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Economic evaluation of pasture renovation options in irrigated dairy farming

Dailin Kularatne[1] and Alister Lawson[2]

[1]Department of Natural Resources and Environment, Ferguson Road Tatura, VIC 3616.
Ph: (03) 58 335 270 Email: dailin.kularatne@nre.vic.gov.au
[2]Department of Natural Resources and Environment, Cooma Road Kyabram, VIC 3620.
Ph: (03) 58 520 514 Email: alister.lawson@nre.vic.gov.au

ABSTRACT

The economics of a number of pasture renovation options were evaluated using a Partial Budget Model. The analysis took into account changes in income (milk, hay and livestock sales), variable costs (feed, shed, herd and casual labour) and overhead costs (depreciation of livestock) resulting from the management changes associated with the pasture renovation scenarios

Oversowing of pastures with either perennial ryegrass or short-lived ryegrass, in a system in which cow numbers were altered in response to changes in pasture supply, resulted in increased pasture consumption, higher stocking rates, increased milk production, increased income and increased gain after costs. These benefits of oversowing occurred in both medium and high concentrate feeding and split calving systems.

Analysis of the resowing of pastures showed that the reduction in pasture consumption in the year of resowing necessitated increased concentrate inputs. This increase in feed costs is approximately double that of the actual pasture resowing costs. The time to breakeven is dependent upon the productivity level of the initial pasture and the species sown.

Keywords: pasture renovation, economic analysis, partial budget

INTRODUCTION

Increased production efficiency is essential if dairy farm businesses are to be internationally competitive and remain viable under continually decreasing terms of trade for agricultural commodities. The amount of pasture consumed is considered to be one of the key factors determining farm profitability (Moran *et al.* 2000).

Perennial pastures used for dairy production in the irrigated region in northern Victoria are based upon perennial ryegrass and white clover, but are invaded and often dominated by paspalum and summer active weeds. A high perennial ryegrass and white clover content of these pastures is crucial to optimising pasture growth and nutritive characteristics in the cooler months. A field experiment was set up at the Kyabram Dairy Centre in northern Victoria in the autumn of 1999 to quantify the effects of a number of pasture renovation options on the dry matter (DM) production, nutritive value and botanical composition of these pastures (Lawson *et al.* 2001).

Oversowing allowed an increase in pasture consumption in the first and second years of 1.0 and 0.9 t DM/ha, respectively, for perennial ryegrass and 1.4 and 1.8 t DM/ha, respectively, for short-lived ryegrass. Given that oversowing with either genotype costs approximately $150/ha, oversowing may be an economical way of increasing pasture consumption and milk production. However, consideration needs to be given to the utilisation of the extra dry matter in a whole farm context and to the longevity of the responses in examining the effects of these practices on profitability.

Resowing of pasture requires that the area be taken out of production until the new pasture has established. In the first year after resowing there was a decrease in DM consumption of 3.5 to 4.0 t DM/ha, although there is an associated increase of up to 6-7 % units in the DM digestibility of the pasture on offer. In the second year, the DM consumption from the resown perennial ryegrass pasture was similar to the existing pasture while that from the resown tall fescue pasture was 2.4 t DM/ha higher. The changes in pasture consumption in years 1 and 2 would necessitate a change in supplementary feeding to maintain per cow and herd milk production. These changes in supplementary feeding costs need to be considered in addition to the establishment cost of a new pasture at around $250/ha. Finally, the risk associated with both resowing and oversowing are important in deciding which option to pursue with the failure of a resowing program being expensive (renovation costs and lost pasture production) compared to oversowing (renovation costs only).

This paper covers the modelling and economic analysis of some of these pasture renovation treatments in a whole farm context.

