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The economics of reseeding on a dairy farm

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Herbage production and utilization on Irish dairy farms is well below its potential. A number of factors influence herbage production and utilization, not least the level of annual reseeding (introduction of a new grass ley) on the farm. The potential farm performance is reduced by old permanent pasture due to the combined effects of reduced out-of-season herbage production and lower overall herbage yield when compared to perennial ryegrass. Based on the sales of grass seed, it is estimated that approximately 2% of the land area on dairy farms in Ireland is reseeded annually. This has created a situation where the overall percentage of perennial ryegrass in sward is low. The objective of the present study was to investigate the economic benefits of reseeding through simulating the consequences of reseeding different proportions of the farm on an annual basis. Four levels of an annual reseeding programme were evaluated: 1%, 5%, 10% and 15% of the farm reseeded annually; evaluated at three milk prices (20 c/L, 27 c/L and 33 c/L). Increasing the level of reseeding resulted in an increase in total and seasonal herbage production and, when accompanied by an increased stocking rate, increased herbage utilization. At a milk price of 27 c/L, farm profitability was €20 764, €24 794, €30 073 and €33 515 on a 40 ha farm when 1%, 5%, 10% and 15%, respectively, of the farm was reseeded annually. Irrespective of milk price, increasing the level of reseeding had a positive effect on profitability and the highest gain was achieved at the highest milk price. Sensitivity analysis showed that sward persistency and, to a lesser extent, herbage utilization had significant effects on the benefit from reseeding.

Keywords: dairy farm; profitability; reseeding

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Introduction

Irish dairy farmers are facing challenging times due to major changes in national and international agricultural policies. The continued reform of the Common Agricultural Policy (CAP) of the EU is likely to change the production landscape dramatically for all milk producers in the EU (McCarthy *et al*. 2007). This policy reform will create significant opportunities for Irish dairy farmers, facilitated by the allocation of additional quota allowing expansion pre milk-quota removal in 2015. Under the CAP regime, milk price supports, through import tariffs and export subsidies, stabilized prices in the EU compared to those outside the EU (O'Donnell *et al*. 2008). In the future a World Trade Organisation agreement is likely to result in a reduced EU milk price through lower domestic support, tariff cuts and a reduction in export refunds (Dillon *et al*. 2008).

Business success in an environment with a lower and more volatile milk price requires producers to become more focused on maximizing efficiency. This can be achieved by more judicious use of inputs, innovation and increased productivity; adopting the most efficient combination of inputs and outputs which will lead to the greatest return to the farm business.

Approximately 44% of the variation in total profit per hectare can be explained by variation in herbage utilization (quantity of herbage harvested per hectare) (Shalloo 2009). Grazed grass is the cheapest feed available to all ruminant systems (Finneran *et al*. 2010), with a relative cost ratio of grazed grass to grass silage and to concentrate of 1:1.8:2.4. A strong relationship between grazing season length and technical efficiency was reported by Kelly *et al*. (2011), using data from the National Farm Survey for 2008. Due to climatic conditions, Irish grass-based systems have the potential to achieve a long grass-growing and grazing season. Currently, on the average farm, 6.4 t/ha of herbage is being utilized over a 210-day grazing season (McCarthy, Shalloo and Geary 2011), on the farm area around the milking facility. In contrast, efficient commercial farms are utilising 12 to 14 t/ha day matter (DM), over a 280-day grazing season, on farms stocked at over 3.0 cows/ha. A relationship between stocking rate and herbage grown for a sample of Irish dairy farms is shown in Table 1, with higher stocked farms growing substantially more herbage than more lowly stocked farms. Herbage utilization is related to herbage production per hectare, stocking rate and grassland management. Nationally, the average stocking rate on the grazing area of dairy farms is 1.78 livestock units per hectare (O'Donnell *et al*. 2008). Some reasons advanced for the poor herbage utilization on the average Irish dairy farm centre around the type of grass, grassland management and overall farm stocking rate, with other factors such as soil type, altitude and climatic conditions having smaller effects.

