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Original article

Performance of a herd of Holstein cows managed without the dry period

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Summary — The performance of a commercial herd of 37 high-yielding Holstein cows managed without the dry period is described. Milk yield was high (9 340 kg for primiparous and 10 900 kg for multiparous cows in 300 days) and rich in proteins (33.2 g/kg). The somatic cell count was relatively high (326 000 and 484 000/ml for primiparous and multiparous cows, respectively) and tended to be positively related to immunoglobulin content and, between cows, to free fatty acid content. In each of the 13 udders studied for bacteriological analysis, at least two quarters were not negative. In late pregnancy, the milk was progressively enriched with fat, proteins, immunoglobulins and somatic cells, with growing individual differences. Between months 3 and 10 of lactation, the cows gained over 100 kg body weight. The career of the 28 multiparous cows in the study was completed with monthly data recorded by the Contrôle Laitier. Milk yield increased by about 11 and 15% between lactations 1 and 2, and 2 and 3, respectively. Monthly persistencies in the declining phase were 97.2, 94.0 and 94.5%, respectively.

dairy cow / dry period omission / milk production / feeding level

Résumé — Production laitière d'un troupeau de vaches Holstein conduit sans période sèche. Les performances d'un troupeau privé comportant 37 vaches Holstein fortes productrices, conduit depuis plus de 15 ans sans période sèche, ont été décrites pendant un an. Pendant la période hivernale, le troupeau recevait un mélange d'aliments à base d'ensilage de maïs (42 % de MS) à volonté, et de l'aliment concentré en quantité limitée. En été, le troupeau passait quelques heures par jour au pâturage et continuait de recevoir la ration hivernale à l'étable. La production laitière a été élevée (9 340 kg pour les vaches primipares et 10 900 kg pour les multipares, en 300 jours). Elle était encore de 24 kg/jour deux mois avant le vêlage suivant et de 14 kg/jour la semaine avant le vêlage. Le lait a été riche en protéines (33,2 g/kg). La numération cellulaire a été relativement élevée (res-

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pectivement 326 000 et 484 000 /mL en 300 jours) et la teneur en immunoglobulines a eu tendance (p = 0,09) à varier dans le même sens. Entre vaches, la teneur en acides gras libres mesurée dans le lait natif ou dans le lait ayant séjourné 18 heures au réfrigérateur a également varié dans le même sens que la numération cellulaire (p = 0,09 et p = 0,024, respectivement). Au dixième mois de lactation, chez les 13 vaches dont l'étude bactériologique des laits de quartier a été réalisée, deux au moins des quatre quartiers ont été déterminés positifs. En fin de gestation, le lait s'est progressivement enrichi en matières grasses, en protéines, en immunoglobulines et en cellules somatiques, en présentant des différences individuelles croissantes. Dans quelques échantillons, tous prélevés au cours des deux derniers mois de gestation, les concentrations en acides gras libres ont été supérieures à 1 g d'acide palmitique/100 g de matières grasses. Les quantités moyennes d'ensilage de maïs + foin et de concentré ingérées ont été respectivement de 13,5 et 4,1 kg MS par jour en été. Pendant l'hiver, les quantités moyennes de concentré ingérées ont été comprises entre 4,4 et 4,7 kg MS par jour. Le poids vif des primipares s'est accru de 13 kg au cours des deux premiers mois de lactation et celui des multipares n'a diminué que de 29 kg. Entre le troisième et le dixième mois de lactation, les poids vifs de ces deux groupes d'animaux ont augmenté de plus de 100 kg. Le début de carrière des 28 vaches multipares présentes au cours de l'année d'étude a été reconstitué avec les performances mensuelles enregistrées par le Contrôle laitier. La production laitière s'est accrue de 11 % entre la première et la deuxième lactation, et de 15 % entre la deuxième et la troisième lactation. Les persistances mensuelles de la production laitière dans la phase descendante de la lactation ont été respectivement de 97,2, 94,0 et 94,5 % pour les lactations 1, 2 et 3. Le haut niveau d'alimentation du troupeau semble avoir compensé le fort effet négatif sur la quantité de lait produite systématiquement provoqué par l'omission de la période sèche, selon les résultats cohérents de la bibliographie.