METHODOLOGY

Simulations of field data in UDDER

The agronomic data generated in the field experiment (DM digestibility and pasture consumption) were used in the dairy farm management model, UDDER, a Desktop Dairy farm for Extension and Research (Larcombe 1990), to model pasture growth and milk production on a whole farm basis. UDDER simulations involved the optimisation of stocking rate, the timing and amount of concentrate fed to the milkers, and the timing and area of pasture cut for forage conservation (hay) in order to take advantage of any increases in pasture growth and/or nutritive characteristics. Stocking rate was calculated on the basis of cows / effective (EFF) ha, where EFF ha corresponded to the area of perennial pasture (the simulated farm had no annual pasture).

To minimise the effect of the specified grain price on the optimisation routine within UDDER, a pre-determined quantity of pellets per cow were fed in the oversowing scenarios and sufficient pellets fed in the resowing scenarios to ensure that milk production per cow milk was approximately the same as in the base farm (see below). In both cases, the most appropriate time to feed pellets was decided by looking at the residual pasture cover as simulated by UDDER with the aim of keeping it in the range of 4 to 5 cm. This residual pasture height has been shown to optimise the compromise between pasture growth rates and the efficient use of supplements (Lawson *et al.* 1998; Stockdale 2000).

The base farm was 85 ha, of which 72 ha was perennial pasture, carried 217 spring calving cows, and fed pellets throughout the year (1.0 t DM/cow.year) and maize silage in autumn (0.42 t DM/cow.year). Young stock were carried on the milking area, but the dry cows were sent to an outblock from drying off until just prior to calving. No hay was fed on the milking area with any hay made being sold off the milking area. The pastures had a low perennial ryegrass (ranging from 15 %DM in late summer to 45 %DM in late spring) and a high paspalum content (>40 %DM in summer).

The pasture renovation scenarios simulated in UDDER are shown in Table 1.

Table 1. Pasture renovation scenarios simulated using UDDER.

Scenario	Description of pasture renovation practice
Base Farm	Nil
Oversown – PRG1	Oversow 100% of farm with perennial ryegrass in year 1
Oversown – PRG1&2	Oversow 100% of farm with perennial ryegrass in both years 1 and 2
Oversown – SLRG	Oversow 100% of farm with short-lived ryegrass in both years 1 and 2
Resown – PRG1	Resow 20% of farm with perennial ryegrass in year 1
Resown – PRG1&2	Resow 20% of farm with perennial ryegrass in year 1 and oversow the same 20% with perennial ryegrass in year 2
Resown - Fescue	Resow 20% of farm with tall fescue in year 1

Economic analysis of the oversowing scenarios was done under a range of farm systems. (The resowing scenarios were only examined in system 1). These systems were:

1. Spring calving, medium concentrate input (1.0 t DM of concentrate/cow.yr).
2. Split calving (30% autumn, 70% spring), medium concentrate input (1.0 t DM of concentrate/cow.yr).
3. Spring calving, high concentrate input (2.0 t DM of concentrate/cow.yr).

Two approaches were taken to use any extra pasture grown. These were:

- Cow numbers were varied and concentrate inputs per cow kept constant (used for oversowing scenarios in systems 1, 2 and 3).
- Cow numbers were kept constant and concentrate inputs per cow varied (used for oversowing and resowing scenarios in system 1).

Economic analysis of output from UDDER

The outputs of UDDER were used to produce an economic analysis of each pasture management scenario using a Partial Budget Model (Kelly 1999). This economic analysis took into account changes in income (milk, hay and livestock sales), variable costs (feed costs including pasture renovation and agistment, shed, herd and casual labour) and overhead costs (depreciation of livestock) resulting from the management changes associated with the pasture renovation scenarios. This model was used instead of the Gross Margin Analysis within UDDER as Kelly and Malcolm (1999) found that not all of the economic implications of changes in stocking rate or supplementary feeding practices are adequately captured within the economics associated with the UDDER package, and in some situations, the results may be misleading.

Discounting at a rate of 10% was used to bring the extra costs of pasture renovation (mostly in year 1) and the extra benefits of pasture renovation (usually spread over a number of years) to the present value in order to have a common ground for comparison.

