RELATIONSHIPS BETWEEN MILK SOMATIC CELL COUNTS, PRODUCTION INDEX AND DRY COW THERAPY IN SEASONAL DAIRY HERDS

K. L. MACMILLAN,* G. F. DUIRS† and I. S. HOOK‡

SUMMARY

Milk samples were cell counted from 12 233 cows in 106 herds which were production tested on five occasions during the 1978-9 season. The data were coded 0, 1, 2 or 3 for cell counts of less than 250×10^3, 250 to 500 $\times 10^3$, 501 to 750 $\times 10^3$, and greater than 750×10^3 cells/ml, respectively. The five scores for each cow were summed. The relationship between seasonal score and geometric mean cell count (GM) was described by the equation GM = 46.1 + 19.1 (score) + 4.02 (score)^2 (r^2 = 0.98). Scores for each age category tended to be distributed into four subgroups comprising animals with low, medium, high or very high scores. Whereas 86.5% of 2-year-olds were in the low-scoring subgroup, only 53.0% of mature cows were in this category. The respective percentages in the very high subgroup were 0.8 and 7.1.

Regression analyses showed that for each unit increase in seasonal score amongst the mature cows, the Production Index (PI) declined by 0.63 (± 0.06). In 2-year-olds the decline was not significant (0.19 ± 0.19). On a population basis, only 3.9% of cows were in the very high-scoring subgroup, but because their average cell count level was 1085 $\times 10^3$ cells/ml, they contributed 25.3% of all the cells. The identification of these cows through cell counting could allow bulk milk cell counts to be significantly reduced by culling.

The use of dry cow therapy produced a small but significant increase in early lactation PI (101.9 vs. 99.7). This PI difference was not sustained for the whole of lactation (102.0 vs. 101.7).

INTRODUCTION

The development of somatic cell counting and alternative methods of estimating leucocyte numbers in milk samples has been described previously (Duirs and Macmillan, 1979). Bulk milk cell counting of each supplier's milk by factories is increasingly common and will become mandatory within the next few years. While a bulk milk cell count level of less than 200 $\times 10^3$ cells/ml may be regarded as satisfactory in terms of milk quality and over 500 $\times 10^3$ count as unsatisfactory, a herd owner may not be aware of

*Ruakura Animal Research Station, Hamilton.
†National Dairy Laboratory, Hamilton.
‡Wellington-Hawke's Bay Livestock Improvement Association, Palmerston North.

differences in cell counts beween individual cows in his herd. The concurrent developments of owner sampling for production testing and centralized processing of these samples have meant that milk samples from individual cows can also be cell counted. However, there has been some conjecture about the use which herd owners could make of these cell count data and about the relationship between cell count levels and production. In spite of these doubts, one livestock improvement association has provided a cell counting service. The records from herds in this association have been analysed to determine the influence of some factors such as age on cell count levels and to estimate the relationship between these levels and production index (PI). Since dry cow therapy (DCT) has been widely advocated as a method for reducing both the incidence of mastitis and cell count levels, a field trial was also undertaken as part of this study.

MATERIALS AND METHODS

Somatic Cell Counts

Records were obtained from 106 seasonal and 30 town supply herds which used the owner-sampling production testing and milk somatic cell counting services offered by the Wellington-Hawke's Bay Livestock Improvement Association during the 1978-9 season. Most of the cows in these herds were sampled on at least five occasions during their lactation. The seasonal PI was used as a measure of each cow's relative level of production on a within-herd basis, with proportional correction factors being used if a herd's PI was above 100. This meant that because each cow's lactational record had been corrected for age and calving date, each cow with a PI of 100 could be regarded as one which performed at the herd average. Deviation from 100 indicated the percentage superiority or inferiority in the production of a particular cow. Each cell count result was coded as 0, 1, 2 or 3 for counts $<250 \times 10^3$, 250 to 500 $\times 10^3$, 501 to 750 $\times 10^3$ or $>750 \times 10^3$ cells/ml, and the five scores added together to provide a seasonal score (SS). The minimum score was 0 (5×0) and the maximum 15 (5×3). Geometric means (GM) for each of 781 cows in seven seasonal herds with scores from 0 to 15 were calculated and used to estimate the regression equation and correlation coefficient between these two parameters. While all herd owners had identified which cows in their herds were 2, 3 or 4 years old at the commencement of the 1978 season, many

only classified older cows as "mature". Thus, only four age group categories could be considered. Analyses were completed to determine the relationship between seasonal score and PI.