Perennial ryegrass is a high quality feed and is more nutrient responsive than other grass species. Data from recent studies at Moorepark have shown that when newly reseeded swards were compared, under similar management, to swards with < 20% perennial ryegrass the newly reseeded swards produced more DM (3 t/ha) (Creighton *et al*. 2011b). The herbage DM production also differed across the grazing season (Figure 1) when swards containing 30% perennial ryegrass (*Agrostis* and *Poa* species made up the balance of sward content) were compared with those containing 100% perennial ryegrass (all swards received the same level of N application: 250 kg ha^{-1} $year^{-1}$). The majority of the difference in DM yield between the swards occurred between February and mid May.

Table 1. Mean and range in herbage dry matter production on 17 dairy farms in southern (Munster region) Ireland in 2009

Farm location	Dry matter production (kg/ha)			Stocking rate (cows/ha)
	Average	Top 20% of paddocks	Bottom 20% of paddocks	
Tipperary	14.4	17.0	9.5	3.0
Limerick	13.4	14.5	11.4	3.1
Tipperary	12.8	14.3	10.1	2.5
North Cork	12.4	14.6	10.6	2.9
Tipperary	11.9	15.0	8.0	2.2
North Cork	11.7	14.5	8.3	2.5
North Cork	11.0	13.5	7.1	2.7
North Cork	11.0	13.2	8.5	2.1
North Cork	11.0	12.9	8.5	3.1
North Cork	10.9	13.2	8.4	2.6
Tipperary	10.2	13.3	7.5	2.2
North Cork	9.9	13.3	6.3	2.7
Tipperary	9.6	11.7	7.5	2.5
North Cork	9.4	12.8	7.2	3.3
North Cork	9.3	11.5	6.0	2.0
North Cork	9.2	11.9	7.7	2.2
North Cork	9.2	11.0	6.3	2.7
Average	11.0	13.4	8.2	2.60

While perennial ryegrass is by far the most widely sown grass species in Ireland, accounting for approximately 95% of forage grass seed sold (DAFF 2009), its introduction to Irish pastures is low with level of reseeding (introduction of a new grass ley) at approximately 2% per annum. As its name suggests, perennial ryegrass is capable of surviving in well managed pastures over a long period. It establishes rapidly from seed, with a strong tillering capacity, to produce a dense sward, is highly acceptable to stock and capable of withstanding intensive grazing, and responds well to fertile conditions and inputs of nitrogen. A recent survey (Creighton *et al*. 2011a) confirmed the decline in grassland reseeding in Ireland. Twenty three percent of dairy farmers stated that they had not reseeded

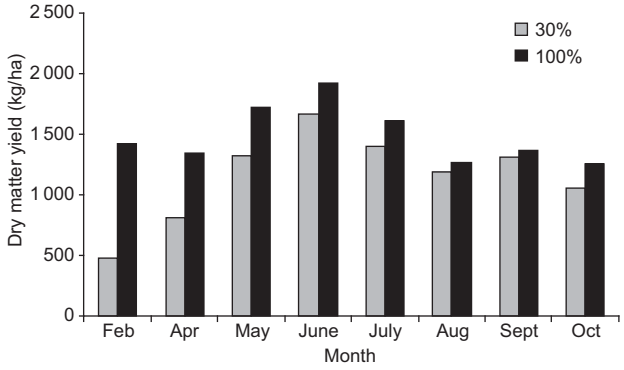

Figure 1. Herbage dry matter yield across the grazing season for swards with 30% and 100% perennial ryegrass.

in the previous 3 years and, where reseeding occurred, farmers were more likely to reseed the grazing area rather than the area used for silage.

The objectives of the work reported in this paper were to use simulation modelling to: (i) determine the biological and economic benefits from reseeding pastures for grazing dairy livestock, (ii) quantify the effect that reseeding different proportions of the farm has on biological and financial performance, and (iii) determine the effect of persistency and herbage utilization of the reseeded sward on profitability.