The base farm was assumed to have 2 full time labour units and infrastructure (dairy and laneways) that was capable of handling extra cows. However, any increase in cow numbers would necessitate additional casual labour at a rate of 1 labour unit (38 hours per week) per 100 cows.

Standard prices were adopted for costs and returns and were sourced from ABARE (Aitken 1996) and Target 10 (Moran 2000). When a range of costs were found, the higher values were used. The milk price used was midway between the Murray Goulburn opening prices for 2000/01 and 2001/02 (approximately $6.50/kg butterfat equivalent). A concentrate price of $180/t DM was used.

A sensitivity analysis of the effect of the DM response to resowing on the physical and economic outcomes was undertaken. Since the initial base pasture would not normally be viewed as requiring resowing (due to its "high" pasture consumption level of 10.7 t DM/ha), new base pastures with growth rates of either 60%, 80% or 100% of the initial base pasture were generated on 20% of the farm in order to simulate a range of productivity levels of the base pasture. The growth rate on the other 80% of the farm, and the DMD on the entire farm, were not altered. The growth rates of the resown pastures were then compared to these new base pastures.

RESULTS

Oversowing in a spring calving, medium concentrate input system (variable cow numbers)

In a spring calving, medium concentrate input system, the higher pasture growth in the oversown scenarios allowed an increase in cow numbers and resulted in higher pasture consumption (Table 2). In the Oversown-SLRG scenario, the high spring growth rates required some forage conservation (0.6 t DM/ha was conserved and sold off the milking area) and this resulted in a smaller increase in cow numbers than suggested by the increase in pasture growth rates. Milk production per cow was similar in all scenarios.

Table 2. Farm parameters predicted by UDDER for the oversown scenarios in a spring calving, medium concentrate input system.

Parameter	Base farm	Oversown – PRG1		Oversown – PRG1&2	Oversown – SLRG	
		Year 1	Year 2	Year 2	Year 1	Year 2
Milking cows (head)	217	233	231	237	227	234
Stocking rate (cows/EFF ha)	3.0	3.2	3.2	3.3	3.1	3.2
Pasture removed (t DM/EFF ha)*	10.7	11.6	11.5	11.8	12.0 (0.6)	12.2 (0.6)
Pellets Fed (t DM)	217	233	231	237	227	234
Milk Production (L/cow)	5,225	5,272	5,254	5,299	5,313	5,342

* total pasture removed (grazed and conserved). The amount conserved (if any) is shown in parenthesis.

All of the oversowing scenarios resulted in extra income (principally milk sales) as a result of the increase in cow numbers (Table 3). There were considerable increases in variable costs in all of the oversowing scenarios, with the major areas of increased costs being pasture renovation, purchased feed and casual labour. The increase in overhead costs was small, accounting for between 6% and 13% of the increase in total costs. The discounted total extra gains after interest were $7,214, $3,688 and $9,676, for the Oversown-PRG1, Oversown-PRG1&2 and Oversown-SLRG scenarios, respectively.

Table 3. Economics of the oversown scenarios in a spring calving, medium concentrate input system.

Income Parameter	Oversown – PRG1		Oversown – PRG1&2	Oversown – SLRG	
	Year 1	Year 2	Year 2	Year 1	Year 2
Economic analysis before interest					
Extra income	25,555	21,656	34,092	22,740	35,184
Extra variable costs	23,039	10,421	25,584	18,590	23,729
Extra overhead costs	1,792	1,568	2,240	1,120	1,904
Extra total costs	24,831	11,989	27,824	19,710	25,633
Total extra gains	724	9,667	6,268	3,030	9,551
Discounted cumulative values after interest after year 2					
Total extra gains		7,214	3,688		9,676
Extra return: Extra costs ratio		1.19	1.07		1.21
Return on marginal capital		31%	13%		48%

Oversowing in a spring calving, medium concentrate input system (variable concentrate inputs)

In a spring calving, medium concentrate input system, in which cow numbers were kept constant, the higher pasture growth with oversowing was utilised by reducing concentrate inputs, on a whole farm basis, by 36 to 62 t DM with perennial ryegrass and by 7 to 14 t DM with short-lived ryegrass (Table 4). The small reduction in concentrate inputs in the Oversown-SLRG scenario was a result of increased spring and reduced summer pasture growth. Consequentially, the reductions in supplement inputs in early lactation were largely mitigated by increased supplement use during summer.

