	90.3	0.4	1.7	6.5	105.2	60.4
2003/04	22.3	3.9	87.0	2.0	1.7	6.0	104.5	43.2
COARSE GRAINS								
1992/93	26.3	4.2	109.3	0.6	13.0	64.4	102.6	85.4
1993/94	25.8	4.5	117.2	1.3	12.0	70.2	109.3	82.5
1994/95	26.1	4.4	114.3	6.4	1.6	79.6	118.0	83.6
1995/96	27.3	4.6	124.5	3.0	0.2	82.4	120.2	90.6
1996/97	29.1	4.9	141.3	2.1	4.0	86.6	126.3	103.8
1997/98	28.1	4.1	114.7	1.6	6.2	90.7	125.1	88.8
1998/99	29.1	4.9	143.5	2.6	3.4	91.9	128.9	102.6
1999/00	29.6	4.6	137.2	2.3	10.0	93.2	129.5	102.7
2000/01	26.5	4.3	114.0	2.4	7.3	93.4	130.1	81.7
2001/02	27.5	4.4	122.3	2.0	8.6	94.2	133.1	64.2
2002/03	27.7	4.7	129.2	1.8	15.3	95.0	136.3	43.6
2003/04	26.7	4.5	121.3	2.1	8.0	96.0	138.6	20.3

Source: USDA

- The world wheat and coarse grain carry-in stock will be at historical lows: it is currently estimated at 230 Mt, the lowest level over the last 30 years, both in terms of tonnage and in terms of ratio to annual consumption (15%).

- World feed use of grains has increased by 4 Mt only in 2003/04, against an annual average increase of 6 to 7 Mt over the last 5 years. There is now a need to recover.

- Possibility of a dollar appreciation against the euro.



Source: Tallage / USDA

Fig. 3: World wheat stocks (as a % of demand) and prices

Table 5: World wheat and coarse grain balance-sheet – Mt

	Area harvested	Yield	Production	World trade	Feed use	Total use	Ending stocks	Stocks as % of cons.
1975/76	564.7	1.76	993.7	139.2	457.1	984.3	179.5	18.2
1976/77	575.1	1.92	1106.4	142.9	489.4	1044.8	241.1	23.1
1977/78	570.7	1.87	1068.9	158.3	511.7	1076.8	233.2	21.7
1978/79	569.7	2.08	1183.1	161.8	556.8	1138.1	278.2	24.4
1979/80	569.0	2.03	1153.1	182.6	573.9	1157.6	273.7	23.6
1980/81	577.7	2.01	1159.5	200.6	562.6	1179.3	255.2	21.6
1981/82	588.0	2.05	1204.2	196.9	573.5	1178.4	281.0	23.8
1982/83	577.1	2.16	1248.3	189.6	593.4	1197.3	332.1	27.7
1983/84	563.9	2.06	1162.5	193.2	588.3	1216.2	278.5	22.9
1984/85	567.1	2.32	1315.3	203.6	609.9	1253.9	339.9	27.1
1985/86	571.1	2.33	1328.7	165.2	613.1	1248.0	420.5	33.7
1986/87	565.9	2.38	1348.8	174.7	644.2	1300.4	468.9	36.1
1987/88	545.1	2.35	1283.2	202.2	655.2	1329.8	420.1	31.6
1988/89	542.3	2.25	1218.0	203.3	618.2	1301.6	336.5	25.9
1989/90	548.4	2.42	1327.0	208.9	643.0	1345.9	317.5	23.6
1990/91	548.7	2.58	1417.1	190.1	666.8	1368.8	365.8	26.7
1991/92	545.3	2.48	1353.7	207.5	649.8	1363.3	356.2	26.1
1992/93	549.4	2.61	1433.4	206.3	662.0	1392.1	394.7	28.4
1993/94	540.4	2.51	1356.7	188.3	654.1	1390.8	360.6	25.9
1994/95	537.9	2.59	1392.8	200.1	669.8	1400.5	353.0	25.2
1995/96	532.8	2.51	1339.3	187.4	640.2	1385.3	307.0	22.2
1996/97	553.0	2.70	1490.9	198.3	673.2	1447.5	350.4	24.2
1997/98	539.4	2.77	1492.8	190.1	684.5	1450.2	393.1	27.1
1998/99	533.1	2.78	1481.1	198.7	678.6	1450.0	424.2	29.3
1999/00	515.2	2.84	1462.8	217.5	684.8	1468.3	418.7	28.5
2000/01	514.7	2.80	1441.4	208.1	690.8	1465.7	394.4	26.9
2001/02	515.3	2.86	1474.3	212.5	705.6	1491.3	377.4	25.3
2002/03	506.9	2.84	1438.7	212.5	704.7	1506.1	310.0	20.6
2003/04	510.1	2.81	1435.9	201.8	709.1	1518.1	227.7	15.0

Source: USDA

Bearish factors

- Weather permitting, grain production in the EU 25 is expected to recover by a large amount. On the basis of our preliminary assessment, the grain acreage could increase by more than 1 Mha in the EU 15 and by 1.9 Mha in the EU 25. On the basis of trend yields, grain production in the EU could recover by more than 30 Mt in the EU 15, and by 40 Mt in the EU 25.

- Grain production is set to recover also in the FSU because current weather conditions are better than a year ago.

Table 6: Recovery in EU area and production

Cereals		Area (kha)				% Change	Yield (t/ha)				% Change	Production (Mt)				% Change
		01/2	02/3	03/4	04/5	03/4	01/2	02/3	03/4	04/5	03/4	01/2	02/3	03/4	04/5	03/4
Soft wheat	EU 15	13.0	14.0	13.4	14.0	5%	6.4	6.7	6.2	7.0	13%	83.3	93.8	82.4	97.6	18%
	EU 25	18.8	19.4	18.4	19.5	6%	5.6	5.9	5.3	6.1	13%	105.9	114.5	98.5	118.0	20%
Barley	EU 15	10.7	10.5	10.5	10.7	2%	4.5	4.5	4.4	4.7	6%	48.0	47.6	46.6	50.4	8%
	EU 25	13.5	13.3	13.4	13.5	1%	4.2	4.2	4.1	4.3	7%	56.7	56.1	54.7	58.8	8%
Maize	EU 15	4.6	4.4	4.3	4.6	7%	8.8	9.0	7.2	9.1	27%	40.0	40.1	31.0	42.0	36%
	EU 25	6.3	6.3	6.1	6.4	5%	8.0	8.0	6.4	8.1	28%	50.5	49.9	38.9	52.4	35%
Durum	EU 15	3.5	3.8	3.6	3.8	3%	1.9	2.4	2.2	2.5	12%	6.9	8.9	8.0	9.3	16%
	EU 25	3.5	3.8	3.6	3.8	3%	1.9	2.4	2.2	2.5	12%	6.9	8.9	8.0	9.3	16%
Rye	EU 15	1.2	1.1	0.9	0.8	-3%	5.1	4.4	3.7	4.5	21%	6.3	4.7	3.2	3.8	18%
	EU 25	3.5	2.9	2.6	2.7	4%	3.4	3.2	2.7	3.0	13%	11.9	9.2	6.9	8.2	19%
Other cereals	EU 15	3.2	3.4	3.4	3.4	1%	4.0	4.1	3.7	4.0	6%	12.9	13.9	12.6	13.6	8%
	EU 25	7.5	6.9	6.9	7.0	2%	3.3	3.4	3.1	3.3	7%	25.1	23.8	21.4	23.2	9%
Total cereals	**EU 15**	**36.3**	**37.2**	**36.1**	**37.4**	**4%**	**5.4**	**5.6**	**5.1**	**5.8**	**14%**	**197.3**	**209.1**	**183.9**	**216.7**	**18%**
	EU 25	**53.2**	**52.6**	**51.1**	**52.9**	**4%**	**4.8**	**5.0**	**4.5**	**5.1**	**14%**	**257.0**	**262.4**	**228.4**	**269.8**	**18%**

Source: Strategie Grains as of January 2004

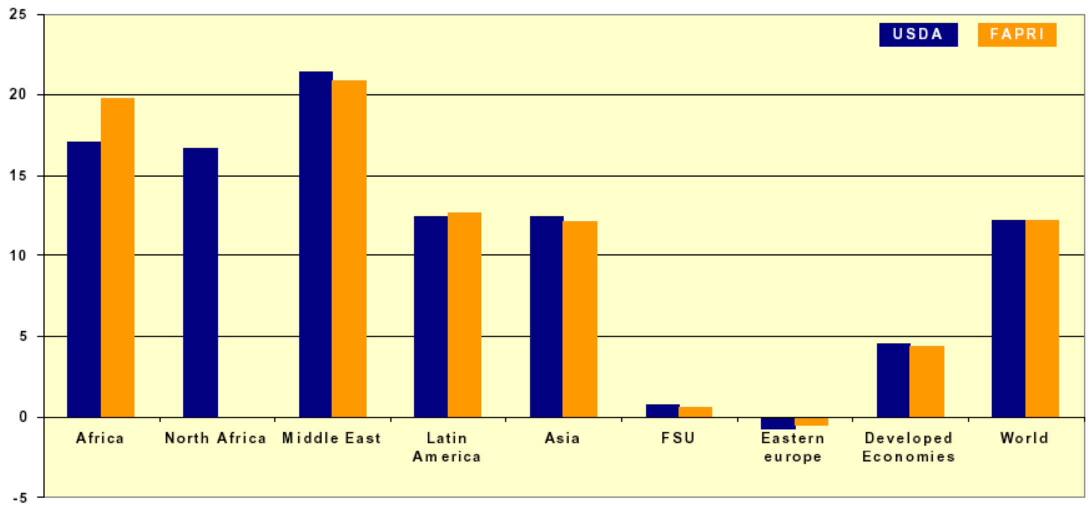
Without any big climate problems (like severe winter frosts or severe droughts), the EU grain deficit should disappear next year. Instead, the EU should again be able to export quite large amounts of grains. The EU 15 wheat exportable surplus could increase to slightly more than 10 Mt (against a 2003/04 export forecast of 5.5 Mt). While the EU exportable surplus is going to increase, it is not however predicted to be dramatically high (in other words, even with a recovery of FSU supplies, it should be easy to export 10 Mt of West European wheat onto the world market if the US crop is down). In conclusion, the EU wheat balance sheet will be heavier than in 2003/04 but it is not going to be a depressive balance sheet.

In a first stage, prices could drift lower in order for EU wheat to regain some competitiveness on the world market (currently EU wheat 2003 costs 40 $/t more than US wheat) and because cheaper imports could be available from the FSU. However, the EU may not need to offer large quantities of grain into intervention, so that wheat prices should not need to drop as low as the intervention level. Today, US wheat 2004 is priced at about 160 $/t Fob on December 2004. If the world situation really tightens again, world wheat prices for the 2004 harvest will still increase from this level and this will have a positive effect on EU prices, as will any recovery in the dollar rate against the euro.

As is the case for wheat, the EU barley balance sheet should not be too heavy either, because the forecast output increase is quite close to the reduction in carry-in stocks.

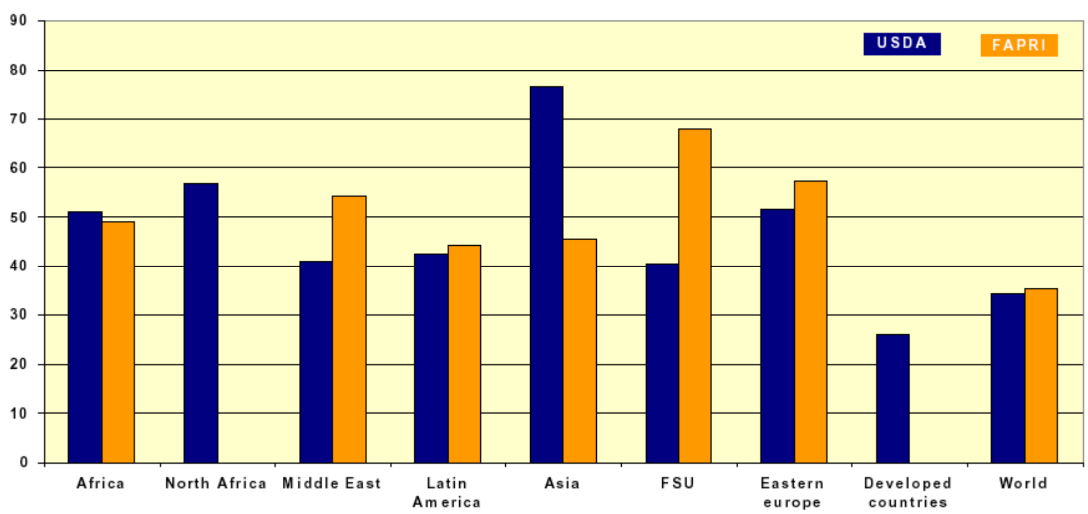
MEDIUM-TERM PROSPECTS: IMPROVEMENT IN WORLD GRAIN TRADE

According to the EU Commission's summary of the main medium-term outlook forecasts made by institutes like FAPRI and OECD, a slow but continuous recovery of agricultural markets may be expected. The medium-term prospects for agricultural markets would be mainly driven by an improved macro-economic environment with more broadly based, robust and sustainable growth. Combined with higher population, urbanisation and changes in dietary pattern, particularly in many emerging economies, these prospects for stronger economic growth would support a steady increase in food demand.



Source: USDA-FAPRI- EU Commission

Fig. 4: Cumulative population growth 2001-2011 (%)



Source: USDA-FAPRI- EU Commission

Fig. 5: Outlook for GDP growth in % per region (cumulative) 2001-2011

World trade in agricultural commodities would demonstrate strong growth, as demand for food products would outpace production in many developing countries. Despite a big production increase potential in some regions (like the FSU and Eastern Europe), the tightening of the stock-to-use ratio would in turn sustain commodity prices over the medium term.

Most of the growth would come from the non-OECD regions, which would constitute the main driving force behind these relatively favourable perspectives.

Table 7: Outlook for imports in cereals – 2001-2009 – Mt

	2001		2009		Change in trade	
	USDA	FAPRI	USDA	FAPRI	USDA	FAPRI
Wheat	106.7	85.1	128.1	108.9	21.4	23.8
Coarse grains	101.9	84.0	120.1	107.3	18.2	23.4
Maize	74.2	60.8	87.0	80.3	12.8	19.5
Barley	16.8	15.2	20.5	18.2	3.7	2.9
Total cereals	208.6	169.1	248.2	216.2	39.6	47.1

USDA figures include intra-FSU trade. FAPRI: net trade Source: FAPRI- USDA – EU Commission

Table 8: Outlook for wheat net imports for major importing countries – 2001-2009 – Mt

	2001		2009		Change in trade	
	USDA	FAPRI	USDA	FAPRI	USDA	FAPRI
Total Asia	15.8	22.2	25.9	36.1	10.1	13.9
China	1.0	0.5	8.0	5.1	7.0	4.6
Indonesia	4.2	-	5.2	-	1.0	-
Japan	5.8	5.2	5.8	5.3	0.0	0.1
Africa & M. East	42.9	41.2	44.7	46.9	1.8	5.7
North Africa*	13.8	14.6	13.8	17.6	0.0	3.0

* Morocco, Algeria, Tunisia, Egypt Source: FAPRI- USDA – EU Commission

Table 9: Outlook for coarse grains net imports for major importing countries – 2001-2009 – Mt

	2001		2009		Change in trade	
	USDA	FAPRI	USDA	FAPRI	USDA	FAPRI
Total Asia	34.6	36.2	41.2	52.0	6.6	15.8
China	2.8	0.5	8.9	11.4	6.1	10.9
Indonesia	1.5	1.4	2.1	1.7	0.6	0.3
Japan	19.6	19.2	19.0	19.3	-0.6	0.1
Mexico	10.8	11.0	12.5	12.5	1.7	1.5
Other Lat. America*	10.5	7.2	13.2	8.8	2.7	1.6
Africa & M. East	26.0	24.9	32.9	27.7	6.9	2.8
North Afr.**& M. East	24.5	20.2	30.9	22.6	6.4	2.4

* excluding Argentina
**only Algeria and Egypt in FAPRI Source: FAPRI- USDA - EU Commission

Notwithstanding the relative improvement in the market fundamentals of most agricultural sectors that is projected over the medium term, a prudent interpretation of these favourable perspectives is deemed necessary. These projections remain subject to many uncertainties that can be expected to moderate the positive pattern forecast for future trade and price growth. The most important include the future course of agricultural policy in many regions (notably the US Farm Security and Rural Investment Act), the new round of multilateral trade negotiations, the future macro-economic perspectives and the scope for further productivity growth in some regions. In the EU however, decoupling could limit slightly (but not stop) the increase in grain production and this could contribute to this overall tightening trend.

In the world cereal markets, higher demand would outpace domestic supply in many developing countries, including China, North Africa and Latin America, and trigger a sustained expansion in global cereal trade. Total cereal trade would increase by between 40 and 47 M t by 2009/10, i.e. at a much quicker pace than in the 1980s and 1990s.

Global trade in wheat would strengthen, with annual growth averaging about 2.3% - 3.1%, whereas coarse grain trade would exhibit a similar pattern with an annual average ranging between 2.0% and 3.1% over the 2001/02-2009/10 period.

After having bottomed out at the turn of the century, world prices are projected to display a slow and moderate recovery over the medium term as supply adjusts and global demand strengthens.

The crop years 2002/03 and 2003/04 have provided a good illustration for this price recovery. However, these 2 years have been characterized by severe output reductions in some of the main exporting countries. This may not be repeated every year. So, even if the coming price trend is on the upside compared to the average of the 90s, it does not mean that prices will remain as high as they are now.

The Impact of the Fischler Reforms on Irish Tillage Farms[1]

Fiona S. Thorne
Teagasc
Rural Economy Research Centre, 19 Sandymount Avenue, Dublin 4

SUMMARY

The key objective of this particular research was to evaluate the impact of the 'Mid Term Review' on Irish tillage farms. The analysis included farmers anticipated effects of the reforms, based on a survey conducted in Autumn 2003, and projected effects of the reforms, based on a profit maximisation economic model.

The majority of farmers anticipated that the new policy proposals would not have a significant effect on their farming operations. Most farmers believe that it will not effect their overall farm income, level of cereal production, area of land rented or the enterprise mix of the farm.

The average tillage farmer will receive the highest Single Farm Payment and highest entitlement value per hectare post decoupling, compared to other farming systems. Furthermore, the majority of 'mainly tillage' farmers will need to be offered somewhere between €1,500 and €2,500 per entitlement in 2006 before sale of these valuable assets would be considered. However, there will of course be individual farmers who will be willing to sell for a lot less than this value and others who will not consider selling at this price.

The 'standing still' farm profile does not seem to be a viable option for tillage farmers when the MTR is introduced. This research shows that if farmers retain the same farm profile that existed pre decoupling then these farms will experience a decline in profitability, as a direct result of the introduction of the MTR. In 2005 average profitability is estimated to be 5% lower decreasing to 7% lower in 2012 as a result of the introduction of the MTR, if and only if they remain 'standing still'.

When 'entitlement farming' (giving up production of cereals, oilseed and protein, and just farming the decoupled payments) is presented as an option for tillage farmers the net result is that farm profitability could be 6% higher than the baseline of no policy change by 2012. In 2005, 20% of tillage farmers, rising to 36% of tillage farmers in 2012, would be 'better off' if they became 'entitlement farmers' rather than continuing to produce cereal, oilseed and protein crops. However, even when some farmers opt for 'entitlement farming' there still

remains 67% of tillage farmers in 2012 who will be worse off as a result of the introduction of the new policy.

When summer grazing and REPS farming are included as possible options for tillage farmers, in addition to 'standing still' and 'entitlement farming', the results are a lot more positive. In this case, 70 per cent of tillage farmers could increase their profitability by 2012, relative to the baseline. It is therefore, the flexibility of switching between enterprises that presents as the major challenge when the MTR is introduced.

In summary, it appears that some of the anticipated effects of the policy reforms, as outlined by individual tillage farmers, are in line with the projected impact identified in this research. However, if the anticipated net effect on farm income is to be valid, many more farmers need to consider alternatives in order to maintain farm incomes.

INTRODUCTION

This paper presents the outlook for Irish tillage farms as a result of impending changes due to the Mid Term Review (MTR) of the Common Agricultural Policy (CAP), as agreed at the European Council in Luxembourg in June 2003. The impact of this policy, as outlined in the Luxembourg Agreement, in June 2003, have been examined, for specialist tillage farmers in Ireland (See Appendix I for further details of this Agreement). The **baseline scenario**[2] of no policy change (assumes the present policy of Agenda 2000 remains in place but also allows for known changes such as projected trends in cereal yields) versus the **MTR scenario**[3] is examined, whereby the net effect of the change in policy is determined.

To begin with, this paper outlines the methods used in this analysis to determine:

1) the *anticipated* impact of the MTR for Irish tillage farmers,

2) the *projected* impact of the MTR on Irish tillage farms, to include:
   - single farm payments (SFP) and entitlement values,
   - the likely number of 'entitlement farmers',
   - the projected impact on profitability.

The anticipated impact of the MTR is then outlined, as detailed by actual farmers. Subsequently, the results of the economic analysis are presented and compared to how farmers are thinking the reforms will affect them. These results include the likely income stream that tillage farmers can expect to receive as a decoupled payment. These payments will in turn influence the number of 'entitlement farmers' (farmers that allow their land to go fallow and use it only to activate their entitlement) there will be in the future. Estimates of the number of tillage farmers that would be 'better off' farming the entitlements rather than cereal, oilseed, and protein (COP) crops in the future are outlined. Further to these results, possible ways in which profitability can be improved upon are presented. The paper concludes with some main findings and conclusions.

METHODOLOGY

The *anticipated* effects of the impending policy reforms, are based on the results of a survey conducted at farm level in Autumn 2003. This survey was carried out among a representative sample of 1,030 farmers (71 of which were 'mainly tillage farms') involved in the Teagasc National Farm Survey (NFS), to determine farmers' opinions on issues relating to the proposed policy changes and how these could impact on their future livelihood in farming. The results for the 'mainly tillage farms' in the survey are detailed below[4].

The *projected* impact of the MTR at farm level presented in this paper is based on two separate datasets, the National Farm Survey (NFS) for the year 2002, and the output from the FAPRI-Ireland partnership aggregate sector models (see Appendix II for further details of this research), which were used to determine the farm levels effects of the MTR on Irish tillage farms. The sample of 'mainly tillage farms'[5] was selected from the NFS and the effect of changing prices, costs, and profitability on these farms was projected, starting in 2005 and ending in 2012.

The analysis of the effects of the policy reforms began by estimating the individual farms decoupled payment. In reality, these decoupled payments, will be based on the average number of premium claims, in the reference period of 2000, 2001 and 2002, but paid at 2002 values, (the higher values secured under Agenda 2000). However, due to data limitations, it was not possible to base the estimation of the entitlements in this analysis on the average of the three years, because this would have reduced the number of observations significantly, and compromise the representivity of the dataset. Instead only the farm data from 2002 was used. The relevant subsidies included in the estimates are as follows: special beef premium, special bull premium, suckler cow premium, slaughter premium, extensification premium, ewe premium, rural world premium, cereal, oilseed, protein and set aside payments and national envelope top ups.

Following the estimation of the decoupled payment, the net margin for two separate scenarios was calculated for each farm, for each year from 2005 to 2012, taking into the account the change in costs, prices, and yields, as projected in the FAPRI aggregate sector models (see Appendix III for further details). The scenarios considered were restricted to the land area on which cereals, oilseeds and proteins were previously grown[6] included:

- the static situation, whereby the same cereal, oilseed and protein crops were grown post decoupling as were evident in the farm profile pre 2005.

- the 'entitlement farming' option, whereby the land is only maintained and no crops or livestock are farmed. Variable and fixed maintenance costs were taken into account.
- Summer grazing, whereby steers are bought in March and April and sold from July to November[7].
- REPS (Rural Environment Protection Scheme farming) farming for smaller tillage farms that were considered suitable for this scheme[8].

Initially, a projection was made of the likely effect of the MTR scenario versus the baseline of no policy change, in which the *static enterprise* situation was the only enterprise considered (Scenario 1). In this scenario, inputs and outputs were re-priced to reflect projections for the baseline the MTR policy, but the resources and enterprise mix were held constant. No farmer response was projected and each farm in the sample continued with the same farm profile post decoupling. However, this is not considered a likely situation, and it is anticipated that farmers will react to the new policy situation. Therefore, the second scenario to be assessed was the option of '*entitlement farming'* and a profit maximisation trade-off was used to determine the number of farmers that would be 'better off' ceasing production and 'farming only the entitlement'. Additionally, the summer grazing option and REPS farming options were also considered and the profit maximisation trade-off was again used and the net effect on farm profit projected (Scenario 3).

The alternative scenarios examined in this analysis are just some of the ways in which tillage farmers may react after decoupling is introduced in 2005. A wide variety of different options are available and the options used here show that decoupled payments provide farmers with alternative options when payments are no longer linked to production.

RESULTS

The results of this research are divided into two sections:

- farmers' opinions on the impact on the MTR at farm level;
- the projected impact of the MTR at farm level.

Farmers' Opinion on the Impact of the MTR

The farmers that took part in the survey were questioned on their knowledge of and opinions about the impact of the MTR Agreement. They were also asked detailed questions about how they would adjust their individual farm enterprises. These results which detail the *anticipated* impact of the policy reforms at farm level may be compared with the *projected* impact which is based on the sample of NFS farms and the FAPRI-Ireland aggregate model results.

In the survey, all farmers were first asked how they believed the new policy would effect their own farm income in the long term (Fig. 1).

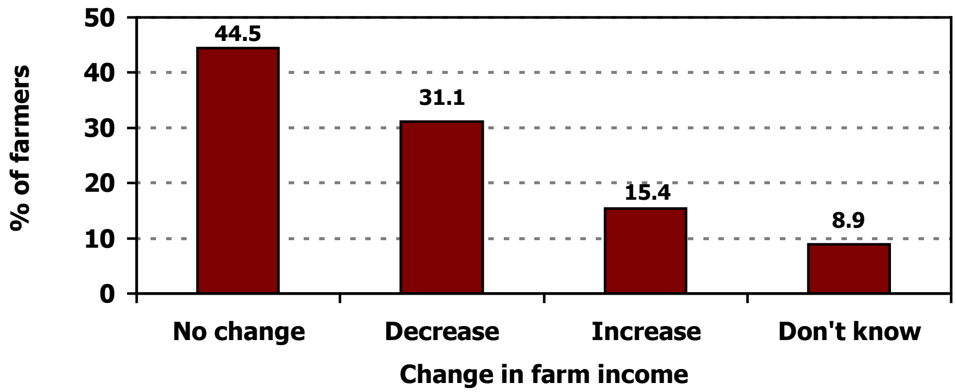


Fig. 1: Farmers' views on the effect of the MTR on farm income

Fig. 1 shows that the majority of tillage farmers believed that the new proposals would not change their farm income (44.5%), but 31.1% believed that the Luxembourg Agreement would result in a decrease in farm income in the long term. A further 15.4% of farmers believed that the new policy proposals would result in an increase in their own farm income over the long term and the remaining 8.9% of farmers did not know how the proposals would affect their farm income.

The specific questions relating to the implications of the proposals for cereal enterprises included the anticipated impact on the production of cereals, land rental and tillage enterprise mix. Farmers were asked whether under 'full decoupling' they would expand, contract of maintain their 2003 cereal acreage. The 'full decoupling' scenario was one in which existing levels of direct payment were received by the farmers, without the need to produce the crop. Farmers' views on this topic are shown in Fig. 2 below.

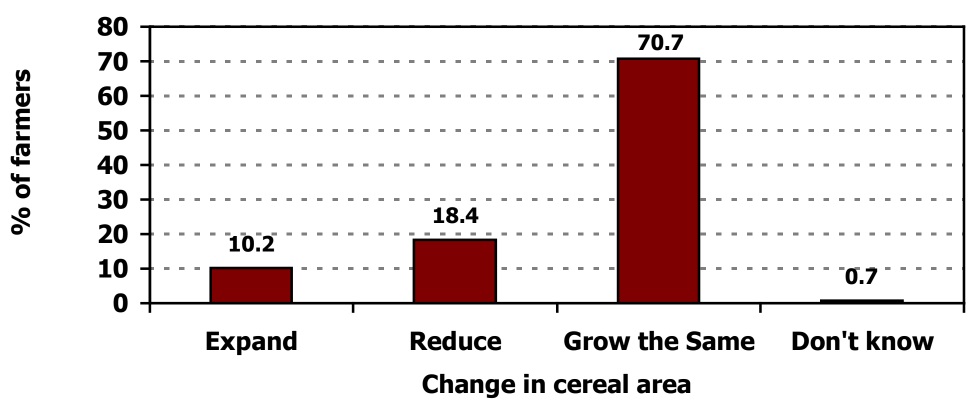


Fig. 2: Farmers' views of the effect of decoupling on individual cereal acreage

Fig. 2 shows that the majority of farmers believed that they would grow the same cereal acreage post decoupling (70.7%). In addition, only a small number of farmers (10.2%) said that they would expand cereal acreage, with a higher proportion of farmers (18.4%) saying that they would grow less cereals post decoupling. Less than 1% of farmers said that they did not know what effect the proposals would have on their cereal production.

Subsequently, the farmers that said they would expand cereal acreage post decoupling were asked about their plans for land rental. The majority of farmers (80%) said that their intention to expand cereal acreage would not result in any change in their area of land rented. This implies that the majority of tillage farmers that intend to grow more cereals in the future will do so at the expense of some other enterprise that currently operates on the farm. Only 18% of farmers intending to increase cereal production said they would rent more land in the future and the remaining 2% did not know whether or not they would rent more land to expand cereal acreage.

Tillage farmers were also asked whether or not they anticipated that the proposals would have any influence on the enterprise mix on their farm. The majority of farmers (58.9%) did not believe that the proposals would have any effect on their enterprise mix. A further 30.1% said that the proposals would influence their enterprise mix and 11% did not know.

In summary, it appears that the majority of Irish tillage farmers *anticipate* that the new policy proposals will not have a significant effect on their farming operations. Most farmers did not expect the new policy to affect their overall farm income, level of cereal production, area of land rented or the farm enterprise mix.

