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Milk production in East Friesian-cross ewes lambing year round

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ABSTRACT

Milk production of groups of East Friesian cross ewes lambing at intervals of 73 days (i.e., five times per year: August (n = 21), November (n = 29), January (n = 13), March (n = 14) and June (n = 14)) was measured on alternate days in the first week post partum and at weekly intervals for nine weeks. Ewes with single and twin lambs were enrolled if they safely delivered the appropriate number of lambs indicated by previous scanning. Ewes and lambs were separated in the morning and ewes milked by machine following i.v. oxytocin (1 i.u.) and stripped by hand until empty. Ewes returned to pasture whilst lambs were housed and bottle-fed. At afternoon milking (after a precisely measured interval of about 6 h) milk yields were recorded. From that yield and the time interval, daily milk yields were calculated. Data were analysed using a mixed linear model for repeated measures. Twin-bearing ewes produced significantly more milk than single-bearing ewes ($P < 0.001$). Lactogenesis differed significantly ($P < 0.001$) between the lambing groups. Over the whole lactation, milk yield differed significantly ($P < 0.001$) between different lambing groups. Milk yields were highest following June lambing (2223 ± 35 g/day), followed by November (2107 ± 24 g/d), August (1932 ± 36 g/day), January (1826 ± 31 g/day) and March (1742 ± 30 g/day). A significant lambing group by rearing rank interaction ($P < 0.001$) indicated that single- and twin-bearing ewes responded differently to seasonal differences; ewes with twins increased milk yield proportionately more than ewes with singles in June, November and January.

Keywords: milk yields; sheep; STAR system.

INTRODUCTION

Milk yield of sheep differs between breeds and with stage of lactation, and is also affected by environmental factors (Geenty, 1980) such as season of lambing, number of lambs, shearing, internal-parasite burden, nutrition, mastitis, and frequency of milk removal. This paper considers factors affecting the milk yield of sheep grazing with lambs at foot in New Zealand (NZ): the ewes were not in a dairy situation. There have been numerous reported NZ studies of lactation in general-purpose ewes published in the last 50 years (Barnicoat *et al.*, 1949a and b; Geenty & Jagush, 1974; Geenty *et al.*, 1975; Geenty, 1980; Geenty & Sykes, 1986; Peterson *et al.*, 1990; Peterson 1992; Peterson *et al.*, 1994; Peterson *et al.*, 1997; Muir *et al.*, 1998; Moffat *et al.*, 2002), each involving different methods of estimating milk yield (Geenty & Sykes, 1986), but none have presented detailed estimates of yield throughout lactation, and prior to 1990, no reports revealed differences in milk production in different seasons.

Milk yield in ewes is affected markedly by season. Autumn-lambing ewes produced 30-40% less milk than spring-lambing ewes fed the same diet (Peterson *et al.*, 1990; Peterson 1992). The mechanism is not understood, but it is presumed that it is mediated by photoperiod or other seasonal factors other than nutrition, since the differences were apparent in ewes fed the same diet and altering prolactin secretion produced similar effects. So far, this has only been studied in the April/May period and the August/September period; thus, there is no knowledge of whether it is a progressive or a sudden change. This trial, in which groups of ewes lambed at five times throughout the year, provided an opportunity to examine lactogenesis and total milk yields at different times of the year.

Such a study is important for two reasons. First, seasonal differences in milk production in sheep will become more important in the industry as farmers attempt to produce lambs at different or more frequent intervals to meet emerging markets or to adapt to seasonal climate. An adequate supply of milk in the first few days is crucial to survival of the lambs and will be more important as litter size increases (viz. would a system in which ewes produce triplets in autumn lead to catastrophic losses?). Second, since we cannot explain the seasonal variation in milk yields, it is apparent that we do not understand the process of lactogenesis adequately; the seasonal difference may be used as a model to investigate the process of lactogenesis more thoroughly.

Hence, the objective of this trial was to measure milk yields in groups of ewes lambing at five equal intervals throughout the year, specifically to determine if lactogenesis and/or whole-lactation yields differed with season. Ewes with single or twin lambs were included to determine if they responded differently to lambing season. An additional objective was to identify management practices that might influence milk yields.

MATERIALS AND METHODS

Animals

The mixed-age ewes were a cross breed, chosen for good lactation and the possibility of a longer breeding season than the more traditional breeds available. The ewes were 7/8 East Friesian and 1/8 Romney and they were mated to composite 1/2 East Friesian 1/4 Poll Dorset and 1/4 Texel rams. All animal procedures were approved by the Massey University Animal Ethics Committee.