Table 4. Farm parameters predicted by UDDER for the oversown scenarios in a spring calving, medium concentrate input system.

Parameter	Base farm	Oversown – PRG1		Oversown – PRG1&2	Oversown – SLRG	
		Year 1	Year 2	Year 2	Year 1	Year 2
Milking cows (head)	217	217	217	217	217	217
Stocking rate (cows/EFF ha)	3.0	3.0	3.0	3.0	3.0	3.0
Pasture removed (t DM/EFF ha)*	10.7	11.4 (0.1)	11.4 (0.2)	11.7 (0.2)	11.9 (0.9)	12.1 (1.0)
Pellets Fed (t DM)	217	171	181	155	210	204
Milk Production (L/cow)	5,225	5,197	5,212	5,168	5,317	5,332

* total pasture removed (grazed and conserved). The amount conserved (if any) is shown in parenthesis.

There was little change in income in the Oversown-PRG scenarios while in the Oversown-SLRG scenario there was an increase in income as a result of higher per cow milk production (Table 5). The reduction in concentrate use in the Oversown-PRG1 scenario resulted in only a small increase in costs in year 1 (the cost of oversowing) and a reduction in costs in year 2. For the Oversown-PRG1&2 scenario, there was no change in year 2 costs as the cost of pasture renovation was similar to the reduction in costs due to reduced concentrate inputs. The minimal reduction in concentrate inputs in the Oversown-SLRG scenario resulted in increased costs in both years. Overhead costs did not change in any scenario as cow numbers did not change. The discounted total extra gains after interest were

$1,864, -$6,253 and $428, for the Oversown-PRG1, Oversown-PRG1&2 and Oversown-SLRG scenarios, respectively.

Table 5. Economics of the oversown scenarios in a spring calving, medium concentrate input system.

Income Parameters	Oversown – PRG1		Oversown – PRG1&2	Oversown – SLRG	
	Year 1	Year 2	Year 2	Year 1	Year 2
Economic analysis before interest					
Extra income	-984	233	-2,226	9,920	11,226
Extra variable costs	3,164	-6,380	89	10,707	9,889
Extra overhead costs*	0	0	0	0	0
Extra total costs	3,164	-6,380	89	10,707	9,889
Total extra gains	-4,148	6,613	-2,315	-787	1,337
Discounted cumulative values after interest after year 2					
Total extra gains		1,864	-6,253		428
Extra return: Extra costs ratio		0.29	-0.93		1.02
Return on marginal capital *		-	-		-

* no marginal capital was employed

Oversowing in a spring calving, high concentrate input system (variable cow numbers)

To maintain pasture consumption, the base farm had 22% higher cow numbers and 12% higher milk production per cow milk in the high concentrate input system (Table 6) than in the medium concentrate system (Table 2). All of the oversowing scenarios in the high concentrate input system had a higher optimal cow number than the base farm (Table 6), with this increase in cow numbers removing the need for fodder conservation in spring, even in the Oversown-SLRG scenario.

Table 6. Farm parameters predicted by UDDER for the oversown scenarios in a spring calving, high concentrate input system.

