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Impact of farm management decision rules on the production and profit of different strains of Holstein-Friesian dairy cows

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ABSTRACT

Management decision rules (‘old’ rules) have been used at the Dexcel No. 2 Dairy Farm to remove subjectivity from the management of farm systems research and have also been promoted to the dairy industry. A trial involving these rules where three strains of Holstein-Friesian (HF) cows were compared has completed its third season. The trial included two high breeding worth (BW) strains of either North American (OS90) or New Zealand (NZ90) genetics, and one low BW strain of NZ genetics (NZ70). Under the ‘old’ rules the OS90 cows had fewer days in milk than the other two strains, mainly because they were dried off earlier due to their lower body condition score (BCS). In the third lactation ‘new’ rules were applied that allowed cows at the higher feed allowances to be dried off later (but at the same BCS) than would have been allowed under the ‘old’ rules. For the herds receiving the higher feed allowances, this change resulted in increased days in milk (NZ90 + 2 days; OS90 + 17 days) more milksolids (MS) per cow (NZ90 +2 kg; OS90 +21 kg), and more feed required (NZ90 + 10 kg; OS90 + 157 kg DM/cow) with all herds reaching target BCS by their next calving. It is calculated that this reduced the difference in economic farm surplus (EFS) per ha between the NZ90 and OS90 from $488 to $219. These results indicate the need to alter management rules to get the best performance from North American HF genetics.

Keywords: Holstein-Friesian; body condition score; drying-off decision rules.

INTRODUCTION

In 1955, over 90% of artificial breeding (AB) inseminations in New Zealand (NZ) were with Jersey semen. By the early 1990s, this had decreased to less than 30% with Holstein-Friesian (HF) inseminations increasing to over 70% (LIC 1999). Dairy selection objectives and farm production systems in United States of America and Europe are different from those in NZ where HF dominates. The use of overseas HF semen in NZ in the last 20 years has reduced the proportion of NZ genetics in the HFs (Harris & Winkelman, 2000; Harris & Kolver, 2001) and implications of this change in NZ farm production systems are of potential economic importance. The Dexcel Strain trial was designed to measure the amount of genetic progress in the NZ HF dairy herd during the last 25 years, and the performance of high merit North American HF cows under a pasture-based feeding system.

During the 1980s and 1990s a series of simple management decision rules based on the results of previous trials were devised (Macdonald & Penno, 1998). These rules were based on genotypes in use at the time, with only a limited influence (< 10%) of overseas HF (Harris & Kolver, 2001). These decision rules aim to optimise per cow performance across a range of feed allowances and are primarily used to ensure research farmlets are treated consistently both within and between years. Application of these rules requires many of the variables within the dairy farming system to be quantified, thereby removing subjectivity from management decisions. These rules set out either a process, (e.g. the use of the Dexcel spring rotation planner (Dexcel Farm Facts 5-5) to calculate rotation lengths), targets (e.g. calving body condition score (BCS)) or ‘thresholds’ (e.g. autumn BCS, cow intakes) that trigger decisions such as feeding supplements or drying off. The decision rules lead to differences in management including rotation length, threshold intakes for supplementation and drying off date between the herds.

This trial includes two high breeding worth ($BW) strains of Holstein-Friesian of either North American origin (OS90) or NZ origin (NZ90), and a low $BW strain of 1970 NZ Friesians (NZ70) (Table 1). In the first two years of this trial, the same set of decision rules was used for all farmlets. In the second lactation, although all cows calved at close to the optimum BCS of 5.5, the OS90 cows were below 4.0 during most of lactation with averages for each strain during the year of 5.1 (NZ70), 4.5 (NZ90), and 4.1 (OS90) (SED 0.10). Daily milksolids (MS) production was similar for the NZ90 and OS90 but annual production was lower for the OS90 (NZ70, 380 kg; NZ90, 468 kg; OS90, 415 kg; SED 15.7) primarily because the OS90 had fewer days in milk (NZ70, 286 days; NZ90, 286 days; and OS90, 252 days; SED 5.6). During early lactation the OS90 cows lost BCS and failed to put it back during lactation regardless of the feeding level (Macdonald, 2004). Under the existing decision rules, low BCS was the major determinant for the early drying off of the OS90 cows and this meant they were unable to achieve their production or economic potential in the first two years of the trial. A summary of the first two lactations has already been presented (Macdonald, 2004).