vache laitière / omission de la période sèche / production laitière / niveau alimentaire

INTRODUCTION

The production cycle of specialized dairy cows almost universally consists of an approximately 10 month period of milk secretion, followed by a 2 month dry period, before the following calving. Reduction or omission of the dry period eases or suppresses the drying off and lessens the mobilization of body reserves at the beginning of the following lactation (Swanson, 1965; Farries and Hoheisel, 1989). Therefore, a reduction in the length of the dry period decreases the risks of metabolic diseases (Farries and Hoheisel, 1989; Davicco et al, 1992) and enhances milk protein content (Rémond et al, 1992a). These modifications are of interest to producers, but they are accompanied by a decrease in milk yield of 20 to 40% when the dry period is omitted (Sanders, 1928; Klein and Woodward, 1943; Swanson, 1965). Consequently, omission of the dry period seemed unlikely to be applied in practice. However, a technical magazine (Perrot, 1986) reported the performance of a private herd in which none of the (Holstein) cows had been dried off for at least the last 15 years, to the deepest satisfaction of the farmer. Surprisingly, this herd, which was enrolled in the Contrôle Laitier (organization for milk monitoring), ranked among the most productive French herds with a yield of nearly 11 000 kg/cow in 1992.

The contrast between the performance of this herd and that expected from the consistent data in literature, our previous incapacity to implement omission of dry period on all cows and on successive lactations in experimental conditions (Rémond et al, unpublished results), and the current interest of dairy farmers in new management schemes since the enforcement of the EEC milk quota policy, prompted us to evaluate, for 1 year, the performance of this herd, which was unique to our knowledge.

MATERIALS AND METHODS

Herd and management

The herd consisted of 37 Holstein cows on average during the period of measurement, of which 35% were primiparous (P). They were managed in one group and were housed in a free-stall barn with straw as litter. During the winter period, cows received a mixture of maize silage (42% dry matter [DM]), hay (ca 1.7 kg/cow), soya cake (ca 1 kg/cow) and a feed rich in minerals, vitamins and some additives (ca 130 g/cow), once daily for ad libitum intake. The cows had access, through a magnetic collar, to one or two automatic feeders in which concentrate was delivered. During the period of grass growth, cows were turned out after the morning milking for a few hours to the pastures surrounding the farm. The herd spent the remaining time in the barn and continued receiving a very similar diet to that offered in winter. The distribution of concentrate was relatively constant throughout the lactation cycle and the year. Between cows, the concentrate offered at the automatic feeders was roughly increased by 1 kg/5 kg milk above a yield of 16 kg milk, and by 0.8 kg in P cows compared to multiparous (M) cows. Milking times were 0600 and 1700 hours. During the study, 23 cows and 18 heifers calved, of which 30 calved between August and December.

Measures and samplings

Measures and samplings were carried out on 55 different cows by a technician from INRA, once every other week, between 20 January 1993 and 4 January 1994.

Milk yield was measured and sampled with Tru-Test milk-meters, at the evening milking, at each visit during the last 2 months of lactation (and pregnancy) and during the first month and a half of lactation and once every other month thereafter.