Parameter	Base farm	Oversown – PRG1		Oversown – PRG1&2	Oversown – SLRG	
		Year 1	Year 2	Year 2	Year 1	Year 2
Milking cows (head)	264	280	278	288	288	292
Stocking rate (cows/EFF ha)	3.6	3.9	3.8	4.0	4.0	4.0
Pasture removed (t DM/EFF ha)*	10.7	11.5	11.4	11.8	12.1	12.2
Pellets Fed (t DM)	528	560	556	576	577	584
Milk Production (L/cow)	5,863	5,933	5,918	5,931	5,993	6,021

* total pasture removed. There as no pasture conservation in any scenario.

The economics of the oversowing scenarios in a spring calving, high concentrate input system, are summarised in Table 7. There were large increases in income for all scenarios, particularly for the Oversown-SLRG scenario, resulting mainly from higher milk production due to the increased cow numbers (Table 3). There were also considerable increases in variable costs in all of the oversowing scenarios, with the major areas of increased costs being pasture renovation, purchased feed and casual labour. The increase in overhead costs was small, accounting for between 6% and 11% of the increase in total costs. The discounted total extra gains after interest were $13,483, $9,869 and $31,431, for the Oversown-PRG1, Oversown-PRG1&2 and Oversown-SLRG scenarios, respectively.

Table 7. Economics of the oversown scenarios in a spring calving, high concentrate input system.

Income Parameters	Oversown – PRG1		Oversown – PRG1&2	Oversown – SLRG	
	Year 1	Year 2	Year 2	Year 1	Year 2
Economic analysis before interest					
Extra income	31,513	27,370	45,484	52,427	61,316
Extra variable costs	25,713	12,851	33,021	33,333	37,300
Extra overhead costs	1,792	1,568	2,688	2,688	3,136
Extra total costs	27,505	14,419	35,709	36,021	40,436
Total extra gains	4,008	12,951	9,775	16,406	20,880
Discounted cumulative values after interest after year 2					
Total extra gains		13,483	9,869		31,431
Extra return: Extra costs ratio		1.31	1.16		1.41
Return on marginal capital		59%	33%		79%

Oversowing in a split calving, medium concentrate input system (variable cow numbers)

To maintain pasture consumption, the base farm had 5% higher cow numbers and 5% lower milk production per cow milk in the split-calving system (Table 8) than for the spring calving system (Table 2). All of the oversown scenarios in the split-calving system had a higher optimal cow number than the base farm (Table 8), with this increase in cow numbers resulting in no fodder conservation in the Oversown-PRG scenarios and only a small amount in the Oversown-SLRG scenario.

Table 8. Farm parameters predicted by UDDER for the oversown scenarios in a split calving, medium concentrate input system.

Parameter	Base farm	Oversown – PRG1		Oversown – PRG1&2	Oversown – SLRG	
		Year 1	Year 2	Year 2	Year 1	Year 2
Milking cows (head)	228	249	245	252	258	265
Stocking rate (cows/EFF ha)	3.1	3.4	3.4	3.5	3.6	3.7
Pasture removed (t DM/EFF ha)*	10.7	11.6	11.5	11.9	12.1 (0.2)	12.4 (0.2)
Pellets Fed (t DM)	228	250	245	252	258	265
Milk Production (L/cow)	5,146	5,143	5,149	5,192	5,090	5,113

* total pasture removed (grazed and conserved). The amount conserved (if any) is shown in parenthesis.

The economics of the oversown scenarios in a split calving, medium concentrate input system, are summarised in Table 9. There were considerable increases in income for all scenarios resulting from increases in cow numbers. The variable costs increased in all of the oversowing scenarios, with the major areas of increased costs being pasture renovation, purchased feed and casual labour. The increase in overhead costs was small, accounting for between 8% and 14% of the increase in total costs. The discounted total extra gains after interest were $9,080, $5,089 and $8,155, for the Oversown-PRG1, Oversown-PRG1&2 and Oversown-SLRG scenarios, respectively.

Table 9: Economics of the oversown scenarios in a split calving, medium concentrate input system.