Projected Impact of the MTR on Irish Tillage Farms

The results presented in the section above showed farmers *anticipated* impact of the new proposals at farm level. Whereas, the results presented in this section are based on the *projected* impact of the MTR on Irish tillage farms, using data from the NFS and results from FAPRI-Ireland projections.

To begin with, estimates of entitlements under the MTR policy are presented. Following this, the impact of the policy at farm level versus the baseline of no policy change is analysed (scenario 1 – the static scenario). However, the freedom to farm (or not to farm) is not captured by scenario 1 where the farm mix stays identical to what it was before decoupling. Therefore, scenario 2 considers 'entitlement farming' as an option. The number of farmers that would have a higher farm profit if they discontinued cereal, oilseed and protein production, and maintained the land subject to '*basic standards for the environment, food safety, animal health and welfare and good agricultural and environmental conditions*' is projected (European Commission, 2003, p.3). In addition a further two farm options are examined – summer grazing and REPS farming (scenario 3). The change in farm profit between the baseline and the two MTR scenarios is examined.

The single farm payment (SFP) on Irish tillage farms

This section outlines the reliance of Irish tillage farms on direct payments before decoupling, what the likely SFP and entitlement values per hectare will be for these farms post decoupling, and what the net present value (NPV) of these entitlements are likely to be if they are offered for sale.

The degree of direct payment (DP) support under the current policy is shown in Table 1. This shows the proportion of family farm income (FFI) that is derived from DPs, including only those DPs that are used for the calculation of entitlements.

Table 1: Direct payment support for NFS farm systems[9]

Farm system	Mainly tillage	Dairy specialist	Dairy and other	Cattle rearing	Cattle and other	Sheep
FFI (€)	27,365	28,200	24,000	7,600	7,700	9,400
DPs (€)	17,047	3,200	8,700	5,700	7,300	6,300
% of FFI from DP	62	11	36	75	94	67

Source: NFS (2000), Breen and Hennessy (2003), and own estimates.

Table 1 shows that DPs comprise a higher proportion of FFI on tillage farms than on the two dairy systems[10], but the degree of dependence is higher on the two cattle systems and the sheep system. Although the degree of dependence on tillage farms is not as high as some other systems, the absolute value of DP support is much higher than in other farm systems. This is an indication that the decoupled entitlement payment from 2005 to 2012 will be higher on tillage farms than other farm systems.

The estimated SFPs for 'mainly tillage' farms, classified in the NFS is presented in Fig. 3. These values take account of the deductions as outlined in the Luxembourg Agreement: a 3% reduction to create the National Reserve, a 3% reduction in 2005 as a result of modulation and a further 1% in 2006 and 2007 (taking into account a €5,000 franchise
11

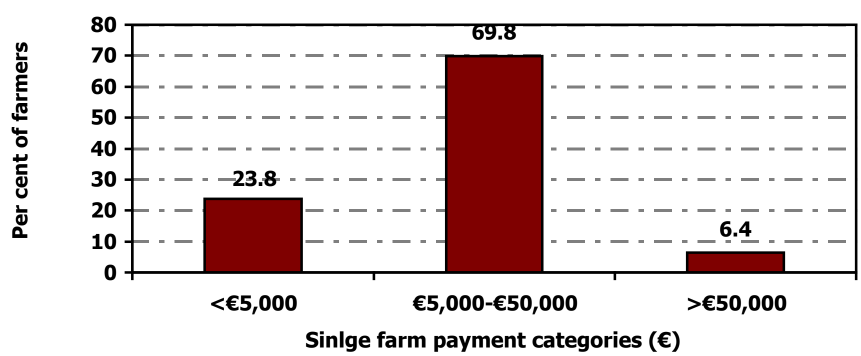


Fig. 3: Percentage of 'mainly tillage' farmers in different entitlement categories, 2007

Fig. 3 shows that the majority (68.9%) of 'mainly tillage' farms will have a SFP of between €5,000 and €50,000 in 2007, when the full effects of modulation are in place. Table 2 compares the average absolute SFP for 'mainly tillage' farms with the remaining five categories of farms classified in the NFS, in 2007.

Table 2: Single farm payment estimates for farm systems in 2007*

Farm systems	Dairy	Dairy and other	Cattle rearing	Cattle and other	Sheep	Mainly tillage
Single farm payment	€13,199	€18,972	€10,392	€14,146	€9,765	€21,526

Source: FAPRI- Ireland Farm Level Model (2003) and author's estimates

*After deductions are made as outlined in the Luxembourg Agreement and full dairy compensation is paid.

Table 2 shows that the average SFP is highest on 'mainly tillage' farms, with the lowest estimated SFP on sheep farms. The Luxembourg Agreement states that individual entitlements will be expressed per eligible hectare. Due to data limitations it was not possible to identify the number of eligible hectares per farm. Therefore, forage, cereal, oilseed, protein and set-aside area was assumed as a proxy for eligible hectares. Table 3 shows the average entitlement value per hectare for the different systems of farms. These values are presented for the year 2007, when the full effects of modulation are in place and deductions for the national reserve are taken into account.

Table 3: Estimated value of entitlements per hectare in 2007

Farm systems	Dairy	Dairy and other	Cattle rearing	Cattle other	Sheep	Mainly tillage
Entitlement value per hectare	€296	€290	€333	€349	€231	€363

Source: FAPRI- Ireland Farm Level Model (2003) and author's estimates

Table 3 shows that 'mainly tillage' farms not only have the highest estimated SFP post decoupling but also the highest entitlement value per hectare when the full effects of modulation are evident. The two cattle systems have the next highest entitlement values per hectare, followed by the two dairy systems and finally sheep farms. The maximum, minimum and standard deviation statistics show that there is substantial variation in entitlement values within systems. For instance, the average entitlement value per hectare, on mainly tillage farms, in 2007 is estimated at €363 but the minimum estimated value is €59 per hectare and the maximum value is €645 per hectare[12]

The SFP and the entitlement values outlined above for 'mainly tillage' farms can be misleading in that compliance costs also need to be taken into account. The Net Present Value (NPV) of the entitlements in 2006 takes into account the income stream from the decoupled payments, post all deductions, in addition to the compliance costs associated with the payments. This value represents the least amount of money that an individual farmer would expect to receive for his entitlements before he or she would consider selling the entitlements. This value *'converts the money flows that occur over a period of future years into a single current value so that alternative*(s)….. *can be compared on the basis of a single value'* (Boehlje and Eidman, 1984). Fig. 4 below shows the proportion of farms in different NPV categories in 2006[13].

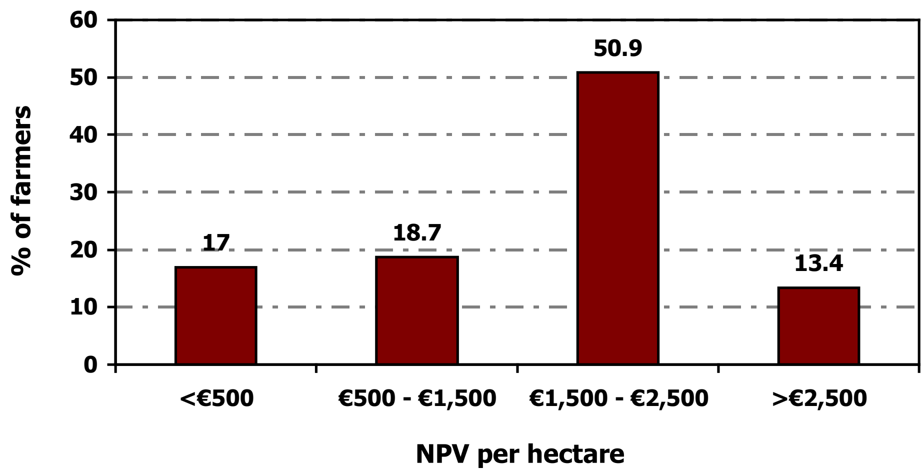


Fig. 4: The NPV of entitlements in 2006

Fig. 4 shows that the majority of tillage farmers would have to be offered between €1,500 and €2,500 per entitlement (per hectare) before they would consider selling the entitlement. Otherwise, it would make more economic sense to maintain the entitlement themselves. The average NPV of entitlements in 2006 (i.e. the value below which a farmer would not consider selling his or her entitlements) is estimated at €1,645 per hectare. This is an important finding for any farmers that would be considering buying entitlements post decoupling, as it is an indication of what entitlements are likely to trade at. However, it should be noted that anyone buying entitlements need eligible land to activate the payments, which means that current entitlements can't be 'topped up'. Therefore, it is anticipated that the trade in entitlements is likely to be limited.

In summary, the average 'mainly tillage' farmer will receive the highest SFP and highest entitlement value per hectare post decoupling, compared to other Irish farm systems. Furthermore, in order for the average tillage farmer to consider selling these entitlements in 2006 he or she would have to be offered in excess of €1,645 before sale of these valuable assets would be considered.

The MTR versus the baseline of no policy change (Scenario 1)

This section reviews the impact of the new policy proposals on the profitability of tillage farms. Breen and Hennessy (2003) stated that the best method of examining policy effects like this '*is not comparing projections of incomes in 2012 to current incomes but instead, comparing projections of farm incomes in 2012 under the scenario against incomes that would have been earned in 2012 if the proposed policy was not adopted, in other words, farm incomes under the baseline'* (p.84).

Given price and cost projections provided by the FAPRI-Ireland aggregate model (see Appendix III for further details) it was possible to determine the net impact of the new policy versus the baseline of no policy change, on the sample of tillage farms selected form the NFS. As the main objective of this research was to determine the impact of the reforms on tillage farms, and specifically crops which are managed under the Common Agricultural Policy (CAP), it was necessary to isolate cereal, oilseed and protein crops (COP) from other farm enterprises on the individual tillage farms in the sample. Consequently, the impact on profitability shown in Fig. 5 below relates to COP enterprises only.

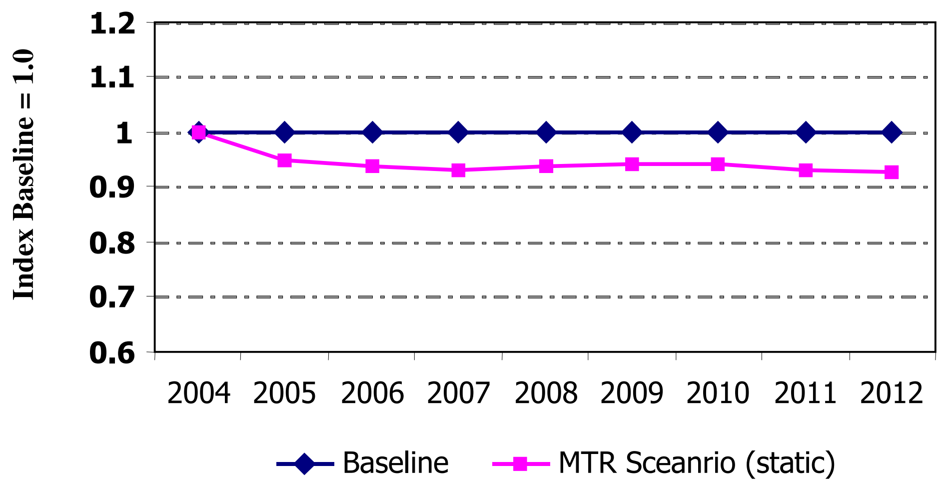


Fig. 5: Projections of average tillage farm profitability (baseline versus the MTR *static*[14] scenario)

Fig. 5 shows that if tillage farmers on 'mainly tillage' farms continue with the same enterprise mix after decoupling as before, then farm profitability will be lower. In 2005 average profitability is estimated to be 5% lower decreasing to 7% lower in 2012 as a result of the implementation of the Luxembourg Agreement. However, these results are only indicative of what may happen post 2005, if and only if, tillage farmers do not respond to the new policy reforms. If tillage farmers continue the same enterprise mix post decoupling, if farmers that were making a loss previously continue to do so even though the new policy does not require them to do so, and above all if tillage farmers do not respond to the challenge of the new policies, this 7% drop in profitability is what lies ahead for them.

It is interesting to compare these results from the economic model to what the farmers said in the survey. The majority of farmers, when asked in the survey, said that they believed that the new policy would not change their farm income. However, 30% of farmers did say that they would change their enterprise mix when the new policy was introduced, which is not captured by this scenario.

Furthermore, this scenario of 'standing still' does not capture the challenge for farmers and advisors to manage costs and improve productivity in the years ahead. For example, 46% of 'mainly tillage' farmers that grew spring barley in 2002 achieved a yield less than the average yield of 4.7 tonnes per hectare. This indicates that there is ample scope for improving profitability through improved productivity. In addition, the opportunity to alter the enterprise mix of cereal, oilseed and protein crops also exists, i.e. to consider the gross margins per hectare for individual COP crops and select the most profitable crops, which are suitable given the whole farm profile. Table 4 below shows the gross margin for a number of cereal crops, which provides 'food for thought'.

Table 4: Average gross margins for cereal crops in 2002

	Winter wheat	Winter barley	Winter oats	Spring wheat	Malting barley	Spring feed barley	Spring oats
Gross Margin per hectare	€650	€523	€628	€503	€487	€351	€547

Source: Thorne and Kelly, 2003

Table 4 shows that there are quite significant differences between the average gross margin for the individual cereal crops. These figures may provide 'food for thought' to individual farmers that may be considering staying in cereal production, but altering their product mix.

In summary, it appears that if 'mainly tillage' farms retain the same farm profile that existed pre decoupling these farms will experience a decline in profitability, as a direct result of the introduction of the MTR. However, there are still opportunities for these farmers that continue to grow cereals, to increase profitability through improved productivity, cost management or changing the individual cereal crops produced.

'Entitlement farming' under the MTR (Scenario 2)

Previously, it was shown that the profitability of growing tillage crops, managed under the CAP, on Irish tillage farms, will be reduced as a result of the introduction of the MTR. However, these results do not take into account the number of farmers that would be financially 'better off' discontinuing the production of COP crops. Previously, a number of farmers did not produce these crops at a profit but continued to grow the crops to receive the direct payments. Based on this research, it is estimated that in 2002, approximately half of the 'mainly tillage' farmers in Ireland, would have had a negative family farm income if direct payments were excluded from the calculation. However, in a decoupled policy situation these farmers can make the choice to discontinue growing these crops and become 'entitlement farmers', by maintaining the land in a manner that meets the environmental criteria laid down by the policy. Fig. 6 below shows the number of farmers that would be 'better off' financially (i.e. have a higher net margin) if they became 'entitlement farmers' rather than continuing to produce the same crops as they did previously.

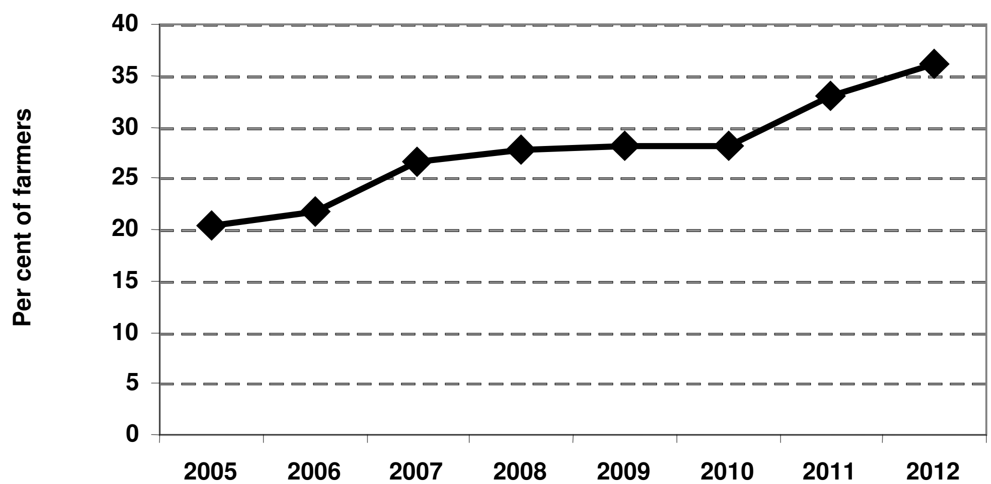


Fig. 6: Projections of 'Entitlement' tillage farmers

Fig. 6 shows that 20% (in 2005) rising to 36% (in 2012) of tillage farmers would be 'better off' if they became 'entitlement farmers' rather than continuing to produce COP crops. The main reason why the number of entitlement farmers increases over the period is because of the increasing costs over the period. Breen and Hennessy (2003) estimated that ' *by 2012, overhead costs are almost 25 per cent higher than in 2002'. Overhead costs increase more than direct costs because a larger proportion of overhead costs are non-agricultural based and are increasing more rapidly over the projection period*' (p.86). As overhead costs increase the proportion of farmers that would be better off in 'entitlement farming' increases.

The magnitude of these figures correspond positively with the results presented above for the anticipated effects of the policy reforms, as reported by tillage farmers in the NFS survey, where 18.4% of the farmers said that they would grow less cereals under the new policy and 30% said that the policy proposals would likely cause a change in their enterprise mix.

The resulting impact on profitability as a result of the introduction of the 'entitlement farmer' is shown in Fig. 7 below.

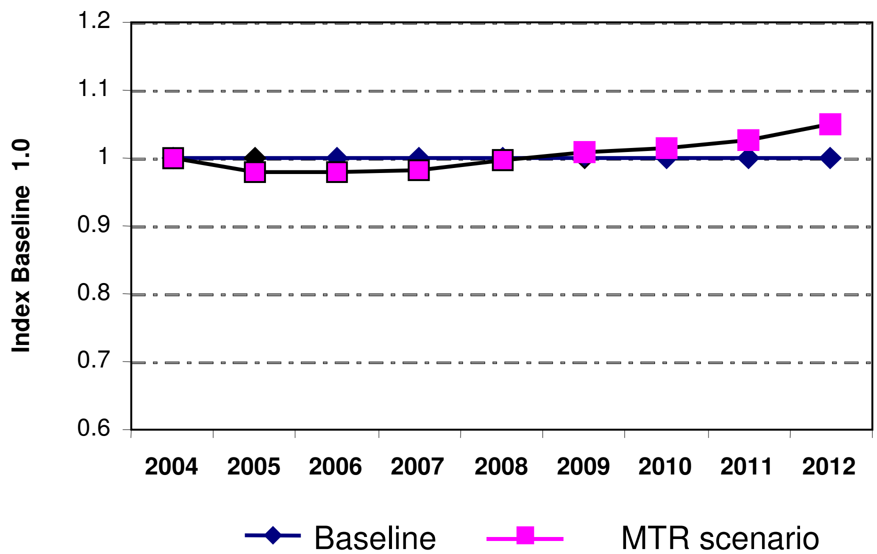


Fig. 7: Projections of average tillage farm profitability (baseline versus the MTR *dynamic*[15] scenario)

Fig. 7 shows that if individual tillage farmers base their farming operations post decoupling on sound economic reasoning, consequently, opting for 'entitlement farming' if it makes economic sense to do so, the estimated average farm profitability could be 6% higher then the baseline of no policy change by 2012. These results are similar to findings from research carried out by the University of Cambridge which examined the impact of CAP reform on British cereal producers. This research found that '*in the longer run, under the current price and cost structure of the cereal sector decoupling is predicted to raise farm incomes. The main reason for this is that farms no longer have to maintain unprofitable production in order to receive support*'' (Renwick, 2003).

Despite the appealing message presented in Fig. 6 above, it is important to remember that the increase in average profitability presented, is in fact just that, an average figure. Behind every average there are individual farmers that may '*feel like a fugitive from th' law of averages*' (Mauldin, 1945). To account for such differences Fig. 8 shows the number of farmers that will be 'better off' and 'worse off' due to the scenario.

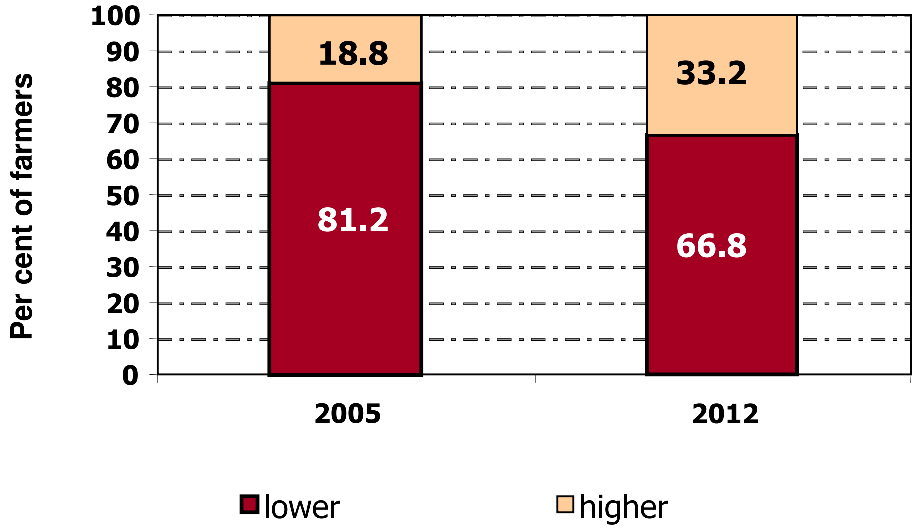


Fig. 8: Profitability effects due to the MTR (dynamic scenario), by percentage of farmers (2005 and 2012)

The results presented in Fig. 8 are not as reassuring as those presented previously. These results show that in 2005 and also in 2012, the majority of farmers will be worse off as a result of the introduction of the MTR, despite the fact that average farm profitability (as shown in Fig. 7 above) is projected to increase relative to the baseline by 2012. These findings indicate that the farmers who make the switch to 'entitlement farming' were making substantial losses previously, and as a result of the introduction of decoupled payments, the profitability of these farms increases quite substantially. This is shown by the result that over 30% of farmers that will make the switch to entitlement farming in 2012 will increase farm profitability by more than 100%, relative to the baseline of no policy change. Substantial changes in profitability like this, results in average farm profitability increasing by 6% relative to the baseline as shown in Fig. 6 above, despite the fact that percentage wise most farmers will be worse off.

In summary, it appears that between one fifth and one third of 'mainly tillage' farms over the lifetime of the policy, would be 'better off' if they discontinued COP production and became 'entitlement farmers', which would result in an increase in farm profit of 6% by 2012, compared to the baseline. However, 'entitlement farming' does not appear to be the best option for the remaining farmers. If these farmers continue with the same farm profile as they had pre decoupling, and are subject to modulation, they will inevitably experience a decrease in profitability compared to the baseline. Consequently, even after some farmers opting for 'entitlement farming' and increasing farm profitability, 67% of farmers will still be worse off as a result of the introduction of the policy proposals.

Alternative enterprise options under the MTR (Scenario 3)

The estimates of the impact on profit resulting from the Luxembourg Agreement presented so far are based on the assumption that farmers have only two options: (1) continue to grow the same COP crops as they did previously or (2) to enter into 'entitlement farming'. However, the introduction of decoupled payments introduces a wide variety of options to individual farmers when the SFP is not linked to production[16] To illustrate this point two individual alternative farm profiles were introduced to the analysis: REPS farming and summer grazing of steers. Fig. 9 shows the number of farmers that will be 'better off' and 'worse off' in 2005 and 2012, based on a profit maximisation trade-off between four scenario options: (1) status quo, (2) 'entitlement farming' (3) summer grazing, and (4) REPS farming. Not all farmers were included in this analysis.

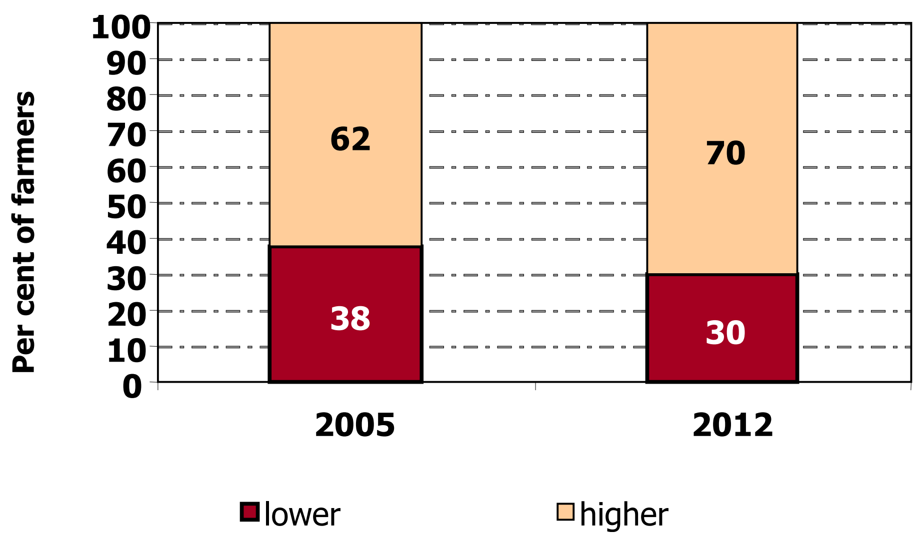


Fig. 9: Profitability effects due to the MTR (alternatives scenario), by percentage of farmers (2005 and 2012)

Fig. 9 shows that it is possible for the majority of 'mainly tillage' farmers to increase farm profitability after the adoption of the Luxembourg Agreement, if they adjust their enterprise mix. From this analysis, it is estimated that 62% (in 2005) increasing to 70% (in 2012) of farmers can increase profitability, relative to the baseline of no policy change, if they respond to the changing policy environment. These results are similar to those obtained for the income effects due to the MTR on cattle farms. Breen and Hennessy (2003) found that '*almost 35 per cent of cattle farmers will be 'worse off' in the scenario than the baseline, the remaining 65 percent will be better off'* (p.89).

It is important to remember that these results are based on the four options outlined above, i.e the status quo of pre-decoupling, 'entitlement farming', REPS farming and summer grazing. As the life time of the policy progresses the relative profitability of COP production relative to the other options deteriorates. However, this is based on the margin that exists at the moment between the purchase price of steers in the Spring and the sale price from July to November[17]. If a large number of farmers opt for this farming system it will inevitably effect the purchase and sale price of these animals, thus reducing the profitability of the system.

In summary, it appears that there are a number of options available to tillage farmers, that would increase farm profitability post decoupling. It is therefore the flexibility of switching between enterprises that presents as the major challenge when the MTR is introduced. Further details on the options available to tillage farmers post decoupling is available from local advisory offices.

CONCLUSIONS

- The majority of Irish tillage farmers *anticipate* that the policy proposals set out by the Luxembourg Agreement will not have a significant effect on their farming operations. Most believe that the proposals will not have a significant effect on farm income (45%), that they would grow the same cereal acreage post decoupling (71%), and that the proposals would not have any influence on the enterprise mix of the farm (59%). However, a further group of farmers believe that the proposals would have a significant depressing effect on income (31%), that individual cereal acreage would be reduced (18%) and that enterprise mix on the farm would change as a result of the proposals (30%).

- Before decoupling, the level of Direct Payments (DPs) as a percentage of Family Farm Income (FFI) was highest on cattle and sheep farms. Dairy farms had the lowest a percent of FFI. The average absolute value of DPs on tillage farms was estimated to be higher than other farming systems predecoupling. Furthermore, estimates based on the research discussed in this paper indicate that ‘mainly tillage’ farms will have the highest SFP and entitlement value per hectare in 2007, compared to other farming systems. The majority of ‘mainly tillage’ farmers will need to be offered somewhere between €1,500 and €2,500 per entitlement in 2006 before sale of these valuable assets would be considered. However, there will of course be individual farmers that will be willing to sell for a lot less than this value and others that will not consider selling at this price.

- The net impact on profitability as a result of the introduction of the Luxembourg Agreement for the average tillage farmer that continues with the same enterprise mix post decoupling is projected to be at 5% less in 2005 decreasing to 7% less in 2012, relative to the baseline of no policy change (scenario 1).

- Based on a profit maximization model, based on the net margin of COP production versus ‘entitlement farming’, 20% (in 2005) increasing to 36% (in 2012) would be ‘better off’ in entitlement farming, than continuing with their 2002 enterprise mix. The net impact on average profitability of this scenario versus the baseline of no policy change, is forecasted to be 6% higher in 2012. However, despite a projected increase in average farm profit there will still be more farmers 'worse off' in this scenario versus the baseline.

- The flexibility to switch between enterprises is a new opportunity for farmers brought about as a result of the Luxembourg Agreement. It is estimated that the majority of tillage farmers could increase farm profitability in a decoupled situation if the enterprise mix on the farm is changed. It is estimated that 70% of farmers could increase profitability if alternative farm profiles were considered. Further details on the options available to tillage farmers post decoupling is available from local advisory offices.

- Finally, only some of the anticipated effects of the policy reforms, as outlined by individual tillage farmers, are in line with the projected impact identified in this research. The number of farmers that said that they would grow less cereals (18.4%) and would consider a change in their enterprise mix (30%) are similar to the projected number of farmers that would be 'better off' opting for 'entitlement farming' (20% in 2005 rising to 36% in 2012). However, if the anticipated net effect on farm income is to be valid, many more farmers need to consider alternatives in order to maintain farm income. It is only when alternatives are included in the farm profile that the anticipated impact on farm income is similar to the projected impact.

REFERENCES

Boehlje, M.D. and Eidman, V.R. 1984. Farm Management, John Wiley and Sons, New York.

Breen, J. and Hennessy T. 2003. ' The impact of the MTR and the WTO reform on Irish farms', in Outlook 2003, Medium Term Analysis for the Agri-Food Sector, (conference proceedings), pp. 78-92, Teagasc, Dublin.

Connolly, L., Cushion, M., and Moran, B. 2003. 'Situation and Outlook – farmers Plans for 2004', in Situation and Outlook in Agriculture 2003/04, (conference proceedings), pp.1- 4, Teagasc, Dublin.

European Commission, 2003. CAP Reform, Council Regulation – establishing common rules for direct support schemes under the common agricultural policy and establishing certain support schemes for farmers, final text, 19th September, DS 303/1/03 REV 1.

Kelly, P., Maher, J., and Wallace, M. 1999. 'Farm level effects of Agenda 2000, paper presented at the National Tillage Conference 1999**,** pp. 62-75).

Mauldin, B. 1945. Cartoon caption in Up Front.

Renwick, A. 2003. '*The Impact of CAP Reform on British Cereal Producers'*, presentation to HGCA Market Outlook Conference 2003, London.

