AgBioForum, 7(4): 149-157. ©2004 AgBioForum.

An Economic Cost-Benefit Analysis of GM Crop Cultivation: An Irish Case Study

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Presently, no genetically modified (GM) crops are cultivated in Ireland. It is anticipated, however, that the introduction of coexistence guidelines could encourage the uptake of certain GM varieties. The objective of this research was to comparatively assess the costs and benefits of that uptake through the selection of five hypothetical GM crops. The research reports that the economic performance of the technology varies significantly between crops and traits. When disease pressure and/or weed concentration is high, it is predicted that specific GM crops will economically outperform conventional crops, based on the cost of chemicals and their application.

Key words: cost-benefit analysis, genetically modified crops, GM, Ireland

Introduction

Economic information on genetically modified (GM) crop cultivation is readily available for the principal GM crop-growing countries. For European countries, such information was limited by the introduction of a de facto moratorium on the import and production of GM foods in 1998. Although the moratorium was lifted in 2004, it is anticipated that the commercial cultivation of GM crops will not commence in Ireland for a number of years. The provision of this intervening time period affords an opportunity to initiate an assessment of the potential economic impact of GM crop cultivation in Ireland. The objective of the presented research is to examine the predicted costs and/or benefits a producer could experience if a select group of GM crops were cultivated in Ireland.

Background

For producers, the provision of an economic incentive is a highly significant factor in decisions to adopt or reject a new technology (e.g., GM crops). For this research, it is assumed that producers will base their decision on the relative prices of conventional and GM seeds, synthetic pesticides, labor, capital, and other relevant inputs and choose a system that will minimize these costs. If producers are to be motivated to adopt GM technology, production costs will have to decrease or remain static (Kalaitzandonakes, 2003). In addition, farmer diversity, in terms of management ability, agronomic factors, and/or geographic location (Fulton & Keyowski, 1999), will determine the extent of economic gain from GM crops, as producers will differ in their tolerance for risk (Kalaitzandonakes, 2003). Consequently, it can be concluded that some producers will benefit from the new technology while others may not (Fulton & Keyowski, 1999).

In parallel to the anticipated cost savings associated with the adoption of GM technology, the GM producer will also bear additional costs. A technology cost typically will be passed to farmers in the form of a seed premium (PG Economics, 2003) as demonstrated in the United States and Argentina (US General Accounting Office, 2000), Spain (Demont & Tollens, 2004b), and the United Kingdom (May, 2003). Compliance with the pending coexistence guidelines for Ireland will also increase costs, through such measures as a "coexistence levy," as legislated in Denmark (Tolstrup et al., 2003). Further compliance-associated costs (cleaning of machinery and drying and storage facilities; separate transport and storage) will also arise at the harvest and postharvest stage. These costs will vary; it can be expected that they will be lower on farms where GM-only or non-GM-only production is carried out and machinery is segregated for GM/non-GM cultivation purposes (Tolstrup et al., 2003).

Taking account of these issues, this report describes an initial assessment of the economic cost and/or benefit of cultivating five hypothetical GM crops in Ireland. The crops (winter wheat, spring barley, sugar beet, and potato) were selected based on their economic importance to Irish agriculture, and the described traits (disease resistance and herbicide tolerance) were selected because of the difficulties these issues impose upon present crop management regimes. In the case of GM sugar beet, the availability of specific crop output data permitted a more detailed analysis, in contrast to winter wheat, spring barley, and potato, where the analysis was restricted to the benefit associated with reduced chemical input.

Sugar Beet

In 2003, 31,500 hectares (ha) of sugar beet (representing 1.5 million tonnes of saleable product) were cultivated in Ireland. Weed control is a critical component of Irish sugar beet cropping, as less than 80% control of weeds will reduce yield through increased competition or greater losses at harvest. Although sugar beet is bred to be biennial, approximately 1% will bolt and flower in the first year ("bolters"). The resulting bolter seed will emerge in the rotation as "weed beet," which, at one bolter plant per square meter, can reduce crop yield by up to 12% (Mitchell, 2002). Nonselective and selective herbicides (glyphosate/diquat and sulfonylureas, respectively) will eradicate weed beet in cereal crops, but to reduce the weed beet population in the longer term, 98% bolter control is required (O'Mahony, 2004).