Supplementary samples were taken by the farmer in order to describe in more detail the immunoglobulin G1 (IgG) concentration around calving. Immediately after sampling, the milk was poured into different flasks and cooled or frozen until analysis for fat, total (true) proteins, soluble proteins (after clotting with rennet) and lactose by infra-red spectrophotometry, for somatic cells (SC) by automatic counting and for IgG by radial immunodiffusion (Levieux, 1991). For the free fatty acid (FFA) analysis (Chazal and Chilliard, 1986), a sample was immediately heated at 65 °C for 0.5 h and then frozen (FFA-0), whereas another sample underwent the same treatment after 18 h at 4 °C (FFA-18). For the urea analysis, individual samples from mid-lactation and winter period were pooled: 17 P cows, 21 M cows producing less than 34 kg of milk/day, 15 M cows producing more than 34 kg of milk/day. At the end of month 10 of lactation, milk from each of the four quarters was sampled in an aseptic manner for microbial analysis (Laboratoire d'Analyses vétérinaires et biologiques du Département du Puy-de Dôme). Sampling was limited to one cow per milking (ie, one cow per 2 week period) to minimize disturbance. As a consequence, only 14 cows were sampled (50 results on quarter milk are available). The mixture of maize silage, hay and soya cake delivered to the cows and the refusals were weighed once a month. The quantity of concentrate ingested from the automatic feeders was considered as the quantities delivered. Cows were weighed after the morning milking, during weeks 1 or 2 and during weeks 8, 9 or 10 after calving, and at the end of month 10 of lactation.

To describe, in the same cows, the evolution of milk production throughout the lactation, and mainly from one lactation to another, we reconstructed the beginning of the career of the 28 M cows that completed lactation in our study, with the data (milk yield, and fat, [true] proteins and SC counts) recorded monthly by the Contrôle Laitier.

Analysis of the results

Evening milk yields (x) were converted into daily yields (y) by a regression calculated from data from 223 morning and evening milkings recorded by the Contrôle laitier: $y = 2.04\ x + 0.5$ ($r^2 = 0.97$). Milk contents were not corrected.

Milk yields and contents measured during the year of observation were classified by stages of lactation relative to the preceding calving (seven stages between day 1 and day 240; see figure 1) and to the following calving (seven stages between day –150 and day –1). Effects of rank of lactation (1 vs 2 and more) and of stage of lactation (stages 4 to 7 in early and mid-lactation, stages 8 to 14 for cows in late lactation) were tested by variance analysis according to the GLM procedure of SAS (1988) using the model: variable = rank, cow(rank), stage, rank x stage, stage x cow(rank). Relationships between milk parameters and SC count were calculated with the model: variable = rank of lactation, cow(rank), period, rank x period, SC count (expressed in logarithms). Arithmetic means are presented in the text, figure 1 and table I.

The data from three cows that died or were culled in the few weeks following calving because of health disorders were excluded from the study.

RESULTS

Milk production during the year of our measurements

Late lactation

Milk yield was not different between P and M cows during the last 5 months of lactation and pregnancy (stages 8 to 14; fig 1). The high milk yield during the period in which cows should normally be dried-off (about 24 kg/day) as well as the yield during the last week before calving (14 kg/day) should be noted.

The P cows yielded a milk richer in caseins and fat (fig 1) than the M cows, by 2.2 and 3.7 g/kg, respectively (interaction of rank of lactation and stage of lactation was not significant). Stage of lactation had a significant effect on all parameters, except FFA. Evolution of milk composition became more pronounced as calving approached and was accompanied by a sometimes (IgG, FFA, SC) considerable increase in individual variability. As a result, medians changed less than means. Mean concentration in FFA rose sharply during late lactation due to the abrupt appearance of some very high values: five samples (all in the last month) and nine samples (all in the last 2 months) from 97 analyzed showed FFA-0 or FFA-18 contents (respectively) higher than 1 000 mg palmitic acid/100 g of fat. One sample at stage 12 of lactation was analyzed several times and inexplicably had a FFA-0 content of 18 550 mg palmitic acid/100 g of fat and a FFA-18 content of 24 670 mg/100 g of fat.

During the last 2 months of pregnancy, IgG content and milk yield were negatively related ($r = -0.71$; $P < 0.01$). In the same period, contents (all expressed in logarithms) in IgG, FFA-0 and FFA-18 were positively and closely ($P < 0.01$) related to SC counts.

Table I. Body weights at calving and their variations during lactation (kg).