Teagasc (various contributors) 2003. 'The Luxembourg CAP Reform Agreement: Analysis of the Impact on EU and Irish Agriculture', Teagasc, Dublin.

Thorne, F. and Kelly, P. 2003. ' Situation and Outlook for Tillage 2003/04'**,** in Situation and Outlook in Agriculture 2003/04, (conference proceedings), pp.36- 42, Teagasc, Dublin.

APPENDIX I :– The Luxembourg Agreement and Irish Tillage Farmers

A Mid Term Review (MTR) of the Agenda 2000 CAP agreement began in 2002, with an outline of the proposals published in July 2002. In June 2003 an agreement was reached by the Council of Ministers in Luxembourg (The Luxembourg Agreement). This agreement outlined a policy which included fully or partially decoupled Single Farm Payments (SFP). The Irish government has already made the decision to opt for fully decoupled payments.

The main issues of concern included in the Luxembourg Agreement, that are relevant to tillage farmers are outlined below:

1. A "**Single farm payment**" (SFP) will be paid to farmers from 2005 to 2012.
This SFP will be based on the average number of animals, or hectares in the case of arable crops, on which payment was received in the three reference years (2000, 2001 and 2002), multiplied by the 2002 rates of payment. Eligible farmers for the SFP include:
Farmers granted direct payments in the reference period 2000-2002.
Farmers who received the holding or part of the holding, by way of actual or anticipated inheritance from a farmer as above.
Farmers receiving payment entitlements from the national reserve or by transfer.

Farmers must apply for the SFP in early 2005 by a date fixed by the Dept. of Agriculture but not later than 15 May 2005. Entitlements not attributed shall revert to the national reserve.

2. Calculation of "entitlements" will be based on the SFP divided by the average area returned on the area aid form in each of the three reference years. New farmers in the reference period can take an average based on the calendar year(s) during which they farmed. There are further provisions for hardship cases e.g. death, long term professional incapacity and severe natural disasters etc.

3. Use & transfer of entitlements
Any entitlement accompanied by an **eligible hectare** shall give right to the payment of the amount fixed by the entitlement.
An 'eligible hectare' is any agricultural area taken up by arable area or permanent pasture except areas under permanent crops, fruit, vegetables, ware potatoes, forest or used for non agricultural activities, which was submitted on area aid forms in the reference period.
Entitlements unused for 3 years shall be allocated to the National Reserve.
Entitlements may be transferred by: actual or anticipated inheritance, sold with or without land or leased with land.
Entitlements may be transferred only after at least 80% of the entitlements have been used in at least one calendar year.

4. Set aside

Setaside entitlements will be separate to other entitlements. They are calculated on obligatiory setaside (10%) used in the reference period and payment will be at €383.04/ha.

"Hectares eligible for setaside entitlements" include any agricultural area of holding taken up by arable land which is set aside from production except areas which on 31 May 2003 were under permanent crops, forest, permanent pasture or used for non agricultural activities.

Set aside entitlements shall be claimed **before** any other entitlements.

Set aside may be rotated.

Land set aside shall not produce any crop for commercial purposes except for products not primarily intended for human or animal consumption and organic farms.

5. Deductions from payments

(a) **Modulation**: all payments over €5,000 will be reduced by 3% in 2005, 4% in 2006 and 5% thereafter to 2012. The first €5,000 will be modulation free.

(b) **National Reserve**: Up to 3% of payments may be clawed back to constitiute the national reserve.

(c) **National Payments Ceiling**: Each member state shall not exceed its national reference amounts of payments but if it does these will have to be clawed back from farmers.

6. Additional Arable Payments

(a) A **protein crop premium of €55.57/ha** will be paid on peas, beans and lupins up to max of 1.4 million ha in EU.

(b) Aid for **energy crops (biofuels) of €45/ha** will be paid up to max of 1.5 million ha in EU.

APPENDIX II: – The FAPRI- Ireland partnership

The FAPRI-Ireland partnership was founded in 1997. The research partners are Teagasc, and five Irish universities, namely, NUI Cork, NUI Dublin, NUI Galway, NUI Maynooth and Trinity College Dublin. The partnership produces objective analysis of agricultural policy options, the most recent analyses included: 'The Luxembourg CAP Agreement: Analysis of the Impact on EU and Irish Agriculture' (2003).

The specific objective of the overall project is to build econometric models of the agri-food sector. These are then used in analysing and projecting the impacts of policy and other changes on: farm production, prices, incomes, product consumption and government expenditure, and on the market prospects for leading farm products and agricultural inputs.

The research incorporates macro level modelling and farm level modelling. The macro level modelling focuses on the development of sectoral models for Irish agriculture. Individual models have been developed for agricultural outputs such as beef, milk, sheep meat, pig meat, poultry and crops. Agricultural inputs models have also been developed. These are econometric models which means that historical data has been used to establish relationships between variables to allow future projections to be made.

The farm level modelling projects the effects of a change in agricultural policy at the farm level. This research focuses on the implications of sectoral projections, from the macro model, for individual farms. These models have not yet been developed on a consistent basis to project the effect of policy changes at farm level on tillage farms. *Ad hoc* analyses for tillage farms, including this research, have been carried out from time to time.

APPENDIX III: – FAPRI-Ireland sectoral model projections
(MTR scenario versus the baseline)

	2005	2005	2007	2008	2009	2010	2011	2012
	MTR scenario versus the baseline							
Cattle reference price	-6%	-1%	+2%	+5%	+7%	+8%	+9%	+10%
Male store cattle	-13%	-8%	-6%	-3%	-2%	-1%	≅	+1%
Feed wheat price	+0.13%	-0.05%	-0.03%	+0.27%	+0.45%	+0.35%	+0.16%	+0.13%
Feed barley price	+0.21%	-0.11%	-0.11%	+0.22%	+0.44%	+0.33%	+0.22%	+0.11%
Malting barley price	-0.17%	-0.09%	≅	+0.18%	+0.46%	+0.37%	+0.19%	+0.19%
Wheat yield	≅	≅	≅	≅	≅	≅	≅	≅
Barley yield	≅	+0.3%	+0.6%	+0.7%	+0.7%	+0.7%	+0.7%	+0.7%

Source: FAPRI-Ireland macro level model (2003)

Appendix III shows that there is relatively very little impact on the price and yield of cereal crops as a result of the introduction of the MTR, compared to other variables, such as the cattle reference price and male store cattle price.

End Notes

[1]The author would like to acknowledge Michael Cushion and Anne Kinsella for the provision of data and Thia Hennessy, Michael Hennessy, Paul Kelly and Jim O'Mahony for their comments on an earlier draft of this document. All remaining errors and omissions are the responsibility of the author.

[2]Baseline projections incorporate estimates of commodity prices, input costs and aggregate production levels assuming that policies that are agreed and in operation in 2004 remain in place for the future. The impact of the baseline policy is then examined at farm level to determine the impact on farm profitability.

[3]MTR scenario projections incorporate estimates of commodity prices, input costs and aggregate production levels assuming that the MTR comes into effect in January 2005 and remains in place until 2012. The subsequent impact on farm profitability is determined.

[4]An overview of the results of this survey as detailed by the full sample of respondents can be obtained from Connolly *et al.,* (2003).

[5]A sample of 110 farms were defined as 'mainly tillage' farms in the 2002 NFS. A weighting system which represents size and system was applied to these farms, which provides a population estimate of 6,330 individual farms.

[6]The effect of the policy reform on the land devoted to other tillage crops (such as potatoes, vegetables or sugar beet) and livestock farming was not examined in this analysis.

[7]The market based gross margin for this enterprise used in the analysis was based on estimates from the Management Data for Farm Planning (2002) handbook, and adjusted throughout the life of the policy using estimates from the FAPRI aggregate sector model. The fixed costs for this enterprise were based on the costs that existed on the individual farms pre decoupling and adjusted based on the assumption that fixed costs are lower on summer finishing cattle systems than on specialist tillage farms.

[8]A number of simplifying assumptions were made regarding suitability for REPS farming which included: size of operation, crop mix and land ownership. Kelly *et al.,* (1999) provided estimated yield losses and compliance costs associated with REPS farming.

[9]All data presented in Table 1 for farm systems refers to the year 2000. All farm systems except 'mainly tillage' are adopted from Breen and Hennessy (2003).

[10]Direct payments on dairy farms increase in the MTR, unlike other farm systems.

[11]The Luxembourg Agreement allows for a reduction of between 1% and 3% to create the National Reserve. It also allows for a further reduction if the sum of all the individual entitlements exceeds the National Ceiling. The estimation of entitlements was based on the assumptions that the maximum 3% reduction for the national reserve is introduced and no reduction for the national ceiling overshoot is enforced.

[12]It is important to bear in mind that these calculations are based on the assumption that all land devoted to forage, cereal, oilseed, protein and set-side pre-decoupling gave rise to payments and as such are defined as eligible hectares *for the purpose of estimating entitlement values per hectare*. If some of the land in the reference years mentioned above did not give rise to payments the resulting entitlements per hectare on a farm basis will be higher than those presented in Table 3.

[13]The Luxembourg Agreement states that at least 80% of entitlements must be activated before transfer. Therefore, the entitlements can only be sold in 2006 at the earliest. The estimated NPV values presented in Fig. 4 assume that the MTR ceases in 2012, but at the moment there is no reason to believe that there will not be an extension of the policy.

[14]The MTR static scenario refers to the situation where tillage farmers continue with the same enterprise mix as they had pre decoupling, when the MTR introduces the SFP.

[15]The MTR dynamic scenario refers to the situation where tillage farmers opt for entitlement farming if it makes good economic sense to do so. In other words, farmers opt for entitlement farming if they are making less profit from farming the enterprise mix which they had pre decoupling compared to a situation where they only farm the entitlements.

[16]Land under permanent crops, potatoes, fruit, vegetables or forestry is not considered eligible land for claiming entitlements.

[17]Projections (from 2005 to 2012) for the purchase and sale price of animals in a summer grazing system were made based on FAPRI-Ireland projections for these animals.

Tillage Farming Now and In The Future - a Farmer's Viewpoint

Martin O'Regan
Ballinrichard
Belgooly
Co. Cork

INTRODUCTION

2003 will be remembered as an exceptional year in Irish farming. We had an early spring sowing and a long dry harvest season for both cereals and sugar beet. What a difference a year makes! On the other hand, 2002 will be remembered as a very difficult year and the main difference was the weather. These past two years illustrate how dependent we tillage farmers are on the weather.

I am a tillage farmer from Belgooly, near Kinsale, south-west of Cork city. The land I farm is in six different locations, all within a reasonable distance of my home. My brother also farms nearby and we use the one set of machinery. I also share farm with a neighbour.

The soil type of the land is free draining, brownstone, varying from very light to medium. It is flexible land, suitable for tillage or grass farming. The crops grown are sugar beet, spring wheat and spring barley. We also produce some beef from purchased store cattle. We do all our own cereal tillage work but we hire a contractor to sow and harvest the sugar beet. Last year we grew 78 acres of spring wheat *(Raffles),* 140 acres of spring barley *(Tavern, Saloon and Fractal)* and 50 acres of sugar beet.

CEREAL DETAILS

Spring wheat is sown from the end of February to 1 April, depending on the season. Spring barley is sown from mid-March onward, depending on weather and soil conditions. I do not believe in January/February sowing because it is too far away from spring growth and leads to too much bird damage. 10-10-20 is the fertiliser that we use mainly, as our P levels are on the low side. We broadcast the fertiliser before preparing the seedbed with a *Rabe* power harrow; we do not use a one-pass system. Crops are sown with a 4-metre *Fiona* trailed drill. We work 20 metre tramlines. Nitrogen top dressing is applied to crops when they are actively growing. Wheat, which is grown after sugar beet with beet tops ploughed in, receives a total of 110/115 units of nitrogen. Barley receives 100/110 units N per acre - depending on location and field history.

WEED CONTROL

Last year we used three different herbicide products for cereals: *Biplay* and *Dupluson; Ally* and *Dupluson;* and *DP928* and *Dupluson*. All cereal crops are treated for aphids with *Sumi Alpha*. We do not dilute the main herbicides much, as the saving is not cost effective when the sugar beet crop comes in the rotation. For example, a saving of €1.5 or €2 per acre to stunt the weeds in a cereal crop may cost an extra €20 to control in sugar beet. *Fools parsley* (wild carrot) was rare in tillage crops ten years ago and it is now widespread.

Ideal spraying conditions are rare and I find it is always a compromise job, especially in the month of May. It is either wet, too cold or blowing a gale, with a possible threat to nearby emerging beet crops, but we make good progress using 20 metre tramlines. To maximise spraying opportunity we use low drift nozzles on all crops, including sugar beet. While we had very good sowing conditions last March, the weather in May/June was difficult, broken weather, with low temperatures.

FUNGICIDES USED

We use a two-spray fungicide programme on wheat and barley; the first at a reduced rate. Coming up to the first node last year the wheat got *Menara, Corbel* and *Cycocel.* We also used *Grasp* and *Output* for wild oat control. The second spray was a mix of *Amistar, Opus* and *Bravo* and was sprayed on 20 June at late flag leaf, when the first heads appeared. The fungicide spray programme on the barley varied. Some crops got *Menara,* others got a *Sanction* and *Corbel* mix. All crops got *Grasp* and *Output* for wild oat control and trace elements as per soil samples. The second fungicide spray varied; I used three mixes: *Allegro, Corbel* and *Bravo*; *Accanto, Lyric, Corbel* and *Bravo;* and *Swift, Sanction* and *Bravo.*

Some crops were treated with *Round-up* pre-harvest where necessary. All crops were harvested in August. In south Cork, spring wheat sown up to the 1 April can be harvested in the last days of August. Barley straw is baled for sale to farmers in west Cork and wheaten straw is sold for the mushroom compost market. There is an uncertain future in the wheaten straw market and there is less barley straw going to west Cork in recent years.

Last year my wheat yielded 3.5 tonnes per acre at 19 to 20% moisture. My barley yielded 2.95 tonnes at 16 to 17% moisture.

Strobilurin resistance has brought uncertainty into disease control programmes. We had hoped that one strob-type fungicide would be adequate for spring barley but now I am not so confident. We are all aware that chemical costs are exorbitantly high. In choosing their disease control programmes, growers must juggle keeping costs down while getting maximum disease control, and at the same time dependent on unpredictable weather. In many cases, extra product, which in hindsight may be unnecessary, is used for insurance purposes.

Any new developments which research can provide to bring more precision to this process would be welcome.

SUGAR BEET

We spread lime before ploughing in December/January. Last year for the first time we rolled one field after ploughing to break down too many large lumps before ploughing headlands. Fertiliser applied was nine x 500 kg bags of No. 1 beet compound per acre. Beet was sown in March with one run of the power harrow, one field on the flat, because it is a high light field, the other was sown on drills. The varieties sown – *Ocean, Oisin, Celt* and *Atlantis*. *Draza* was applied at sowing. In mid-April we sprayed *Dursban* in one field for leather jackets and we should have sprayed the other, as a high leather jacket population thinned out some parts of that field. All the herbicides are sprayed on the cereal crops before the sprayer gets a good washing with *All Clear Extra* before beet is sprayed. Beet was top dressed with 40 units of N on 9 May and it was sprayed for weeds on 10 May with *Debut, Betenal Expert*, *Venzar* and *Fortune Oil*. It was sprayed again on 25 May with *Debut, Goltix, Betenal Expert, Venzar* and *Actipron*. On 6 August *Score* was applied for leaf disease control. The beet was harvested in October/November. It averaged 21 tonnes of washed beet per acre, average tare 9.8%, average sugar 17.9%. It was our most trouble free beet harvest ever with our highest ever sugar content. I had one load at 19.1%.

Over the past few years, I spent a lot of time away from my farm representing sugar beet growers. As a result, when I was at home we had to get through our work quickly. We kept our farming system simple to minimise hassle. In the past I grew winter wheat and winter barley. I gave up winter wheat 10 years ago in favour of spring wheat. It is cheaper to grow with little difference in yields and margins. Winter barley I grew from 1980 to 2000. But when I increased my beet contract in the restructuring scheme we decided in favour of spring barley to keep July free from grain harvesting and crow duty. This now gives me more time to keep weed beet under control. We are determined to contain the spread of weed beet any further and we hand rogue the beet three times per growing season.

SOIL COMPACTION

I am very conscious of soil damage. Machinery is getting heavier and the land is all in long-term tillage. We have our fields as big as we can make them and we have cut the headlands to a minimum. Farmers involved in eco tillage are very conscious of soil damage by compaction in stubble fields because of effect on succeeding crops. Compaction in conventional tillage is an equally serious problem. Driving a combine harvester is a great educator. A driver can easily identify the parts of fields where straw bales or beet trailers were loaded in the previous season. We must respect the soil if we expect it to continue to give good yields.

SEED DRESSING

I believe the removal of bird repellent in the cereal seed dressing is another backward development. We are advised to cut our costs by reducing seeding rates and it very stressful to watch flocks of birds removing the expensive seed that we have just sown. This problem must be addressed.

The 2003 harvest crop yields were very good and cereal prices got a boost as a result of drought in south and central Europe. However, the year-end assessment showed that there was little spare cash.

In 2004, production costs will increase due to increased material and overhead costs. Good grain prices are needed again for our next harvest. Merchants have done very well in this past year following the unpredicted rise in grain prices since last harvest and should be in a position to pay good prices to growers.

DECOUPLED PAYMENT

It is hard to predict how this will work out. Will dairy/beef/lamb/pig and poultry production in Ireland and the EU continue at present levels or will they rise or fall? I believe that, as long as animal producers make a reasonable margin, production will continue. Producers and users are all interdependent. We must all make a margin to survive.

To qualify for the decoupled payment I understand that a farmer must continue to farm the same acreage as was farmed in the three reference years. Since 2000, 2001 and 2002 – the reference years – a lot of land has gone out of agricultural production due to road and housing development, etc. Maintaining acreages for some is going to be impossible; some are going to lose out and will not get their full entitlements. A common sense solution is needed.

SUGAR BEET REFORM

As a sugar beet grower, I am concerned about the EU sugar regime in the future. There is pressure from the WTO to reform but there is also pressure from within Europe. A number of options were put forward by the Commission:

- Maintaining the status quo
- Liberalising the market fully
- Reducing internal prices and abolishing quotas

The one getting most prominence is price cuts/import tariffs reduced – leading to reduced production. This proposal will prove very bad for Ireland, as it will lead to a substantial reduction or abandoning of quotas over time. We must look to where we are at present. The present sugar regulation, where each country is allocated a sugar production quota, has been in place for over 30 years and has coped with a number of EU enlargements already. It has served all the parties (growers, processors, consumers) very well.

The sugar beet crop is the hub crop of my tillage farming and this is replicated on most Irish tillage farms. Endangering Irish sugar production would radically alter the whole system of Irish tillage farming; I strongly believe most tillage farms would not survive without a beet quota. Brazil, Australia and Thailand are the main critics of the EU system and are constantly pressing, through the WTO, to get access to the EU market. It should be noted that there is no production control for countries outside of the EU. In 1991, Brazil exported less than 2 million tonnes of sugar; in 2002 they exported 13 million tonnes and continue to expand production.

The cane/beet sugar production ratio has altered dramatically in the past 20 years:

		Total world sugar production
1980	Cane 60%	
	Beet 40%	88 m tonnes
2002	Cane 75%	
	Beet 25%	150 m tonnes

The EU Commission's intervention in the sugar regulation must proceed with caution. Commitments were made to the LDC countries (least developed countries) to import into the EU, post 2009, unlimited quantities of sugar tariff free. Now here is a dilemma, if the EU substantially dilutes the present sugar regime which results in reduced prices, it will make LDC access to the EU sugar market a lot less attractive than it is presently. It will also substantially reduce or eliminate the current EU beet growers income. I believe it would make better sense to control imports to the EU using a quota system similar to the present ACP (African Caribbean Pacific) Agreement. The LDC countries are now realising that they would be better off with a fixed quota system. Preserving the present sugar regime with minimal changes is paramount and achievable. In the long term, it would benefit producers in the poorer LDC countries and also safeguard the future of EU sugar beet growers.

EU guiding principles were: food security, community preference and higher living standards for its citizens. Present European farmers, Irish farmers included, have a reasonable expectation of a decent standard of living. It is not acceptable that we continue to be sacrificed and used as pawns in international trade politics. I cannot help but feel that the EU

Commission are bending over backwards to facilitate countries outside the EU, regardless of the consequences for the farmers already within the EU.

There is a huge task ahead for our Minister for Agriculture Joe Walsh, the Department of Agriculture and our Irish Government to safeguard the future of Irish beet growers. These issues are certain to become serious bones of contention in the coming months. It is imperative that EU growers are supported and get first priority.

Meanwhile, the Irish sugar industry, growers and processors, ought to have a co-ordinated programme to be more competitive. Some beet growers achieved yields of up to 30 tonnes per acre in the past year. Achieving an increase in the average sugar beet yield from its present 20 tonnes per acre could be, and should be, the mission of the combined talents of Teagasc, Irish Sugar and our better growers. It can, and should be, addressed immediately.

I have never regretted becoming a farmer. I have enjoyed tillage farming. When I started farming there were no restrictions or quotas. There is a tremendous personal satisfaction at harvest time. There is nothing to beat starting with a bare field in the spring and harvesting a high yielding crop in the autumn, having sowed and nurtured it successfully through the different growth stages. I remember harvesting my first 3-ton wheat crop in 1975 and my first 4-ton crop in 1984. I have yet to attain 5-tons but others in my area have. I harvested my first 3-ton barley crop in 1978 and a 4 ton in 1989.

SHARE FARMING

I referred earlier to a farm share arrangement with a neighbour. An opportunity arose for my neighbour to develop another aspect of his career. He has a third-level qualification. Our agreement is very satisfactory for both of us. It enables me to spread my machinery costs over a larger acreage. My neighbour is still involved in the farming of his land.

I have investigated, and am still considering if I should join REPS but one part I do not personally like is leaving wider margins around fences. It goes against everything I was taught – plough as tight as possible to keep clean headlands.

To survive in tillage, experts tell us we need ever-increasing acreages. I maintain chasing a receding horizon is not the way forward. If it becomes necessary and possible, I may have to follow but I maintain this trend is not progress and not good for rural Ireland and, in the long-term, for Ireland Inc.

Changes will take place and neighbouring farmers may have to co-operate more, – share farming, etc. The Department of Agriculture must acknowledge, and aid, and not hinder such developments.

My generation picked up the baton from our parents and we, as custodians of the agricultural industry, have an obligation to hand over the baton to the next generation, ensuring that farming will continue to be a viable, satisfying and rewarding occupation.

Coping with New Challenges in Cereal Weed Control

Jim O'Mahony and Bryan Mitchell
Teagasc
Crops Research Centre, Oak Park

SUMMARY

Successful weed control is a key requirement of modern cereal production systems. However, achieving good weed control continues to pose difficulties. Effective and economic weed control will be achieved when an appropriate rate of a suitable herbicide is applied to a susceptible weed at the correct growth stage. This requires that weeds are properly identified and their likely impact on yield is assessed. Suitable herbicides must then be selected and a rate appropriate for the weed growth stage and prevailing environmental conditions is chosen. Each of these steps requires a considerable knowledge input. The cost of weed control is mainly dictated by the weeds present. It can vary from €7.5/ha to over €125/ha. Successful weed control will involve an integrated approach to rotations, cultivations and herbicide use in each field.

New challenges for weed control include the reduction of the competitive ability of crops as a result of using reduced seed rates. Earlier sowing of winter wheat is leading to increased problems. Problems are associated with the use of reduced tillage systems, particularly with grass weeds. New weed species are also becoming prevalent, including weed beet and sterile brome. The emergence of herbicide resistance may also pose increased difficulties for weed control in the future.

The trend in winter cereals is for early post-emergence herbicide application, tank-mixed with an aphicide at the 2-3 leaf stage of the crop. However, a two-spray programme is suggested for wheat sown in September/early October. Timing is critical for success. Spring cereals will generally be sprayed at the 3-5-leaf stage. Again, timing is crucial for successful weed control. Wild oats, brome, ryegrasses, canary grass and cleavers will need specific strategies.

Research at Teagasc Oak Park indicates that herbicide rates can be reduced by up to 50% where the weed spectrum is susceptible and the herbicides are applied under very good conditions to actively growing young weeds in crops with good dense crop structures.

INTRODUCTION

Poor weed control in cereals can lead to considerable yield losses, make harvesting difficult and is visually undesirable. In addition, poor control in one season can lead to problems with increased weed populations in subsequent crops. However, despite the availability of numerous herbicides, problems with weed control in cereals persist. There are a number of contributing factors. Changing husbandry practices, such as early sowing, eco-tillage and low seed rates as well as complacency following the introduction of very successful herbicides in the 1980s are resulting in more costly weed control in crop rotations. The switch to winter cereals and the increased area of monoculture winter wheat in particular is changing the weed spectrum in many fields. The constant use of the same herbicides is further selecting for weeds not well controlled by a particular herbicide, e.g. fumitory which is not well controlled by Ally or Cougar. The situation is being aggravated by more stringent EU registration requirements, resulting in loss of some useful herbicides and much fewer new active substances being commercialised due to the high costs involved.

With these problems in mind, it is timely to examine the problems being experienced with weed control in cereals and to outline strategies which will allow these problems to be avoided in the future.

In this paper I will:

- outline the fundamentals of weed control
- outline new challenges for weed control
- examine trends in herbicide availability and performance
- suggest cereal weed control strategies for the future

FUNDAMENTALS OF WEED CONTROL

Effective and economic weed control will be achieved when an appropriate rate of a suitable herbicide is applied to a susceptible weed at the correct growth stage. This requires that:

(a) weeds are properly identified and their likely impact on yield is assessed
(b) suitable herbicides are selected
(c) rate appropriate for the weed growth stage and prevailing environmental conditions is chosen

Weed Identification and Impact on Yield

Identifying the weeds present in a crop is the first key requirement to obtaining good weed control. This can be difficult, particularly when the weeds are at the cotyledon stage, but failure to correctly identify the weeds can lead to the application of an unsuitable herbicide which will lead to poor control. A knowledge of what weeds were present in particular fields in the past will give a good indication of what weeds are likely to appear in a field and weed mapping is useful in this regard.

Knowing which weeds are competitive and how they propagate is also important. Some weeds are much more competitive than others. The competitiveness of an individual weed species will vary according to crop type. Generally, weeds that share the same canopy characteristics and growth patterns as the crop are relatively more competitive in that crop type than weeds that have canopy characteristics which are different from that of the crop. For example, wild oats which has a similar canopy and rooting structure to cereals is highly competitive towards cereals. Knowing the competitive abilities of weeds helps to identify priority weeds for control. Table 1 gives the relative competitive abilities of a range of common weeds in winter wheat from a number of years of UK research. It can be seen that cleavers and wild oats are the most competitive weeds and the biggest yield robbers, and therefore control programmes must aim to achieve a high level of control of these. Other weeds such as groundsel and fumitory, are much less competitive and low levels of these in a particular crop are not likely to cause economic yield loss. In addition, crop species and even varieties of a particular species vary in their competitive ability towards weeds. For example, oats is more competitive than barley which in turn is more competitive than wheat towards weeds.

The timing of weed emergence affects weeds competitiveness and is also important from a control point of view. Weed plants that emerge at the same time as the crop are more competitive than those individuals from the same species emerging later. There is also variation on a seasonal scale between weed species with regard to their germination patterns. Some weeds germinate mainly in the spring, e.g. black bindweed, knotgrass and orache and are very unlikely to be a problem in winter cereals. On the other hand, many weeds germinate over a very protracted period, e.g. meadow grasses, chickweed, cleavers, fumitory, groundsel etc. This has obvious implications for herbicide timing and choice of residual versus contact types etc.

The time of the start of competition that will result in a crop yield loss varies according to the relative growth characteristics of the crop and weed. The late start of the period of rapid growth in cleavers is the reason why it can be controlled at a later growth stage (in wheat) without crop yield loss than for other broad-leaved weeds where rapid growth starts earlier. Grass weeds including meadow grasses and wild oats will need to be controlled early, as they can compete with the crop from an early stage, and in the case of meadow grasses existing products give poor control once the grass is past the 3-leaf stage. In general, most weeds do not compete strongly with the winter cereal crop until the spring (around gs 31), unless they are at very high populations. However, by that stage they may be too advanced to achieve acceptable weed control, particularly where winter wheat crops are sown early.

Table 1: Relative competitiveness of weeds in winter wheat

Weed (common name)	Competitive index (% yield loss/weed)	No. of weeds/m^2 to cause a 5% yield loss
Cleavers	3.0	1.7
Wild oats	1.0	5.0
Mayweed	0.4	12.5
Charlock/mustard	0.4	12.5
Thistle	0.3	16.7
Black bindweed	0.3	16.7
Field bindweed	0.3	16.7
Fat-hen	0.2	25.0
Chickweed	0.2	25.0
Annual meadow-grass	0.1	50.0
Knotgrass	0.1	50.0
Fumitory	0.08	62.5
Speedwell	0.08	62.5
Groundsel	0.06	83.3
Sow thistle	0.03	166.7

Source: IACR/HGCA UK

Herbicide Selection

Selecting the most appropriate herbicide is key to successful weed control. A number of factors must be considered. The crop to which it is applied and the weeds present are obviously key factors in herbicide selection. The chosen herbicide must kill the weeds present without damaging the crop. This will require information on weed species and growth stage as well as crop growth stage. Most herbicides have restrictions as to the crops to which they can be applied and for any crop there are normally a limited range of growth stages at which it can be applied. Site factors, such as soil type, pH and organic matter content, also need to be taken into account for some herbicides. Many herbicides are applied with other pesticides and therefore tank-mix restrictions must be taken into account when selecting the herbicide. Effects on succeeding crops will also be important as many herbicides can persist in the soil and affect establishment of the succeeding crop. Avoiding the build up of resistant weeds should also be considered.

Selecting an Appropriate Rate

Herbicides used at full rates will generally give the highest and most consistent levels for weed control in cereals. However, falling cereal margins are forcing growers to reduce costs while maintaining output and reducing herbicide input is one option to be considered. Farmers' experiences with reduced rates in appropriate circumstances have been generally positive. Extensive research (1993-'96) by B. Mitchell, Teagasc, Oak Park on the effectiveness of reduced rate herbicide in winter barley, winter wheat and spring barley confirms that rates can be reduced by up to 50% in certain circumstances without loss of yield or quality, although weed control can be slightly lower than with full rates. Reductions below 50% rate can give unacceptable levels of weed control. Herbicides used at 25 % of the recommended rates give moderate levels of weed control but tend to give lower grain yield.