A recent cost-benefit analysis for GM herbicide-tolerant (GMHT) sugar beet estimated that the private benefits forgone for the European Union approximated to €169 million per year due to the noncultivation of GMHT sugar beet (Demont, Wessler, & Tollens, 2004). It is clear therefore, that GMHT sugar beet has the potential to present the Irish farmer with an opportunity to reduce herbicide input while decreasing the labor-intensive requirements of bolter control and subsequently improving crop yields (Brants & Harms, 1998; May, 2000, 2003; Mitchell, 2000; Moll, 1997; Tenning, 1998; Wauters, Hermann, & Gestat de Garambe, 2000; Wevers, 1998a, 1998b; Wilson, 1999; Wilson, Dean Yonts, & Smith, 2002).

Winter Wheat

As a consequence of the mild and wet climate, fungal diseases are the greatest challenge to Irish tillage farmers. *Septoria tritici*/*Septoria nodorum* (septoria) and *Fusarium* spp. (fusarium head blight) are the principal fungal diseases of wheat. Over 60,500 ha of winter wheat were sown in 2003, but traditional disease control regimes have been complicated with the recent emergence of fungicide-resistant strains of *S. tritici* (O'Sullivan, 2004). Septoria can inflict annual yield losses of 10–20%; head blight, though not as prevalent as septoria, can under favorable conditions produce mycotoxins, which pose a serious risk to animal and human health (Bhat & Miller, 2004). As both septoria and fusarium are of economic importance to Ireland, GM winter wheat varieties expressing resistance to either septoria (GMSR) or fusarium (GMFR) could serve to benefit the farmer through reduced chemical input.

Spring Barley

In 2003, 163,270 ha of spring barley was sown. As with wheat, disease control is crucial to achieving high spring barley yields. The primary fungal disease of spring barley is *Rhynchosporium secalis* (leaf scald), which is currently controlled with a fungicide mix. The development of GM *Rhynchosporium*-resistant (GMRR) barley could therefore present the farmer with an opportunity to reduce current levels of fungicide input.

Potato

Phytophthora infestans (late blight) continues to be a major problem in Ireland, causing annual losses in yield and quality estimated at €15 million per annum[1] (Copeland, Dowley, & Moore, 1993). Present crop regimes require a regular, high-rate fungicide application at short intervals throughout the growing season. In 2003, 3.6% of Ireland's total crop production area (14,150 ha, representing 488,210 tonnes) was planted with potato; producers have to spray up to 14 times to ensure adequate blight protection (Dowley, Leonard, Rice, & Ward, 2001). As with the previous crops, the commercialization of a specific GM late-blight-resistant (GMLBR) potato variety could potentially offer a significant cost savings to the producer (Gianessi, Sankula, & Reigner, 2003).

Methods

To examine the economic cost-benefit analysis of GM crop cultivation in Ireland, the cropping regimes of the four listed crops were compared with equivalent, hypothetical GM scenarios. All figures used were based on crop production data for Ireland and include variable and some element of fixed costs: materials (seed, fertilizers, herbicides, fungicides, insecticides, growth regulators), machinery hire (plowing, tilling, sowing, spraying, fertilizer spreading, harvesting), and miscellaneous costs (interest [7%] and transport; O'Mahony, 2002, 2003; Teagasc, 2002, 2003). For the purpose of assumptions used in the economic tradeoff analysis, care was exercised in referring to non-peer-reviewed literature, which was only employed when peer-reviewed

1. *This figure was updated using price indices from the Central Statistics Office to represent yield and quality losses in terms of 2003 data.*

literature was not relevant to Ireland's agronomic system.

The sugar beet analysis included data for seed cost, herbicide spray, and application costs in conjunction with data from England (May, 2003). As yield data has been reported with regard to GMHT sugar beet, the impact of the technology on yield was predicted by adopting an average reported yield effect (6%) calculated from an Irish (Mitchell, 2000) and several European trials (Brants & Harms, 1998; May, 2000; Moll, 1997; Tenning, 1998; Wevers, 1998a, 1998b). Importantly, the treatment of the yield effect was carefully constructed in the economic analysis, as prescribed by Mitchell (2000) and Kniss, Wilson, Martin, Burgener, and Feuz (2004). The overall economic implications of the introduction of the new technology were outlined both including and excluding the yield effect, an approach adopted due to the problems associated with predicting accurate yield effects, as highlighted by Mitchell (2000) and Kniss et al. (2004).