Treatments

The experiment was carried out at Massey University's Haurongo farm, seven kilometres south of Palmerston North, NZ (latitude 40.23° S and longitude 175.37° E). Ewes were part of a larger trial (Morris *et al.*, 2004) investigating the practical implementation of the STAR system of sheep production (Hogue *et al.*, 1987). Oestrus was synchronised in all ewes using progesterone CIDRs. PMSG (Knight *et al.*, 1989) was used for mating in January, August and November. Ewes were enrolled in the trial if they lambed during the first cycle and if they gave birth to the same number of live lambs as seen in an earlier ultrasound scan. Ewes were excluded from the trial if their lamb died or if they had mastitis that did not respond rapidly to treatment. Numbers of ewes finally included in the analyses in each seasonal group were: August (n = 21), November (n = 29), January (n = 13), March (n = 14) and June (n = 14).

Ewes from each seasonal group were milked on days 1, 3, 5, 7, 14, 21, 28, 35, 42, 56 and 63 of lactation. Milk yield of the ewes was estimated by the 'oxytocin method' first described by McCance and Alexander (1959). The technique involves i.v. injection of 1 i.u. synthetic oxytocin (Oxytocin-V, Vetpharm (NZ) Ltd, Auckland, NZ) then emptying the udder by machine and hand milking, and repeating the milking procedure a measured time (about 6 h) later, at which time the milk yield is measured. The lambs were separated from the ewes (and bottle fed as required) during the intervening period.

Animal health

In all seasonal groups except the (first) August-lambing group, all ewes were drenched for internal parasites on the first day of milking and subsequently at two-week intervals with a standard dose of abamectin given separately to a standard dose of a combination of albendazole plus levamisole. In the August-lambing group, the ewes were first drenched at week seven. Ewes were monitored for other problems such as foot rot, fly strike, and mastitis. When infections were detected, animals were treated with procaine penicillin (Phoenix Pharmacillin, Phoenix Pharm Distributors Ltd, Auckland, NZ), or in the case of severe mastitis, with 250,000 units of benzyl penicillin (Mamyzin, Boehringer Ingelheim (NZ) Ltd, Manukau City, NZ).

Nutrition

Ewes were grazed at pasture, or on a crop, and given supplementary baleage, as required throughout the trial, depending upon seasonal pasture availability. Pasture DM intake of the experimental ewes was not estimated but pasture DM cover (kgDM/ha) was estimated fortnightly (data not shown).

Shearing

Farm shearing policies meant that ewes were not all shorn at the same time with reference to lambing. In the August and November lambing groups, about half of the ewes were shorn at day 100 of pregnancy: the remainder were all full-fleeced.

Statistical analyses

Data were analysed using a mixed linear model for repeated measures. All means presented are least-squares means (LSM). Both the shape of the curve and the overall production were considered. For analysis of lactogenesis, LSM and the slope of the regression for only the first 7 days were considered. Since live weight of ewes was significantly ($P < 0.001$) related to their milk yields, milk yield data presented were adjusted for number of lambs born and for both linear and quadratic effects of pre-lambing live weight.

RESULTS

Lactogenesis

Mean milk yields during the first week (days 1, 3, 5 & 7) were significantly ($P = 0.001$) different among lambing groups (Table 1). The slopes of the regression differed significantly among groups, the regression line for January being flatter than those for November ($P = 0.01$), March ($P = 0.06$) and June ($P = 0.07$) although the regression for January was not significantly different from zero. On average, over all lambing groups, ewes with twins (2106 ± 21 g/day) produced more ($P < 0.005$) milk in the first week then those with singles (1826 ± 18 g/day). Figure 1 shows LSM milk yields for ewes with single and twins in each season. There was a significant birth season by rank interaction ($P < 0.05$). In March, milk yield did not differ significantly between ewes with singles and twins, but the difference was significant for the other lambing groups and greatest in June.

FIGURE 1: LSM (± SEM) daily milk yields during the first seven days of lactation for groups of East Friesian-cross ewes with single and twin lambs, lambing in August, November, January, March and June. (n is given within each column and asterisks denote significance differences within a lambing group).