Table 2: Effect of reduced herbicide on weed control in winter barley 1993-'96

Product	Control (%)	Yield (t/ha)
Cougar 1.5 l/ha	95	7.4
Cougar 0.75 l/ha	80	7.5
Cougar 0.375 l/ha	70	7.4
Untreated	-	5.6

Table 3: Effect of reduced herbicide on weed control and yield of late-sown winter wheat, 1993-'96 (Site, Co. Wexford)

Product	Control (%)	Yield (t/ha)
Ally 30 g/ha + Starane 0.5 l/ha	95	11.8
Ally 15 g/ha + Starane 0.5 l/ha	85	11.7
Ally 7.5 g/ha + Starane 0.5 l/ha	71	11.4
Untreated	-	9.5

However, when using reduced rates it is essential that the correct product is applied under good conditions when weeds are at their most susceptible. The levels of weed control obtained with reduced rates of herbicides varied with weed species and the growth stage of weeds at the time of spraying. Thus, selection of herbicides and rates of herbicides should be field specific. Because of higher crop competition reduced herbicide rates tends to give more consistent results in barley than in winter wheat.

Trials at Oak Park indicate that rates down to 50% of suitable herbicide applied pre-emergence or early post-emergence can give optimum results in a high proportion of crops where grass weeds are not a problem. If inadequate weed control is obtained in winter cereals with a reduced autumn herbicide, a follow-up spray of reduced rate herbicide in the spring is necessary.

TRENDS IN HERBICIDE AVAILABILITY AND PERFORMANCE

There will be over 35 different cereal herbicide formulations on the Irish market in 2004. Therefore, there will generally be a number of herbicide options for any particular weed problem and selection of the most appropriate option is vital to success.

The 35 different herbicide formulations tabulated according to their major use/activity are presented in Tables 4-7 as follows:

Table 4:	Herbicides for broad-leaved weeds in cereals
Table 5:	Herbicides for wild oats and grass weeds in cereals
Table 6:	Herbicides for grass and broad-leaved weeds - winter wheat and barley
Table 7:	Herbicides for undersown spring cereals

These tables provide an overview of the products available, the crops to which they can be applied, and the correct growth stages for application as well as comments as to the efficacy of each product in particular situations.

Table 4: Herbicides for broad-leaved weeds in cereals

Name	Chemical	Crops	Timing	Rate/ha	Comments
Ally (Jubilee) (ALS)	Metsulfuron Methyl 20% W/W	Wheat Oats Barley	gs 22/23 to 39	30 g Jubilee in water sol bag	Wide range of weeds controlled. Great on docks, c. marigold, chickweed, mayweed, charlock, nipplewort, sow thistles. Fair on fathen, orache, knotgrass. Resistant weeds include cleavers, fumitory and ivy leaved speedwell.
Ally Express (ALS)	Metsulfuron Methyl 10% W/W Carfentrazone ethyl 40%	Wheat Oats Barley	Feb 1 - gs 32	Max 50 g	Effective at temp >4^{0}C. Good on cleavers + ally weeds. Do not mix with fungicides, oil or PGRs other than CCC.
BiPlay PX (DP 911) Improved formulation (ALS)	Metsulfuron-methyl 13% Tribenuron-methyl 26%	Wheat Barley Oats	gs 13-39 From February 1	38.33 g 115g pack/3ha	= Ally @ 83% + Cameo @ 53%. Add CMPP or wetter for fumitory, fathen, orache. Add Ioxy-Bromxynil (not oats) for bindweed, knotgrass, ILV speedwell.
Cameo (Quantum) (ALS)	Tribenuron Methyl 75% W.W	Wheat Oats Barley	gs 23-39	25 g (4 x 7.5g tablets/ha)	Wide range of weeds controlled. Very good on fumitory*, thistles, fathen*, orache*, knotgrass. *Add non-ionic wetter e.g. Agral at 0.02% spray mix. Cleavers are resistant. Do not tank mix with any formulation containing Pelikan. Do not use wetter in tank mix with any other product on spring wheat.
Calibre (ALS)	Thifensulfuron Methyl 50% Tribenuron methyl 25%	Wheat Barley	gs 13-39	30-40g	Wide range weeds controlled. Very good on docks, vol. Potatoes, polygonums, buttercup, speedwells. Do not tank mix with Pelikan or any formulation containing chlorpyrifos (Dursban), propiconazole (Tilt).
DP 928 (ALS)	Thifensulfuron-methyl 42.9% Metsulfuron-methyl 8.6%	Wheat Barley	gs 13-39 From February 1	58.3 g 1 water sol bag	=Ally @ 83.5% + Harmony (Thifensulfuron) @ 60% + Target broadspectrum weed control including polygonums. Do not tank mix with Pelikan or any formulation containing chlorpyrifos (Dursban), propiconazole (Tilt).
Harmony M (ALS)	Thifensulfuron Methyl 68% Metsulfuron Methyl 7%	Wheat S.Barley	gs 13-39	60-75 g	Wide range of weeds controlled. Very good on docks, vol. Potatoes. Good on advanced weeds. Fumitory is resistant.
Hussar (ALS)	Iodosulfuron-methyl -sodium 5%	Wheat S. Barley Triticale	gs 13-32 After Feb 1	150-200 g	AMG, ryegrasses, BL W. mix restrictions
Eagle (ALS)	Amidosulfuron 75%	Wheat Oats Barley	gs 13-49	30-40 g	Very good on cleavers, charlock, osp, runch, Shepherd's purse.
Boxer (ALS)	Florasulam 50g/l	Wheat Barley Oats	gs 13-49 From February 1	50-150 ml	Target weeds include cleavers, chickweed, brassicas, mayweed. Rate depends on weed species and size.

Table 4 contd…..

Name	Chemical	Crops	Timing	Rate/ha	Comments
CMPP	CMPP CMPP-P	Wheat Oats Barley	Winter Cereals gs30-31/32 Spring Cereals gs11/12-31	2.8-4.2 L (O.A.I. 1.5-2.5 L)	Narrow window of application. Need soil temp 8ºC+ for best results.
Platform S	CMPP-P 60% Carfentrazone 1.5%	Wheat Oats Barley	gs12-33	1 kg	Good on cleavers + CMPP weeds. DO NOT MIX WITH OILS or adjuvants, Opus, Morpholines, Flusilazole, HBNs or PGRs other than CCC.
Affinity	Carfentrazone-ethyl 7.5g/kg; IPU 500g/kg	Wheat Barley	gs12-29	2.25 kg	Very good on cleavers, chickweed, speedwells, deadnettles, groundsel, A. meadowgrass. Works in cold conditions. Do not mix adjuvants.
Brontril Oxytril CM Stellox	Ioxynil 200g/l Bromoxynil 200g/l	Wheat Oats Barley	gs13-32	1-2 L	Useful mixer with SUs for difficult weeds Speedwells, corn marigold, f. pansy
Foundation	CMPP 600g/l Dicamba 84g/l	Wheat Oats Barley	gs15-31	0.75-1.25 L	Useful tank mix partner for SUAs. Improved control of polygonums, cleavers, mayweed, docks, fumitory, forget-me-not.
Starane 2,Binder Hurler Reaper	Fluroxypyr 200g/l	Wheat Oats Barley	Wheat & Barley: gs12-45 Oats: gs12-31	1.0 L	V.g. cleavers, chickweed and hempnettle control. Good control of vol. potato. Limited weed spectrum.
Treble	Fluroxypyr 90 g/l, ioxynil 100 g/l, bromoxynil 100 g/l	Wheat Barley	Gs 12-31	1.5-2.5 L	Equal to Advance

N.B. Appendix 1 contains the weed susceptibility to post-emergence herbicides

Table 5: Herbicides for wild oats and grass weeds in cereals

Herbicide	Safe crops	Crop growth stage	Wild oat growth stage	Rate/ha (Euro/ha, ex. vat)	Comments
Puma Extra (Fenoxaprop - P - Ethyl 69 g/l) (FOP)	Wheat	Emerg. to flag leaf, gs 39	Emerg to mid stem elongation g.s. 33	0.8-1.0 L Water 200 l/ha	Controls R.S. meadowgrass and bent. **Tank mixes**:-**Wheat**- Do not mix hormone herbicides or SUAs except Eagle. Leave 7 days interval between application of these and Puma. Include **oil** on wheat
	Barley All varieties except Opal	up to gs. 31		(50-63)	**Barley**- Only fungicides and aphicides allowed Not oil/adjuvants on barley
Cheetah Super (Fenoxaprop - P - Ethyl 55 g/l) **Croplink Fathom** (FOP)	Wheat	Emerg. to flag leaf	Emerg to flag leaf gs 39	1.0-1.5 l Water 200 l/ha (35-52)	Controls R.S. meadowgrass, bent and awned canary grass. **Tank mixes**:-**Wheat**- Do not mix hormone herbicides or SUAs except Eagle. Leave 7 days interval between application of these and Cheetah Super
Grasp (Tralkoxydim 250g/l) (DIM)	Barley Wheat	2 leaf to flag leaf gs. 12-39	2 leaf to 1st node	1.0-1.4 l (33-47)	Controls ryegrass and bent. Reduced rate for early use. **Must add output @ 0.375% spray vol** **Do not mix hormone or SUA herbicides.** Must leave 15 days interval between application of hormones or SUAs and Grasp or 5 days after Grasp application. Compatible with fungicides, insecticides and PGRs (except Meteor) and Starane.
Pelikan (Flamprop - M-isoprophyl 200g/l) (FOP)	Barley Wheat	Leaf sheath Erect to flag leaf Gs. 30-47	Before heading	3.0-3.5 l (62-73)	Controls onion couch and black bent. **See label for tank mixes**. Only Starane, CCC, Mn chelate and fungicides may be mixed.
Topik (Clodinafop-propargyl 80g/l Cloquintocet-Mexyl 20g/l (FOP)	Wheat	gs. 11-39	gs. 11-39	0.19-0.375 l (25-50) Add Actipron at reduced rate	Good control of RSMG and moderate control of Italian ryegrass, onion couch, black and loose silky bent at gs. 11-23. Tank mixes-ok except hormone herbicides.

Table 6: Herbicides for grass and broad-leaved weeds - winter wheat and barley

Name	Chemical	Crops	Rate/ha	Latest timing	Strengths	Weaknesses
Arelon Guideline Tolkan SIPTU	Isoproturon 500g/l	Wheat Barley	3.0-5.0 l	Depends on Weeds	Good on Wild Oats Flexible timing, useful in tank mixes	Limited Weed Spectrum
Cougar	Isoproturon 500g/l Diflufenican 100g/l	W. wheat W.barley	1.5-2.0 l	End February	Good on wide range of weeds	Weak on Fumitory, Poppy
Bacara*	Flurtamone 250g/l Diflufenican 100g/l	W. wheat W. barley W. oats	0.5-0.75 l	End of December gs 32	Can be used on oats for AM-Grass	Limited weed spectrum
Stomp	Pendimethalin 400g/L	W. wheat	2.5-5.0 l	gs 23	Useful in tank mixes for Fumitory and Meadow-grasses	Limited Weed spectrum
Trump	Pendimethalin 236 g/l Isoproturon 236 g/l	W. barley	4.0-5.5 l	gs 31	Good weed spectrum including Fumitory, Poppy, Meadow Grasses	Weak on Groundsel
Affinity	Carfentrazone-ethyl 7.5 g/kg IPU 500 g/kg	W. wheat W. barley	2.25 kg	gs 29	Good on Grass, Cleavers, Speedwells. Can use at low temp.	Not very ??? residue
Monitor	Sulfosuluron 80%	W. wheat	2.5 g	From Feb. 1 to gs 39	Good on brome, scutch, rsmg, cleavers, mayweed, charlock, shepherd's purse, fool parsley	Do not use in tank mix or in sequence with others Sus. Must add adjuvant.

Table 7: Herbicides for undersown spring cereals

Trade name	Active ingredient	Stage of growth			Rate/ha
		Cereals No. leaves	Clover No. trifoliate leaves	Grasses No. leaves	
Alistel	2,4 DB MCPA Linuron	W.B.O. – 5	1+	2	3.5 l
Acumen	Bentazone MCPB MCPA	W.B.O. – 2	White 1+ Red 1-3 only	2	5 - 6.5 l
Legumex DB	2,4 DB MCPA	W – 3 B.O. – 1	1+	2	7 l
MCPA Do not exceed 1.5L/ha	MCPA	W.B.O. – 4	White 3-4 Red 1	2	1.5 l
Nintex	2, 4 DB CMPP	W – 4 B.O. – 2	1	-	7 l

The EU has harmonised pesticide legislation across the member states with Council Directive 91/414/EEC. This directive requires that registered active substances have acceptable risk to human health and the environment, and that products have acceptable efficacy. The EU is in the final stage of reviewing all active substances that were notified so that they comply with the demanding standards set out in Directive 91/414/EEC. As a result of this process a number of herbicides have been withdrawn from the market in 2003 (Table 8).

Table 8: Cereal herbicides withdrawn in 2003

Product Name	Active substance	Main use
Avenge 2	Difenzoquat	Wild oat control
2,4DP	Dichloroprop	Broad-leaved weed control
Fortrol	Cyanazine	Grass and broad-leaved weed control
Legumex Extra	Benazolin	Broad-leaved weed control in undersown cereals

The registration for Commando (Flamprop-M) expired on 31 December 2003 and Pelikan (Flamprop-M) is due to expire on 31 March 2004.

The launch of new cereal herbicide active ingredients in Ireland is now a rarity. This means that in the future herbicide options may become more limited as old products are removed and no new products come to market to replace them. However, there are some new herbicides in the pipeline.

Hussar, containing the SU iodosulfuron-methyl-sodium 5% ww, has been launched on the Irish market by Bayer in the last year. Target weeds include annual meadow-grass, ryegrass and broad-leaved weeds, e.g. cleavers, chickweed, mayweed etc. Crops include winter and spring wheat, spring barley and winter triticale.

There will be a number of new generic wild oat herbicides available in 2004, e.g. Croplink Fathom containing fenoxaprop-P-ethyl. Croplink is awaiting PCS clearance for Avena which contains tralkoxydim the active ingredient in Grasp.

NEW CHALLENGES

There are a number of current issues that are rendering weed control more difficult. These include

(a) Trend towards earlier sowing and lower seed rates
(b) Adoption of reduced tillage systems
(c) Occurrence of new weeds
(d) Occurrence of herbicide resistance

Trend Towards Earlier Sowing and Lower Seed Rates

In recent years there has been a trend towards both earlier sowing and the use of lower seed rates than heretofore. Both these factors can have a significant effect on weed problems in a crop. In general higher seeding rates will allow the crop to achieve ground cover earlier and thereby increase the crop's competitiveness towards weeds. A key method of combating weeds in organic agriculture is to use high seed rates, which make it difficult for weeds to get established. The open nature of a crop of winter wheat sown at low seed rate is ideal for weed establishment and growth. This is likely to be a key factor contributing to the problems being experienced with annual meadow-grass in winter wheat crops in recent times.

Sowing date is also important. With winter wheat, early sowing means that weeds germinate and establish in relatively good growing conditions and can become established more quickly. However, as the cereal's main competitive advantage is for light, which does not come into play until stem extension in the spring, it is at a disadvantage to the weed in early-sown crops. The well-established weeds are then more difficult to control with herbicides.

Adoption of Reduced Tillage Systems

The increase in the acreage devoted to reduced tillage has also lead to increased problems with herbicide weed control. Some of these problems are undoubtedly linked to the use of earlier sowing and low seed rates as outlined above, with consequent effects on crop competitiveness. However, there are other associated problems. This technique relies on getting weed seeds to germinate before sowing and then killing them, as opposed to ploughing them to a depth from which they will have difficulty in germinating. The relatively short interval between cultivation after harvest and sowing, which is often associated with dry soil conditions, probably means that many weed seeds do not germinate until after the crop is sown, meaning that the crop will experience increased weed levels. While the germination period could be extended, this could lead to poor conditions at sowing and is probably not a realistic option. The increase in organic matter levels, which occur as a result of reduced tillage, will also have a deleterious effect on the effectiveness of the herbicides used for weed control in winter cereals.

Occurrence of New Weeds

A number of new weed problems are beginning to emerge. Increasing incidences of sterile brome on intensive winter cereal farms is frustrating the efforts of even top class growers to combat this weed. Canary grass (*Phalaris minor*) is causing problems in a limited number of fields in Wicklow, Kildare, Cork and North Tipperary.

Herbicide Resistance

Recently a new challenge for weed control has been receiving attention, that of herbicide resistance. Herbicide resistance is the inherited ability of a weed to survive a rate of herbicide that would normally kill it. However not all cases of apparent herbicide failure are attributable to resistance. Herbicides may fail to kill weeds because of inappropriate choice of herbicide, adverse weather conditions at application, weed size, inappropriate dose or faulty application. When such factors have been eliminated resistance can be suspected. In the UK, black grass resistance is extensive and there is growing concern with resistance in wild oats, ryegrass and certain broad-leaved weeds. Dupont have confirmed two incidences of resistance (chickweed and corn marigold) to sulfonylureas in Ireland in 2003. A nation-wide survey by Teagasc tillage advisers identified a further 9 suspected sulfonylurea resistant cases (chickweed and marigold) in counties Carlow, Donegal, Meath, Wexford and Wicklow. We intend to further investigate these and any other problems in the coming year.

Herbicides can be classified into groups according to their site of activity within the plant (Table 9). Most herbicides work by interfering with plant enzymes. Most, but not all, herbicides will bind themselves onto specific enzymes - and render them inactive, killing the weed. This makes them very susceptible to the development of resistance within weed populations to that herbicide, as any change in the structure of the enzyme may prevent the herbicide from acting. Other herbicides are more complex, with a range of mechanisms.

There are three modes of action that are most significant to Irish growers:

ALS inhibitors. ALS inhibitors are so called because they inhibit a single enzyme called acetolactate synthase. Key members of the group are the sulfonylureas (SUs), such as Ally, Cameo, Monitor, Hussar etc. Boxer and Dagger, while not SUs are ALS inhibitors. Herbicides with this mode of action predominate in modern crop production. Unfortunately the number of resistance problems continue to increase internationally.

ACCase inhibitors. - ACCase inhibitors target a single enzyme, also in this case acetyl CoA carboxylase. Herbicides with this mode of action include the fops (Topik, Cheetah, Falcon) and the dims (Grasp and Checkmate).

Photosystem II inhibitors. This group of herbicides act by disrupting the photosynthetic process in the plant. However, herbicides within this group do not all work at exactly the same point in the process. As a result this group is more complicated, because although the ureas and the triazines are both in this group resistance may develop to the ureas while the triazines may be unaffected. For this reason scientists have split this group into two-sub group, one containing the triazines and one containing the ureas.

A small number of plants in any weed population are likely to be naturally resistant to a given herbicide. If that herbicide is not applied these plants are not selected for and remain at very low levels within the population. Where repeated application of that herbicide occurs it will allow these plants to survive and set seed, while killing the plants that are not resistant. As a result the resistant plants will multiply until they dominate the population.

The two main resistance mechanisms are target site and enhanced metabolism. The mechanism present will influence the pattern of resistance, particularly to the cross-resistance profile and the dose response.

Table 9: Herbicides grouped according to biochemical mode of action

Group	Mode of action	Chemical family	Active ingredient	Product name
A	Inhibition of acetyl CoA carboxylase (ACCase inhibitors)	Aryloxphenoxy-propionates ('fops') Cyclohexanediones ('dims')	Clodinafop-propargyl diclofop-methyl fenoxaprop-P-ethyl fluazifop-P-butyl propaquizafop quizalopfop-P-ethyl cycloxydim serthoxydim tepraloxydim tralkoxydim	Topik In Tigress Ultra Cheetah Super Fusilade Falcon Sceptre Laser Checkmate Aramo Grasp
B	Inhibition of acetolactate synthase (ALS inhibitors)	Sulfonylureas Sulfonylamino Carbonyl-triazolinones Imidazolinones	Metsulfuron-methyl Tribenuron methyl Flupyrsulfuron-methyl Sulfosulfuron Propoxycarbazone-Na Imazamethabenz-methyl	Ally Cameo Lexus Monitor Attribut Dagger
C	Inhibition of photosynthesis at photosystem II	Triazines Triazines	Atrazine Cyanazine Simazine Terbutryn metribuzin	Various Fortrol Various Alpha Terbutryn Sencorex
C2	Inhibition of photosynthesis at photosystem II	Ureas	Chlorotoluron Isoproturon Methabenzthiazuron Metoxuron	Various Various Tribunil Dosaflo
D	Photosystem 1 – electron diversion	Bipyridyliums	Paraquat	Gramoxone
F1	Inhibition of pigment synthesis (bleaching)	Inhibitors of PDS	Flurtamone	In Bacara
F3	Inhibition of pigment synthesis (bleaching)	Unknown target	Amitrole	Weedazole
G	Inhibition of EPSP synthase	Glycines	Glyphosate	Roundup
H	Inhibition glutamine synthetase	Phosphinic acids	Glufosinate-ammonium	Challenge
K1	Inhibition of microtubule assembly	Benzamides Dinitroaniline	propyzamidetebutam pendimethalin trifluralin	Kerb Comodor Stomp Treflan
K2	Inhibition of microtubule organisation	Carbamates	carbetamide propham	Carbetamex Tripart Sentinel
K3	Inhibition of cell division	Acetamides Chloroacetamides Oxyacetamides	napropamide metazachlor flufenacet	Devrinol Butisan In Crystal
N	Inhibition of lipid synthesis - not ACCase inhibition	Thiocarbamates Benzofuranes	Tri-allate Ethofumesate	Avadex Nortron
Unknown			Flamprop-M-isopropyl Difenzoquat	Commando Pelican Avenge

Target site resistance blocks the site of activity specific to the herbicide's mode of action. This usually results in complete resistance to herbicides acting on that specific site but not to herbicides acting on different targets. It usually occurs with herbicides that have a very specific mode of action, e.g. affect a particular enzyme. Two types have been identified in the UK: one affects 'fop' and 'dim' grass weed herbicides (ACCase inhibitors); the other affects sulfonylurea broad-leaved weed herbicides (ALS inhibitors). Resistant populations can develop rapidly when target site resistance occurs.

Enhanced metabolism results in herbicide detoxification. Resistance tends to be partial, with plant growth being stunted rather than a complete loss of efficacy. With this type of resistance plants may be cross-resistant to herbicides with different modes of action. Currently, this is the most common resistance mechanism in grass weeds in the UK.

Weeds are relatively immobile compared to diseases or pests. Herbicide resistance usually develops on individual farms due to the weed control programmes used. Herbicide resistance can be more easily prevented on a specific farm, compared to fungicide or insecticide resistance. Preventing resistance occurring is an easier and cheaper option than managing a confirmed resistance situation. Factors that influence the occurrence of resistance are outlined in Table 10.

Table 10: Herbicide resistance risk factors

	Risk of resistance	
	Low	High
Cropping system	Good rotation	Winter wheat monoculture
Cultivation system	Annual ploughing	Continuous minimum tillage
Grass weed control	Cultural only	Herbicides only
Herbicide use	Many modes of action	Single mode of action
Control in last 3 years	Excellent	Poor
Weed infestation	Low	High
Resistance in vicinity	Unknown	Common

CEREAL WEED CONTROL STRATEGIES

Successful weed control will involve an integrated approach to rotations, cultivations and herbicide use in each field. Cost effective herbicide programmes necessitate knowledge of the weeds present, choosing appropriate herbicides, using appropriate rates at the correct growth stage of the weeds and crop. The cost of weed control is mainly dictated by the weeds present. It can vary from €7.5/ha (€3 per acre) where CMPP is sufficient to control soft weeds like chickweed, charlock etc. to €125/ha (€50/acre) where grass weeds, wild oats, cleavers and volunteer potatoes are present.

Cultural Control

The first step in any weed control strategy should be to maximise the use of cultural control. This will reduce the need for herbicides, thereby reducing cost and will also reduce the risk of resistance developing. Many options are available, although some may conflict with advice for control of pests and diseases or for reducing nitrate leaching. The main options include manipulating crop competitiveness, crop rotation and using techniques which prevent the spread of weeds.

Establishing a competitive crop is a key method of cultural control in cereals. Cereal species vary in terms of their competitive ability, with oats being more competitive than barley, which in turn is more competitive than wheat. Therefore where serious weed problems are continually encountered, using a more competitive crop can be considered. However, in most instances factors other than weed competitiveness dictate crop choice. Therefore, the aim must be to make the chosen crop as competitive as possible. As outlined earlier, sowing date and seeding rate are key factors which affect the competitiveness of a crop.

Adopting as diverse a rotation as possible using autumn and spring-sown crops, including non-cereals, will help to reduce the dominance of most annual grass weeds. Overall herbicide use may be reduced and the choice of herbicide modes of action extended.

Hand rogueing of weeds is feasible at very low weed populations or for patches of tall weeds, e.g. wild oats. This will prevent seed return. Cutting tall weeds is also an option. Avoiding the spread of seeds and plants will also be an aid to weed control. This can occur through contaminated seed, combine harvesters, cultivation equipment, straw or manure. All field equipment should be cleaned between fields.

Other options which reduce the need for selective herbicides include spraying stubble or seedbeds with a non-selective herbicide before sowing, to ensure that all weed seedlings which have emerged are destroyed. Using set-aside to reduce populations of troublesome weeds should also be considered. The use of mechanical weed control, e.g. harrowing, can also be considered to reduce the necessity for selective herbicides.

The stale seedbed technique used in reduced tillage can be usefully used to assist control of annual weeds. Unploughed land is cultivated with a tined or disc harrow to 5-8 cm (2-3.5 in) and rolled immediately to conserve moisture. A glyphosate based product, e.g. Roundup, Gallup, or Sting, is applied 2-3 weeks later to kill emerged weeds. Sowing can proceed 6 hours after application of Sting and 5-6 days following glyphosate. Where non-inversion tillage is being used, delayed drilling winter cereals will allow a high proportion of weed seedlings to emerge and be controlled before sowing. Black-grass and Italian ryegrass infestations can be effectively reduced if there is sufficient soil moisture for germination. Badly infested fields should be sown last.

Ploughing reduces weed numbers, particularly of species that are relatively non-persistent in the soil, e.g. black-grass and Italian ryegrass. Consider rotational ploughing every two to five years, if annual ploughing is not feasible.

Herbicide Strategies

Winter cereals

For winter cereals there is a choice between autumn or spring applied programmes. There are many benefits to autumn treatment including easier control of weeds when they are small, the potential to use lower herbicide rates, a reduced need for complicated tank-mixes in the spring and avoidance of problems with crop growth stage restrictions for spring applied products.

The trend is for early post-emergence herbicide application, tank-mixed with aphicide, at the 2-3 leaf stage of the crop. Pre-emergence applications are largely confined to late-sown sites likely to be difficult to travel in the spring. Crops sown in November/December will normally have their weeds controlled in the spring. However, where crops are sown in September/early October and where difficult weeds are present, a more intricate strategy may be needed.

Broad-leaved weed control should focus on the most competitive weeds, particularly cleavers. Grass weed control is targeted at meadow grasses particularly annual meadowgrass but also rough-stalked meadow-grass. These must be controlled before the 3-leaf stage at the latest! However wild oats can also be reduced with autumn applications. Both IPU and pendimethalin will control wild oats emerging in the autumn when applied in the autumn.

The three main active ingredients for autumn weed control are isoproturon, pendimethalin and diflufenican.

Isoproturon (**IPU**) is the best of the grass weed herbicides but unfortunately it is subject to leaching by heavy rainfall. IPU is the active ingredient in Arelon, Guideline, Sipti and Tolkan, but is also included with other actives in Affinity, Cougar and Trump.

Pendimethalin (**PDM**) gives good control of meadowgrasses and is 4-6 weeks more persistent than IPU as it is not as subject to leaching. PDM is the active ingredient in Stomp, but is also included with IPU in Trump.

Diflufenican (**DFF**) is a shoot absorbed herbicide only available in mixtures (Cougar and Bacara).

For September/early October sown wheat a two-spray programme may be necessary. Apply the first spray at the 2-3 leaf stage of crop with the aphicide. Use Cougar 1.5 l/ha or Trump 4 l/ha or IPU 2-3 l/ha depending on weed spectrum. It is important that IPU or PDM are applied before the early tillering (3-leaf) stage of grasses at the latest, otherwise control will be compromised. The second herbicide may be required in early November. Product choice will depend on weeds present but IPU (Arelon, Guideline, Tolkan) at 1.5-2.5 l/ha should be adequate in most situations. Fumitory and, to a lesser extent, poppys have become abundant in some fields where Cougar has been used persistently. Useful alternatives include Stomp or Trump. Cameo plus a non-ionic wetter may also be used for broad-leaved weeds in the autumn.

With mid-October to mid-November sown wheat crops the herbicide should be applied with the aphicide at the 2-3 leaf stage of the crop. Product choice will depend on weeds present. One herbicide at the 2-3 leaf stage should be adequate for winter barley. The product choice includes Cougar or a combination of Cougar and IPU at reduced rates of IPU + Cameo.

Winter oats rarely needs a grass weed herbicide because the crop has such a dense canopy meadow grasses cannot compete. Bacarra 0.5-0.75 l/ha is the only herbicide with grass weed activity that can be used on oats. For broad-leaved control, CMPP or Cameo can be used in the autumn.

Where autumn applications have failed to give satisfactory control or where a decision was made to delay herbicide application until the spring the following strategies can be adopted. Where a previous herbicide has been applied, the aim will usually be to control weeds such as wild oats and cleavers which were not adequately controlled in the autumn. For cleavers, a follow-up treatment with a post-emergence product such as Eagle, Boxer, Starane 2, Hurler, Binder or Reaper may be needed in the spring. Products containing carfentrazone, e.g. Affinity, will give very good results in the December to February period. Boxer or Eagle are the products of choice for application in February/March. Starane will give excellent results later, up to flag leaf fully emerged stage.

Options for wild oat control in the spring in wheat include Topic, Puma Extra, Cheetah Super, Grasp and Fathom. The adjuvant Output must be used with Grasp. In barley, options include Grasp, Puma Extra and Pelikan for late use.