In contrast, yield estimates for GM wheat, barley, and potato were not available; hence, the likely cost benefits gained from increased yields associated with these GM crops could not be represented. For winter wheat and spring barley, the cost of cultivating GMSR and GMFR winter wheat and GMRR spring barley was compared with conventional cropping regimes in terms of the impact the technology would have on fungicide sprays and their application. In the main-crop potato sector, the cost effect of decreasing the number of spray applications through the use of a GMLBR potato variety was examined. Note that to safeguard the durability of host resistance, a two-spray regime was included in the model.

Taking into account proposed coexistence guidelines, it was assumed that Irish GM producers could incur a coexistence levy of up to €25. Although GM seed will be more expensive than its conventional equivalent, predicting the cost is difficult, as there is no precedent in Ireland, and the cost of GM seed varies greatly between country, crop, and variety. For the purposes of this study, crop-specific seed premium prices have been used (as proposed by Alston, Hyde, Marra, & Mitchell, 2002) when suitable data was available from the literature. However, based on the crops examined in this analysis, a relevant crop-specific seed premium for Ireland was only available for sugar beet (average of €30/ha; May, 2000). For the remaining crops, a tentative premium of 15% was assumed. Alternative seed premium assumptions were considered for the remaining crops, such as that proposed by Alston et al. (2002), where "the variable costs per acre would be the same as for a representative conventional... control technology" (p. 71). However, due to data limitations, in particular on yield estimates for the remaining crops, it was not possible to follow this approach of static average variable costs.

As GM cultivation has yet to commence in Ireland, it was also assumed that GM crops would be treated as conventional crops with regard to cultivation and that GM products would be sold at the same price as conventional products. Hence, our analysis does not address the issues surrounding the saleability of the products and assumes that a market for GM-derived products will develop over time.

The cropping regimes, including the spray program assumed for this analysis, were based on Farm Management Protocol (FMP) data (Teagasc, 2002, 2003). Compiled from annual *Crop Costs and Returns* (O'Mahony, 2002, 2003), this data set provided variable costs (i.e., plowing, tilling, sowing, spraying, fertilizer spreading, harvesting, interest, and transport) and was chosen ahead of the National Farm Survey (NFS; http://www.teagasc.ie/publications/2004/20040809.htm) data. This approach was adopted due to (a) the lack of itemized data from NFS sources and (b) the need to acknowledge the typical early adopters in a technology cycle (Fernandez-Cornejo, Daberkow, & McBride, 2001), for whom the farm management protocol data was deemed more representative. To account for annual differences with respect to yield and disease pressure, both 2003 (high yield, low disease) and 2002 (low yield, high disease) were examined. The low yields obtained in 2002 were attributed to mild humid conditions, which led to elevated levels of disease pressure.

Results

For GMHT sugar beet, the reduction in spray volume and number of applications, combined with the additional GM costs (seed cost [€30/ha extra] and a technology cost), resulted in an average cost saving of €85.63/ha (6.06%), representing a 9.69% increase in gross margin (Table 1; Figures 1 & 6). When a predicted 6% yield increase (Brants & Harms, 1998; May, 2000; Moll, 1997; Tenning, 1998; Wevers, 1998a, 1998b) was incorporated into the analysis, crop profitability increased from 9.69% to 25.29% (Table 1; Figure 6).

In 2003 and 2002, growers of winter wheat incurred a cost of €150/ha and €179/ha respectively for conventional fungicide applications (Table 2). If commercialized, GMSR varieties could decrease this expenditure to

Table 1. The total cost and profit margins for sugar beet (€/ha).