	Primiparous cows			*Multiparous cows*		
	n	*Mean*	*SD*	n	*Mean*	*SD*
Week 1 [1]	15	517.4	70.4	17	699.0	77.2
Month 2–week 1 [2]	15	13.1	24.0	12	–28.9	30.6
Month 10–month 2 [3]	6	126.8	47.8	8	100.3	49.0

[1] Mean day after calving = 7.2 (primiparous cows) or 8.3 (multiparous cows); [2] mean duration (days) = 53.4 (primiparous) or 52.7 (multiparous); [3] mean duration (days) = 254.0 (primiparous) or 258.4 (multiparous)

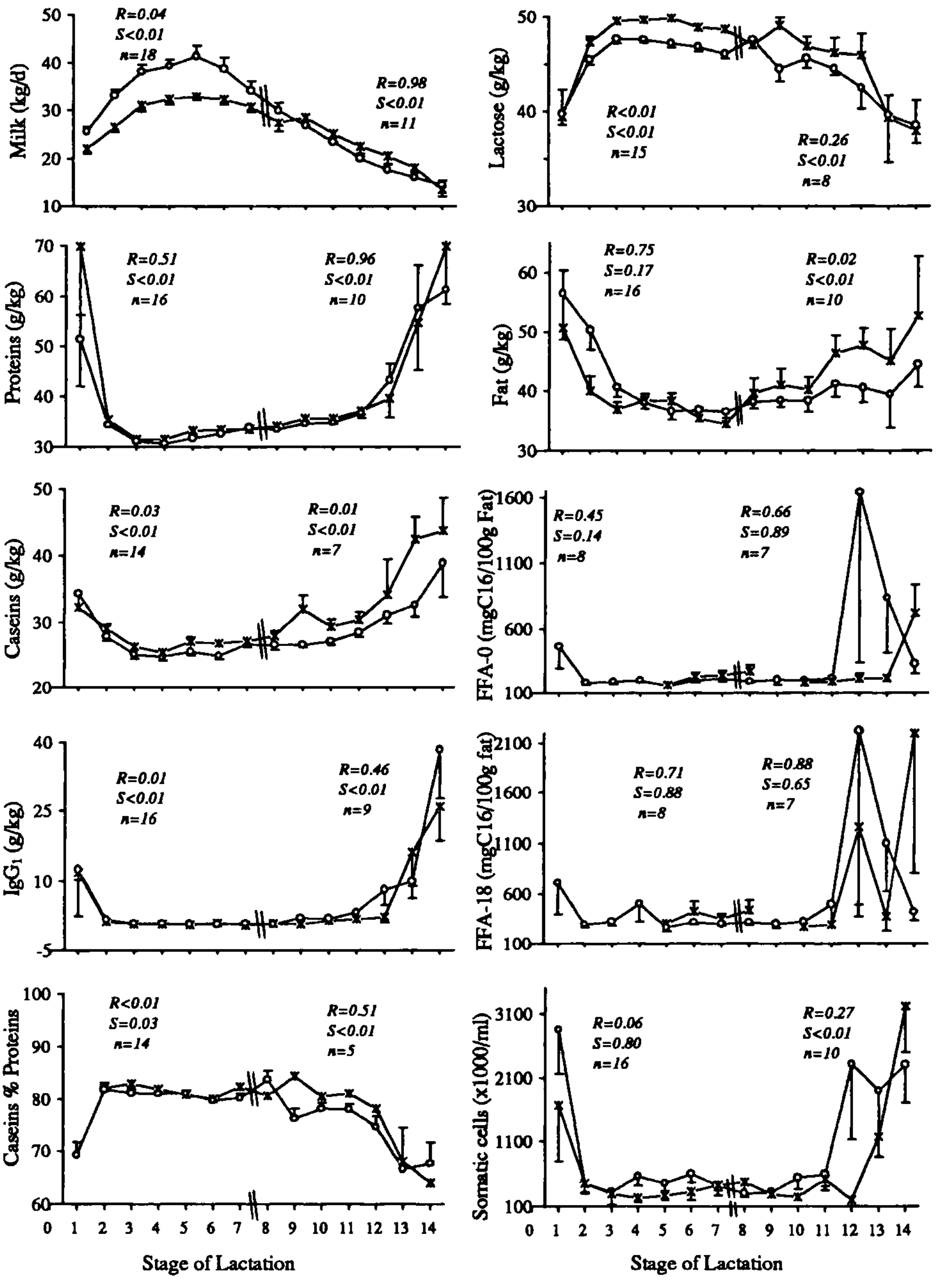

Fig 1. Evolution of milk yield and composition in primiparous (✱) and multiparous (o) cows during the first 240 days after calving (seven lactation stages: 1 = days 1 to 5; 2 = days 6 to 15; 3 = days 16 to 30; 4 = days 31 to 60; 5 = days 61 to 120; 6 = days 121 to 180; 7 = days 181 to 240) and during the last 150 days before the following calving (seven stages: 8 = days –150 to –121; 9 = days –120 to –91; 10 = days –90 to –61; 11 = days –60 to –31; 12 = days –30 to –16; 13 = days –15 to –6; 14 = days –5 to –1). Error bars indicate standard error of the mean. *S* gives the significancy of the effect of stage of lactation, *R* the effect of rank of lactation, *n* the mean number of cows per point.

Major pathogens (species and number of infected quarters: *Staphylococcus aureus*: 8; *Steptococcus uberis*: 3; *Streptococcus* spp: 3; *Enterococcus*: 4; *Pasteurella multocida*: 1) were detected in milk samples from 18 quarters (35% of the total) from eight cows among the 13 analyzed. Minor pathogens (*Corynebacterium* spp and coagulase-negative *Staphylococcus*) were detected in 21 milk samples (42%), and 11 milk samples (22%) were negative. Every cow had at least two positive quarters.

Early and mid-Lactation