Materials and Methods

The Moorepark Dairy Systems Model (MDSM) (Shalloo *et al*. 2004a) was used to simulate herd performance, nutritional requirements, land use and total inputs and outputs across the calendar year. The MDSM is a stochastic budgetary simulation model that provides a comprehensive framework for integrating the biological, physical and economic processes of a dairy farm. The revenues are milk and livestock sales. Within the model, land area is treated as an opportunity cost with additional land rented when required or leased out when not required for the herd. Variable costs (fertilizer, concentrate, silage, veterinary medicine, artificial insemination, reseeding and contractor charges), fixed costs (car, electricity, labour, machinery operation and repair, phone, insurance, etc.) and receipts (livestock and milk) were based on current prices.

A spring-calving grass-based milk production system, which is similar to the production system on most Irish dairy farms (Dillon *et al*. 2005), was simulated using the MDSM. Cows were turned out to grass immediately post-calving; mean calving date was 24th February, calving interval was 365 days and 70, 20 and 10% of the cows calved in February, March and April, respectively. To achieve this, breeding was started on a fixed calendar date in late April, with every cow detected in estrus served using AI, regardless of the number of days since calving; the breeding season length was 13 weeks.

The system simulated optimizes the use of grazed herbage as a proportion of the total diet of the lactating dairy cow, allowing high cow performance, while the system is designed to maximize profitability within the various farm constraints. The net energy system, described by Jarrige (1989), was used to determine the energy requirements of the herd. The proportions of the feeds offered (grass, grass silage and concentrate) were adjusted to meet the net energy requirements for milk production, maintenance, pregnancy and bodyweight change.

Analysis assumptions

Scenario 1 (S1): In order to simulate the effects of different levels of reseeding a number of levels of reseeding were modelled. In the analysis, the base herbage production was assumed to be 8704 kg/ha DM with a utilization rate of 85%, which was made up of 8400 kg/ha DM from old permanent pasture with the remainder originating from a perennial ryegrass sward (1% of the farm reseeded per annum). This was then compared to farm situations where 5%, 10% or 15% of the farm was reseeded annually. Each reseeded paddock produced 15 t/ha DM in year 1 after reseeding with subsequent production declining at a rate of 2% per year (based on consultation and expert opinion). It was assumed that approximately 50% more N fertiliser would be applied to the reseeded swards, based on expected higher response to N input. The analysis

was carried out for three milk prices (20, 27 and 33 c/L).

Scenario 2 (S2): The base assumption was that 10% of the farm was reseeded annually and the effect of reseeding on profitability was evaluated after individual components were altered:

(a) herbage utilization reduced by 5 percentage points
(b) persistency of newly reseeded swards was reduced from an annual decline in yield of 2% (as in S1) to a decline of 5% per annum,
(c) reseeding cost was increased by 20%

The key assumptions used in the MDSM are shown in Table 2. The reseeding cost (€540/ha) comprised €148, €65, €141, €111 and €75 for tilling, spraying, fertilizer, seed and other costs, respectively. It was assumed that the reseeded sward was depreciated based on the level of reseeding on the farm. For example if 10% of the farm was reseeded annually then the whole farm would be reseeded over a 10-year period, therefore, the reseeding cost was depreciated over a 10-year period; if 5% of the farm was reseeded annually then the reseeding was depreciated over a 20-year period. Both interest and depreciation were considered an expense. Interest was included at 5% per annum. It was assumed that the net yield in the year of reseeding did not change, as the period of time when the paddock was not producing would be compensated for by increased production subsequently within the year (Creighton *et al*. 2011b). The performance of the paddock was based on the average performance expected over the years that the sward was in production.