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TABLE 1: Results from the third year of the Dexcel Strain trial, involving 3 strains of Holstein Friesian [New Zealand cows of 1970's genetics (NZ70); New Zealand cows of 1990's genetics (NZ90); cows derived from Overseas 1990's genetics (OS90)] at differing annual feed allowances (t DM/cow/year), milksolids (kg/cow), body condition score (BCS), live weight (kg) averages for the year and change in days in milk (DIM) when using the 'new' drying off rules. Economic farm surplus (EFS) is calculated from Dexcel Farm Facts 7-3.

	Farmlets											
Strain	NZ70	NZ70	NZ70	NZ90	NZ90	NZ90	NZ90	OS90	OS90	OS90	OS90	SED
Farmlet	1	2	3	4	5	6	7	8	9	10	11	
Feed allowance	Low	High	High	Low	Low	High	High	Low	Low	High	High	
Stocking rate	3.8	3.1	3.1	3.4	3.1	3.1	3.1	3.1	3.1	3.1	3.1	
Pasture allowance (t DM/cow/year)	4.5	5.5	5.5	5.0	5.5	5.5	5.5	5.5	5.5	5.5	5.5	
Supplement allowance (t DM/cow/year)			0.5			0.5	1.0		0.5	1.0	1.5	
Annual feed allowance (t DM/cow/year)	4.5	5.5	6.0	5.0	5.5	6.0	6.5	5.5	6.0	6.5	7.0	
Comparative stocking rate (kg live weight/t DM)	111	91	84	100	91	84	77	100	92	85	79	
Milksolids (kg/cow)	336	422	422	432	464	497	532	405	442	484	529	15.7
Average BCS	4.8	4.8	5.1	4.5	4.5	4.5	4.8	4.2	4.2	4.2	4.2	0.10
Average live weight (kg)	480	488	480	487	498	504	527	524	529	534	540	10.5
EFS ($/ha) under 'new' rules[1]	2764	2972	2535	3316	3186	3627	3540	2769	2636	3483	3247	
EFS ($/ha) under 'old' rules[2]		2887	2541			3597	3541			3304	2887	
EFS ($/ha) advantage to 'new' rules		+85	-6			+30	-1			+179	+360	
Change in DIM between 'old' and 'new' rules	0	+8	+1	0	0	+4	+1	0	0	+20	+14	
Intake measured[3] (MJ ME/cow/day)				143			183	157			193	
Intake required[4] (MJ ME/cow/day)				151			175	156			190	
Efficiency (MJ ME/kg MS) for full season	145	133	145	129	133	126	130	151	150	137	148	
Drying off BCS year three				4.4			4.8	3.9			4.0	
Calving BCS year four				5.4			5.9	5.6			6.1	

[1] The EFS was calculated using actual data derived from the third year of the trial

[2] The EFS was derived by considering when the cows would have been dried off under the 'old' rules and then calculating an EFS with the reduced days in milk, lower milksolids produced, reduced DMI required and the effect of BCS loss.

[3] Intake was measured from pre and post visual assessments of the area grazed by the herd and the amount of DM that disappeared was recorded as the amount consumed by the herd. Supplements fed were recorded and with an allowance for 15% loss. Total intake was calculated from pasture and supplements from 1 January to 30 June.

[4] The calculated amount of feed required to achieve the MS produced (allowing for maintenance, gain of BCS and fetal growth, Holmes *et al*., 2002) was calculated for the period 1 January to 30 June 2004.

In the third year of the trial, changes were made to the drying off rules to allow the thinner cows to continue milking beyond the existing drying off date, but then to be fed generously after drying off. This paper reports the effect of these management changes, on the physical and economic performance of the herds, during the third year of the trial, including the rate at which the dry cows gained BCS.