P cows presented a milk yield lower by 5.1 kg/day (fig 1) than M cows. The milk of P cows was richer in caseins (1.4 g/kg) and in lactose (2.2 g/kg), and lower in IgG (0.11 g/kg). SC count was relatively high for both groups (326 000 and 484 000/mL for P and M cows, respectively; $P = 0.061$), because of cows that showed chronic or acute high values. The FFA-0 and FFA-18 were related neither to rank of lactation nor to period. The lowest mean protein content recorded over the lactation was 31 g/kg in the period 31 to 60 days after calving.

The SC count was negatively related to lactose ($P = 0.020$) and to the proportion (%) of caseins in proteins ($P = 0.047$), and tended to be positively related to IgG (log) ($P = 0.09$). No relation was observed between SC count and FFA. Nevertheless, between cows (mean for periods 4 to 8), SC count (log) tended to be positively related to FFA-0 ($P = 0.086$) and to FFA-18 ($P = 0.024$; one cow was excluded from the relation).

Milk production over several consecutive lactations

For the 28 cows of which we reconstituted at least the first two lactations, milk yield in 300 days was 8 735 kg during the first lactation (age at calving = 25.6 months) and 9 577 kg (+10%) during the second lactation (age at calving = 38.9 months). Yields of the 17 cows (among the 28 preceding ones) for which we reconstituted the first three lactations were 8 161 kg during the first lactation, 9 222 kg (+13%) during the second and 10 608 kg during the third (+30% compared to the first lactation). Maximal yields were reached in the period 31 to 60 days after calving (30.5, 37.4 and 42.9 kg/day, respectively for lactations 1 [$n = 28$], 2 [$n = 28$] and 3 and more [$n = 48$]). Calculated between the third and the tenth consecutive 30 day periods, persistencies of milk yield (mean of the seven ratios: yield in period n/yield in period $n - 1$) were 97.2, 94.0 and 94.5%, respectively. Contents of (true) proteins and of fat (31.2 g/kg and 36.9 g/kg) showed classical evolutions, but SC counts were relatively high (336 000, 425 000 and 585 000/mL for lactations 1, 2 and 3 and more, respectively).