Other grass weeds particularly ryegrasses, meadow grasses, bromes, bent grasses, creeping soft grass, yorkshire fog, onion couch and scutch may also need to be controlled. Table 11 gives a susceptibility rating for available cereal grass weed herbicides. Topic and Puma Extra will control rough stalked meadow grass which is the most common grass seen taller than winter wheat or barley at harvest time. It is 4-5 times more competitive than annual meadow grass which normally only grows to 10-15 cm high (4-6 in).

Monitor, for use on winter and spring wheat, will control brome grasses, volunteer barley and suppresses scutch, wild oats and other grasses. Onion couch and Italian ryegrass are moderately susceptible. It also has useful activity on a range of broad-leaved weeds. Include an adjuvant such as a non-ionic wetter (e.g. Agral) or Arma with Monitor.

Table 11: Wild oats herbicides - grass susceptibility

	Topic	Puma Extra Cheetah Super	Grasp	Monitor
Wild oats	S	S	S	MS
Rough stalked meadow grass	S	S	MS	MS
Annual meadow grass	-	-	R	(MS)
Italian ryegrass	MS	(MR)	S	MS
Perennial ryegrass	MS	(MR)	S	-
Bent grass	S	MS	(S)	MS
Scutch	-	-	-	MS
Onion couch	MS	(MR)	MS	-
Awned canary grass	S	S		-
Brome	-	-	-	S
Creeping soft grass	-	-	-	S
Volunteer barley	-	-	-	S
Yorkshire fog	-	-	S	MS

S = Susceptible, MS = Moderately susceptible, MR = Moderately resistant, R = Resistant

Spring cereals

Timing of herbicide application is crucial for successful weed control in spring cereals. Spray early at the 3-5 leaf stage when weeds are small. This is particularly important with undersown crops, as the herbicides used here have to be applied by the first node stage of the crop at the latest and moreover the products do not work well on advanced weeds. Appropriate timings for herbicides in spring wheat and barley are given in Table 12.

Sulfonylureas are now the main products used but hormones are still the only products available for undersown crops. Cleavers, volunteer potatoes, thistles and wild oats will need particular attention. Wild oats are now at epidemic proportions. They are best controlled by the first node stage.

There is a need to distinguish between crops not undersown and those undersown with grass or clover as the herbicide strategy for both situations will be different. Pulsar (from BASF) can be applied to arable silage mixtures including peas. The recommended rate is 4 l/ha for use from 2 leaf to first node detectable stage of the cereal (gs 12-31).

Table 12: Timing of herbicides for spring wheat and barley

Crop stage	Herbicides
2-3 leaves to flag leaf	Ally (Jubilee), BiPlay (DP911), BiPlay PX, Boxer, Cameo (Quantum), Calibre, DP928, Eagle, Harmony M. Starane 2/Binder/Hurler/Reaper
2-3 leaves to second node	Ally Express, Brontril, Hussar, Platform S, Treble
2-5 leaves to first node	Brontril, CMPP, Duet, Foundation, Stellox, Undersown products

Sulfonylurea (SU) herbicides will be used on virtually all spring cereals not undersown with grass and clover. In a lot of fields CMPP will be tank-mixed with SUs for cleavers, fat hen, orache and fumitory. Adjuvants such as Arma and Torpedo will significantly improve the activity of SUs on many weeds. Non-ionic wetters such as Agral are recommended for improved control of some weeds with many SUs.

Options for wild oats in spring cereals include Puma Extra and Grasp. Puma should be applied before gs 31 in spring barley, while grasp can be applied up to gs 31 of the wild oat.

CONCLUSIONS

- It has to be known what weeds are present and the level of infestation in each field. Keep annual field records and simple maps of the location of problems.

- Most weeds are easier to control when they are small. Grass weeds must be controlled before the 3-leaf stage.

- Sulfonylureas dominate herbicide chemistry at present. They give excellent control when appropriate products are used on identified weeds. Resistance is a growing problem internationally but only two cases have been confirmed in Ireland. Combat resistance by integrating cultural and chemical control. Use tank/product mixes or sequences of herbicides with different modes of action within individual crops, or successive crops.

- Numerous reports of unsatisfactory weed control are possibly due to poor skills in weed identification and inappropriate choice of herbicides and rates in some cases. Weed control is more challenging where monoculture winter wheat is early-sown at low seeding rates and where minimum tillage is practiced.

- The cost of weed control is mainly dictated by the weeds present. It can vary from €7.5/ha to over €125/ha.

Appendix 1: Weed susceptibility to post-emergence herbicides

	Ally	Ally Express	Boxer	Calibre	Cameo	CMPP	Dicamba +	DP911 BiPlay	DP928	Eagle	Foundation	Harmony	Platform S	Starane
Annual Nettle	S	-	-	MS	S	S	S	-	S	-	-	-	-	R
Annual Sowthistle	S	S	S	S	S	MS	S	S	S	-	S	S	-	-
Black Bindweed	MR	MS	S	MR	MR	MS	S	MR	MS**	MS	S	S	(MS)	MS
Charlock	S	S	S	S	S	S	S	S	S	S	S	S	S	R
Chickweed	S	S	S	S	MS	S	S	S	S	MR	S	S	S	S
Cleavers	R	S	S	MS	R	S	S	MR	MS**	S	S	MS	S	S
C + CR Buttercup	MS	S	-	MS	MS	MS	S	S	MS**	-	S	MS	-	-
Corn Marigold	S	S	MS	MS	MS	R	R	S	MS	MS	R	S	-	R
Corn Spurrey	S	S	MR	S	S	MR	S	S	S	MS	-	S	-	-
Fat Hen	MR	S	R	S*	MS*	S	S	MS*	MS*	MR	S	MS	S	R
Field Pansy	MS***	S	R	MS	MS***	R	R	MS	MS	MR	R	MS	(MS)	MR
Forget-Me-Not	MS	(S)	S	MS	MS	R	-	S	MS	-	-	S	-	S
Fumitory	R	-	R	MS*	MS*	MS	S	MS*	MR	-	S	MR**	(S)	MS
Groundsel	S	S	MS	S	S	MR	S	S	S	MR	S	S	MS	MR
Hempnettle	S	S	MS	S	S	MR	S	S	S	-	MS	S	S	S
Knotgrass	MS**	(S)	MR	S*	MS**	MR	S	S*	S**	MS	S	S	(MS)	MS
Mayweeds	S	S	S	S	S	R	(S)	S	S	MS	S	S	-	MR
Nipplewort	S	S	MR	S	MS	-	S	S	S	-	-	S	-	-
Orache	MR	MS	R	MR	S*	MS	S	MS*	MR**	-	S	S	-	-
Pale Pericardia	S	S	-	S	S	MR	-	S	S	MS	-	S	-	MR
Parsley Piert	S	S	S	S	S	-	-	S	S	-	-	S	(MS)	-
Poppy	S	S	MR	S	S	MR	MS	S	S	MS	MS	S	(MS)	R
Red Deadnettle	S	S	R	S	S	MS	R	S	S	R	R	S	S	MS
Redshank	S	S	MR	S	S	MR	R	S	S	MS	S	S	(MS)	MR
Runch (W. Radish)	S	-	S	S	S	S	S	S	S	S	S	S	S	-
Scarlet Pimpernel	S	S	-	S	S	MR	S	-	-	-	-	S	-	-
Shepherd's Purse	S	S	S	S	S	S	S	S	S	S	S	S	S	R
Speedwell Common	S	S	R	MS	MS	MS	MS	S	S	R	MS	S	S	MR
Speedwell Ivy-leaved	R	S	R	MS	R	MS	-	MS	MS	-	-	MS	S	MR
Creeping Thistle	MS	S	MR	S	S	MS	MR	S	(MS)	R	MS	MS	(S)	-
Docks	S	S	MR	S	MS	MS	S	S	S	MS	MS	S	S	MS
Vol. Beans	MR	-	S	-	-	-	-	MR	MR	-	-	S	S	-
Vol. Beet	S	S	S	S	S	-	-	S	S	-	-	S	-	-
Vol. Potato	MS	-	MR	S	MR	-	-	MR	MS	-	-	S	-	MS
Vol. OSR	S	S	S	S**	S	S	S	S	S	S	-	S	S	R

S = Susceptible, good control **R** = Resistant, no control **M** = Moderate

* Improved control by addition of non-ionic wetting agent, e.g. Agral at 0.02% of spray mix

** Improved control with CMPP; *** Improved control with HBN

J. O'Mahony – 21 January 2004

Cereal Diseases and Fungicide Resistance

Eugene O'Sullivan
Teagasc
Crops Research Centre, Oak Park

SUMMARY

Strobilurin resistance was reported in early 2003 in *Septoria tritici* from leaf samples taken from winter wheat crops in summer 2002. Subsequently, Teagasc, Oak Park, in collaboration with Teagasc Advisory staff, undertook a survey of *S. tritici* populations in winter wheat crops to determine the extent and frequency of resistance. Resistance to strobilurins was found in all but one of 21 crops sampled, at levels ranging from 9% to 84% with an average of 48%.

The effect of different fungicide programmes on resistance was studied during summer 2003 at two experimental sites. Levels of strobilurin resistance in *S. tritici* increased during the summer, in unsprayed plots and plots treated with triazole fungicides as well as in those treated with strobilurins at both sites.

Septoria populations in all 21 crops sampled were tested for resistance to MBC fungicides and to epoxiconazole (Opus). Over 90% of isolates from all crops were resistant to MBC but all populations were sensitive to epoxiconazole.

Studies of the barley leaf blotch pathogen *Rhynchosporium secalis* showed that resistance to MBC fungicides occurred in 10-30% of isolates collected from crops in 2001, 2002 and 2003, but all isolates were sensitive to triazole and strobilurin fungicides.

Studies of eyespot populations in winter wheat crops showed that the R type (*Tapesia acuformis*) is the dominant strain comprising over 70% of isolates collected in 2001 and 2002. Over 90% of isolates in both years were resistant to MBC fungicides and 40-50% showed reduced sensitivity to prochloraz.

INTRODUCTION

Disease control failure due to fungicide resistance is a relatively recent phenomenon in crop production. Since the introduction of fungicides for disease control in the latter half of the nineteenth century, through the first half of the twentieth century, all the fungicides used were protectant products. These products were multi-site inhibitors i.e. they interfered with a number of vital functions that are mediated by a number of genes in the target fungal pathogen. In order for resistance to develop a number of specific mutations would have to occur simultaneously in the fungal cell. The probability of this happening is low and reports of resistance were rare. Nevertheless, such resistance did occur and an example was resistance to organo-mercury seed dressings in the oat leaf stripe fungus, *Pyrenophora avenae*, in Ireland and elsewhere in the 1960s.

Systemic fungicides were introduced into the market in the 1960s; the earliest of these being the benzimidazole (MBC) group. The MBC fungicides were soon followed by further groups of systemic products including the sterol dimethylation inhibitors (DMI), the phenylamides and more recently the strobilurins. Because of their superior attributes, systemic fungicides rapidly superseded and replaced the older protectant-type products for the control of all major crop diseases. However, many of the systemic fungicides are single-site inhibitors i.e. they interfere with a vital function mediated by a single gene in the target fungus. This facilitates the development of resistance since a single mutation or change in this gene is sufficient to negate the effects of the fungicide. The intensification in cereal production that coincided with the introduction of the systemic products resulted in increased fungicide usage and increased frequencies of applications of fungicides to crops. Consequently, fungal pathogens were exposed to the effects of fungicides for longer periods which facilitated the development of resistance in cereal pathogens.

In the early 1970s it became clear that the MBC fungicides were highly prone to the development of resistance and there were many reports of resistance to these in various crop pathogens (Delph, 1980). Populations of the cereal eyespot fungi (*Tapesia yallundae* and *T. acuformis*), in Ireland and throughout Europe, became predominantly resistant to MBC fungicides in the 1980s (Fitt *et al*., 1988; Cunningham, 1990). There have subsequently been reports of resistance to other groups of systemic fungicides. Reduced sensitivity to triazole fungicides has been reported in the wheat foliar pathogen, *Septoria tritici* (Herman and Gisi, 1994). The most important instance of fungicide resistance in Ireland before now was that of the potato blight fungus (*Phytophthora infestans*) to the phenylamide group of fungicides, first reported in the early 1980s (Dowley and O'Sullivan, 1981).

Strobilurin resistance in *Septoria tritici*

Septoria tritici causes the most important foliar disease of winter wheat crops in Ireland. Disease epidemics are favoured by wet weather. The earliest infections in most winter wheat crops are initiated by airborne ascospores originating in stubble or trash from the previous season. Ascospores are the sexual phase of the pathogen and the high incidences of infections frequently occurring in winter wheat crops following non-cereal break crops demonstrate the importance of these in the spread of the disease between wheat crops. The subsequent development of disease within a crop, and damage to the upper leaves, occurs through rain-splash of spores from pycnidia produced in lesions on the lower leaves. These are the asexual spores and several cycles of these are produced during the growing season. There is also some evidence that air-borne ascospores may also play a role in the progress of disease during the growing season.

The strobilurin fungicides have been used widely for the control of Septoria disease in wheat crops since they became available commercially in Ireland in the latter half of the 1990s. By the end of the 1990s most winter wheat crops were receiving two or three applications of strobilurins each season.

Shortly after the introduction of the strobilurins, resistance to them developed in European populations of the wheat powdery mildew fungus, *Erysiphe graminis* f. sp. *tritici*. In 2001 Teagasc, Oak Park, participated in a survey of European populations of powdery mildew and *Septoria tritici* conducted by Syngenta. The result showed high levels of resistance in Irish populations of powdery mildew but no trace of resistance in *S. tritici* samples collected from high-risk sites. The absence of resistance after several seasons of strobilurin usage suggested that it would not occur in *S. tritici*. Also, it was thought that if resistance did develop it would spread very slowly since Septoria is spread by rain-splashed pycnidiospores or by airborne ascospores, which disperse over relatively short distances, compared with long-distance dispersal of airborne conidia of powdery mildews.

The wet summer of 2002 resulted in high disease pressure during the growing season. There were some reports of poor Septoria control and epicentres or ‘hot-spots’ of severe disease in many crops. Strobilurin resistance was reported in early 2003 in some leaf samples taken from a few of these crops in summer 2002. Subsequently, Teagasc, Oak Park, in collaboration with Teagasc Advisory staff undertook a survey of *S. tritici* populations in winter wheat crops to determine the extent and frequency of resistance.

Samples of leaves infected with Septoria were taken from 21 crops in winter wheat-growing areas ranging from Donegal to Cork, during February and March 2003. *S. tritici* was isolated from lesions on several leaves from each crop. The isolates were then grown on an agar media amended with different concentrations of strobilurin fungicide.

Resistance to strobilurins was found in septoria populations in all but one of the crops sampled. The results are presented in Table 1 and summarised in Table 2. The frequency of resistance ranged from 0% to 84%. It was greater than 30% in 16 of the 21 crops, greater than 50% in 9 crops and greater than 70% in 6 crops. The average level of resistance was 48%.

Table 1: Resistance to strobilurin fungicides in *Septoria tritici* populations in winter wheat crops in February- March 2003

County	% Resistance	County	% Resistance
Carlow (Oak Park)	60	Waterford (b)	76
Meath	57	Waterford (c)	77
Louth (a)	84	Kilkenny (a)	77
Louth (b)	50	Kilkenny (b)	0
Tipperary	50	Kilkenny (c)	9
Wicklow (a)	33	Dublin	50
Wicklow (b)	38	Cork (a)	22
Wicklow (c)	74	Cork (b)	22
Wicklow (d)	75	Donegal	13
Kildalton College	44	Kildare	60
Waterford (a)	35		

The finding of resistance in all crops and the high frequencies with which it occurred was unexpected given that resistance had not been detected in 2001. Since the spread of infection during the growing season was considered to be mainly by rain-splashed spores it was thought that if resistance developed in Septoria it would spread slowly. The rapidity with which strobilurin resistance spread in Ireland suggests that air-borne ascospores may have a more important role in the spread of the disease within crops during the growing season than had been considered previously. High incidences of resistance were found in winter wheat crops following non-cereal break crops and this demonstrates the role that ascospores can play in the spread of resistance between crops as well as the spread of the disease.

Table 2: Summary of resistance in *Septoria tritici* populations in winter wheat crops 2003

Range of resistance in crops 0% to 84%	
Greater than 30% in 16 crops	76% of crops
Greater than 50% in 9 crops	43% of crops
Greater than 70% in 6 crops	29% of crops
Average for all crops ~ 48% resistance	

In summer 2003 Septoria populations in trial sites in counties Cork and Meath were studied to determine the influence of different fungicide programmes on the build-up of resistance. The levels of resistance increased at both locations during the season irrespective of fungicide programme (Table 3). At Cork the level of resistance in the crop prior to laying down the trial was 22%. In late June this had increased to 100% in plots that got three sprays of Modem and to 55% and 57% respectively in unsprayed plots and plots sprayed three times with Opus. At Meath the initial level of resistance was 57%. In July the level of resistance in plots receiving three sprays of Modem was 100%. The levels of resistance in unsprayed plots, plots sprayed three times with Opus and plots sprayed with Opera at T1 followed by Opus at T2 and T3 were 89%, 85% and 94% respectively.

Table 3: Resistance (%) in *S. tritici* following different fungicide programmes at Cork and Meath 2003

	Cork	Meath
Before spraying	22	57
	After spray programmes applied	
Modem x 3	100	100
Opera T1 + Opus T2 + T3	-	94
Opus x 3	57	85
Untreated	55	89

The 100% resistance following three sprays of Modem is not surprising since Modem would control sensitive strains of Septoria leaving the resistant strains to proliferate. Resistance levels in plots not treated with strobilurins remained lower than those of strobilurin-treated plots. However, they increased substantially above the levels initially detected. The substantial increase in frequencies of resistance where there was no selective pressure from strobilurin use is difficult to explain. The Septoria populations in these plots may have been influenced by the close proximity of strobilurin-treated plots, though the leaf samples were taken well away from the plot margins and therefore unlikely to be influenced by rain-splash of pycnidiospores from adjacent plots. Also the role of air-borne ascospores in disease spread during the growing season is still unclear. An interchange of ascospores between plots may account for the increases in levels of resistance where there was no direct influence of strobilurins. There is also the possibility that resistance confers a fitness advantage on the pathogen though a fitness penalty is more often associated with fungicide resistance. However, as will be discussed later, there is clearly not a fitness penalty associated with MBC resistance in Septoria. The same may be true for strobilurin resistance in Septoria.

However, the results from the Cork and Meath locations indicate that levels of resistance increase drastically where strobilurins have been used but that they can increase also in the absence of the selective pressure of strobilurin usage. This suggests that, despite the decreased usage of strobilurins in 2003, the levels of resistance at the end of season will be as high, if not higher, than those at the beginning of the season. Teagasc, Oak Park, will be monitoring the levels of resistance again in early 2004 and the results will be available well in advance of the beginning of the spraying season.

MBC resistance in *S. tritici*

Resistance to MBC-generating fungicides developed fairly rapidly in many pathogens following their introduction in the 1960s but there was no information on the extent of resistance in *S. tritici* populations in Ireland. All isolates from the 21 crops surveyed were tested for MBC resistance. Over 90% of isolates in all crops were resistant. This is surprising since MBC products have not been used extensively on winter wheat crops for many years, and it might be expected that any resistance that developed would have disappeared. It clearly shows that there is not a fitness penalty associated with MBC resistance in Septoria. It is clear also that, if other fungicides are required in future to augment the triazole group, then MBC products cannot be reintroduced in this role for Septoria control in wheat crops.

Testing of *S. tritici* for resistance to triazole fungicides

Opus (epoxiconazole) is probably the triazole fungicide most widely used for septoria control in winter wheat. Resistance to this product in addition to strobilurin resistance would have serious implications for septoria control. All isolates of *S. tritici* from the 21 crops surveyed were tested for resistance to epoxiconazole. The isolates were grown on agar media amended with different concentrations of the fungicide. The results show that all isolates from all crops were sensitive to this fungicide (Fig.. 1). All isolates grew at 0.123 ppm epoxiconazole, 76% of these grew at 0.37 ppm and only 3% of isolates grew at 1.1 ppm. No isolates grew at the next highest concentration used (3.3 ppm). Samples taken from experimental crops sprayed three times with Opus showed the same level of sensitivity as all other isolates tested. Usually, fungi becoming resistant to one fungicide of a particular group exhibit cross-resistance to the other fungicides in that group. Sensitivity to epoxiconazole, therefore, would indicate that Irish populations of septoria are sensitive to all triazole fungicides.

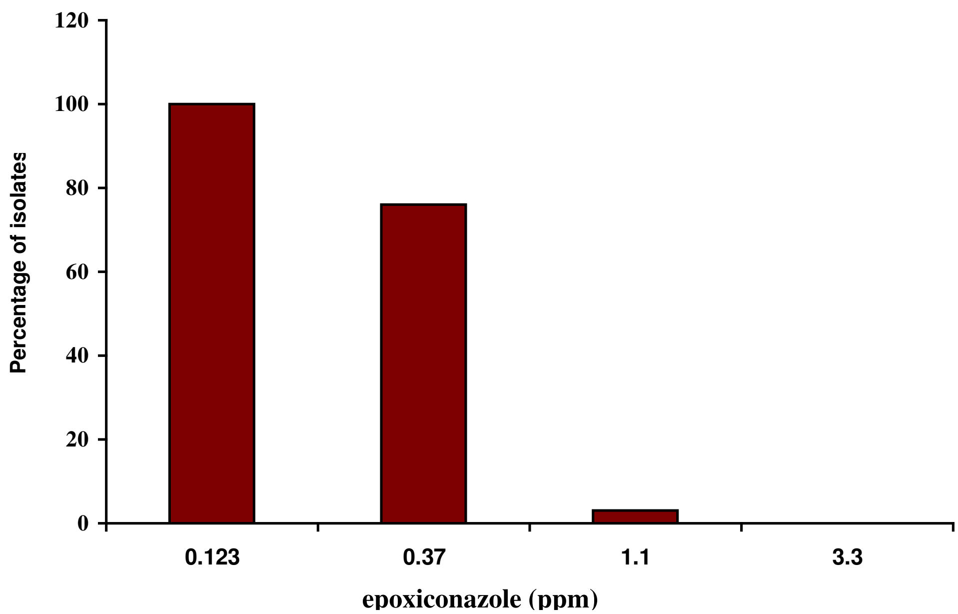


Fig. 1: The sensitivity of *S. tritici* isolates to epoxiconazole (Opus)

Resistance to MBC and strobilurin fungicides occurs as a single genetic change in the pathogen with dramatic effects on disease control. Resistance to triazoles appears to occur through smaller cumulative increases in resistance, that eventually add up to decrease the field performance of these fungicides.

Monitoring of *S. tritici* populations for resistance to epoxiconazole, and other triazoles, will be continued at Oak Park this year and in future years. The level of sensitivity detected in

2003 will be used as a baseline against which the results of future sensitivity tests will be measured. In this way any shift in the sensitivity of septoria populations to triazole products should be detected. Because of the widespread occurrence of resistance to strobilurins in septoria populations in Ireland there will be an increased dependence on triazole fungicides for disease control in the immediate future. Resistance monitoring will be important so that any changes in sensitivity that may occur are detected before there is breakdown in disease control.

Resistance Testing of Foliar Pathogens of Barley

Rhynchosporium leaf blotch

Rhynchosporium leaf blotch (*Rhynchosporium secalis*) is one of the major diseases of winter and spring barley in Ireland. The disease is spread mainly by rain-splashed spores. Rhynchosporium can also be carried on trash and it can be seed-borne, though seed transmission is probably of minor importance. There is no known air-borne stage of the fungus so that if resistance to fungicides does develop its spread should be slow.

Resistance to MBC fungicides occurs in populations of *R. secalis* throughout the UK and there have been reports of resistance to Opus in some parts of Scotland.

R. secalis isolates collected in 2001, 2002 and 2003, were tested for sensitivity to the major groups of fungicides used for foliar disease control in barley. The fungicides MBC (carbendazim), Opus (epoxiconazole), Sanction (flusilazole), Unix (cyprodinil) and Amistar (azoxystrobin) were selected as representing the major fungicide groups. The fungus was isolated from infected fresh leaf material during the summer. The isolates were tested on agar media amended with various concentrations of the fungicides listed.

Resistance to MBC fungicides occurred in *R. secalis* but at a lower frequency than in *S. tritici*. Resistance was found in 14% of isolates in 2001, 22% in 2002 and in 29% of isolates from the 2003 population tested to-date (Table 4).

Table 4: Resistance in *R. secalis* to MBC fungicides

Year	No. of isolates	No. of crops	% resistance
2001	76	8	14
2002	175	14	22
2003	102	11	29

There was no variation in the sensitivities of isolates to either epoxiconazole (Opus) or flusilazole (Sanction). All isolates of *R. secalis* were less sensitive to Sanction than to Opus. They grew well at 1.1 ppm flusilazole but only at 0.37 ppm epoxiconazole. Resistant isolates of *R. secalis* have been found in Scotland that can grow well at 30 ppm epoxiconazole but no isolates were found in Irish populations that can grow well above 0.37 ppm.

All *R. secalis* isolates tested were sensitive to strobilurin fungicides.

Eyespot in Winter Wheat

Populations of the eyespot fungi were last investigated in Ireland in 1990. At that time the R type (*Tapesia acuformis*) predominated in all crops having replaced the previously dominant W type (*T. yallundae*). All populations of eyespot were predominantly resistant to MBC-generating fungicides (Cunningham, 1990). MBC-generating fungicides have not been used to control eyespot since the 1980s. In 2001 work was initiated at Oak Park to investigate the current distribution of R and W types as well as the sensitivities of eyespot populations to MBC, Sportak (prochloraz) and the more recently introduced fungicide Unix (cyprodinil).

Winter wheat crops were sampled in the summer and infected stems were dried and stored until winter when isolations of the pathogens were made. Sensitivity tests were carried out on Potato Dextrose Agar amended with carbendazim (2 ppm), prochloraz (2 ppm) or cyprodinil (1, 10, 100 ppm).

A total of 133 isolates of eyespot were obtained from 36 winter wheat crops in 2001 and 421 isolates from 76 crops in 2002. The R type (*T. acuformis*) is still the dominant strain comprising 77% of isolates in 2001 and 72% of isolates in 2002 (Table 5). MBC resistance is still as widespread in eyespot populations as it was in 1990, with 90% of isolates resistant in 2001 and 91% in 2002. This is despite the fact that MBC fungicides have not been used for eyespot control. Reduced sensitivity to prochloraz was also widespread in eyespot populations with 45% of isolates in 2001 and 52 % of those in 2002 growing at 2 ppm prochloraz. However, many of these isolates grew at a reduced rate on the prochloraz-amended medium compared with prochloraz-free medium indicating reduced sensitivity rather than complete resistance. Nevertheless, the percentage of isolates with reduced sensitivity has increased from 28% when isolates were last tested in 1989 to the 50% level detected now.

Table 5: Distribution of strains and fungicide resistance in eyespot populations in winter wheat

Year	No of isolates	No. of crops	R type (*T. acuformis*) (%)	W type (*T. yallundae*) (%)	MBC resistance (%)	Prochloraz reduced sensitivity (%)
2001	133	36	77	33	90	45
2002	421	76	72	28	91	52

The majority of isolates of eyespot fungi were sensitive to cyprodinil. However, some isolates (18% in 2001 and 27% in 2002) grew at 100 ppm cyprodinil. Growth was reduced at 1 ppm and drastically reduced at 10 and 100 ppm. This suggests that some isolates are becoming less sensitive to this fungicide. The sensitivity levels detected in these two years will be used as a baseline against which future sensitivity tests can be measured.

CONCLUSIONS

- Resistance to strobilurin fungicides is endemic in populations of *Septoria tritici* in wheat crops in Ireland.

- Levels of resistance at the end of the 2003 season are likely to be higher than they were at the beginning, despite the reduced usage of strobilurins in 2003.

- *Septoria tritici* populations in all crops are resistant to MBC fungicides but sensitive to triazoles.

- Populations of *Rhynchosporium secalis* in barley crops in Ireland have some resistance to MBC fungicides but there are no signs of resistance to triazole and strobilurin fungicides.

- All populations of eyespot pathogens in winter wheat crops are predominantly resistant to MBC fungicides and the R type (*Tapesia acuformis*) is the dominant strain in all crops.

REFERENCES

Cunningham, P. C. 1990. MBC fungicide resistance in populations of the eyespot pathogen *Pseudocercosporella herpotrichoide* from intensively cropped cereal fields. *Research Report, Crops Research Centre, Oak Park* 179-180.

Delph, C. J. 1980. Coping with resistance to plant disease control agents. *Plant Disease*, **64:** 652-657.

Dowley, L. J. and O'Sullivan, E. 1981. Metalaxyl-resistant strains of *Phytophthora infestans* (Mont) de Bary in Ireland. *Potato Research*, **24:** 417-424.

Fitt, B. D. L., Goulds, A. and Polley, R. W. 1988. Eyespot (*Pseudocercosporella herpotrichoides*) epidemiology in relation to prediction of disease severity and yield loss in winter wheat: a review. *Plant Pathology* **37:** 31-328.

Herman, D. and0 Gisi, U. 1994. Cross-resistance among DMI fungicides and sensitivity distribution of *S1eptoria tritici* populations. *Proceedings of the Brighton Crop Protection Conference – Pests and Diseases*, 487-492.

Disease Control Strategies for Cereals

Brendan Dunne
Teagasc
Crops Research Centre, Oak Park

SUMMARY

In 2003 septoria levels were moderate to high on winter wheat crops but good control was obtained from several fungicide programmes that gave significant yield increases and reduced disease levels. There were significant differences between programmes. The addition of strobilurin fungicides did not improve disease control or yield when used in programmes, however, in trials designed to test the performance of strobilurins used alone, their use did give significant yield increases over the untreated but were significantly lower yielding than straight triazoles. This was probably due to early septoria control before resistance levels rose. The 2003 trial results indicate that for effective and season long disease control in winter wheat a robust T1 spray based on triazoles is a solid basis for disease control. While the strobilurin fungicides have no effect on the control of septoria they do control other diseases and can have yield benefits due to their effects on the physiology of the plant especially when applied at T2 or T3 timings. Trials in 2003 indicated that this effect was small but such responses would be expected to vary depending on season.