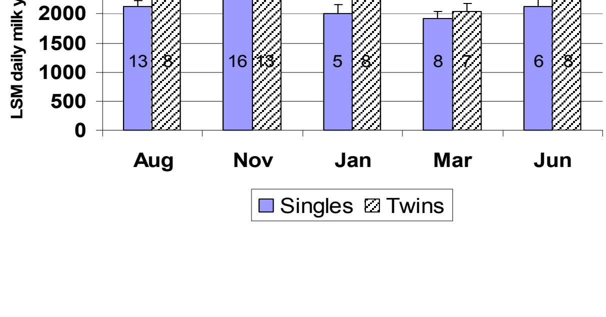
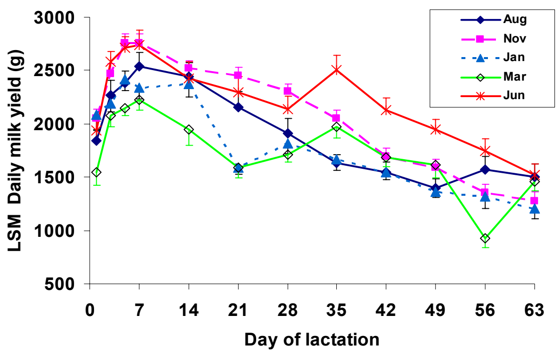


TABLE 1: Pre-lambing live weight (± SEM) and LSM (± SEM) milk yields during the first seven days of lactation for groups of ewes lambing in August, November, January, March and June.

Lambing group	Pre-lambing live weight (kg)	LSM milk yield (g/day)	Slope of regression of milk yield on time	Significance of regression
Aug (n = 21)	62.7 ± 2.0[a]	2221 ± 71[a]	91 ± 22[ab]	P < 0.001
Nov (n = 29)	73.2 ± 1.7[b]	2536 ± 58[b]	132 ± 19[a]	P < 0.001
Jan (n = 13)	78.4 ± 2.6[b]	2223 ± 92[a]	43 ± 29[b]	NS
Mar (n = 14)	74.0 ± 2.5[b]	2029 ± 81[c]	117 ± 28[a]	P < 0.001
Jun (n = 14)	64.2 ± 2.5[a]	2462 ± 73[b]	112 ± 2[a]	P < 0.001

Means in columns with differing superscripts differ significantly (P < 0.05)

FIGURE 2: LSM daily milk yields of groups of East Friesian-cross ewes lambing in August (n = 21), November (n = 29), January (n = 13), March (n = 14) and June (n = 14).



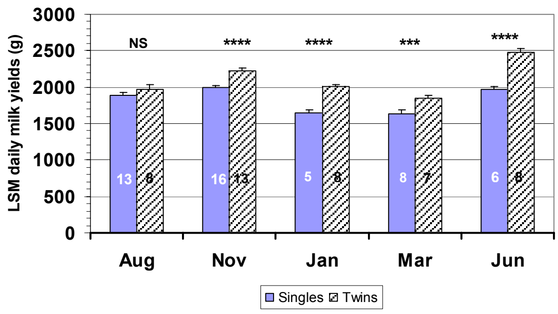
Whole-lactation milk yields

For the whole lactation period (63 days), the estimated LSM daily milk yields (Figure 2) differed significantly amongst lambing groups (P < 0.001). Milk yields were highest in June (2223 ± 35 g/day), followed by November (2107 ± 24 g/day), August (1932 ± 36 g/day), January (1826 ± 31 g/day) and March (1742 ± 30 g/day). Ewes with twins produced significantly more than those with singles (P < 0.001). The season by day interaction was significant (P < 0.001), indicating that that shapes of the lactation curves differed between lambing groups, as was the season by rank interaction (P < 0.001), which indicated that the lactation curves of ewes with twins responded differently from those of ewes with singles at the different seasonal lambing times (Figure 3).

Live weight

Mean live weights differed significantly (P < 0.001) between seasons (Table 1). There was a trend for ewes with twins (71.5 ± 1.4 kg) to be heavier than those with singles (69.5 ± 1.5 kg) but the difference was not significant (P = 0.09). There was no interaction between lambing group and number of lambs.

FIGURE 3: LSM (± SEM) daily milk yields during the whole of lactation for groups of East Friesian-cross ewes with single and twin lambs, lambing in August, November, January, March and June. (n is given within each column and asterisks denote significance differences within a lambing group).



Management

Farm management affected milk yield on several occasions. No statistical analyses have been undertaken to test the significance of the effects of those actions, but the coincidence with changes in milk yields (see Figure 2) indicates that they were the likely causes. Actions that were relevant to milk production are summarised in Table 2.