	Conventional			GM			GM vs. conventional			Difference (%)	Saving (%)
	2002	2003	Average	2002	2003	Average	2002	2003	Average		
Sugar beet (no yield increase)											
Yield (t/ha)	45.00	45.00	45.00	45.00	45.00	45.00	0.00	0.00	0.00		
Output	2295.00	2295.00	2295.00	2295.00	2295.00	2295.00	0.00	0.00	0.00		
Seed	97.00	106.00	101.50	127.00	136.00	131.5	30.00	30.00	30.00		
Technology cost	0.00	0.00	0.00	25.00	25.00	25.00	25.00	25.00	25.00		
Herbicides	188.00	155.00	171.50	33.84	27.90	30.87	-154.16	-127.10	-140.63		
Spray application	57.00	56.00	56.50	57.00	56.00	56.50	0.00	0.00	0.00		
Other costs	1120.00	1045.00	1082.50	1120.00	1045.00	1082.50	0.00	0.00	0.00		
Total costs	1462.00	1362.00	1412.00	1362.84	1289.90	1326.37	-99.16	-72.10	-85.63	93.93	-6.06
Gross margin	833.00	933.00	883.00	932.16	1005.10	968.63	99.16	72.10	85.63	109.69	9.69
Sugar beet (yield increase included)											
Yield (t/ha)	45.00	45.00	45.00	47.70	47.70	47.70	-2.70	-2.70	-2.70		
Output	2295.00	2295.00	2295.00	2432.70	2432.70	2432.70	-137.70	-137.70	-137.70		
Seed	97.00	106.00	101.50	127.00	136.00	131.50	30.00	30.00	30.00		
Technology cost	0.00	0.00	0.00	25.00	25.00	25.00	25.00	25.00	25.00		
Herbicides	188.00	155.00	171.50	33.84	27.90	30.87	-154.16	-127.10	-140.63		
Spray application	57.00	56.00	56.50	57.00	56.00	56.50	0.00	0.00	0.00		
Other costs	1120.00	1045.00	1082.50	1120.00	1045.00	1082.50	0.00	0.00	0.00		
Total costs	1462.00	1362.00	1412.00	1362.84	1289.90	1326.37	-99.16	-72.10	-85.63	93.93	-6.06
Gross margin	833.00	933.00	883.00	1069.86	1142.80	1106.33	236.86	209.80	223.33	125.29	25.29

an average of €100/ha (40% savings), while GMFR varieties could decrease the fungicide requirement to an average of €113/ha (31% savings). When these costs (Table 2) were incorporated into the cropping regime along with the accepted GM costs (seed cost [€9/ha extra] and technology cost), the comparative difference between the conventional and GM regimes equated to an average cost savings of €30.5/ha (3.3%) for GMSR winter wheat (Figure 2) and €17.5/ha (1.8%) for GMFR winter wheat (Table 2; Figure 3)—a potential 9.6% and 5.9% respective increase in profit.

Similar cost evaluations showed that the adoption of GMRR spring barley could reduce the cost of fungicide applications from €75/ha to €37.5/ha (Table 2). When combined with additional GM costs (seed cost [€9.6/ha extra] and technology cost), an average cost saving of €6.9/ha (0.8%) could be returned to the producer (Table 2; Figure 4), corresponding to a 10.5% profit increase. Reducing blight control to two applications in main-crop potato production could decrease average associated expenditure by up to €285/ha. When considered with expected GM costs (15% seed cost [€122/ha extra] and technology cost), this could provide a cost saving of up to €199/ha (4.3%), representing a 14.5% increase in profits (Table 2; Figures 5 & 6). In summary, all five GM crops were more cost efficient than their conventional equivalent, with the highest saving recorded by GMHT sugar beet (Figure 6). Similarly, an increase in gross margin was reported for each GM crop, with GMHT sugar beet recording the highest percentage cost saving (Figure 6).

Discussion & Conclusions

Cultivation of the described GM crops in both 2002 and 2003 would have provided savings for the producer, with a greater benefit recorded in 2002 for sugar beet, wheat, and barley due to the higher chemical inputs (Figures 1, 2, 3, & 4). Based solely on fungicide/herbicide chemical cost and their cost of application, this demonstrates that under typical Irish climactic conditions, specific GM crops have the potential to economically outperform their conventional equivalents where high disease pressure and/or weed proliferation is recurrent. Our analysis shows that GMHT sugar beet cultivation could be economically beneficial to the Irish farmer (Table 1) in the absence (9.69% saving) or presence

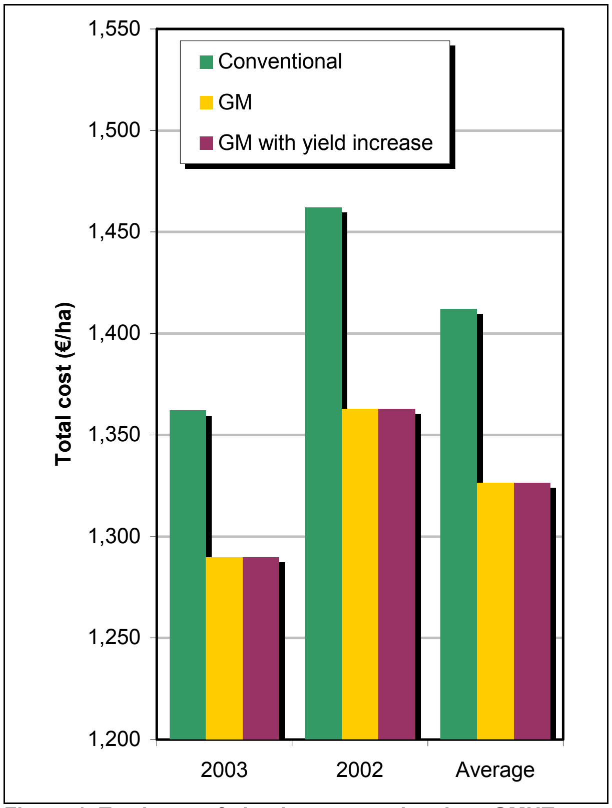

Figure 1. Total cost of planting conventional vs. GMHT sugar beet.