For early sown crops there was a benefit from the use of a pre-T1 spray. However, this increase may not occur in all situations. The trial crops in 2003 were early sown and it is in this situation where one would expect that a pre-T1 spray might give a positive return. Later sown crops probably would not benefit. One advantage of this early spray is that it allows the T1 spray to be delayed until growth stage 32, which is when the eventual third leaf is emerging, and this is the leaf that is targeted at the T1 spray timing. A pre-T1 fungicide is an extra cost, and if the product used contains active ingredients that will be used in the later spray application, the risk of reduced sensitivity or resistance arising is increased.

Triazole products will also be the basis for the T2 spray but it is recommended that another product with a different mode of action be added so as to safeguard the triazoles. Chlorothalonil, which is a multi-site inhibitor, is the obvious choice as a tank-mix partner for triazoles when controlling disease in wheat.

Over the past number of years a number of fungicide programmes in spring barley, costing either €50 per hectare or €80 per hectare were compared at trials carried out at a number of sites. Not all programmes gave a significant yield increase above the yield of the untreated. These negative returns emphasise the importance of monitoring the crop before applying a spray and choosing the appropriate product and rate to control the diseases that are present or pose a threat. Routine prophylactic spraying of spring barley crops can result in negative returns from fungicide use.

INTRODUCTION

For cereals, the 2003 growing season was much improved compared to 2002. The weather was generally more favourable and yields in general were good. Septoria was still a major disease concern in wheat especially as resistance to strobilurin fungicides had arisen in this pathogen and a complete rethink on disease control programmes and strategies was required. Ear fusarium was at very low levels mainly due to the dry weather at the time of flowering of the wheat crop. Spring barley crops in general had low disease levels and gave good yields.

Most winter wheat crops received the normal three-spray programme but in many crops a pre-T1 spray or T0 spray was applied. The timing of this spray was between growth stage 25 and 30.

Spring barley crops generally received a two-spray programme, mainly as insurance as disease levels in spring barley were at their lowest levels for a number of years.

Winter Wheat Fungicides

In 2003 fungicide trials on winter wheat were carried out at Teagasc's Crop Research Centre, Oak Park Carlow, Kildalton Agricultural College, and in commercial crops in Co. Cork and Co. Meath. These trials focused on strategies for disease control in the presence of strobilurin resistance and on fungicide programmes and spray timings. A further objective of the trials was to investigate the effects of strobilurin and non-strobilurin treatments on resistance to strobilurin fungicides by *Septoria tritici* (*Mycosphaerella graminicola*).

Programmes trials

The standard three-spray programme used in these trials was T1 Opus (1.0 l/ha) + Bravo (1.0 l/ha), T2 Opus (1.0 l/ha) + Amistar (1.0 l/ha) and T3 Score (0.5 l/ha). Various fungicide products and mixtures were then applied at each of these growth stages to compare their effectiveness against the standard treatments.

Pre-T1 Treatments

Two pre-T1 (T0) treatments were applied to trials in Co. Meath and Co. Cork. The products used were Opus (0.5 l/ha) and Bravo (2.0 l/ha). The spray was applied at growth stage 25, the actual dates being 18 March in Co. Meath and 3 April in Co. Cork. The results of these treatments and comparison with the standard and the unsprayed are shown in Table 1.

Table 1: Effect on disease and yield of T0 treatments

Fungicide Applied at T0 (T1,T2 and T3 standard)	Rate (l/ha)	% Septoria 2nd leaf		Yield (t/ha)	
		Meath	Cork	Meath (Claire)	Cork (Access)
Opus	0.5	7	52	11.64	7.44
Bravo	2.0	29	67	11.32	7.58
Standard no T0	-	29	88	11.05	6.81
Unsprayed		100	100	7.08	3.33
L.S.D. (5%)		19	15	0.7	1.0

The T0 treatments were higher yielding and had less disease than the standard three-spray programme at both sites. The differences were significant for percentage septoria at the Cork site for both T0 treatments. The T0 treatment yields were higher than the standard treatment at both sites but the differences were not significant.

Both these crops were early sown and this fact may have enhanced the yield and disease response.

T1 Treatments

Nine T1 treatments were compared as a T1 spray. T2 and T3 sprays were the standard sprays discussed previously. The results of these treatments are shown in Table 2.

There were no strobilurin containing treatments included at T1 as the label recommendations for 2003 only allowed a strobilurin application between growth stage 37 and growth stage 71.

Table 2: Effect on yield and disease of various fungicides applied at growth stage 31/32

Fungicide Applied at T1 (T2 and T3 standard)	Rate (l/ha)	Cost of T1 (€/ac)	% Septoria* 2nd leaf		Yield (t/ha)	
			Meath	Cork	Meath	Cork
Opus	1.0	18	50	98	10.56	6.73
Opus + Bravo	1.0 + 1.0	21	29	88	11.05	6.81
Flamenco plus + Bravo	2.3 + 1.0	20	37	89	10.85	7.01
Jau + Bravo	0.8 + 1.0	-	23	68	11.41	7.72
Opus + Unix + Bravo	1.0 + 0.5 + 1.0	30	24	96	11.18	6.56
Sportak + Bravo	0.9 + 1.0	10	53	96	10.27	6.72
Menara + Bravo	0.5 + 1.0	18	45	95	10.77	6.10
Jau/hwg + Bravo	1.25 + 1.0	-	14	66	11.29	7.50
Sportak + Opus + Bravo	0.9 + 0.4 + 1.0	17	27	89	10.54	6.77
Untreated			100	100	7.08	3.33
L.S.D (5%)			19	15	0.7	1.0

*Assessed early July

All treatments significantly out-yielded the untreated. There were also significant differences between treatments for both percentage septoria and yield. The addition of Bravo to Opus at this spray timing improved the disease control and yield. This improvement was more evident at the Meath site than at the Cork site. As disease assessments were carried out during the first week of July, approximately ten weeks after application of the T1 spray, the long lasting disease control benefits from this spray are evident.

T2 Treatments

Seven fungicide products were applied at the T2 spray timing; T1 and T3 applications were the standard treatment.

All treatments were higher yielding than the unsprayed but there were no significant differences between treatments in either disease control or yield. Results for these treatments are shown in Table 3.

Table 3: Effect on yield and disease of various fungicides applied at growth stage 39/45

Fungicide Applied at T2 (T1 and T3 standard)	Rate (l/ha)	Cost of T2 (€/ac)	% Septoria 2nd leaf		Yield (t/ha)	
			Meath	Cork	Meath	Cork
Amistar + opus	1.0 + 1.0	40	29	88	11.05	6.81
Opus	1.0	18	26	90	11.21	7.08
Opus + Bravo	1.0 + 1.0	21	20	91	10.91	6.88
Allegro	1.0	28	34	100	10.59	6.41
Opera	1.5	32	26	95	10.91	6.89
Jau + Twist	0.8 + 1.5	-	24	86	10.82	6.87
Flamenco + Bravo	1.5 + 1.0	20	26	96	10.72	6.02
Unsprayed			100	100	7.08	3.33
L.S.D. (5%)			19	15	0.7	1.0

Due to wet weather in May 2003 the time interval between the T1 and T2 sprays in these trials was more than five weeks, rather than the usual three to four weeks. This meant that a high degree of curative activity was required from these fungicide treatments.

There was no yield advantage from the strobilurin + triazole treatments over that of the non-strobilurin treatments even though their costs were higher. The reasons for this may be that the strobilurins (with the exception of pyraclostrobin) have little curative activity or that the resistance levels of the septoria pathogen were so high that the strobilurins had little effect on the disease level.

Neither was there an advantage from the Opus-Bravo mixture over that of the straight Opus. Again this may be that because chlorothalonil is a preventative product and would have little disease control effect in a curative situation.

There was obviously no strobilurin effect on yield. The strobilurin effect will only be evident in crops where there is excellent disease control.

Strategies trials

The objective of the strategies trials was to examine the contribution to disease control and yield of strobilurin based and non-strobilurin based treatments at each of the key spray application timings and to evaluate the contribution of single sprays at growth stages 32 and 39. A second objective of these trials was to investigate the effects of strobilurin and non-strobilurin treatments on resistance to strobilurin fungicides by the *Septoria tritici*.

Table 4: Effect of individual products applied as a three-spray programme on yield and disease

Timing Growth Stage	Treatment	Rate (l/ha)	% Septoria 1st Leaf Meath	% Septoria 1st Leaf Cork	Yield (t/ha) 15% Meath	Yield (t/ha) 15% Cork	Av. % yield increase (Two sites)
31/32	Opus	1.0	5.6	31	10.40	6.72	75
39/45	Opus	1.0					
59	Opus	1.0					
31/32	Opera	1.2	10.8	66	9.85	6.16	63
39/45	Opera	1.2					
59	Opera	1.2					
31/32	Modem	1.0	59.9	100	8.58	4.92	36
39/45	Modem	1.0					
59	Modem	1.0					
31/32	Opus + Bravo	1.0 + 1.0	26.5	100	8.96	4.56	33
39	Opus + Bravo	1.0 + 1.0	18.5	83	9.09	5.77	52
Unsprayed			77	100	6.7	3.43	
L.S.D			9.0	20	0.59	0.78	

Table 4 shows the yields and disease levels from the use of individual products (Opus, Opera and Modem) applied as a three-spray programme.

The highest yields and lowest disease levels were obtained where Opus was used. The Modem treatment gave the lowest yield and the highest amount of disease. A single application of Opus + Bravo at either growth stage 32 or growth stage 39 was higher yielding than three Modem treatments. However the Modem programmes were significantly higher yielding than the untreated. This was probably due to early Septoria control before resistance levels rose.

The levels of resistance rose in all treatments, including the unsprayed, over the period of the spraying season but greatest increase was where a strobilurin was applied three times. The resistance figures for these treatments are quoted in E.O'Sullivan's paper.

Strobilurin effect

In 2003 the use of strobilurin fungicides in disease control programmes did not improve control of septoria over that of non-strobilurin programmes. However, strobilurins give an additional yield response over that of disease control alone because of their physiological effects on the crop.

A trial was carried out in 2003 to investigate the strobilurin effect on yield. A robust three-spray non-strobilurin programme was compared with this same basic programme plus a single strobilurin at each of the individual growth stages 32, 39,59 and plus two strobilurins applied at growth stages 32 + 39, 32 + 59 and 39 + 59.

The results are shown in Table 5.

Table 5: Effect of one and two strobilurins on yield and disease levels 2003 cultivar Madrigal

Treatment	Rate (l/ha)	Applied G.S.	Yield (t/ha) 15%	% Septoria 2nd leaf
Opus + Bravo	0.8 + 1.0	32	10.91	4.7
Opus + Bravo	0.8 + 1.0	39		
Opus	0.8	59		
Amistar + Opus + Bravo	0.8 + 0.8 + 1.0	32	11.15	4.2
Opus + Bravo	0.8 + 1.0	39		
Opus	0.8	59		
Opus + Bravo	0.8 + 1.0	32	11.11	6.3
Amistar + Opus + Bravo	0.8 + 0.8 + 1.0	39		
Opus	0.8	59		
Opus + Bravo	0.8 + 1.0	32	11.22	4.2
Opus + Bravo	0.8 + 1.0	39		
Amistar + Opus	0.8 + 0.8	59		
Amistar + Opus + Bravo	0.8 + 0.8 + 1.0	32	11.42	3.3
Amistar + Opus + Bravo	0.8 + 0.8 + 1.0	39		
Opus	0.8	59		
Amistar + Opus + Bravo	0.8 + 0.8 + 1.0	32	11.62	4.8
Opus + Bravo	0.8 + 1.0	39		
Amistar + Opus	0.8 + 0.8	59		
Opus + Bravo	0.8 + 1.0	32	11.18	4.5
Amistar + Opus + Bravo	0.8 + 0.8 + 1.0	39		
Amistar + Opus	0.8 + 0.8	59		
Untreated			6.13	99.0
L.S.D.			0.46	4.2

There is no significant difference between treatments in the levels of disease on the second leaf. Any yield increase should be due to the non-disease effect of the strobilurin fungicide. The average yield increase from the single application of a strobilurin in this trial is 0.25 t/ha and the average increase from two strobilurin applications is 0.6 t/ha. This latter yield is significantly higher than the three-spray non-strobilurin programme.

This physiological response from the use of strobilurins has been evident since the introduction of these products. There was a then dual benefit from the use of strobilurins, firstly excellent disease control and secondly a physiological response which enhanced yield. As the level of resistance to the strobilurins in the Septoria fungus in Ireland is high, little septoria control can be expected from the use of strobilurins in 2004. However the strobilurins still have a useful effect on other wheat diseases such as fusarium.

The physiological effect on yield by strobilurins varies from season to season and from site to site. As part of the physiological effect prolongs green leaf area, it would be expected that in a season with an early harvest, that the strobilurin effect would be most marked. A season when disease pressure is low would also give a good strobilurin effect. Variety will also affect the response. Further investigations are required on the dose rates and spray timings necessary to achieve an economic yield response from the physiological effect of strobilurin fungicides.

Spring Barley

As in 2002, disease levels were low in spring barley and response to fungicide treatment was low. Trials comparing a number of fungicide programmes were carried out at two sites, Oak Park, Co. Carlow and Killeagh, Co. Cork. The objective of these trials was to investigate the disease control, yield and economic response of a number of fungicide programmes. A number of fungicide programmes, both one and two-spray, costing either €50 per hectare or €80 per hectare were compared. Disease levels were very low at both sites the only disease present was *Ramularia collo-cygni*

Results for these trials are shown in Table 6.

Yields were good but yield responses to fungicide programmes were low. At Oak Park six treatments were significantly higher yielding than the unsprayed while at Killeagh there was no significant yield differences between the fungicide treated plots and the unsprayed treatment.

The average yield of the €50/ha programmes at Oak Park was 7.34 t/ha (0.15 t/ha over the untreated) and the average yield of the €80/ha was 7.5 t/ha (0.3 t/ha over the unsprayed).

Assuming a grain price of €100 per tonne @ 15% moisture, a yield increase of 0.5 t/ha and 0.8 t/ha would be required to break even from a €50/ha programme and a €80/ha programme respectively. At Oak Park the highest yield response from a programme was 0.75 t/ha.

All disease control programmes at Oak Park would have returned a negative MOFC (Margin Over Fungicide Costs) in 2003, ranging from a loss of €14/ha to €60/ha.

Table 6: Effect of spring barley programmes on disease and yield
Oak Park (cv. Tavern) and Midleton (cv. Lux) 2003

Treatment	Rate (l/ha)	Cost (€/ha)	% Green area 2nd leaf Oak Park	% Green area 2nd leaf Midleton	Yield t/ha @ 15% Oak Park	Yield t/ha @ 15% Midleton
Stereo Punch C	0.75 0.625	52.86	60	53	7.45	8.12
Stereo Acanto	0.75 0.5	47.08	36	38	7.46	7.81
Tilt Punch C	0.5 0.625	51.62	35	33	7.56*	7.71
Allegro Allegro	0.3 0.4	47.60	50	49	7.27	7.83
Corbel Acanto	0.5 0.5	47.42	19	37	7.35	7.88
Stereo Twist	0.75 1.0	51.38	47	42	7.46	7.67
-Acanto + Opus	0.5 + 0.5	51.25	38	47	7.23	7.68
-Twist + Opus	0.75 + 0.5	47.23	39	34	7.21	7.59
-Opera	1.0	53.11	36	42	7.07	7.72
Acanto Acanto + Opus	0.5 0.5 + 0.5	80.03	35	42	7.65*	7.76
Tilt Acanto + Opus	0.5 0.5 + 0.5	68.17	57	66	7.49	7.99
Stereo Covershield	1.0 1.0	83.98	52	56	7.49	8.05
Stereo Twist + Opus	1.0 1.0 + 0.5	81.51	56	57	7.65*	7.52
Stereo Charisma	1.25 1.5	75.09	50	62	7.24	7.36
-Acanto + Opus	0.8 + 0.8	81.98	58	62	7.40	7.96
Stereo Hec/Jau	0.75 1.0		83	89	7.75*	8.13
Stereo Jau	0.75 0.65		97	82	7.96*	7.97
Stereo Punch C + Bravo	0.75 0.5 + 1.0	64.22	71	67	7.44	7.76
Acanto + Opus -	0.8 + 0.8	81.98	49	57	7.69*	7.98
Unsprayed			22	15	7.19	7.62
L.S.D.			20	26	0.37	n.s.

* Yield significantly higher than the unsprayed

These negative returns emphasise the importance of monitoring the crop before applying a spray and choosing the appropriate product and rate to control the diseases that are present or pose a threat. Routine prophylactic spraying of spring barley crops can result in negative returns from fungicide use.

While the MOFCs in these trials are negative it has to be borne in mind that there were extremely low disease levels at both sites. In similar trials in 2002, when disease levels were slightly higher, there were no negative returns although there were some treatments that just broke even.

Disease Control in 2004

As the strobilurins are no longer effective for the control of Septoria, disease control programmes in winter wheat will have to be based on triazole fungicides.

The use of a pre-T1 spray in winter wheat gave a yield increase in 2003 trials. However, this increase may not occur in all situations. The trial crops in 2003 were early sown and it is in this situation where one would expect that a pre-T1 spray might give a positive return. Later sown crops probably would not benefit. One advantage of this early spray is that it allows the T1 spray to be delayed until growth stage 32, which is when the eventual third leaf is emerging, and this is the leaf that is targeted at the T1 spray timing.

A pre-T1 fungicide is an extra cost, and if the product used contains active ingredients that will be used in the later spray application, the risk of reduced sensitivity or resistance arising is increased.

Disease control programmes in winter wheat in 2004 will be triazole based. As discussed in the previous paper, the longer a pathogen is exposed to a fungicide the greater are the chances of resistance arising. This makes it essential when planning and using spray programmes in 2004 that anti-resistance strategies be employed at each application. The simplest way of achieving this is to use a mixture of fungicides, each with a different mode of action. Chlorothalonil, which is a multi-site inhibitor, is the obvious choice as a tank-mix partner for triazoles when controlling disease in wheat. As resistance to strobilurin fungicides in Septoria is widespread, the strobilurin fungicides would not provide any extra protection to the triazole fungicides in this regard. The strobilurins still have a place in wheat disease control programmes as they have an effect on other disease besides Septoria and also have the physiological effect discussed earlier.

Over a number of seasons, but especially the last two, the yield responses achieved from fungicide use on spring barley have been low. Because of this, when planning disease control measures in spring barley crops, the particular diseases present and their levels have to be matched with the most appropriate fungicide products taking dose rate and price into account.

CONCLUSIONS

- Septoria levels were moderate to high on winter wheat crops in 2003. The use of strobilurin containing fungicides was much reduced due to the presence of high levels of resistance to this group of fungicides.

- The application of fungicide products at pre-T1 (or T0) spray timing gave a positive yield response.

- The use of chlorothalonil at the T1 spray timing improved yield and disease control.

- The increased use of triazole based fungicides in 2004 will increase the selection pressure on these active ingredients. Fungicide mixtures will have to be employed to reduce this potential threat.

- When carrying out disease control programmes in spring barley matching disease levels with fungicide products will be the major consideration.

Potential for Triticale in Low Cost Production Systems

R. Hackett and J.I. Burke
Teagasc
Crops Research Centre, Oak Park

SUMMARY

Triticale is the product of a cross between rye and wheat which has developed into an economic crop inside 100 years with most of the progress occurring in the last 30 years. In many areas of the world it has found a definite role as a crop for growing in low cost systems, on soils less suited to wheat. Considerable effort was devoted to the development of the crop in Europe in the 1960s and early 70s but trials at that time at Oak Park showed that a number of significant problems were associated with the crop which prevented its uptake at farm level. These included excessively weak straw, grain shrivelling and relatively low yield. Most of these problems have now been overcome and there are many situations where triticale can provide an opportunity to reduce costs. Triticale has many potential advantages especially in that it is an easy crop to grow with considerably less management operations compared to winter wheat. Its greater disease resistance compared to wheat or barley is a major advantage. Its suitability to lighter and more marginal soils and as a replacement for wheat in take-all sitaution makes triticale a crop worth considering. It has lower input requirements compared to wheat giving it both economic and environmental advantages. It has potential for use as whole crop where high quality but low cost feed is required for on farm feeding especially on mixed farms. However, if triticale is to have a long-term future it must be able to consistently match or exceed the performance of winter wheat or winter barley. Current trials data from Oak Park show that there are triticale varieties which are able to match, if not exceed, the yield potential of winter wheat and exceed that of winter barley. However, triticale performance will generally not compare with the consistent high yields and financial performance of first wheats grown with high levels of management on high potential soils. It is likely that in the shorter term triticale will be used to substitute for winter barley and for wheat on soils where high yields are not being consistently achieved. It should be borne in mind that triticale matures later than winter barley resulting in a later harvest date which could alter the spread in work load patterns for which winter barley is renowned.

INTRODUCTION

Triticale (*X Triticosecale* Wittmack), a cross between wheat and rye, is gaining in popularity as an alternative to wheat and barley world-wide and Ireland is no exception. The FAO estimate of the area of triticale grown in the EU in 2002 was over 1 million hectares with world production in excess of three million hectares. This is likely to be an underestimation as figures for Canada and the USA are not included. The major triticale producing countries include China, Poland, Germany, France, and Australia. Currently there is likely to be about two thousand hectares sown in Ireland.

Triticale was first investigated at Oak Park in the early 1970's (Neenan, 1973) and has been grown intermittently in Ireland since the '80's. Due to increasing pressure on cereal crop margins, research at Oak Park has focused on ways in which the costs of production can be reduced e.g. early sowing, low seeding rates, minimum tillage, decision support systems etc. When considering costs, modern triticale varieties have a number of potential advantages particularly in terms of fungicide inputs and general ease of management compared to either winter wheat or barley. Consequently there has been an increasing interest in growing triticale in Ireland as an alternative to winter wheat and winter barley and more recently maize, particularly on marginal sites. The increasing popularity of cereal crops as fodder crops has fuelled this increase in its popularity. Its main niche is likely to be as a substitute for winter wheat in environments where winter wheat is not likely to perform satisfactorily. It is seen as a low input crop that does not require the same level of management skills as winter wheat while giving good yields. It is particularly suited to organic farming systems where its superior disease resistance and ability to perform in low fertility sites give it an advantage over winter wheat. However, the lack of a ready market for triticale grain and low awareness of the crop has meant that the crop is a minority crop when compared to wheat and barley. The purpose of this paper is to review the current knowledge on triticale and determine what role triticale has in future cropping systems.

BACKGROUND

Triticale is a synthetic crop that results from a cross between wheat and rye. The name triticale is derived from the scientific names of the two genera involved, wheat (*Triticum*) and rye (*Secale*). The crossing of wheat and rye aims to combine the high yield potential and grain quality of wheat with the favourable characteristics of rye such as increased pest and disease resistance, winter hardiness, drought tolerance and adaptability to marginal conditions. Triticale is, therefore, a crop which is particularly suited for marginal environments (e.g. acid or drought-prone soils) or where disease pressure is high.

The first deliberate crossing of wheat and rye was achieved in Scotland in 1875 (Wilson, 1876) although the name 'triticale' did not appear in the scientific literature until *circa* 1935. Early attempts to cross wheat and rye produced only sterile offspring and it was not until 1891 that fertile offspring were produced (Muntzing, 1979). However, it was the mid-twentieth century before serious efforts were made to develop the crop from a scientific curiosity into a commercially acceptable crop and most of the progress in triticale has been made in the last three decades.

Triticale is synthesised by crossing rye with either tetraploid (durum) wheat or hexaploid (bread) wheat to give triticale which is hexaploid or octaploid respectively (Simmonds, 1976). Most of the currently available triticales are hexaploids due to their superior vigour and reproductive stability compared to the octaploid type. The production of commercially acceptable triticale varieties is complex. In many cases the wheat or rye parents are pre-bred to ensure they have the desired characteristics. After the initial cross between rye and wheat (primary triticale) further crossing with wheat or other triticales usually takes place to develop a variety with acceptable characteristics.

Early varieties of triticale had a number of undesirable characteristics including floret sterility, seed shrivelling and low yield. They also tended to be late-maturing, were prone to sprouting and were tall and hence lodging prone. This meant that they were not competitive with other animal feeds (e.g. barley, feed wheat) or for human food. However, they did posses some advantages such as high lysine availability in the grain and a good level of resistance to pests and diseases.

In recent years a lot of progress has been made in triticale breeding with the result that the best varieties of triticale can achieve similar or greater yield potential when compared with wheat, particularly when grown in marginal sites. The progress in triticale breeding is readily visible in the yield data from the CIMMYT triticale breeding programme in Mexico (Hede, 2001), one of the oldest triticale breeding programmes in the world. In 1968 the highest yielding line yielded 2.4 t/ha with a hectolitre weight of 65.8 kg/hl. By 1979 the highest yielding line yielded 8.5 t/ha with a hectolitre weight of 72 kg/hl and it is estimated that since then the average yield increase has been 1.5% per year with yields in excess of 10 t/ha now recorded. Triticale yields in excess of 10 t/ha have been regularly achieved at Oak Park. Yields of a range of varieties at Oak Park in 2003 are presented in Table 1.

Table 1: Yields of triticale varieties at Oak Park in 2003

Variety	Yield (t/ha)
Taurus	10.2
Lupus	10.8
Cylus	11.0
Bienvenue	11.3
Versus	11.4
Fidelio	11.9
Tricolor	12.1
Trilogie	12.2
LSD (5%)	*0.8*

Uses

The majority of triticale production is destined for animal feed. However, it can be used for human consumption. While most of the varieties available are not suitable for leavened breadmaking on their own because of a weak and sticky gluten they can be used in leavened products when blended with wheat flour. Triticale is suitable for producing a range of unleavened products such as cakes, waffles, noodles, flour tortillas and spaghetti (Skovmand *et al.,* 1984).

Feed potential of grain

Many studies have shown that triticale can be substituted for other cereals in animal diets. Briggs (2001) found that most recent reports of triticale performance in pig and poultry diets confirmed that triticale was equal to or better than wheat and maize. Irish studies carried out by An Foras Taluntais in the mid-1980's (Hanrahan, 1986) found triticale grain to be slightly inferior to wheat as a feed for pigs although the differences were small. Recent work by Teagasc has found that triticale grain compares favourably with wheat in terms of feeding value (Stacey *et al*., 2003).

For ruminants triticale can be used either as a grain or as a wholecrop silage. Van Duinkerken *et al*. (1999) studied the effects of replacing maize silage with triticale wholecrop silage in a roughage mixture with grass silage on dairy cow productivity. They concluded that there was no difference in either feed intake or lactational performance between whole-crop silage and maize silage. This would indicate that in the more marginal areas of Ireland for maize production, triticale is a suitable alternative supplementary forage source for use with grass silage. Commercial experience with triticale whole-crop silage as an alternative to grass silage in beef fattening units in Ireland would also appear to be positive (Young, 2003). Results at Oak Park in 2003 indicate that triticale can give high yields of whole-crop silage compared to wheat (Table 2). However, when cut at a similar height there was substantially lower proportion of grain in the triticale whole-crop silage compared to the wheat silage, which would indicate a reduced feeding value. As the grain contributes a large proportion of the feeding value to whole-crop silage it is important that triticale crops intended for wholecrop are grown with a view towards maximising grain content of the silage.

The main nutritional advantage of triticale grain over other feed grain is its more beneficial amino acid profile. In particular the lysine content of the grain is generally, somewhat, higher than wheat. Lysine is often the limiting amino acid in monogastric nutrition (pigs and poultry) and has to be supplemented in many monogastric diets. Bailey (1975), when comparing Irish cereal samples found triticale to have a higher lysine content than wheat but a lower lysine content than barley but concluded that the differences between the cereals were not large. The greater lysine content of triticale, when compared to wheat, has been repeatedly reconfirmed worldwide (Briggs, 2001).

Table 2: Yield and composition of wheat and triticale whole-crop silage at Oak Park in 2003

Variety	Yield (t DM/ha)	% grain (DM basis)	% straw (DM basis)	Grain yield* as a percentage of ripe grain yield
Claire	17.8	51.4	48.6	100
Fidelio	18.7	44.0	56.0	85
Taurus	19.3	44.4	55.6	100
LSD (5%)	*1.5*	*2.8*	*2.8*	-

* at time of wholecrop harvest

Use of triticale as an alternative feed for pigs is usually reported in the literature as very successful (Briggs, 2001). Complete replacement of other feed cereals (e.g. wheat, corn, barley, millet) has been found to be readily achievable without loss of productivity or product quality. Jaikaran *et al*. (2000) concluded that triticale could be used as a substitute for wheat with no significant loss of performance. An energy value for the triticale of 95-100% of maize was estimated. Van Barneveld (1999) found that when pig diets were formulated to supply equal levels of digestible amino acids and digestible energy, the performance of growing pigs fed triticale, as a diet base, is equal to or superior to the performance observed when wheat based diets were used. Where such substitution is made, less protein supplementation is required because of the high lysine content in the triticale, resulting in a lower cost ration overall. Brendemuehl *et al*. (1996) compared the effects of maize, wheat and triticale on carcass composition and on taste and quality characteristics of pork and found that grain source did not affect carcass lean meat content or meat quality characteristics. Commercial adoption of triticale for pig rations has already occurred internationally (e.g. in Australia, USA, Brazil, Poland and Germany) (Briggs, 2001).

The literature would suggest that the use of triticale in poultry diets is not as consistent as with pigs or ruminants (Briggs, 2001). With broilers final weight, weight gain, feed efficiency and carcass yield have all been reduced when triticale has been used as a feed source. Negative effects of laying hens have also been reported. However, there are reports which show that even at 100% inclusion rates there were no differences in productivity of either broilers or laying hens when triticale was used suggesting that there is potential for the use of triticale in poultry diets.

Agronomic Aspects

For triticale to have a place in low cost production systems it must display agronomic traits which make it more cost effective to produce compared to the more conventional feed cereals such as wheat, barley and maize. The following is a summary of the current knowledge with regard to triticale production and how it compares with competing cereals, particularly winter wheat.