MATERIALS AND METHODS

The three strains of Holstein-Friesians were farmed in a range of feeding systems for 3 years. Systems were designed to provide total feed allowances of 4.5 to 7.0 t DM/cow/year, based on different stocking rates and supplement inputs (Table 1). When feed allowance was higher than 5.5 t DM/cow, additional feed above pasture grown was supplemented in the form of maize silage and maize grain. The trial started in 2001 with all the cows being first lactation animals. An annual replacement rate of 25% was used with first calving heifers. There were 15 cows in each NZ70 farmlet and 20 in the NZ90 and OS90 farmlets in the third year of the trial with the age structure being 55% (4 year), 20% (3 year) and 25% (2 year old) cows.

Trial management was governed by a set of decision rules (Macdonald & Penno, 1998). In the first and second year of the present trial, cows were dried off according to these rules ('old' rules) leading to short lactations and lower production for the OS90 cows due to their lower BCS. For the third year of the trial the drying off rules were changed to allow 'new' rules (Table 2) to dictate when the cows on the high allowance farmlets were dried off. The cows on the low allowance farmlets continued to be dried off at the same BCS as in the 'old' rules (Table 2). The 'new' rules did not lower the minimum BCS threshold but served to delay the date at which the minimum threshold led to drying off. Cows with a high feed allowance (available in the dry period) were able to milk for longer without penalising calving BCS. Thus, this 'new' rule is conditional on dry-period feed being available.

TABLE 2: Drying off body condition score (BCS) for individual cows in the high allowance farmlets in the third year of the Dexcel Strain trial. 'Old' rules were based on a set of decision rules (Macdonald & Penno, 1998) and the 'new' rules were adopted for the third year of the Dexcel Strain trial.

Days from calving	'Old' rules BCS	'New' rules BCS	
	All farmlets	Low allowance farmlets	High allowance farmlets
150	2.5	2.5	2.5
120	3.5	3.5	3.0
90	4.0	4.0	3.5
60	All	All	All

Economic farm surplus (EFS), a measure of the profitability of a dairy farm enterprise widely used as an indicator of economic trends within the industry (Penno *et al.* 1996), was calculated according to Dexcel guidelines (see Dexcel Farm Facts 7-3). Farm income and expenses were calculated on a per hectare basis taking into account any differences in production, inputs (e.g. bought-in maize silage) and management of different farmlets. Where income was measured on a per cow basis, this was converted to per hectare using the stocking rate for that farmlet. Costs of inputs and expenses were based on data from a current economic survey of NZ dairy farms (Dexcel, 2002-2003) and the milk payout was $2.36 and $6.76 per kg fat and protein, respectively. A milk volume charge of $0.0396 per litre was applied based on Fonterra's payment formula for the 2003/2004 season and Fonterra's average milksolids composition of 8.58%. In addition to the calculation based on actual performance with the 'new' rules, the expected physical and financial performance was calculated to show what might have happened if the 'old' rules had been applied. Actual live weight at the actual and calculated date of drying off and the current meat schedule for that time was used for each calculation.

Estimates of DMI were made on 3 days per week from the difference between pre- and post-visual herbage mass assessments and the value for each herd divided by the number of cows in that farmlet to give an intake per cow. Supplements fed to the cows were recorded and a deduction of 15% was made as an allowance for wastage. To verify the estimated intakes, the amount of feed required to achieve the MS produced allowing for maintenance, gain of BCS and fetal growth was also calculated (Holmes *et al*., 2002).

For the 2004/2005 season (4th year) the trial was redesigned. Cows in farmlets 4, 7, 8 and 11 (Table 1) were relocated to Dexcel's Scott farm to continue the trial in a reduced form. Intake calculations (January-June) and 4th year calving BCS were available only for these herds.

Statistical analysis

Data were analysed using ASReml (Gilmour *et al*., 2002). The model included the effects of age at first calving, strain, parity and feed offered (in tonnes of DM as a linear and quadratic covariate within strain). Farmlet and cow were fitted as random effects. As the variance due to farmlet was difficult to estimate it was fixed to 0.10 of the cow variance (Fisher, 1999). The EFS was calculated according to Dexcel guidelines (Farm Facts 7-3).