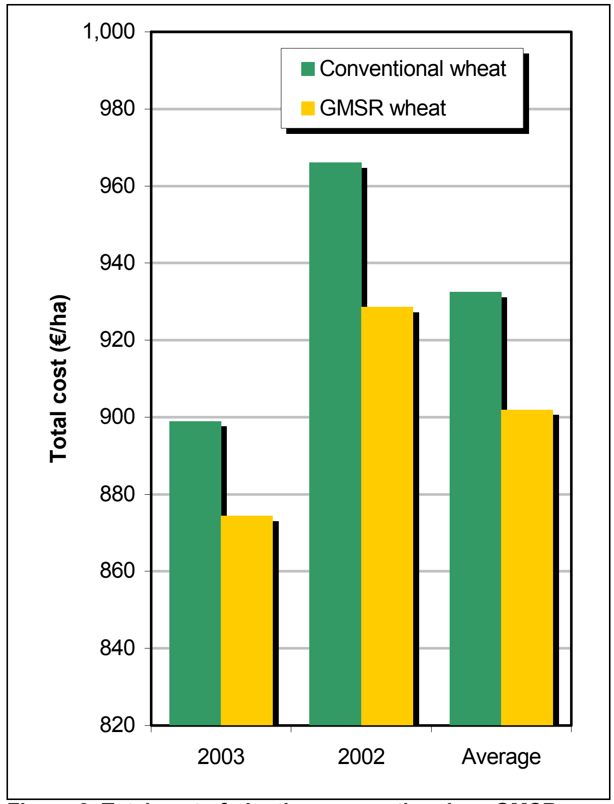

Figure 2. Total cost of planting conventional vs. GMSR winter wheat.

(25.29% saving) of increased yield. This concurs with recent reports (May, 2003; PG Economics, 2003) and underlines the potential economic benefit of commercial-scale GMHT sugar beet adoption to the industry (Demont & Tollens, 2004a). It is important to note, however, that improved yields associated with current GMHT sugar beet are variable and notably dependent on local agronomic practice, as described in previous research (Mitchell, 2000).

Our results confirm assumptions made by van Meijl and van Tongeren (2003) that the productivity impacts of GM technologies differ across GM crops (Tables 1 & 2). Furthermore, although the economic benefit varies between the crops, certain GM disease-resistant cereals could prove economically valuable to the Irish farmer (Figures 2 & 3). Similarly, the cultivation of GMLBR main-crop potato could generate substantial cost savings (4.3%) when present potato production costs are considered (Table 2; Figure 6). Note that cost savings for potato remained static over 2002–2003 as a direct result of current management practice where spraying is a preventative rather than a curative measure.

In addition to the provision of a potential economic benefit, it is important to note that the convenience factor associated with GM crop cultivation is significant, affording the producer the opportunity to reduce labor time, which in turn provides greater flexibility in their management practice. Such a system could appeal to Ireland's part-time farmers (34%; Connolly, Kinsella, & Quinlan, 2004), who may not benefit directly in terms of profitability but rather in terms of improved labor productivity. Although the transfer of these benefits from the farmer to the consumer depends on the intermediate marketing sector (processors, distribution, retailers, etc.), adoption is also dependent on the category of adopter. Fernandez-Cornejo et al. (2001) found that "adoption rates generally increase with size of operation for all technologies" (p. 126). In the United States, adopters were primarily young, educated, and well-performing farmers established on large holdings (Commission of the European Communities [CEC], 2000). If this is applied to Ireland, it can be expected that over the long term, enhanced productivity (along with other factors) could impact significantly on farm restructuring from both an economic and social context.