Income Parameters	Oversown – PRG1		Oversown – PRG1&2	Oversown – SLRG	
	Year 1	Year 2	Year 2	Year 1	Year 2
Economic analysis before interest					
Extra income	30,100	25,256	38,313	40,455	51,845
Extra variable costs	26,056	12,017	28,120	32,728	37,934
Extra overhead costs	2,352	1,904	2,688	3,360	4,144
Extra total costs	28,408	13,921	30,808	36,088	42,078
Total extra gains	1,692	11,335	7,505	4,367	9,767
Discounted cumulative values after interest after year 2					
Total extra gains		9,080	5,089		8,155
Extra return: Extra costs ratio		1.21	1.09		1.10
Return on marginal capital		31%	15%		16%

Oversowing - Comparison between farming systems

Table 10 presents the discounted cumulative gains of the oversowing scenarios in a range of farming systems after years 2 and 4. The table shows that the cumulative gains for the Oversown-PRG1&2 scenario is always less than that of the other 2 scenarios, irrespective of the farming system. The relative advantage of the Oversown-PRG1 and Oversown-SLRG scenarios, however, depends on the farming system in which the comparison is made. The most noticeable difference between the two scenarios is in the high concentrate system where the gains after interest for the Oversown-SLRG scenario is approximately double of that of the Oversown-PRG1 scenario.

Table 10. Discounted cumulative gains ($) of the oversown scenarios in a range of farming systems after years 2 (actual) and 4 (projected). Physical and economic parameters in years 3 and 4 were assumed to be the same as those in year 2.

Farming system	Year	Oversown – Rye 1	Oversown – Rye 1&2	Oversown – SLRG
Medium concentrate input, spring calving,	2	7,214	3,688	9,676
variable cow numbers	4	20,699	11,053	22,600
Medium concentrate input, spring calving,	2	1,864	-6,253	428
constant cow numbers (variable concentrate inputs)	4	12,298	-9,905	2,538
High concentrate input, spring calving,	2	13,483	9,869	31,431
variable cow numbers	4	32,150	22,262	60,841
Medium concentrate input, split calving,	2	9,080	5,089	8,155
variable cow numbers	4	24,818	13,901	18,895

Resowing in a spring calving, medium concentrate input system (variable concentrate inputs)

The reduction in pasture growth rates in year 1 as a result of resowing 20% of the farm with either perennial ryegrass or tall fescue reduced pasture consumption and necessitated the use of an additional 40 t DM of pellets in order to maintain per cow production (Table 11). In year 2, there was a reduction in supplement inputs, particularly with the Resown-Fescue scenario, due to increases in pasture growth relative to the base farm.

Table 11. Farm parameters predicted by UDDER for the resown scenarios in a spring calving, medium concentrate input system.

Parameter	Base farm	Resown – PRG1		Resown – PRG1&2	Resown –Fescue	
		Year 1	Year 2	Year 2	Year 1	Year 2
Milking cows (head)	217	217	217	217	217	217
Stocking rate (cows/EFF ha)	3.0	3.0	3.0	3.0	3.0	3.0
Pasture removed (t DM/EFF ha)*	10.7	9.9	10.8	10.8	10.0	11.1
Pellets Fed (t DM)	217	260	201	200	257	182
Milk Production (L/cow)	5,225	5,236	5,224	5,220	5,232	5,215

* total pasture removed. There was no pasture conservation in any scenario.

Table 12 presents the economics of the resown scenarios in a spring calving, medium concentrate input system. There was minimal change in income, and no change in overhead costs, in any of the scenarios because there was no change in cow numbers. Variable costs in all scenarios in year 1 increased relative to the base farm due to the cost of resowing ($3,711) and increased concentrate inputs ($7,000 to $7,500). In year 2, variable costs were reduced as higher pasture production allowed a reduction in concentrate inputs. The discounted total extra gains after interest were negative for all the resown scenarios, ranging between -$10,198, for Resown-PRG1&2, and -$5,195, for Resown-Fescue.