RESULTS

As for the first 2 years of the trial, in the third year OS90 cows lost more BCS following calving than NZ90 cows and had a season average of 4.2 BCS compared with 4.6 for NZ90 cows (Table 1). The higher feed allowances increased BCS during lactation in NZ70 and NZ90 but not in OS90 cows (Figures 1a - 1c). More importantly, there is little difference in BCS between different feeding levels within OS90 cows but with increased feeding level in the NZ70 and NZ90 cows there is an increase in BCS.

Milksolids produced per cow was similar for NZ90 and OS90 cows at the highest feed allowance. With the use of the 'new' rules, actual days in milk were calculated to have increased by 20 and 14 days for the two highest allowance OS90 herds (Table 1), but had a negligible effect on the NZ70 and NZ90 cows. As a consequence of more days in milk, MS production was calculated to have been increased by 24 and 18 kg per cow for the high allowance OS90 cows, but by much smaller amounts in the NZ70 and NZ90 cows. The increase in MS production generated from the extra days in milk had a positive effect on the EFS, increasing it by $179 and $360 per ha for the two high allowance OS90 farmlets (Table 1) despite the extra feed required.

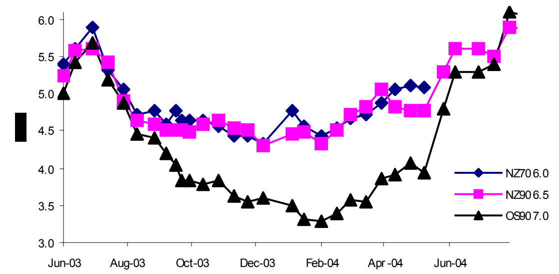
The calving BCS for the following season was unaffected by the change in drying off rules. All herds reached or exceeded the BCS target for calving (minimum average of 5.0) (Figures 1a & c). To achieve this, OS90 cows at the high allowance required from 1 January to 30 June 2004 (Table 1) to be fed an extra 35 MJ ME/cow/day (3.3 kg DM/cow/day as maize silage) more than OS90 cows on the low allowance. During June 2004 the two NZ90 herds consumed 7.7 and 12.2 kg DM/cow/day for the low and high allowance herds, respectively, and 10.0 and 12.9 for the comparable OS90 herds. During the dry period (end of third year to start of fourth year) the NZ90 cows increased BCS by 1.0 and 1.1 for the low and high allowance herds, respectively, and the comparable OS90 cows gained 1.7 and 2.1 in BCS (Table 1).

DISCUSSION

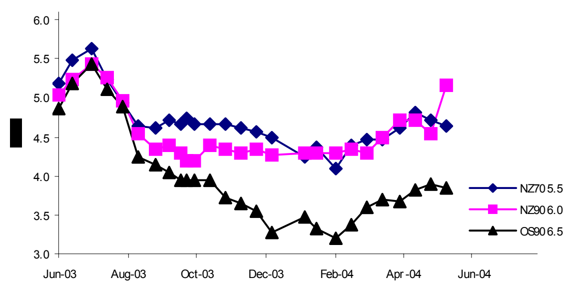
The management decision rules of Macdonald and Penno (1998) were developed from farmlet trials (1982-1997) that generally had high stocking rates, with little or no imported feeds. These rules have proven robust in other trials (Macdonald, 1999; Macdonald *et al.*, 2001) with stocking rates from 2.2 to 4.4 cows/ha (comparative stocking rate (CSR) 62 to 120 kg live weight/t DM). In farmlets where there was a low CSR, the BCS rules did not need changing because the better fed cows maintained a high BCS during lactation so that the threshold was not reached and long lactations and high per cow performance were achieved in these trials.

FIGURE 1: Body condition score (BCS) of 3 strains of Holstein Friesian (New Zealand Friesian cows of 1970's genetics (NZ70), New Zealand Holstein-Friesian cows of 1990's genetics (NZ90) and Holstein-Friesian cows derived from Overseas 1990's genetics (OS90) at differing feed allowances (4.5 to 7.0 t DM/cow/year) but the same comparative stocking rate (CSR) in the third year of the Dexcel Strain trial. (a) CSR = 80 kg Lwt/t DM, (b) CSR = 88 kg Lwt/t DM, (c) CSR = 97 kg Lwt/t DM. (Lwt = live weight)