Table 2. Cost assumptions used in the model

Item	Cost
Opportunity cost of land (€/ha)	297
Reseeding cost (€/ha)	540
Fertiliser cost (€/t)	
Urea	400
Calcium ammonium nitrate	280
Concentrate cost (€/t)	220
Silage contracting cost (€/ha)	
1st Cut	272
2nd Cut	222
Replacement cost (€)	1550
Replacement rate (%)	18
Housing cost (€ per animal)	2500

Results

Effect of reseeding rate on performance

The results show that the level of reseeding had a direct effect on the performance of the farm. Thus, for S1, when the level of reseeding was increased there was a substantial increase in herbage production (Table 3). Since it was assumed that herbage utilization percentage remained constant as production increased, the number of cows was increased to match pasture supply. The total quantity of herbage that was utilized increased (relative to the base) by 13%, 30% and 41%, respectively, and cow numbers increased by 7%, 15% and 20%, respectively, when 5%, 10% and 15% of the farm was reseeded annually. Due to the expected seasonal change in herbage production as a consequence of an increased proportion of perennial ryegrass in the sward, the level of grazed grass, grass silage and concentrate in the diet of the dairy cow changed. In the base scenario the diet consisted of 56%, 30% and 14% of grazed grass, grass silage and concentrate, respectively, compared with 60%, 28% and 12%, respectively, when 5% was reseeded, 65%, 26% and 9%, respectively, when 10% was reseeded, and 69%, 24% and 7%, respectively, when 15% of the farm was reseeded annually. Milk production and total sales increased as the swards became more productive and the number of cows increased.

Table 3. The effect of level of reseeding on aspects of farm performance (40 ha farm)

Item	Proportion of farm reseeded annually			
	1%	5%	10%	15%
Herbage dry matter (DM) production (kg/ha)	8704	9856	11323	12254
Herbage DM utilized (kg/ha)	7402	8382	9629	10421
No. of cows calving	71	76	82	85
Herbage DM grazed (kg/cow)	3003	3195	3414	3641
Herbage DM consumed as silage (kg/cow)	1605	1495	1383	1248
Concentrate DM (kg/cow)	730	614	479	351
Fertiliser N (kg/ha)	166	189	213	236
Reseeding costs (€)	229	1147	2295	3442
Labour costs (€)	31605	32489	33573	34146
Concentrate costs (€)	12409	11461	10127	8264
Fertiliser costs (€)	9540	10478	11421	12294
Total farm costs (€)	130898	137190	144578	147837
Fat sales (kg)	15936	17018	18344	19045
Protein sales (kg)	14425	15404	16605	17239

Effect of reseeding rate on profit

The annual reseeding cost increased, as expected, as the proportion reseeded increased (Table 3). Labour and fertiliser costs increased due to the increase in herd size and fertiliser rate, while concentrate costs declined due to a longer grazing season. Reseeding effects on profitability are shown in Table 4. The effect of level of reseeding on farm profitability depended on the milk price – the relative increase in profitability was higher at 20 c/L compared with a milk price of 33 c/L. Margin per cow and per litre increased by the same proportion as farm profit, across the three milk prices.

Table 4. The effect of level of reseeding on profitability (40 ha farm) for three milk prices

Item	Proportion of farm reseeded annually			
	1%	5%	10%	15%
		Milk price 20 c/L		
Total milk sales (€)	88993	95032	102441	106355
Total farm profit (€)	–10844	–8958	–6311	–4259
Net profit per cow (€)	–152	–118	–77	–50
Net profit per 1 kg milk (c)	–2.44	–1.89	–1.24	–0.80
		Milk price 27 c/L		
Total milk sales (€)	120403	128573	138598	143893
Total profit (€)	20764	24794	30073	33515
Net profit per cow (€)	292	327	367	394
Net profit per 1 kg milk (c)	4.68	5.23	5.89	6.32
		Milk price 33 c/L		
Total milk sales (€)	147286	157281	169544	176021
Total farm profit (€)	47817	53683	61214	65846
Net profit per cow (€)	672	707	748	775
Net profit per 1 kg milk (c)	10.78	11.33	11.99	12.42