Table 12. Economics of the resown scenarios in a spring calving, medium concentrate input system.

Income Parameters	Resown – Rye 1		Resown – Rye 1&2	Resown – Fescue	
	Year 1	Year 2	Year 2	Year 1	Year 2
Economic analysis before interest					
Extra income	389	-83	-230	359	-652
Extra variable costs	11,262	-3,036	-972	10,785	-6,406
Extra overhead costs*	0	0	0	0	0
Extra total costs	11,262	-3,036	-972	10,785	-6,406
Total extra gains	-10,873	2,953	742	-10,426	5,754
Discounted cumulative values after interest after year 2					
Total extra gains		-8,188	-10,198		-5,195
Extra return: Extra costs ratio		0.04	0.02		-0.05
Return on marginal capital *		-	-		-

* no marginal capital was used

Table 13 presents the discounted cumulative gains after years 2 and 4 of the resowing scenarios with a range of relative productivity levels of the area, which was resown. The table shows that the Resown-Fescue scenario is the only scenario, when an initial relative productivity level of 100% was assumed, in which the cumulative gains after 4 years will be positive. However, for the Resown-PRG1 and Resown-PRG1&2 scenarios, positive cumulative gains were achieved after either 2 or 4 years when the relative productivity of the area to be resown was less.

Table 13. Discounted cumulative gains ($) of the resown scenarios after years 2 (actual) and 4 (projected) with a range of assumed relative productivity levels of the area to be resown.

Relative productivity level of area to be resown	Year	Resown - Rye 1	Resown - Rye 1&2	Resown - Fescue
100% of control	2	-8,188	-10,198	-5,195
	4	-3,529	-9,028	3,883
80% of control	2	-21	-2,030	2,972
	4	11,387	5,891	18,800
60% of control	2	6,409	4,399	9,402
	4	23,132	17,634	30,544

DISCUSSION

Oversowing of pastures with either perennial ryegrass or short-lived ryegrass, in a system in which cow numbers were altered in response to changes in pasture supply, resulted in increased pasture consumption, higher stocking rates, increased milk production, increased income and increased gain after costs. These benefits of oversowing occurred in the medium concentrate, the high concentrate and in the split calving systems. Within these systems, the oversown-PRG1&2 scenario was always the least profitable of the 3 oversowing scenarios as the physical advantages compared to the Oversown-PRG1 scenario were small while there was an additional cost of oversowing each year. Although there has not been sufficient data collected to determine the longevity of the benefits of oversowing with perennial ryegrass, the data collected to date suggests that there is no financial benefit of oversowing every year as opposed to oversowing every second year.

The relative advantage of the Oversown-PRG1 and Oversown-SLRG scenarios depended on the system in which the comparison was made. In both the medium concentrate input and the split calving systems, there was little difference in financial terms between the scenarios despite the increase in pasture usage with oversowing being 50% higher in the Oversown-SLRG than in the Oversown-PRG1 scenario. This resulted from most of the extra feed in the Oversown-SLRG scenario being grown in spring, and this necessitated the conservation of excess pasture as hay (which was sold off the milking area). This need for fodder conservation in the Oversown-SLRG scenario in spring occurred despite the minimisation of supplement inputs at this time of the year. Consequently, despite an extra 0.5 t DM/ha of pasture grown in the Oversown-SLRG relative to the Oversown-PRG1, scenario, there were minimal differences between the scenarios in the number of cows, and hence milk production and income.