Dry Cow Therapy

Milk samples from cows in 11 herds whose owners used the owner sampling production service in the 1977-8 season were also cell counted without the owners being aware of it. These have been described as "phantom herds" (Duirs and Macmillan, 1979). Each owner agreed to treat each quarter of each of the even-numbered cows retained in the herd with "Combisec Dry Cow" antibiotic (Pfizer & Co.). Cows in these herds were then production tested and cell counted throughout the 1978-9 season and comparisons made between the groups of cows which did or did not receive DCT. Account was also taken of the cell count level at the last test before the date when the even-numbered cows received DCT. The coded cell counts at this test were 0 if the count was less than 300×10^3/ml, 1 for 300 to 499 $\times$ 10^3/ml, 2 for 500 to 999 $\times$ 10^3/ml, and 3 for 1000 $\times$ 10^3/ml or higher.

The production analyses were based on PI for the 1978-9 season, adjusted when necessary to a herd average of 100. Early-season, mid-season and whole-season PIs were used, with variables included in the model being herd, age group, treatment (DCT vs. No DCT), pre-treatment cell count score and previous season's PI.

RESULTS AND DISCUSSION

The relationship between the seasonal score (SS) and the geometric means (GM) for the season in the 781 cows for which this latter parameter was calculated was $GM = 46.1 + 19.1\,SS + 4.02\,(SS)^2$. As the r^2 value was 0.98, this scoring system could be used as a simple method of describing cell count levels in cows in seasonal herds.

The percentage of animals in each of the 16 (0–15)) scoring categories is shown in Table 1. Within each age group, the greatest percentage of cows had scores of 0. While the percentage of cows in each scoring category tended to decline with increasing score, it was not a steady decline, with unexpectedly small percentages of cows scoring 2, 7 or 12. This pattern of distribution suggests that this total population of 12 233 cows was made up of four subgroups. The largest subgroup comprised 68.4% of

the cows and had scores of from 0 to 2. A reason for the subgrouping is that each of the five scores each cow received showed a high repeatability. For example, the cows in the subgroup with scores of 0 to 2 comprised cows which usually scored 0 at each test,with the odd test score being 1. The scores for the 1 838 cows in the town supply herds (Table 1) showed a similar distribution to that found in cows in seasonal herds.

The significant age effects on the distribution of cows in each of the four subgroups is apparent in Table 2. The average GM cell count for each of these subgroups was estimated using the equation in Fig. 1, and indicates that the subgroups represent cows with low, medium, high or very high cell count levels. These results confirm the previous observations of Duirs and Macmillan (1979) that cell count levels increase with age among cows in seasonal dairy herds.

A most important result derived from the analysis of the data summarized in Table 2 is that PIs differed significantly between subgroups ($P < 0.001$) and between ages ($P < 0.001$). The between-subgroup differences were primarily associated with a linear decline in PI with the increase in cell count score among

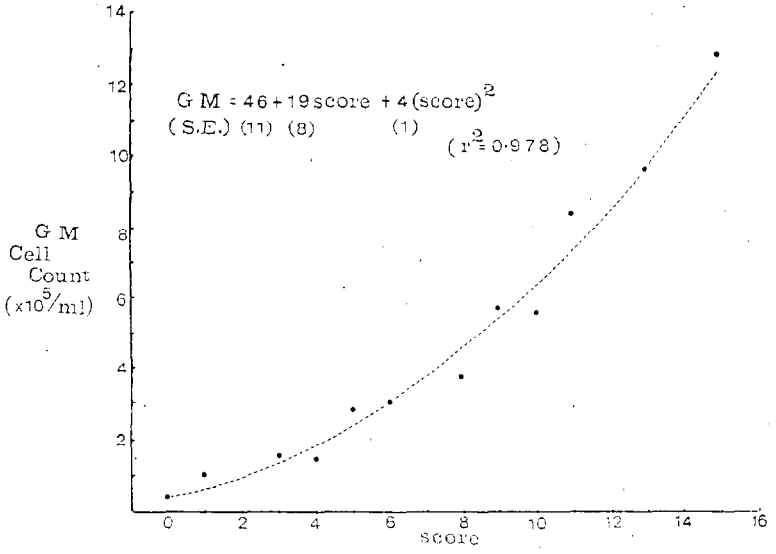

FIG. 1: *Relationship between seasonal geometric mean cell count and seasonal score in 781 cows in seven seasonal dairy herds.*