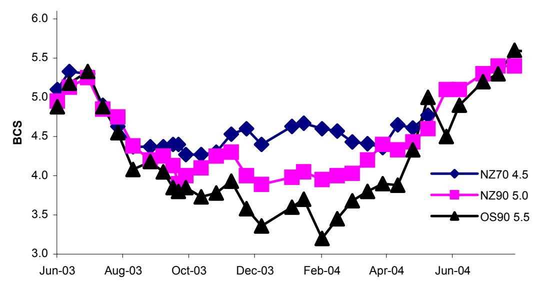
(a)



(b)



(c)



The above management decision rules were based on genotypes in use at the time so only had limited influence from overseas HFs. Under the existing BCS decision rules the NZ70 and NZ90 cows were able to produce high per cow and per ha performance. The changes in the drying off rules had most effect on the OS90 herds, as these were the high allowance herds where BCS was the dominant drying off criterion. Under the 'old' rules OS90 cows at high allowance triggered the BCS rule while they are still milking well and with sufficient feed available. The high allowance NZ70 and NZ90 cows tended to be dried off on the basis of the 60 days-to-calving rule or another rule that dictates that if 50% of the herd is already dried off then the remainder are also dried off, which is necessary in these small herds. Even these changed rules penalise OS90 cows as some were still more than 100 days from calving at the end of May, as they tended to have a longer calving spread (Macdonald, 2004).

The changes in the drying off rules have demonstrated a financial advantage to the OS90 cows but not to the NZ70 or NZ90 cows. The extra feed required to achieve the extra MS and to overcome a slight loss in BCS was calculated to be 167 and 147 kg DM/cow for the two high allowance OS90 herds. The change in drying off rules requires some extra winter feed, to achieve the extra days in milk and gains in BCS. Therefore there must be enough feed within the system so that expensive supplements are not required.

Under the 'old' rules, even at high feed allowances the OS90 cows lost BCS to a degree that they crossed the drying off threshold while still producing well and with feed available. Changing the drying off decision rules to allow a later drying off when sufficient dry-period feed was available allowed the OS90 cows to achieve to their potential in these systems.

Calculations of estimated intakes from pre- and post-grazing visual assessments plus supplements supplied were compared with estimated energy requirements (Holmes *et al*., 2002). The calculated amount of feed required to achieve the MS produced maintenance and fetal growth and allowing for gain of BCS, shows that the calculated requirements were close to that estimated to have been consumed by the cows (Table 1). These calculations for the high allowance cows are all within 6% of the calculated requirements and shows that to allow for maintenance, BCS gain and milk production, the OS90 cows at the highest feed allowance needed to eat about 190 MJ ME/cow/day (Table 1) from 1 January to 30 June 2004, which was about 35 MJ per day more than the lowest allowance OS90 herd. This is equivalent to 600 kg DM as maize silage.

For the whole season, the calculated efficiency (MJ ME/kg MS) was optimised at the second highest feed allowance for each strain, which also had the optimum EFS (Table 1). This shows that the NZ90 were the most efficient and the NZ70 and OS90 were similar. The low allowance OS90 cows were the least efficient mainly because of less days in milk, thus a greater proportion of the feed eaten was used for maintenance.

The extra days in milk for the OS90 high allowance cows did not affect the BCS they attained at calving as they had adequate time and feed to regain BCS due to a spread out calving pattern.

The change in drying off BCS rules depend on sufficient feed being available to herds to achieve the target BCS gain of 1 condition score per month (1 kg LW gain/day) through April and May. If this feed has already been used then the low allowance decision rules must still apply.

CONCLUSION

Decision rules developed in farmlet trials in the 1980s and 1990s proved to be robust in optimising productivity in NZ HF cows of 1970s and 1990s background, across a wide range of feed inputs. However the OS90 cows, even at high feed allowances had short lactations leading to low profitability and feed conversion efficiency.

New decision rules that delayed the date at which the threshold BCS triggered drying off, allowed the high feed allowance OS90 cows to milk for longer without penalising calving BCS. Longer lactations led to improved profitability and feed conversion efficiency.

Clearly, if the OS90 type of cow continues to be a part of the NZ dairy herd, there need to be modifications to their management otherwise their milk production potential will not be realised.

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