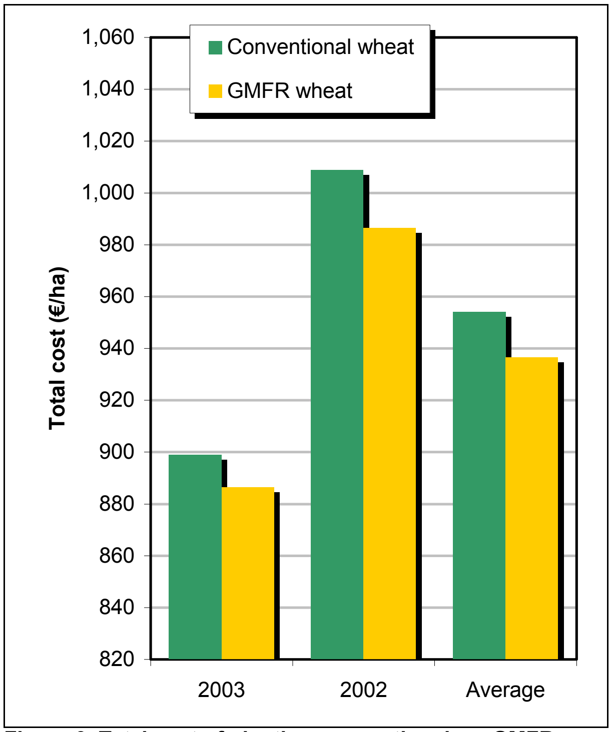

Figure 3. Total cost of planting conventional vs. GMFR winter wheat.

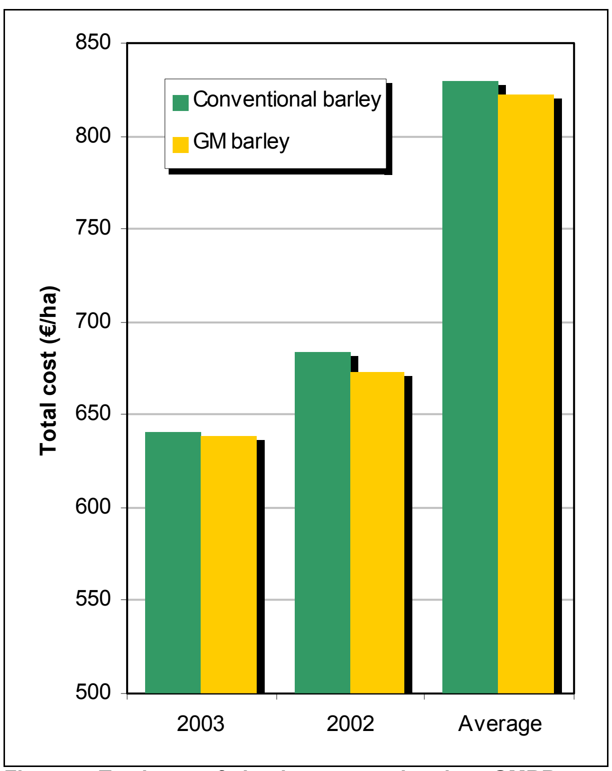

Figure 4. Total cost of planting conventional vs. GMRR spring barley.

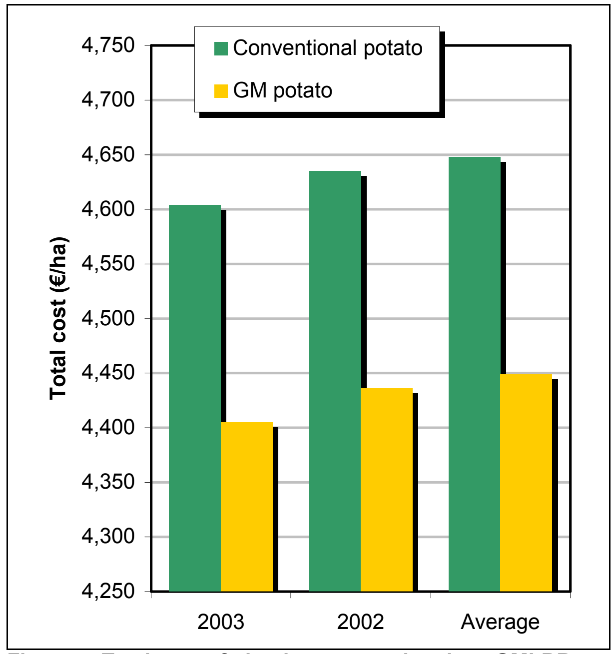

Figure 5. Total cost of planting conventional vs. GMLBR potato.