TABLE 1: PERCENTAGE DISTRIBUTION OF COWS IN SEASONAL AND TOWN SUPPLY HERDS WITH SEASONAL SCORES OF FROM 0 TO 15

	Age Group in Seasonal Herds					
Seasonal Score	*2*	*3*	*4*	*Mature*	*All Groups*	*Town Supply Herds*
0	78.5	71.6	60.4	40.6	57.0	54.4
1	7.5	10.1	12.5	11.7	10.7	9.8
2	1.0	1.1	1.6	1.4	1.3	3.5
3	3.4	4.4	6.7	6.8	5.7	6.8
4	3.2	2.5	5.1	6.0	4.7	4.5
5	2.3	2.7	3.2	6.6	4.5	4.2
6	1.1	2.2	2.4	4.5	3.1	3.8
7	0.5	0.4	1.0	1.8	1.2	2.0
8	0.6	0.8	1.1	3.0	1.8	2.1
9	0.5	0.7	2.0	3.5	2.1	1.9
10	0.3	1.2	1.5	3.6	2.2	2.0
11	0.3	0.8	0.8	2.7	1.6	1.0
12	0.1	0.2	0.5	1.1	0.6	1.0
13	0.3	0.3	0.4	1.7	0.9	0.8
14	0.2	0.4	0.5	1.6	0.9	0.4
15	0.3	0.6	0.6	3.3	1.7	1.6
No. of cows	2 679	1 940	1 993	5 621	12 233	1 848

TABLE 2: AGE AND PRODUCTION INDEX (PI) DIFFERENCES AMONG COWS GROUPED INTO LOW, MEDIUM, HIGH OR VERY HIGH CELL COUNT SUBGROUPS

		Cell Count Subgroup			
Score Range		*Low 0–2*	*Medium 2–7*	*High 7–12*	*Very High 12–15*
2-yr-olds	%	86.5	10.7	2.0	0.8
	PI	99.6	99.4	99.3	91.0
3-yr-olds	%	82.2	12.6	3.8	1.4
	PI	105.7	105.7	100.4	96.6
4-yr-olds	%	73.7	18.6	6.0	1.7
	PI	104.4	102.6	101.0	101.5
Mature	%	53.0	25.6	14.3	7.1
	PI	100.7	97.3	97.2	90.8
All ages	%	68.4	19.1	8.6	3.9
	PI	102.0	99.3	97.1	91.8
Estimated cell count ($\times 10^3$ cells/ml)		50	210	587	1 085

subgroups ($F = 45.8$; 1.15). This linear component accounted for 90% of between-subgroup variation in PI. However, the slopes of the linear declines differed between age groups (Table 3), being least (and not significant) for 2-year-old cows and greatest (and highly significant) for mature cows. When the data were analysed without classifying cows into subgroups (Table 3), the results provided further convincing evidence of the negative relationship between seasonal score and PI, with this relationship being most pronounced in mature cows.

TABLE 3: EQUATIONS DESCRIBING RELATIONSHIP BETWEEN PI AND SCORE SUBGROUP OR INDIVIDUAL SCORE FOR COWS OF DIFFERING AGES

	Subgroup				*Score*			
Age	*Intercept*	(± *SE*)	*Slope*	(± SE)	*Intercept*	(± *SE*)	*Slope*	(± *SE*)
2-yr-olds	99.6	(0.5)	— 0.9	(0.9)	99.6	(0.4)	— 0.19	(0.19)
3-yr-olds	105.8	(0.6)	— 2.0	(0.9)	105.9	(0.5)	— 0.48	(0.17)
4-yr-olds	104.3	(0.6)	— 1.5	(0.7)	104.4	(0.5)	— 0.37	(0.15)
Mature	100.7	(0.4)	— 2.7	(0.3)	100.8	(0.4)	— 0.63	(0.06)

Cell Count Results and Culling

The average seasonal score for the 12 233 cows was 3.6, which is equivalent to a seasonal GM of 167 $\times$ 10^3 cells/ml. This would suggest that cell count levels were not a significant problem in this group of cows. However, if the derived equation is used to estimate the number of cells produced by each of the four subgroups in Table 2, the comparative contribution of each subgroup to the "calculated" bulk milk cell count shows the potential for further reducing cell count levels through culling or by other means. The results in Table 4 show that the 3.9% of cows in the "very high" subgroup contributed 25.3% of the cells. If these cows were identified and then culled, the average bulk milk cell count would decline from 167 $\times$ 10^3 to 130 $\times$ 10^3 cells/ml. The high cell counts in these cows will be associated with a reduction in production of approximately 8 PI units. Most of these cows will be "mature" cows (Table 1). Treating them with selected dry cow antibiotics may reduce their cell count levels in subsequent seasons, but it would seem preferable to cull them and consider treating the 8.6% of cows in the "high" cell count subgroup.