Sensitivity analysis

Results from S2 are summarised in Table 5. Reducing herbage utilization rate reduced the benefit of reseeding. Total farm milk output declined by 4.3% compared to the system where utilization was 85%. While profitability was still substantially higher than when 1% of the farm was reseeded annually (Table 4) there was a substantial negative effect on profitability, especially at lower milk prices. The persistency of the reseeded sward had a significant effect on the benefits of reseeding. When the base level of annual decline increased from 2% to 5% there was a substantial reduction in the benefits of reseeding. The total herbage utilized declined and total milk output declined (Table 5). A 20% increase in the cost of reseeding only had a marginal effect on the financial outcome.

Discussion

Currently, regardless of system or enterprise, grazed grass is the largest proportional constituent of the ruminant feed budget (O'Donovan and Kennedy 2007; Drennan and McGee 2009; Keady, Hanrahan and

Table 5. Sensitivity to change in herbage utilization, persistency of the sward and reseeding cost

Item	Base scenario†	Change‡		
		Herbage utilization	Persistency of reseed	Reseeding cost
Herbage dry matter (DM) production (kg/ha)	11323	11323	10399	11323
Herbage DM utilized (kg/ha)	9629	9057	8843	9630
Cows calving	82	78	79	82
Fat sales (kg)	18344	17538	17689	18344
Protein sales (kg)	16605	15875	16012	16605
Reseeding cost (€)	2295	2295	2295	2762
Labour cost (€)	33573	32914	33038	33573
Concentrate cost (€)	10127	9682	11913	10127
Fertiliser cost (€)	11421	11355	11474	11421
Total farm costs (€)	144578	139735	143413	145046
		Milk price 27 c/L		
Milk sales (€)	138598	132503	133647	138599
Total farm profit (€)	30073	27223	24965	29606
Net profit per cow (€)	367	348	316	362
Net profit per 1 kg milk (c)	5.89	5.58	5.07	5.80
		Milk price 20 c/L		
Milk sales (€)	102441	97937	98782	102441
Total farm profit (€)	–6311	–7562	–10120	–6779
Net profit per cow (€)	–77	–97	–128	–83
Net profit per 1 kg milk (c)	–1.24	–1.55	–2.06	–1.33
		Milk price 33 c/L		
Milk sales (€)	169544	162089	163487	169544
Total farm profit (€)	61214	56994	54993	60747
Net profit per cow (€)	748	728	697	742
Net profit per 1 kg milk (c)	11.99	11.67	11.17	11.90

† Annual proportion reseeded 10%, herbage utilization 85%, persistency 2%, reseeding cost €540/ha.
‡ Herbage utilization reduced to 80%; persistency reduced to 5%, reseeding cost increased to €650/ha.

Flanagan 2009) and grass silage is the principal winter feed for livestock in Ireland (Drennan, Carson and Crosse 2005).

Milk production systems in Ireland have a competitive advantage when compared to most other milk production systems throughout the world; New Zealand is one of the only countries that consistently produces milk for export at a significantly lower cost than Ireland (Shalloo 2009). Ireland's competitive advantage is centered on the conversion of the cheapest feed available (grazed grass) into milk at low cost (Shalloo *et al*. 2004a; Dillon *et al*. 2005). Analysis of farm survey data shows that there is large variation in production costs and profitability and that there is substantial scope to improve system efficiency (Shalloo 2009). Dillon *et al*. (2005) showed that a 10% increase in the proportion of grazed grass in the annual feed budget reduced the cost of milk production by €0.025/L. Further benefits of increasing the proportion of herbage harvested at farm level will be realized when milk quotas are removed.