DISCUSSION

The lactation curves presented here are not representative of true differences resulting from seasonal photoperiod; there are too many other environmental factors involved (e.g., level of nutrition, changes in paddock and herbage type, drenching, shearing). The slope of the lactation curve during the first week did not differ between seasons (apart from January for which the regression was not significant) and, the mean milk yields during the first seven days of each season show no logical association with photoperiod. Any effect of photoperiod on lactogenesis (Peterson *et al.* 1990) has been over-ridden by other factors. Nutrition is a possible factor, but all ewes were well fed in the peri-partum period (it was a wet summer) and pasture was available *ad libitum*. Although McCance and Alexander (1959) found significant effects of nutrition on the onset of lactation, there are no reported rigorous studies of potential effects of nutrition on lactogenesis, mainly because it would be impossible to separate such effects from effects on mammogenesis. Hall *et al.* (1992a) reported increased colostrum yields 6 h post partum in ewes supplemented with protected sunflower seeds for 17 days pre partum but (in another trial) milk yields at day 2 and 9 were not affected by supplementation with lupin or oat grain (Hall *et al.*, 1992b).

TABLE 2: Farm management actions affecting milk production of grazing ewes.

Lambing group	Day †	Action	Apparent effect on milk yield
Aug	P100	9 ewes shorn (P100) 12 unshorn	decreased in shorn ewes
Aug	L50	drench	increased substantially in shorn ewes with twins
Jan	L22	crop	decreased substantially
Jun	L30	new grass	increased substantially
Mar	L21	fertiliser application (fluoride poisoning)	decreased in some ewes
Nov	P100	16 ewes shorn (P100) 13 unshorn	increased in shorn ewes
Nov	L50	crop	perhaps decreased yield slightly

† Day of pregnancy (P) or lactation (L)
Crop was forage brassica, cv Pasja

Whole-lactation curves indicated that milk yields were highest in groups lambing in June and November, and lower in ewes lambing in the traditional period of August, and March, the period now used for lambing in some summer-dry districts, but the poor March yields may have been a result of fertiliser application. January lambing produced the second lowest average milk yields, despite the fact that it was a wet summer with good feed supply. The marked decline in yields evident at 21 days (Figure 2) coincided with introduction to a brassica crop (Table 2) and yields increased on return to pasture.

Presumably because they were better able to take advantage of the conditions, ewes with twins exhibited significantly greater advantage in milk yields than those with single lambs in the groups lambing in June, November and January (Figure 3). If these data are indicative of lactation curves that may typically be achieved using the STAR system, it seems that satisfactory milk yields will be achieved in ewes lambing at times other than those times already used by commercial farmers. Indeed, the data suggest that the traditional times for lambing may need to be re-evaluated from a milk production point of view.

In all lambing groups, peak milk yield was reached by the end of the first week of lactation. Detailed lactation data for general-purpose sheep in the United States of America (Cardellino & Benson, 2002) showed the peak of lactation much later than the peak in the current trial, but the environmental conditions and diet used differed markedly from the NZ situation. The difference may also be due, in part, to the very high dose of oxytocin (10 i.u.) used by Cardellino and Benson (2002). It has been demonstrated in New Zealand ewes (Peterson, 1992; Knight & Bencini, 1993) that milk let down is readily achieved using only i.v. administration of 1 i.u. of oxytocin (c.f. 10 i.u.). Furthermore, Geenty (1980) showed that frequent administration of 5 or 10 i.u. increased daily milk yields by up to 40%. To avoid lactogenic or galactopoietic effects caused by the measurement method, it is important to minimise oxytocin use.

Changes in lactational performance coincident with management activities showed that milk yields are very susceptible to changes in diet, especially introduction to feeding on a crop (detrimental) and fresh new pasture (advantageous). There is also a salutary warning against allowing intake of superphosphate fertiliser, which caused the death of several ewes and contributed to the decline in milk yields evident in the group that lambed in March. Internal parasites apparently have an adverse effect on milk production, especially in shorn twin-bearing ewes (see day 56 in the August-lambing group). In addition, the effect of shearing on milk yields need to be clarified in a controlled situation, although increased milk yields, as seen in the November group, were also recently reported by Cam and Kuran (2004).

In conclusion, this trial has demonstrated definitive lactation curves for East Friesian cross ewes grazing pasture in the Manawatu district of NZ and has shown no detrimental effect on milk yield as a result of lambing in June and November, and that the more frequently used lambing periods of August and March may have some inherent disadvantage. June is potentially the best month for lambing to achieve high milk yields, especially in ewes with twins. There was no evidence of photoperiod effects on milk yields, although any such effects may have been masked by the many other environmental factors involved, including management practices apparently detrimental to milk yields.

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