Sowing date and seeding rate

While most triticale varieties have a low vernalisation requirement there are, however, three types of triticale in existence, winter triticale which has a vernalisation requirement, spring triticale which has no vernalisation requirement and alternative types which have only a low vernalisation requirement. Varieties currently available in Ireland are mainly winter types. In general terms triticale should be sown early; ideally before the end of October. If drilling on light ground it is important to sow early. In such situations BYDV can cause problems so an aphicide should be used in high-risk situations. Triticale can be sown in spring but some varieties, such as Fidelio and Taurus, require some vernalising days so it is important to drill early (before March). Spring/alternative varieties, such as Bienvenue, can be sown in March and April. However, sowing should be completed as early as possible as yield potential is reduced as sowing is delayed.

In recent years a lot of work has been carried out on low seeding rates for winter wheat, the results of which are generally applicable to triticale. Work at Oak Park has shown that autumn-sown triticale has a large tillering capacity with plants, with over 10 tillers recorded where plant populations were low. As with wheat it is possible to obtain good yields over quite a large range of seeding rates. A seeding rate of 250-350 seeds/m^2, depending on sowing conditions, is generally sufficient to produce maximum yields. Generally a seeding rate of 150 kg/ha is adequate when sowing in good conditions, however, the 1000-grain weight of the seed must be taken into account when calculating the seeding rate as there is considerable variation between varieties and between batches of a particular variety.

Weed control

As triticale is generally taller than wheat and its growth, particularly during the early spring, is quite fast, it is likely to be more competitive towards weeds. However, it will still require a herbicide application in most instances. The choice of herbicide strategy for triticale is somewhat limited by the relatively low number of products available, particularly where autumn application is required. This is mainly because IPU-containing products are only recommended for pre-emergence use on triticale. The main active ingredients and their formulated products that are approved for use on triticale in Ireland are given in Table 3. The main product for post-emergence application in the autumn is Stomp. For pre-emergence application Encore or IPU products can be considered, but varietal restrictions should be adhered to where indicated. Where application is delayed until the spring options include Ally, Eagle, Cameo and Starane.

Table 3: Herbicidal active ingredients and their commercial formulations approved for use on triticale in Ireland

Active ingredient	Commercial formulations
IPU (pre-emerge only)	Arelon Liquid, Tolkan liquid
Metsulfuron-methyl	Ally PX, Ally Express*
Tralkoxydim	Grasp
Tribenuron (-methyl)	Quantum, Cameo
Carfentrazone	Platform, Ally Express*, Lexus Class*
Amidosulfuron	Eagle, Pursuit
Diflufenican	Bacara*
Pendimethalin	Encore*, Stomp
Iodosulfuron-methyl-sodium	Hussar
Florasulam	Boxer
Flurtamone	Bacara*
Fluroxypyr	Starane 2, Tomahawk, Hurler

* Denotes product with more than one active ingredient
Always follow label recommendations
(Source: Pesticide Control Service, Dept. Agriculture and Food – http://www.pcs.agriculture.gov.ie/)

Lodging

One of the problems identified with earlier varieties of triticale was the risk of lodging. However, the inclusion of dwarfing genes has reduced the height of modern varieties with the result that the risk of lodging is reduced. There remains a degree of variation in the varietal susceptibility to lodging (Table 4) which allows lodging-resistant varieties to be chosen for high risk sites.

Because triticale is a relatively tall crop it might be concluded that there would be a yield advantage achieved by shortening the stems, in the absence of lodging. However, work by Naylor (1989) in Scotland indicates that, while CCC can alter the structure of a triticale crop, there is generally no increase in yield in response to CCC application in the absence of lodging.

Working with the lodging-prone variety Lasko at Oak Park, Thomas (1984) reported that the best antilodging effect was achieved with CCC applied at GS 30 followed by Cerone applied at GS 41. However modern varieties are not as lodging prone as Lasko and CCC applied at GS 30-31 should be sufficient to minimise lodging. Growth regulators approved for use on triticale in Ireland include CCC type products, Cerone, Terpal and Coolmore.

Table 4: Lodging scores and straw lengths for triticale varieties

Variety	Lodging score (0 – 9)	Straw length (cm)
Lamberto	0	111
Partout	4	118
Tricolor	0	113
Ego	3	122
Fidelio	0	107
Binova	4	102
Vision	2	114
Trinidad	4	116
Taurus	1	104

Source: HGCA

As can be seen from Table 4 some varieties are highly resistant to lodging and may not need a PGR application, however, this decision must be judged in the light of each particular crop, site, place in rotation and in the overall assessment as to the likely lodging risk. The timing and overall level of nitrogen applied are very important factors in lodging prevention. It is essential to avoid too much growth in the spring as this increases the risk of lodging.

Nitrogen

Because of its deeper rooting system it has been hypothesised that triticale has a lower demand for fertiliser than wheat. As it produces a larger biomass it is responsive to nitrogen. A number of workers have found that the response to nitrogen fertiliser of triticale is similar to that of winter wheat. In South Australia Graham *et al*. (1983) reported that a triticale variety and a wheat variety responded similarly to nitrogen. Working in the UK, Ford *et al*. (1984) compared the nitrogen responses of two triticale breeding lines to the response of two winter wheat varieties (Maris Huntsman and Norman) and found little difference between the two species. However, in this case lodging was artificially prevented. Work is currently being carried out at Oak Park to compare the nitrogen response of the new triticale varieties to winter wheat. Results to-date from nitrogen response trials with triticale carried out at Oak Park over three seasons are presented in Fig. 1. There was no significant response to fertiliser N levels in excess of 150 kg N/ha in two of the three seasons. While a response was achieved with each incremental N addition up to 200 kg N/ha in one season it must be emphasised that applying excessive amounts of nitrogen are likely to make the crop more susceptible to lodging which can reduce yield significantly. This is clearly demonstrated in Fig. 2, where lodging increased as N rate increased. Current recommendations for winter-sown triticale in Ireland are for a 20/25% reduction in the amount recommended for a winter wheat crop in a similar situation. Generally nitrogen applications should be carried out in mid- to late March (1/3) with the main application (2/3) applied just prior to second node - generally late April.

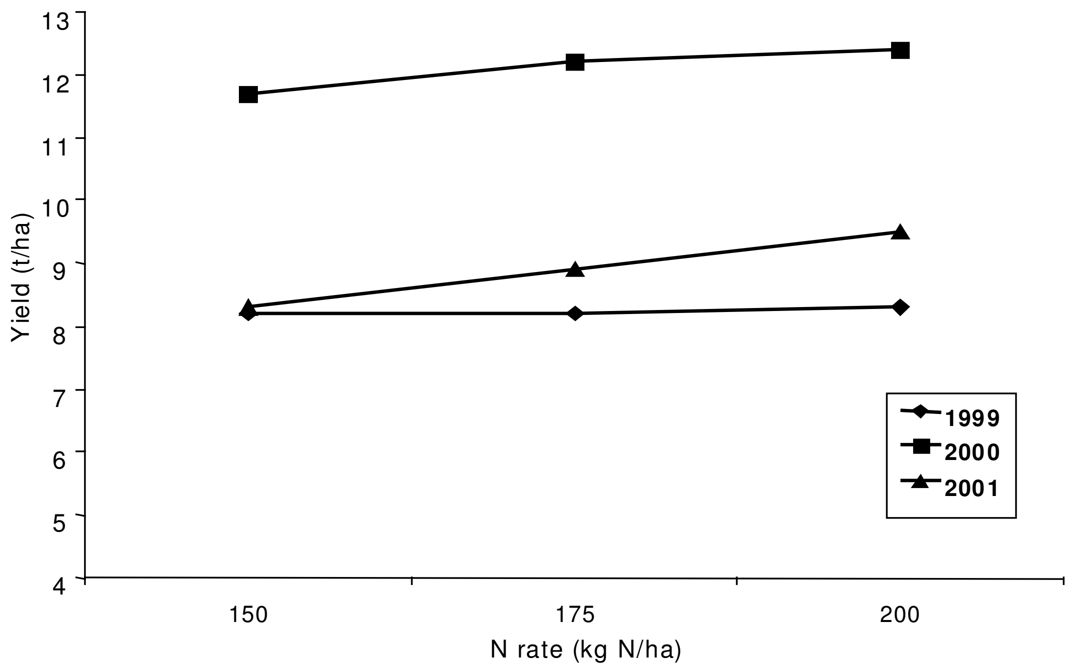


Fig. 1: Response of triticale grain yield to nitrogen fertiliser over three seasons at Oak Park

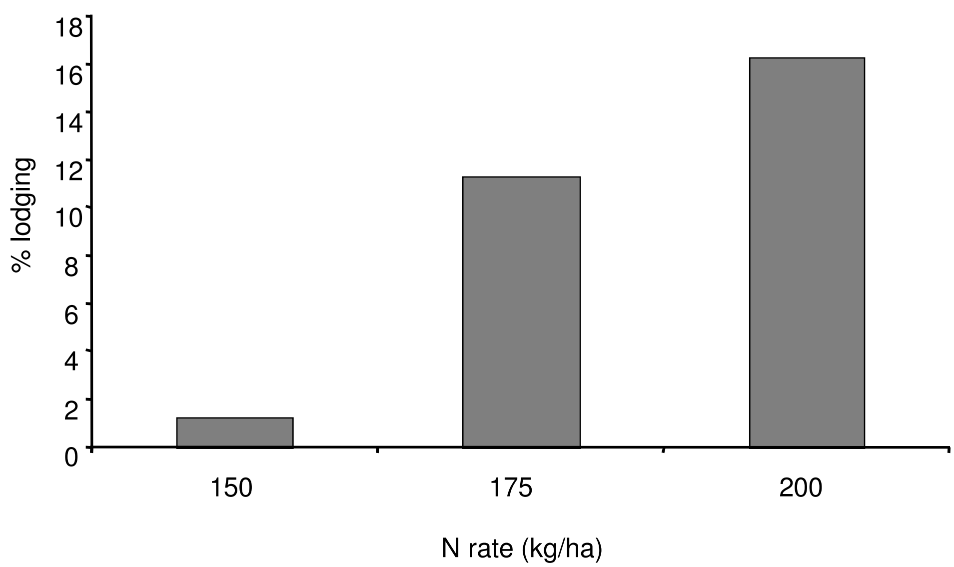


Fig. 2: Lodging of triticale in response to fertiliser N at Oak Park

Foliar diseases

Triticale generally has greater resistance to many diseases than wheat, including rusts, smuts, bunts and powdery mildew. However, it gets disease and, in common with other cereals, there is considerable varietal variation in terms of disease resistance. It can be more susceptible than wheat to some diseases e.g. *Fusarium spp*. (Skovmand, 1984) with little difference between varieties reported Korbas (1998).

While *Septoria tritici* has been reported on triticale (Skovmand, 1984) it does not appear to be a serious pathogen of triticale with many authors reporting a high level of resistance (Mielke, 1995; Bundessortenamt, 1999). *Septoria nodorum* can be a serious disease of triticale and has been identified as the main disease in some European countries (Pojmaj and Pojmaj, 1998). However, there is a wide range of variation in susceptibility to *S. nodorum* between varieties (Oettler and Schmid, 2000).

Triticale is susceptible to both yellow (*Puccinia striiformis*) and brown rusts (*Puccinia recondita*). Triticale is also susceptible to ergot (*Claviceps purpurea*). In the past this was a major limitation to its expansion. However, its susceptibility in the past was linked to problems with floret sterility and ergot is not seen as a major problem in current varieties. Triticale is also susceptible to rhynchosporium (*Rhynchosporium secalis*) and tan spot (*Drechslera tritici-repentis).*

Triticale has been reported as being highly resistant to mildew, even though both wheat and rye are susceptible. Comparing wheat (cv. Norman) and triticale (cv. Salvo) Naylor and Su (1988) reported that, while the wheat became severely infected with mildew, adjacent triticale remained mildew-free. However, with greater levels of production the mildew fungus may evolve to overcome triticale resistance and mildew may become a problem in the future.

Triticale is susceptible to both true eyespot and sharp eyespot. Triticale varieties vary in their susceptibility to both diseases Korbas (1998). When compared with other cereals triticale experiences generally similar levels of these diseases as winter wheat, rye and barley (Gutteridge *et al*., 1993) although Naylor and Su (1988) found that, while triticale experienced the same level of eyespot incidence as wheat, the severity of the disease was much lower.

Take-all

Triticale is susceptible to the take-all fungus *Gaeumannomyces graminis var. tritici* (Ggt) However, its susceptibility is considerably less than that of wheat. Rothrock (1988) found that in a situation where each cereal was inoculated with Ggt the relative susceptibilities of the cereal crops was wheat>triticale>barley>rye. In the U.K, Gutteridge *et a*l. (1993) reported a similar ranking with natural infection. There is some evidence that triticale varieties vary in their resistance depending on the amount of rye genetic material (chromosomes) present with varieties that have a greater amount of rye chromosomes having greater resistance to take-all (Wallwork, 1989).

Given that triticale is susceptible to take-all it does not act as a break crop for take-all. However, as it is less susceptible to take-all than wheat it has the potential to outyield winter wheat when grown in high take-all risk slots such as years 2, 3, 4, and 5 after a break-crop. Gutteridge *et al.* (1993) concluded that the greatest advantage of sowing triticale instead of wheat was likely to accrue in low input conditions on low fertility sites where severe take-all is expected. Overthrow and Carver (2003) concluded that triticale was more profitable to grow than winter wheat or barley as the second and third crop after a break crop where high take-all levels occurred. Similarly Cleal (1993) found that triticale (cv. Purdy) gave higher yields than winter wheat (cv. Galahad) when grown as a second wheat where wheat but not triticale showed visible take-all. Work at Oak Park in 2003 also found that the yield of triticale (cv. Fidelio) grown as a second wheat exceeded the yield of winter wheat by between 0.8 t/ha and 3.1 t/ha depending on winter wheat cultivar, where high levels of take-all were observed. This occurred even where seed treatment against take-all was not applied and where high inputs were used on a fertile site (Fig 3). Indeed the yield of Latitude untreated triticale was similar to or greater than the yield of Latitude treated winter wheat. This demonstrates the benefits of triticale grown in take-all risk slots.

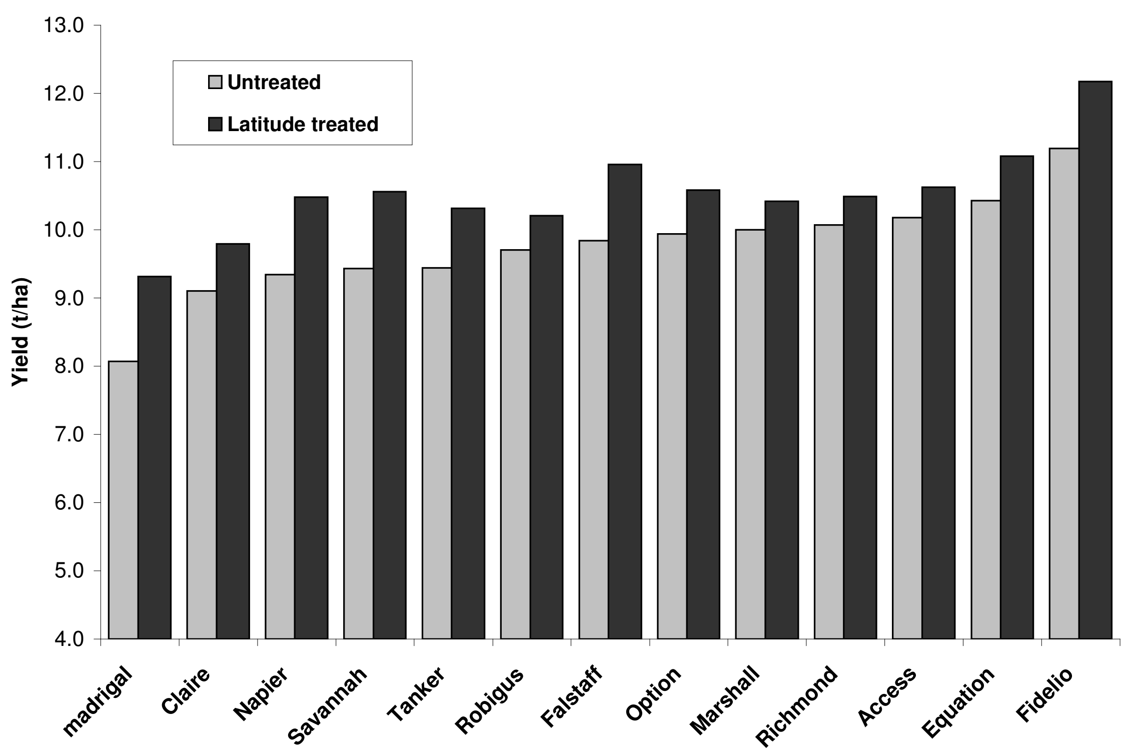


Fig. 3: Response of twelve wheat varieties and one triticale variety (cv. Fidelio) to Latitude seed treatment at Oak Park in 2003

Despite this a response to Latitude seed treatment of 1 t/ha was achieved with the triticale suggesting that, even though it is less susceptible than wheat, an economic response to Latitude may be achieved where take-all levels are high. However, as this was a single site in a single season the results should be interpreted with caution. In a series of 8 trials in Denmark Latitude treatment failed to give an economic response when applied to triticale (Nielsen and Jorgensen, 2002). In a series of experiments at a number of sites over three years Overthrow and Carver (2003) achieved a significant response Latitude seed treatment in triticale only once.

Response to fungicide

While triticale is susceptible to many of the common cereal foliar diseases significant levels of these diseases have only rarely developed to-date under Irish conditions. As a result the grain yield response to fungicide in triticale has been modest. Results from trials examining the response to fungicide at Oak Park over three seasons show that the highest response achieved was 1 t/ha (Fig. 4). In similar trials with winter wheat the highest corresponding yield response was in excess of 3.5 t/ha. There was no significant difference between using a reduced-rate programme, consisting of two 40-50% fungicide doses applied at GS 37-39 and GS 59 respectively, and a high rate fungicide programme, consisting of two 80-100% doses.

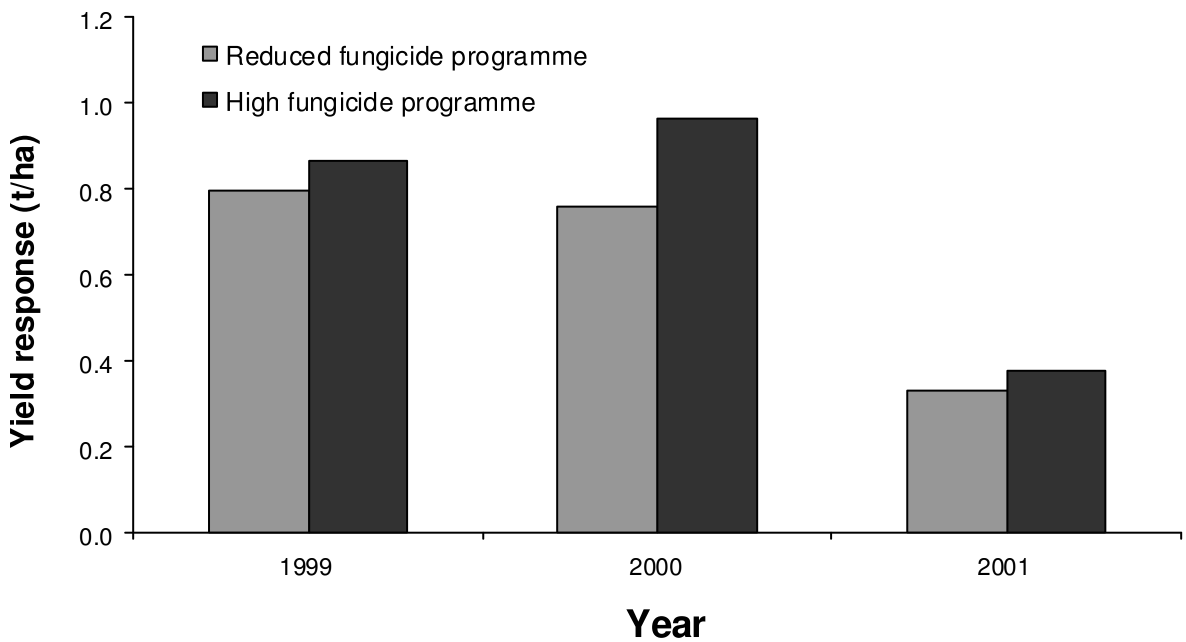


Fig. 4: Grain yield response of triticale (cv. Lupus) to fungicide input over three seasons at Oak Park. Values are the response over an untreated control to two levels of fungicide input. The high fungicide programme comprised a full-rate at GS 37 and GS 59 in 1999 and an 80% rate at GS 37 and GS 59 in 2000 and 2001. Reduced-rate programmes were 50% of the high programme in each season

This suggests that savings in fungicide inputs can be made when triticale is grown instead of winter wheat. However, it must be remembered that the area of triticale grown in Ireland is quite low and as more triticale is grown, particularly if more wheat is included in the crosses, it is possible that that the crop will become more prone to disease. Currently, it is recommended that two reduced-rate broad spectrum fungicide applications are made, one between GS 32-37 and the other around ear emergence.

CONCLUSIONS

- Triticale does have a role in future low input cropping systems. However, the extent of this role will depend on a number of elements. Firstly, in order for triticale area to increase substantially and, therefore, have a significant role a market for triticale grain must be developed. This is, to a large extent, outside the control of the farmer but it would appear that there is no reason why triticale should not become readily tradable.

- Secondly, continued progress in triticale breeding must be made to maintain or increase its yield relative to other cereals.

- The role for triticale will also depend on economic conditions that dictate whether land is used for arable or pastoral purposes. Where economics dictate that pastoral agriculture is more profitable marginal land for tillage is likely to be the first to be converted to pasture. This is the type of land where triticale production is likely to be most profitable and, therefore, if such land is directed away from tillage the potential for triticale may decline.

- However, probably the main factor which will influence the role that triticale has in future low-input cropping systems, assuming that markets are developed, is its production cost relative to other cereals. Given that it can be grown with reduced levels of inputs and that it can outperform other cereals on marginal land it will have a competitive advantage over other cereals in terms of productions costs. In an increasingly environmentally aware society lower levels of inputs will also give it an edge on environmental grounds.

REFERENCES

Bailey, C.J. 1975. A comparative study of the amino-acid composition of Irish grown triticale. *Irish Journal of Agricultural Research* 14:15-19.

Brendemuehl, J.H., Myer, R.O. and Johnson, D.D. 1996. Influence of feeding growing-finishing pigs triticale, wheat or maize based diets on resulting carcass composition and on taste and quality characteristics of pork. *In* H.Guedes-Pinto et al, (eds.) Triticale: Today and Tomorrow. p807-811, Kluwer Academic Pub., Netherlands.

Briggs, K.G. 2001. A study in the growth potential of triticale in Western Canada. Report for Alberta Agriculture, Food and Rural Development, Alberta, Canada. 122 pp.

Bundessortenamt 1999. Beschreibende Sortenliste Getreide, Mais, Ölfrüchte, Leguminosen, Hackfrüchte. Landbuch-Verlag, Hannover.

Cleal, R.A.E. 1993. Effect of growth regulators on the grain yield and quality of triticale and wheat grown as a second wheat on a light soil. *Aspects of Applied Biology* 36:281-286.

Ford, M.A., Austin, R.B., Gregory, R.S. and Morgan, C.L. 1984. A comparison of the grain and biomass yield of winter wheat, rye and triticale. *Journal of Agricultural Science, Cambridge* 103:395-403.

Graham, R.D., Geytenbeck, P.E. and Radcliffe, B.C. 1983. Response of triticale, wheat, rye and barley to nitrogen fertiliser. *Australian Journal of Experimental Agriculture and Animal Husbandry* 23:73-79.

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.

Hanrahan, T.J. 1986. Triticale as an ingredient in pig feeds. *Irish Journal of Agricultural Research* 25:149-152.

Hede, A.R. 2001. A new approach to triticale improvement *In:* Research highlights of the CIMMYT wheat Program, 1999-2000. Mexico.

Jaikaran, S., Robertson, W.M., Aherne, F. and Salmon, D.F. 2000. Feeding triticale to weaner pigs. *Advances in Pork Production 11, Abstract 8.*

Korbas, M. 1998. Infection of triticale varieties with *Pseudocercosporella herpotrichoides* and *Fusarium spp*. *Journal of Plant Protection Research* 38:14-17.

Mielke, H. 1995. Untersuchungen zur Anfälligkeit inländischer Weizen- und Triticalesorten gegenüber *Septoria tritici* Rob . *Ex Desm. Nachrichtenbl. Deut. Pflanzenschutzd.* 47, 9699.

Muntzing, A. 1979. Triticale –results and problems. Verlag Paul Parey, Berlin/Hamburg.

Naylor, R.E.L. and Su, J. 1988. Comparison of disease incidence on triticale and wheat at different nitrogen levels without fungicide treatment. *Tests of Agrochemicals and Cultivars 9 Annals Applied Biology 112 (Supplement).*

Naylor, R.L. 1989. Effects of the plant growth regulator chlormequat on plant form and yield of triticale. *Annals of Applied Biology* 14:533-544.

Neenan, M. 1973. Relative yields of different cereals. An Foras Taluntais Research Report. Crop Husbandry pp. 7-8.

Nielsen, G.C. and Lorgensen, L.N. 2002. Resultater med Latitude. Danske Plantevaernskonference: Pesticider, miljo og postere; DJF Rapport, Markbrug; no 66; pp 15-19. Danmarks JordbrugsForskning: Tjele, Denmark.

Oettler, G. and Schmid, T. 2000. Genotypic variation for resistance to *Septoria nodorum* in triticale. *Plant Breeding* 119:487-490.

Overthrow, R. and Carver, M.F. 2003. The value of triticale in the 2nd /3rd cereal position in crop sequences. HGCA Project Report no.306. HGCA, London.

Pojmaj, M. S. and Pojmaj, R. 1998. Investigation on the resistance of winter triticale to *Stagonospora nodorum* (Berk.) under artificial and natural conditions. *In:* P. Juskiw (ed.), Proc. 4th Int. Triticale Symp., Jul. 26-31, 1998, Red Deer.

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

Simmonds, N.W. 1976. Evolution of crop plants. P118 Longman.

Skovmand, B., Fox, P.N. and Villareal, R.L. 1984. Triticale in commercial agriculture: Progress and promise. *Advances in Agronomy* 37:1-45.

Stacey, P., O'Kiely, P., Rice, B., Hackett, R. and O'Mara, F.P. 2003. Changes in yield and composition of barley, wheat and triticale grains with advancing maturity. Proceedings Agricultural Research Forum, Tullamore, March.

Thomas, T.M. 1984. Triticale. Plant Sciences and Crop Husbandry Department Research Report pp 8-9. An Foras Taluntais, Dublin.

van Barneveld, R.J. 1999. Chemical and physical characteristics of grains related to variability in energy and amino acid availability in pigs. *Australian Journal of Agricultural Research* 50:667-687.

van Duinkerken, G., Zom, R.L.G. and Bleumer, E.J.B. 1999. The effects of replacing maize silage by triticale whole crop silage in a roughage mixture with grass silage on feed intake and milk production by dairy cows. *Proceedings of the British Society of Animal Science Annual Meeting, Scarborough* p. 78.

Wallwork, H. 1989. Screening for resistance to take-all in wheat, triticale and wheat-triticale hybrid lines. *Euphytica* 40:103-110.

Wilson, A.S. 1876. On wheat and rye hybrids. *Transactions and Proceedings of the Botanical Society of Edinburgh* 12:286-288.

Young, P. 2003. Trying Triticale - the future or another fad? *Irish Farmers Journal* 11 January 2003.

Tillage Monitor Farms - Physical and Financial Performance

Michael Hennessy
Teagasc
Kildalton

SUMMARY

The large expansion of tillage farming over the last three decades has resulted in largely one-man tillage operations. The effect of this rationalisation has resulted in the isolation of individuals. Even though access to information has never been easier, interaction as part of a group can often lead to a better learning experience. Monitor farms were picked throughout the tillage counties in Ireland and, in the main, reflect the profile of tillage farmers in the area. The farms are intended to provide a focal point for farmer interaction through meetings and also provide a valuable source of information for all tillage farmers.

Monitor crops provided an important source of information for the crop management decisions in the locality and also influenced the decisions nationally. Key up-to-date information such as growth stages, disease development and financial returns were available through the year. Teagasc staff at Oak Park with the co-operation of monitor farmers ran various trials in 2002 and 2003. The work carried out include fungicide and nitrogen response trials, Department of Agriculture variety trials and various chemical company trials which were carried out in conjunction with the local adviser.

The average yields on the monitor farms in 2002 for winter oats, spring oats, spring wheat, spring barley and sugar beet put the growers in the top 25% of the growers in the country. Yields in 2003 improved upon the yields in 2002 which will confirm that monitor farmers are among the best in the country. Financial returns from 2002 and 2003 were analysed. Net profits on the farms increased in 2003 to €410 per hectare, an increase of €83 per hectare compared to 2002. The profit figure of €410 per hectare includes an average rental cost of €128 per hectare.

There are considerable differences in money spend on variable costs on the farms. Fungicide use on winter wheat and spring barley stand out, where the spend difference was as much as 43% per hectare between farms.

The average fixed costs over all farms are €407 per hectare and represent 47% of all costs on the farm. This figure includes a machinery cost of €187 per hectare or 45% of fixed costs (contractor charges not included). Contractor charges were an average of €87 per hectare on farms. Monitor farms will continue to provide a platform for the monitor farmers to improve profitability and also to provide a vital link between research and commercial farmers. The information the monitor farms provides in the technical and financial areas of farming will help others to improve the profitability on their farms.

INTRODUCTION

The expansion and development of the tillage industry over the last 30 years has come at a price. Figures from the National Farm Survey 2002 indicate that a specialised tillage farmer would need to farm at least 80 hectares to generate an income of €28,000, which is equivalent to the average industrial wage. Due to the time and physical commitment needed on the farm, many farmers are not interacting in the farming community as they would have twenty years ago and many mention isolation as a major obstacle in daily life. In choosing some of the best tillage farmers, the monitor farms are seen as a good forum at local level for farmers to interact, learn, and also share ideas. Monitor farms will also provide a focus where Teagasc research can be adapted, viewed and debated by local farmers. The financial information provided by the farmers will, for the first time, enable other specialised tillage farmers to analyse and compare their own data to some of the best tillage farmers in the country.

Profile of Monitor Farms

We are now entering the third year of the monitor farm programme. The farms were selected on the basis that they were largely representative of the tillage farmers in the area. The farms selected are all full-time farmers and some are also involved in contracting.