The objective of grass-based systems of milk production is to match the supply of feed with feed demand, at the lowest cost possible. This ensures the system can cope with both input and output price volatility through minimizing input purchases and still return a profit at a low milk price. Increasing the period of time during which herbage can be harvested by the grazing animal (i.e., extending the grazing season) has been shown in a number of studies to reduce the cost of milk production per litre while at the same time increasing milk output per hectare (Shalloo *et al*. 2004b). The financial impact of herbage DM yield varies across the season, and is influenced by feed supply and herd demand (Doyle and Elliott 1983). Feed demand generally exceeds supply for Irish grass-based ruminant production systems in spring and autumn whereas herbage supply generally exceeds feed demand during the main grazing season, but the extent depends on stocking rate. Each additional kilogram of herbage produced in spring and autumn has a greater economic impact on a grazing system than a similar increase during the mid-season (McEvoy, O'Donovan and Shalloo 2011).

Increasing the quantity of herbage produced in the period of the year when demand exceeds supply will reduce dependence on purchased feed. The purchase of feed, which is subject to substantial price volatility, exposes the farm business to risk. Reducing exposure to this type of volatility, through increased grazing season length and reduced concentrate feed requirement, will increase the sustainability of the dairy business especially with the expected increased volatility in milk price. While the increased level of reseeding did not fully insulate against the effects of a low milk price, it did reduce the exposure, while the greatest benefit from reseeding was achieved at higher milk prices.

Milk quotas have limited milk production in Ireland since their imposition in 1984. Since then the number of dairy farms has declined from over 70 000 to under 20 000, dairy cow numbers have declined from over 1.5 M to just over 1.1 M and milk output has declined (CSO 2011). The results from the present study have shown that increased outputs and reduced unit costs of production result from reseeding, which will result in substantially increased profitability after milk quotas are removed in 2015. The analysis reported in this paper shows that in order to realize the full potential from reseeding there must not be any associated reduction in herbage utilization rate. The stocking rate should be increased as the farm is being reseeded to utilize the increased production from the sward. Increasing

stocking rate will increase herbage utilization, with a positive effect on profit (Shalloo, O'Donnell and Horan 2007), which will result in increased milk output while at the same time yielding lower unit costs of milk production.

The level of persistency of the reseeded sward affects herbage production and the requirements for subsequent reseeding. High persistency is desirable as frequent cultivation and reseeding of pasture is expensive (Wilkins and Humphreys 2003). The present study has shown that the level of persistency has a substantial effect on the farm profit. One third of the benefits associated with reseeding 10% of the farm *versus* 1% of the farm were lost when the persistency declined (5% *vs*. 2%). While the effect will be smaller where more of the farm is reseeded annually there is still a substantial negative effect on the financial benefits from reseeding with lower persistency. Sward yield persistency is a subject of considerable debate (Parsons *et al*. 2011) without a consensus being reached on the performance of newly established grass leys. The present results clearly show that if there are to be sustainable economic gains from reseeding, the newly established varieties must persist over a prolonged period.

The level of reseeding that is carried out influences the speed at which herbage production is increased on a farm. For example, after reseeding 5% of the farm over a 3-year period, the total herbage DM production increased from 8730 kg/ha to 9315 kg/ha, while reseeding 15% of the farm annually would increase production to 11145 kg/ha. While there is a higher upfront cost, this level of reseeding results in a farm becoming more productive and hence more profitable, in a shorter timeframe. Reseeding levels on farms that are currently productive will have to remain high to maintain performance. The identification of perennial ryegrass cultivars capable of increasing DM production will be a continuous challenge. Grass cultivars that not alone increase average performance but that also increase the performance of the best farms are required if reseeding is to be justified on farms that currently have highly productive pastures. In the future, cultivars that deliver much higher seasonal herbage yield, total herbage yield and are persistent will be required if animal output from grassland is going to be continually increased.

Conclusions

Increasing the level of reseeding on farm will increase grass production and milk sales if accompanied by increased stocking rate so as to maintain herbage utilization. This is true at all levels of milk price but the magnitude is greater at higher prices. The gains that are achieved from reseeding can be lost quickly if the persistency of the new cultivars is low. Increasing the level of reseeding nationally will help to facilitate increased milk production from the Irish dairy industry in a profitable fashion.

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