The 12 233 cows in Table 1 did not include animals which may have had severe clinical mastitis during early or mid-lactation and

TABLE 4: ESTIMATED CELL NUMBERS PRODUCED BY COWS IN FOUR SUBGROUPS WITH VARYING SCORES AND THE PROPORTIONAL CONTRIBUTION WHICH THESE COWS MAKE TO OVERALL BULK MILK CELL COUNTS

Subgroup (Score Range)	*% of Population*	*Av. Cell Count* ($\times 10^3$/ml)	*No. of Cells Produced* ($\times 10^3$/ml)	*% of Total Cells*
Low (0–2)	68.4	50	3 430*	20.5**
Medium (2–7)	19.1	210	4 006	24.0
High (7–12)	8.6	587	5 046	30.2
Very high (12–15)	3.9	1 085	4 233	25.3
Total or Average	100	167	16 715	100

* 68.4 × 50; ** 3 430/16 715.

were culled before late lactation. Therefore, the results summarized in Tables 1 to 4 relate to cows still in the herds at the end of the season.

DCT Trial

The design of this trial meant that cows with a range of cell counts at the end of the 1976-7 lactation received DCT while a comparable group of herd mates were not treated. During early lactation in the subsequent season, the treated group had significantly higher PIs than their untreated herd mates ($P < 0.05$; Table 5). However, this treatment effect was associated with an

TABLE 5: EARLY LACTATION AND TOTAL LACTATION PIs AMONG COWS WHICH WERE OR WERE NOT GIVEN DCT IN RELATION TO CELL COUNT SCORES AT DRYING OFF AFTER THE PREVIOUS SEASON

Cell Count Score at Drying Off		*Early Lactation*			*Total Lactation*		
		Treated	*Untreated*	*Total*	*Treated*	*Untreated*	*Total*
0	PI	99.6	100.4	100.0	100.5	101.1	100.8
	n	234	233	467	251	247	489
1	PI	104.3	100.0	102.2	103.9	103.1	103.5
	n	84	78	162	88	83	171
2 and 3	PI	100.4	98.8	100.3	101.7	100.8	101.2
	n	95	77	172	95	73	168
Total	PI	101.9	99.7	100.8	102.0	101.7	101.9
	n	413	388	801	434	403	837
		SE ±1.1			SE ±0.9		

interaction ($P = 0.07$) involving cell count score at the end of the previous lactation. Cows with scores of 0 when treated had subsequent early lactation PIs lower than similarly scoring untreated herd mates; those with scores of 1 or 2 and 3 subsequently had higher early lactation PIs (Table 5). These PI differences were not significant in analyses using data for the whole of the lactation, suggesting that any early lactation advantage in production (as measured by PI) was subsequently lost.

It could be argued that this loss of advantage may not have occurred if the whole herd had received DCT, thus reducing the likelihood of untreated cows "reinfecting" treated herd mates during early lactation. Since 58% of cows were in the low cell count group (score 0) at the time of treatment, and cows in this group did not show a significant response in PI to treatment (99.6 vs. 100.4, Table 5), the cost of whole-herd treatment would not be justified. In terms of cell count scores in the post-treatment lactation, DCT did not significantly alter the distribution of cows in the four categories described in Table 4.

In some herds, cows are selected for treatment on the basis of whether or not they have had clinical mastitis during the season. In this particular trial the incidence of detected clinical cases varied between herds from 2 to 27%, with an overall average of 14%. However, 45 of the 82 cows (55%) which were treated for clinical mastitis and completed the lactation had cell count scores only of zero and may not have required DCT or shown a significant benefit from it. In many herds where this form of selective DCT is utilized, those cows with persistently high cell counts which are not detected as clinical cases will not receive DCT. Therefore, this form of selection is unlikely to be effective unless used in conjunction with other selection criteria. One advantage in having milk samples from individual cows routinely cell counted is that responses to DCT or to treatment of clinical mastitis can be monitored.

CONCLUSIONS

The results from these studies show that even in herds with relatively low average levels of somatic cells in milk, cell count data can be used to identify that small proportion of cows in the herd which will be contributing a disproportionately high number of the cells. There is also a marked age effect on cell count levels. A simple scoring system can be used to identify cows with persistently high or low cell count levels. These scores

are positively correlated with GM cell counts and negatively correlated with PI, this latter relationship being most pronounced in mature cows.

DCT has a slight influence on early-lactation PIs, especially in cows with cell counts above 300 000 cells/ml in late lactation. Whole-herd therapy in herds with comparatively low average cell counts is unlikely to prove profitable. Since a small proportion of the herd can have a large effect on bulk milk cellls counts, steps taken to reduce such counts may be difficult to monitor with any accuracy unless information for individual cows is also considered. The provision of a cell counting service by such organizations as livestock improvement associations could be of value to herd owners, factory staff, veterinarians, advisers and scientists in reducing cell count levels in milk.

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