In all, there are thirteen monitor farms, including one farm in each of the following counties: Cork, Tipperary, Waterford, Kilkenny, Carlow, Wicklow, Kildare, Laois, Offaly, Dublin, Meath, Louth and Donegal. Of the thirteen farmers, eight have solely tillage farms and the remaining five have mixed tillage and livestock farms.

The average size monitor farm is 180 hectares. Farm size ranges between 97 hectares to 380 hectares. On the farms, 51% (Range 0-100%) of all land farmed is rented. The enterprise mix on monitor farms contains a mixture of winter and spring cereals, sugar beet and potatoes. The enterprise mix depends on the county involved as to what proportion of winter or spring cereals are dominant. In counties towards the north-east, winter cereals tend to dominate the cropping plan and in the midland counties, such as Laois and Offaly, spring cereals dominate the cropping on the farm.

The financial information presented in this paper represents a snapshot of some of the best tillage farmers in the country. The financial information is based on the whole farm and also on an enterprise basis. Individual monitor crops are also examined and they not only highlight the different physical management technique but also the financial implications of field decisions.

The farms are seen as gateways to introduce proven research at farm level so that the monitor farm can benefit from the research and also demonstrate the research to local farmers.

WHOLE FARM FINANCIAL ANALYSIS

Whole farm analysis is crucial on every farm as it shows the contribution to profitability of enterprises rather than fields. Due to the variability in yields from year to year, hard decisions about dropping or substantially increasing an enterprise should only be taken where a three-year average of the farm enterprises is available.

The monitor farm programme is in place for two years and full farm data is available for 2002 and 2003. This data is extremely useful to the tillage industry in light of the current Mid-Term Review (MTR) changes that will be upon us at the start of 2005.

Teagasc E-Profit Monitor Program

Analysis of the whole farm data was carried out using the Teagasc E-Profit Monitor Program. This program is an internet-based program designed so that the adviser or farmer can input the information on-line. The program can deal with all enterprises, including dairy, cattle, sheep and tillage. Individual detailed analysis of the farms can be produced each year and viewed by the adviser and the farmer on the internet. The strength of this program is that it can analyse data from groups of farms with similar enterprises. For example, a highly mechanised potato farm will have a different cost structure to a farm with spring barley and beet.

Farm Profitability

Yield is one of the major driving factors of profits. The monitor farms can be described as excellent farms based on the yield in comparison to the national yields and also to the top 25% of mainly tillage farmers participating in the National Farm Survey 2002.

Table 1: Average monitor farm yields compared to national average yields and position relative to the top 25% of specialist tillage producers in the NFS 2002

	Monitor farms Av. yield 2002 (t/ha)	National yields 2002 (t/ha)	% Difference	N F S Top 25%
Winter wheat	8.64	8.8	-4%	No (In Top 50%)
Winter barley	6.96	6.6	+ 5%	No (In Top 50%)
Winter oats	8.6	7.8	+ 9%	Yes
Spring oats	7.17	5.9	+21%	Yes
Spring barley	5.85	5.3	+10%	Yes
Spring wheat	7.2	7.2	0	Yes
Sugar beet	46	42	+10%	Yes

Table 1 shows that the monitor farms are well ahead of the national average figures in 2002 on all crops except winter wheat and are within the top 25% range of growers for winter and spring oats, spring barley, spring wheat and also sugar beet. In 2002, the top 50% of our winter wheat growers had an average yield of 9.9 t/ha in 2002 but the bottom 50% of growers had average yields of 7.4 t/ha. The lower yield was due to water logging during the winter and also from problems controlling septoria due to developing resistance to strobilurins.

Average yields for winter wheat on the monitor farms in 2003 averaged 9.26 tonne per hectare which will be well above the national average and will put the growers into the top 25% of winter wheat growers in the country.

The overall average net profit from the farms in 2003 was €410/ha. This represents a €83/ha increases in profits over 2002. In all, 51% of all land farmed by the monitor farmers is rented. In 2003, the top 50% group of monitor farmers made a net profit of €535 per hectare, whereas the bottom 50% group made a net profit of €284/ha. However, the bottom 50% group of growers incurred an average cost of €181/ha for all land, whereas the top 50% of growers only incurred a cost of €48/ha for all land farmed. The profits retained by the monitor farms reflect the high standard of the farms involved.

Detailed financial analysis requires individual costs to be examined. Fixed costs accumulate from many different areas and individual costs will be highlighted. Variable costs are particular to the crop grown and this aspect will be dealt with when looking at specific crops later in the paper.

Fixed Costs

Fixed costs tend to be fixed and will not be affected to any great extent by a small change up or down in the size of the farming operation. Fixed costs include machinery and building depreciation, interest, ESB, phone, car etc. The fixed costs incurred on monitor farms represent 39% of gross margin or 47% of all costs incurred (excluding land rental). If there was a 10% reduction in gross margin across the farms then the fixed costs would rise to 54% of the gross margin or a 15% increase.

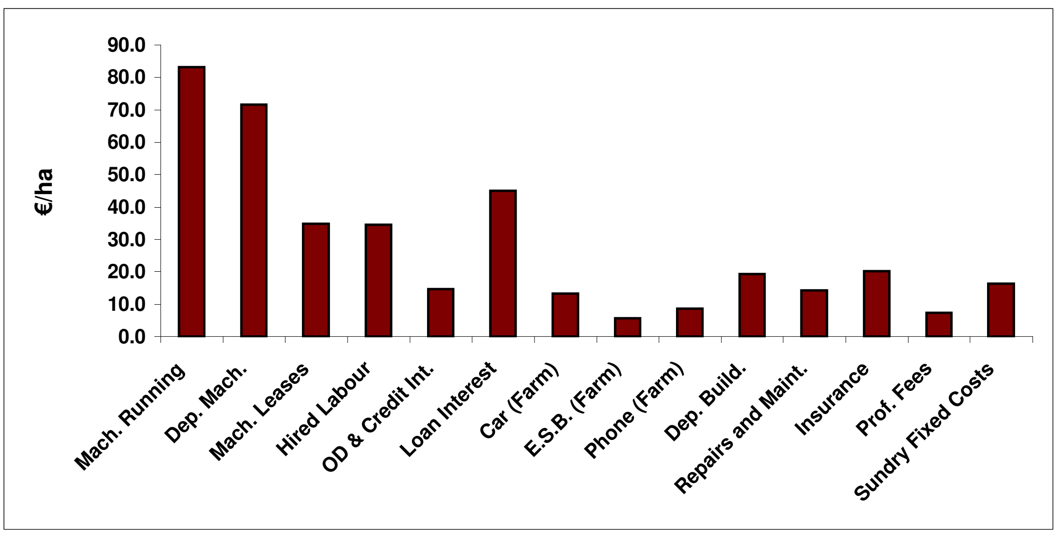


Fig. 1: Monitor farm fixed costs: Average of 2002 and 2003

For the purposes of this comparison, farmers with potatoes as part of their enterprise mix are excluded as they tend to have much larger labour and machinery costs. In as much as possible the costs associated with contracting work completed by the monitor farmers is also excluded.

Fig. 1 shows that the costs associated with machinery represent one of the largest costs on the farms. The average total machinery costs which include depreciation, running and leasing costs represent €189/ha or 48% of the total fixed costs. The range of machinery costs between the farms is €109-€415/ha. The lower cost of €109/ha relates to a farmer who relies on a contractor to gets the majority of the heavy work (ploughing/sowing and harvesting) completed. These figures do not include contractor charges, which vary from €0-€281/ha depending on the farm. When the cost of contracting is added to the machinery costs then the average cost over all farms is €284/ha (range €113-489/ha).

Hired labour and interest represent some of the other larger fixed costs on the farms. As the farms are large one-man operations, hired labour is the only option at busy times, such as sowing and harvest. The high interest charges arise because many of the farms have invested in fixed assets, such as buildings (grain stores) and land.

Land rental is not a part of the above fixed costs but represents a large proportion of the costs on the farms. The rental costs can represent as much as 23% of the gross output. The average rental figure for all land farmed over the two years is €102/ha. Some monitor farmers have no land rental and others operate on all rented ground, which results a range from €0-€373/ha for land rental.

CROP ENTERPRISES

Detailed analysis of major enterprises is always required on farms to ascertain the profitability contribution the enterprise makes to the farm.

Winter Wheat

Winter wheat is one of the major crops on the monitor farms. The yields and returns over the last two years have fallen from the highs in 2000 and 2001. The CSO recorded that the average yield for winter wheat fell from 9.8 t/ha in 2001 to 8.8 t/ha in 2002 and the Teagasc Harvest Report provisionally put the national average yield in 2003 at 8.9 t/ha.

Table 2: Average results for winter wheat enterprise on monitor farms

	2002 *(Range)*	2003 *(Range)*	Average
Tonnes/ha	8.64 (7.09-9.89)	9.09 (7.28-10.36)	8.67
Gross output/t (€)	154	177	165
Total costs/t (€)	120	124	122
Common costs/t (€)	97 (84-100)	103 (74-142)	100
Land rental/ha (€)	142	114	128
Net profit/ha (€)	227	374	300

Table 2 shows the average yield for wheat in 2003 is 9.09 t/ha, which is well ahead of the national average and puts the monitor farms in the top 25% bracket of growers in the country. The wheat yields for 2002 were badly affected by water logging the previous winter and also septoria control problems.

In Table 2 the common costs per tonne relates to all the variable and fixed costs associated with growing a tonne of wheat except land rental, labour and interest. This figure is a better figure to compare across farms, as costs such as rented land, labour and interest can be very farm specific. The common cost-per-tonne figure comprises of variable common costs and fixed common costs. The variable common costs figure rose by €2 per tonne from 2002 to 2003. However, the biggest increase was in the fixed common costs which rose by €4 per tonne over the same period. Although this is worrying and will be examined further, a three-year average figure will be more informative.

The average net profit of winter wheat was €403/ha in 2003 which is an increase of €147/ha compared to 2002.

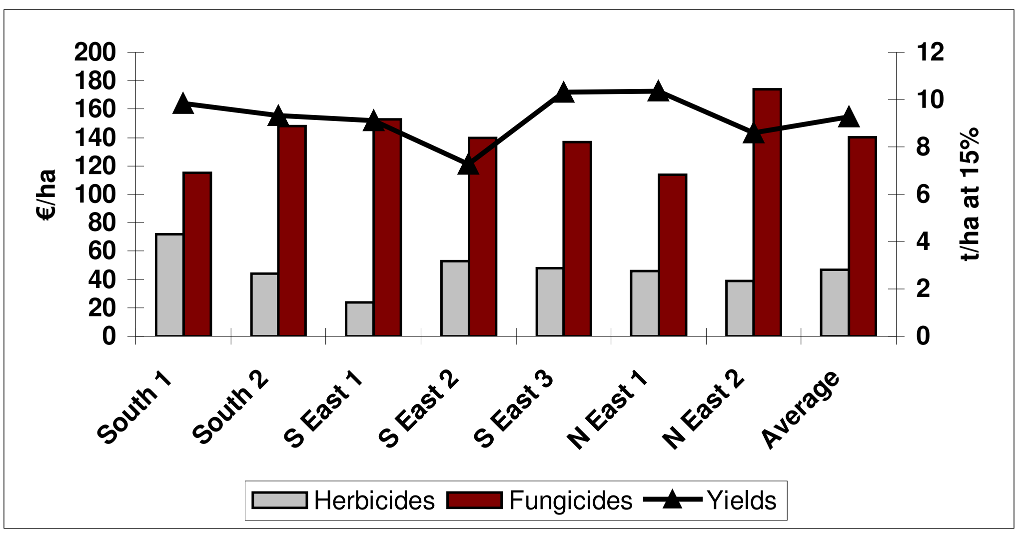


Fig. 2: Herbicide, fungicide and yield for winter wheat, 2003

In Fig. 2 the average fungicide spend is €140/ha. However, the costs vary from €114/ha to €174/ha. The top 50% of growers, in terms of yield, spent an average of €138/ha on fungicides compared to the bottom 50% who spent €144/ha on fungicides.

Spring Barley

The poor weather in 2002 had an adverse affect on crop yields and barley was hit particularly badly in some cases. Despite the setbacks in 2002, the average yield for spring barley across all monitor farms was 5.85 t/ha and is well ahead of the national average, which was 5.3 t/ha. Yields of barley in 2003 are also anticipated to be ahead of the national average.

Table 3: Average results for spring feed barley enterprise on farms

	2002 *(Range)*	2003 *(Range)*	Average
Tonnes/ha	5.85 (3.31-6.7)	6.79 (6.9-7.4)	6.32
Gross output/tonne (€)	183	188	185
Total costs/tonne (€)	143	127	135
Common costs/tonne (€)	114 (80-117)	101 (81-129)	107
Land rental for all areas sown (€)	253	89	171
Net profit (€)	230	445	337

The poor return of 3.31 t/ha by one monitor farmer was a direct result of water logging. The total common costs to produce a tonne of barley ranged by over 40% between the lowest and highest cost of production. The overall cost to produce a tonne of barley is €13 per tonne higher than the total cost to produce a tonne of winter wheat. The main variable costs include fertiliser, herbicides and fungicides. Fertiliser usage will vary depending on site but the average spend was €100/ha.

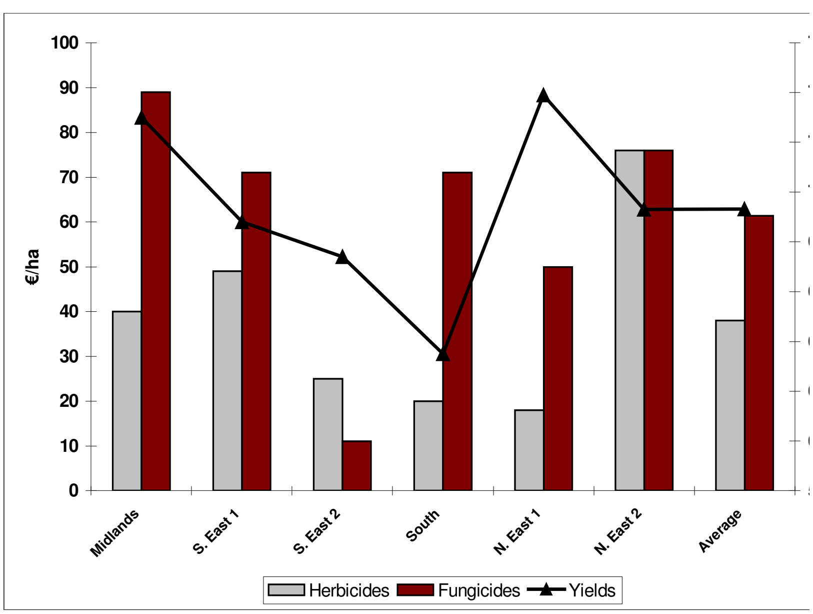


Fig. 3: Monitor farms: herbicide, fungicide and yield for spring feed barley, 2003

Disease control in spring barley could not be described as difficult in 2003 but there were areas where rhynchosporium control proved problematic.

Fig. 3 highlights that one farm spent nearly 47% more on fungicides than the average fungicide spend in 2003. The differences are partly down to variety choice and farm position within the country but it can also underline a larger issue of over-spending on fungicides.

The net profit per hectare from spring barley in 2003 ranged from €17-€573/ha, with an average of €427/ha. Land rental again plays a major role in the financial returns of crops, with an average land rental cost for all barley sown of €154/ha (range €0-€445/ha).

Other Enterprises

As expected, sugar beet profit per hectare was well ahead of all other enterprises, with a net profit per hectare of €575. Herbicides and fertilisers represent the main material inputs in sugar beet. The average herbicide spend was €159/ha and the average fertiliser spend was €233/ha.

Winter oats proved its worth on farms with average net profits over the two years of €200 per hectare for winter oats, which include an associated cost of €226 per hectare for land rental. Spring oats returned an average net profit over the two years of €274 per hectare, which includes an associated cost of €111 per hectare for land rental.

Potatoes, oil seed rape and beans were on some farms but the acreage was small and not enough to comment on.

TRACKING THE GROWING CROPS

The monitor farm programme involves tracking the performance of individual crops on monitor farms through the country. Both winter wheat and spring feed barley were taken as crops to be monitored. The management decisions, both physical and financial, were recorded and posted on the internet. The crops are used by tillage advisors to highlight the growing decisions made and the financial implications of these decisions. The crops can also be viewed through the year on the internet and compared to other monitor crops through the country.

With the help of Oak Park staff exact information on the growth stages and the disease development of the crops were closely tracked during the year.

The Winter Wheat Monitor Crop

In order to obtain top yields of winter wheat correct timing and choice of inputs are vital. The monitor winter wheat crops throughout the country were used at every important decision timing to provide reference information for local farmers.

Table 4 gives an outline of the different growth stages of the crop on 18 March and 10 April last year. This information helped the local advisers and farmers to judge their own crop growth development and correctly time the inputs for that crop.

Table 4: Growth stages of monitor winter wheat crops 2003 at two sample timings

County	Variety	Sowing Date	Growth stage March 18	Growth Stage April 10
Carlow	Soissons	08-Dec	G.S. 2.2 Double Ridge	G.S. 30/31 Lemma Primordium
Cork East	Savannah	08-Nov	G.S. 2.2 Double Ridge	G.S. 30/31 Lemma Primordium
Dublin	Consort	10-Oct	G.S.2.7 Double Ridge	G.S. 30/31 Lemma Primordium
Donegal	Consort	10-Oct	G.S. 2.2 Double Ridge	G.S. 30/31 Glume Primordium
Kilkenny	Savannah	07-Oct	G.S. 2.2 Double Ridge	G.S. 30/31 Lemma Floret
Louth	Richmond	17 Oct	G.S. 2.2 Double Ridge	G.S. 30/31 Lemma Primordium
Meath	Claire	27-Sept	G.S. 3.0 Double Ridge	G.S. 30/31 Lemma Primordium
Tipp South	Claire	27-Sept	G.S. 2.2 Double Ridge	G.S. 31 Terminal spikelet
Waterford	Claire	10-Oct	G.S. 3.1 Floret Primordium	G.S. 3.2 Past Terminal spikelet
Wicklow	Tanker	07-Oct	G.S. 3.0 Double Ridge	G.S. 3.2 Past Terminal Spikelet

Both the double ridge and the terminal spikelet are important growth stages for the management of wheat. The double ridge stage gives an indication of the end of tillering and the onset of the reproductive stage of the plant. Terminal spikelet is important, as it is the growth stage when hormone type herbicides or growth regulators can no longer be applied to the crop without incurring damage to the developing head.

In order to obtain useful management information about septoria, it was felt that the best results from sampling could be gained if sampling took place in early May, just before the T2 fungicide application. The ELISA test for septoria was used to detect the presence or absence of the septoria fungus on the top two leaves of the crops.

The aim of the test was to see if there was any latent septoria present on the upper leaves prior to the application of the T2 fungicide. The results obtained helped in the decision to keep the fungicide rates high. Other factors that influenced the decision are the very wet weather in May and high level of septoria resistance to strobilurins present in the fields.

Physical and Financial Performance of the Monitor Crops

The tillage adviser and the discussion groups had an input to many of the management decisions of the crops. The decisions and subsequent operations and inputs to the crop were posted onto the internet where all Teagasc clients could view the data and compare crops across the country.

All the financial data was closely monitored and a gross margin obtained for each crop. The results for an individual crop will always highlight differences due to field circumstances or due to the position of the field in the country.

Winter Wheat Monitor Crop

The breakdown of the crops and their monitor farms is as follows:

South: Includes counties Waterford, Tipperary South, Cork East and Kildalton College
South-East: Includes counties Wicklow, Carlow and Kilkenny
North-East: Includes counties Dublin, Louth and Meath and Donegal

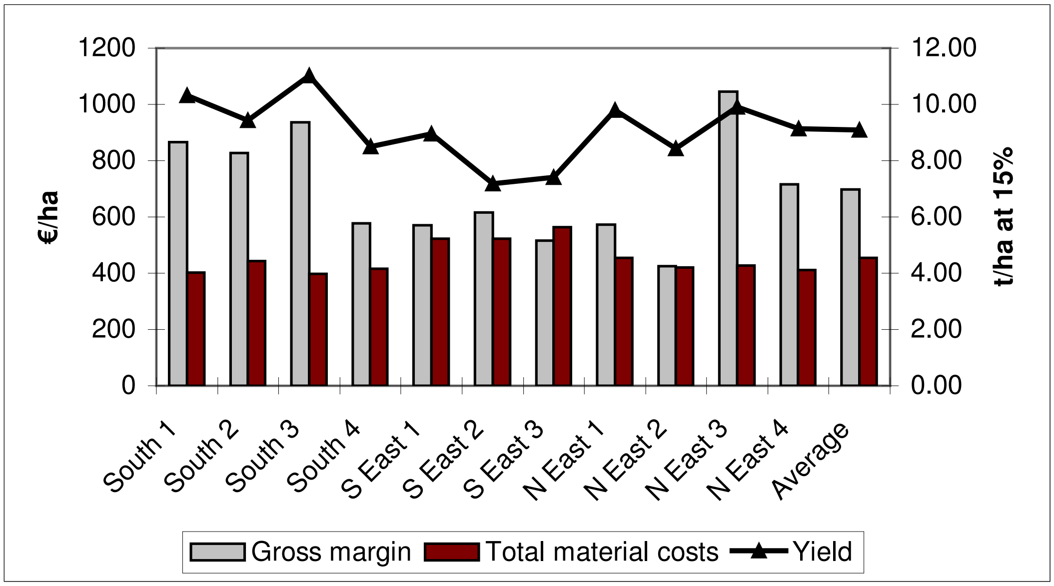


Fig. 4: Yields, material costs and gross margins from winter wheat in 2003

The Gross margin is defined as output minus direct expenses.

Output = Grain sales + Area Aid. Expenses = seed + fertiliser + agri chemicals + machinery costs

The machinery costs are taken from the Teagasc E-Profit Monitor Program, which apportions the machinery costs according to the percentage of gross output of the enterprise compared to the total gross output on the farm. Fig. 4 shows monitor crops had an average yield of 9.1 t/ha in 2003.

The majority of wheat crops were sown after a break crop and generally sown early (before 12 October) with the exception of the S East 1 which was sown after beet in December. The highest yielding crop was a crop of Claire sown on 27 September yielding 11.02 t/ha (4.45 t/ac), with the lowest a crop of Tanker sown on 7 October yielding 7.40 t/ha (2.99 t/ac). This represents a 48% yield difference between the lowest and highest yielding crops. It would be fair to say this huge variation reflected the position on the ground for the typical wheat grower in 2003.

It is difficult to exactly pinpoint the reason for the low yield in some crops, as all crops looked extremely well at the end of June. There are probably a number of contributing factors. The unfavourable wet weather in the autumn combined with the very dry spell in early spring did not favour the development of a large root mass. The dry weather in spring also hindered the uptake of nitrogen. This reduced root mass combined with crops thinning in May and subsequent dry July and August would have increased the incidence and effect of take-all. If you also consider that disease control could not be considered a complete success and very poor in some crops, then maybe it can be seen where yield could be lost.

There was a huge difference in material costs, with a 43% difference between the lowest and highest cost. The lowest costs were in the north-east 1 where the fungicides costs were 26% lower than the average (€139/ha).

A big improvement in gross margin can be seen when the 2003 winter wheat monitor crop figures are compared to last year's figures. Gross margins were up in 2003, on average by €214/ha to €705/ha or a 41% increase. The most significant difference between the two years is the increase in yield and grain price, which rose by 21% in 2003. Total material costs were down by an average of €20/ha in 2003 compared to 2002.

Spring Barley Monitor Crop

Not all our monitor farms grow spring barley we therefore had a smaller number of monitor crops to track through the year. As spring barley tends to move very rapidly through its growth stages the crops were tracked at the three vital growth stages.

The spring barley crop in the midlands 1 suffered due to very high rhynchosporium pressure, consequently the yield and margin suffered. The farms that achieved the highest margins kept the grain post-harvest and benefited from the subsequent increase in price.

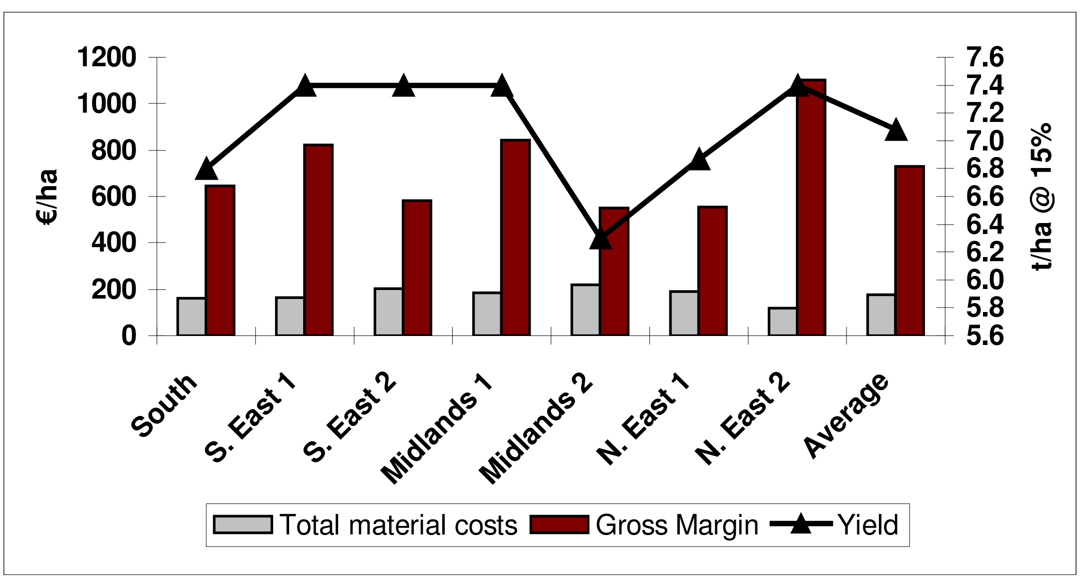


Fig. 5: Yields and gross margins from spring barley in 2003

Collaboration with Crops Research Centre, Oak Park

Where possible, Oak Park scientists were involved in carrying out parts of their research programmes on the monitor farms. These included fungicide and nitrogen trials, with future plans to include the monitor farmers as part of a machinery survey. The farms are also used as part of the growth stage predictions for winter wheat.

One of the main areas where the monitor farms were crucial is early last year where they participated in the initial survey to ascertain the level of septoria resistance to strobilurins in winter wheat throughout the country. The results showed that the average level of resistance in the monitor crops was well above 48% and in some cases as high as 84%. These results set the alarm bells ringing as to the extent of the resistance problem through the country and resulted in a re-examination of the fungicide programmes for the season. The farms also took part in the subsequent intensive nationwide survey in June. Results of this survey were presented this year at the Tillage Conference by Eugene O'Sullivan.

Crops on the monitor farms were also included in a survey that was looking for evidence of resistance to fungicides by eyespot or rhynchosporium. Again the results of this survey were presented by Eugene O'Sullivan.

Concerns were expressed among farmers that the Teagasc nitrogen recommendations for winter wheat were not high enough. Some farmers were using higher nitrogen inputs on winter wheat than the Teagasc recommendations and were obtaining higher yields on their farms. A research programme was put in place and three of the monitor farms participated with Oak Park on this project. The initial observations indicate that the Teagasc nitrogen for winter wheat recommendations are correct.

OTHER ACTIVITIES ON THE MONITOR FARMS

Cost Control Planner

Gathering financial information is always problematic on farms. Some of the monitor farmers who did not have an existing tillage computer package were encouraged to record the day-to-day financial activities on the Teagasc Tillage Cost Control Planner. This computer program enables the farm activities to be grouped into enterprises such as winter wheat, spring barley, etc. Within the program comparisons can be made between a budget which is drawn up at the start of the year and the actual farm expenditure. At the end of the year the collated information can be entered online into the E-Profit Monitor Program, which will compare the farm financial data with the data from the other farms.

Nutrient Management Planning

The nutrient management plan enables the farmer to reduce the risk of environmental pollution, minimise over spending on fertilisers and also plan the quantities of fertilisers needed at the start of the year.

All monitor farms have completed a soil analysis for all land farmed and these results were used to complete a nutrient management plan for the farm at the beginning of the year.

Options Analysis Planning

Options analysis planning involves taking a farm and making changes in the farming operations, such as renting extra land or entering REPS, to see if the changes will improve the overall farm situation. Any change in profits can be projected forward for each of the options. A number of monitor farms availed of this service by using the financial information gathered over the last two years. The analysis of the potential change in profits proved very useful and had a major bearing on the final decisions of the farmer.

CONCLUSIONS

- To-date the monitor farm programme has proved useful The level of visits to the monitor farms by other farmers over the two years is one of the most satisfying aspects of the programme. The majority of visiting farmers were particularly interested in the high quality of crops on display and also the level of time and attention the monitor farmers put into growing the crops. The location of various research trials on these farms has been worthwhile.

- The monitor crops had a major contribution to make about how to best manage crops locally and nationally, and the monitor crops in 2004 will also have a similar input. Farmers now have the ability to gather information about local monitor crops and tailor the crop inputs on their home farm based on this information.

- The physical and financial results indicate that the monitor farms are some of the best in the country. The gross margins on the farms are high but the fixed costs need to be constantly reviewed. Fixed costs on the farms represent 47% of all costs or €407/ha, without including land rental. All monitor farmers recognise that these costs need to be improved upon. Many of our farmers have already taken action to reduce these costs by implementing innovative ideas such as entering machinery sharing arrangements. This type of activity is encouraged and other ideas are presently being discussed to reduce other fixed costs.

- All the monitor farms are under the guidance of specialist tillage advisers who are constantly reviewing the performance of the farms and will endeavour to improve the profitability on the farms year-on-year. The monitor farms will continue to adopt new research into the farm and demonstrate these new techniques to local farmers.

- The monitor farms will continue to host trials from Oak Park, the Department of Agriculture and others, such as An Bord Glas. The farms and trials will be available throughout the coming year to the local farmers and will be used to spark discussion and possibly provoke change in the local area.

- The calibre of monitor farmers and the financial information they supply, should give confidence to all other farmers to analyse and compare their farm data and use this information to improve profitability.

NOTES

NOTES

NOTES

NOTES