It was only in the high concentrate system that the extra grass grown in the Oversown-SLRG, relative to the Oversown-PRG1 scenario, resulted in higher cow numbers, and hence milk production and income. This was a result of the high concentrate inputs allowing the stocking rate to increase to such a level that, despite the high spring pasture growth rates, there was no need for fodder conservation during spring. Consequently, all of the extra pasture grown was used to produce milk, and hence income, and this resulted in discounted cumulative gains after 2 years for the Oversown-SLRG scenario being over twice that of the Oversown-PRG1 scenario. A word of caution required here is whether the high levels of concentrate feeding in late lactation (which reached 11.8 kg DM/cow.day in June), as predicted by UDDER, are achievable without the use of buffers or additional fibre in the diet which would increase the cost of the ration above that used in the model. (The optimisation procedure in UDDER is purely based on energy intake with no consideration of protein requirements or of the need for either fibre, buffers or other additives).

The analyses of the oversowing scenarios show that using the extra pasture grown to replace concentrates as a source of energy in the diet resulted in a loss in the Oversown-Rye 1&2 scenario, no gain in the Oversown-SLRG scenario and a small gain in the Oversown-PRG1 scenario. In all cases it was more profitable to use the extra pasture grown to increase cow numbers and maintain concentrate inputs per cow than to maintain cow numbers and reduce concentrate inputs. This result was a consequence of the need to conserve the extra pasture grown and suggests that the best use of any extra pasture grown is to increase cow numbers, provided that the farm infrastructure is capable of handling them.

The economic analyses assumed that the 2 full time labour units of the original base farm could not manage any extra cows, and this necessitated the use of casual labour, which increased variable costs. If, however, the additional cows could be partially managed by existing labour, then the increase in casual labour costs would not be as great as assumed, and so the returns would be increased considerably. Similarly, it was assumed that the oversowing, hay making and topping was all done by contractors. If, however, the existing labour force could do some or all of these tasks, there would be a further reduction in costs and a corresponding increase in returns, even when an allowance is made for some extra machinery repair and depreciation costs.

The modelling in UDDER and the economic analysis of the resowing scenarios show that the actual resowing costs are only a small proportion of the total costs associated with a resowing program. The major proportion of the extra costs was due to increased supplementary feeding as a result of the 3.5 to 4.0 t DM/ha reduction in pasture consumption from the resown area in the first year after resowing. This increase in feed costs equates to $450 to $500 per ha renovated, and is approximately double that of the actual pasture renovation costs of $250 per ha. Consequently, the total cost of pasture renovation in year 1 was in the order of $700 to $750 per ha renovated, irrespective of whether perennial ryegrass or tall fescue was sown. In order for a farmer to recover these extra costs, there needs to be large increases in pasture consumption from year 2 onwards.

The results from year 2 of the field experiment and the subsequent modelling in UDDER show that breakeven is likely to occur in year 3 for the Resown-Fescue scenario and in year 6 for the Resown-PRG1 scenario. For the Resown-PRG1&2 scenario, the gains after interest in year 2 were so small that this scenario would not be considered a worthwhile renovation option. These results suggest that tall fescue is an economically viable alternative when resowing pastures, provided that suitable grazing management systems can be put into place.

The high dry matter production from the existing pasture means that it is not a typical pasture in which resowing would be considered. Normally, pastures targeted for resowing have a low productivity as a result of domination by unproductive or unpalatable species. In these cases, provided that best management practices are used, large increases in pasture production and nutritive value can be expected. The sensitivity analysis shows that in these situations, when the productivity of the base pasture is reduced by as little as 20%, that both the Resown–PRG1 and Resown-Fescue scenarios would breakeven after 2 years. Hence the profitability of resowing pastures depends very much on the productivity of the existing pasture, whether there are factors other than species composition limiting its performance, and the extent to which it can be increased by improving the species composition.

One of the most important factors determining the profitability of pasture renovation is the longevity of the responses in terms of increased pasture production, pasture consumption or stocking rate (Scott *et al.* 2000). The UDDER simulations and subsequent economic analysis presented in this paper are based on the first 2 years' data of a pasture renovation experiment. A more complete evaluation of the pasture renovation scenarios will require analysis of field data from the third and fourth years of the field experiment, in which the longevity of the responses to pasture renovation will be quantified.

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