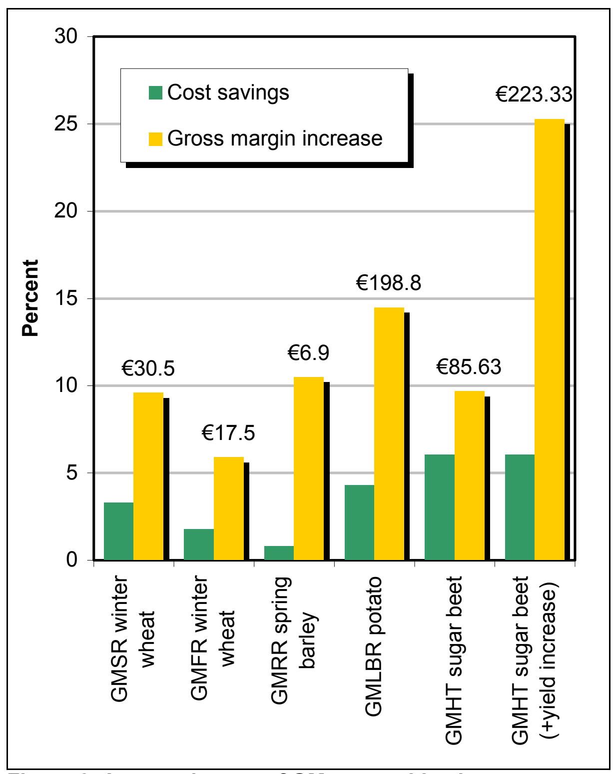

Figure 6. Average impact of GM crop cultivation on cost savings and gross margins for GMSR and GMFR wheat, GMRR barley, GMLBR potato, and GMHT sugar beet—2002 and 2003. The numerical average gross margin value is shown for each data set.

Table 2. The total cost and profit margins for winter wheat, spring barley, and potato (€/ha, unless otherwise noted).

	Conventional			GM			GM vs. conventional			Difference	Saving
	2002	2003	Average	2002	2003	Average	2002	2003	Average	(%)	(%)
Winter wheat (GMSR)											
Yield (t/ha)[a]	9.1	9.1	9.1	9.1	9.1	9.1	0.0	0.0	0.0		
Output (€/t)	866.9	866.9	866.9	866.9	866.9	866.9	0.0	0.0	0.0		
EU area aid	383.0	383.0	383.0	383.0	383.0	383.0	0.0	0.0	0.0		
Output (/ha)	1249.9	1249.9	1249.9	1249.9	1249.9	1249.9	0.0	0.0	0.0		
Seed	57.0	63.0	60.0	65.6	72.5	69.0	8.6	9.4	-9.0		
Technology cost[b]	0.0	0.0	0.0	25.0	25.0	25.0	25.0	25.0	25.0		
Fungicides	179.0	150.0	164.5	108.0	91.0	100.0	-71.0	-59.0	64.5		
Spray application	72.0	70.0	71.0	72.0	70.0	71.0	0.0	0.0	0.0		
Other costs[c]	658.0	616.0	637.0	658.0	616.0	637.0	0.0	0.0	0.0		
Total costs	966.0	899.0	932.5	928.6	874.5	902.0	-37.5	-24.6	-30.5	96.7	-3.3
Gross margin	283.9	350.9	317.4	321.3	375.4	347.9	37.5	24.6	30.5	109.6	9.6
Winter wheat (GMFR)											
Yield (t/ha)[a]	9.1	9.1	9.1	9.1	9.1	9.1	0.0	0.0	0.0		
Output (€/t)	866.9	866.9	866.9	866.9	866.9	866.9	0.0	0.0	0.0		
EU area aid	383.0	383.0	383.0	383.0	383.0	383.0	0.0	0.0	0.0		
Output (/ha)	1249.9	1249.9	1249.9	1249.9	1249.9	1249.9	0.0	0.0	0.0		
Seed	57.0	63.0	60.0	65.6	72.5	69.0	8.6	9.4	-9.0		
Technology cost[b]	0.0	0.0	0.0	25.0	25.0	25.0	25.0	25.0	25.0		
Fungicides	179	150	164.5	123	103	113	-56	-47	51.5		
Spray application	72	70	71	72	70	71	0.0	0.0	0.0		
Other costs[c]	658.0	616.0	637.0	658.0	616.0	637.0	0.0	0.0	0.0		
Total costs	1009.0	899.0	954.0	986.6	886.5	936.5	-22.5	-12.6	-17.5	98.2	-1.8
Gross margin	240.9	350.9	295.9	263.3	363.4	313.4	22.5	12.6	17.5	105.9	5.9
Spring barley (GMRR)											
Yield (t/ha)[a]	5.6	5.6	5.6	5.6	5.6	5.6	0.0	0.0	0.0		
Output	520.8	504.0	512.4	520.8	504.0	512.4	0.0	0.0	0.0		
EU area aid	383.0	383.0	383.0	383.0	383.0	383.0	0.0	0.0	0.0		
Total output (/ha)	903.8	887.0	895.4	903.8	887.0	895.4	0.0	0.0	0.0		
Seed	60.0	68.0	64.0	69.0	78.2	73.6	9.0	10.2	9.6		
Technology cost[b]	0.0	0.0	0.0	25.0	25.0	25.0	25.0	25.0	25.0		
Fungicides	91.0	75.0	83.0	45.5	37.5	41.5	-45.5	-37.5	-41.5		
Spray application	44.0	42.0	64.0	44.0	42.0	64.0	0.0	0.0	0.0		
Other costs[c]	489.0	456.0	618.5	489.0	456.0	618.5	0.0	0.0	0.0		
Total costs	684.0	641.0	829.5	672.5	638.7	822.6	-11.5	-2.3	-6.9	99.2	-0.8
Gross margin	219.8	246.0	65.9	231.3	248.3	72.8	11.5	2.3	6.9	110.5	10.5
Potato (GMLBR)											
Yield (t/ha)[a]	31.7	31.7	31.7	31.7	31.7	31.7	0.0	0.0	0.0		
Output	6016.7	6016.7	6016.7	6016.7	6016.7	6016.7	0.0	0.0	0.0		
Seed	813.0	813.0	813.0	935.0	935.0	935.0	-122.0	-122.0	-122.0		
Technology cost[b]	0.0	0.0	0.0	25.0	25.0	25.0	25.0	25.0	25.0		
Fungicides	343.0	343.0	343.0	57.2	57.2	57.2	285.8	285.8	285.8		

Table 2. (Cont.) The total cost and profit margins for winter wheat, spring barley, and potato (€/ha, unless otherwise noted).

	Conventional			GM			GM vs. conventional			Difference (%)	Saving (%)
	2002	2003	Average	2002	2003	Average	2002	2003	Average		
Spray application	86.5	84.0	85.3	26.6	24.0	25.3	59.9	60.0	59.9		
Other costs[c]	3334.0	3364.0	3349.0	3334.0	3364.0	3349.0	0.0	0.0	0.0		
Total costs	4635.0	4604.0	4648.8	4436.2	4405.1	4449.9	198.8	198.9	198.8	95.7	4.3
Gross margin	1381.7	1412.7	1367.9	1580.4	1611.6	1566.7	198.8	198.9	198.8	114.5	14.5

[a] Yields were generated by taking an average of the output levels listed in the Farm Management Protocol Data (Teagasc, 2002; 2003).
[b] Technology cost comprises a proposed €25 coexistence levy.
[c] This category consists of all costs not affected by changing to a GM regime: fertilizers, herbicides, insecticides, growth regulators, plowing, tilling, sowing, fertilizer spreading, harvesting, interest (7%), transport, and miscellaneous; for potato, desiccant, bags and ties, misting, cultivations, destoning, planting, grading in and out of store, and storage boxes.

Because no GM crops are currently cultivated in Ireland, the data described here is suggestive rather than conclusive evidence that certain GM crops will provide significant economic benefit to the Irish farmer. As with previous analyses (May, 2003), this report is based on a limited number of published studies and is therefore likely to advance and develop as European data for GM crop cultivation emerges in the near future. Consequently, the assumptions made for this paper may be altered, specifically in regard to the yield and market price of GM products or seed. As increased information becomes available from research trials in the European context, and if and when ex post data become available, the input coefficients used for the economic analysis can be updated.

Overall, the adoption of GM crops at farm level is dependent on the technology providing overall cost savings through a reduced need for pest and disease control (or different methods to do so) and/or the achievement of higher yields (CEC, 2000; Kalaitzandonakes, 2003; Magen & Imas, 2004). This report describes the first analysis of GM cultivation in Ireland. In conclusion, our analysis shows that the potential exists for GM crops to be more profitable for Irish farmers than conventional crops, if seed and coexistence costs are offset by savings in pest or disease control costs and/or by higher yields.

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