Nutritional indices

Daily intakes of maize silage, hay and concentrate (added to the roughages and distributed at the automatic feeders) in the summer period (six measurements between 13 April and 14 September) were 12.8, 0.7 and 4.1 kg DM, respectively, for an average milk yield of 31.9 kg/day. During the winter period, daily intake of concentrate was between 4.4 and 4.7 kg DM (range due to some uncertainty in the intake of the mixture of maize silage and associated feeds) for an average milk yield of 30.8 kg/day.

The 15 P cows weighed in weeks 1 or 2, and weeks 8, 9 or 10 after calving were young (26.4 months of age) and relatively light (517 kg) at calving (table I). They gained 13 kg of body weight during the first 2 months of lactation. During the same period, M cows ($n = 12$) lost 29 kg. During the following 8 months, the body weight of both groups of cows (six P and eight M cows) increased by more than 100 kg. Variation in body weight (y) between the first two weighings (body weight in weeks 8, 9 or 10 minus body weight in week 1 or 2) was negatively related to the maximum milk yield (x); thus $y = -3.07\ x + 112.6$ ($n = 27$; $r^2 = 0.59$; $P < 0.01$). The introduction of lactation rank as a supplementary factor had no effect.

Milk urea concentrations were 31,31 and 32 mg/100 mL for P cows and for M cows yielding less than 34 kg/day or more, respectively.

DISCUSSION

The lack of control cows renders most of the conclusions insubstantial and speculative.

Milk yield

The milk yield of this herd shows that the management of a whole herd without a dry period is possible and does not exclude high performance. Whether or not a higher performance would have been achieved with the normal dry period is unknown. The most surprising observation is the normal increase of milk yield (10–13%) between the first and the second lactation: it was similar to that (12–16%) recorded in normally managed cows (Schutz et al, 1990; Anonymous, 1993; Coulon et al, 1995) and thus in contradiction to the depression in milk yield systematically entailed by the omission of the dry period as described in the literature (Klein and Woodward, 1943; Swanson, 1965; Farries and Hoheisel, 1989; Rémond et al, 1992a). The apparent lack of effect of dry period omission on milk yield in the herd could result from a negative effect of this practice which was entirely offset by a positive effect related to the particularly high feeding level throughout the year. This high feeding level is evidenced by all the nutritional indices that were measured: high distribution (and intake) of conserved feeds during summer, high persistency of milk yield, very high body weight gain in the declining phase of lactation and satisfactory milk urea content (Vérité et al, 1995). In P cows, the gain in maternal mass, a good index of energy balance, was 123 kg between calving and month 10 of lactation (month 5.9 in the second pregnancy), the 17 kg weight of the gravid uterus at this period being calculated (Ferrell et al, 1976) and taken into account. At the end of month 10 of lactation, the P cows had therefore already gained about 50 kg more than the gains generally observed (70 to 80 kg) between calvings 1 and 2 (Troccon, 1993). Yet, these P cows were still 100 days from their second calving, and maternal gain probably continued to increase along with the gravid uterus. If a 25 kg increase in body weight gain between calvings 1 and 2 enhances peak milk yield during the second lactation by 1 kg/day, as observed in normally managed cows (Coulon et al, 1995), then the very high body weight gain of the P cows in the herd could have offset and masked the negative effect on milk yield systematically entailed by dry period omission, according to the literature.

The apparent lack of effect of dry period omission could also be due to the lesser sensitivity to this management of high producing cows, compared with lower producing cows, according to Farries and Hoheisel (1989) but not others (Swanson, 1965; Sorensen and Enevoldsen, 1991).

Milk composition

Evolutions of fat, casein and total (true) protein contents in late pregnancy are consistent with previous results (Wheelock et al, 1965; Rémond et al, 1992a). These evolutions extend and intensify the evolutions occurring in the declining phase of lactation, and make this composition increasingly similar to that of colostrum. It should be noted that the principal defects (high content in SC, FFA, IgG) mainly occurred in the last 3 weeks of pregnancy. We cannot explain the few and short-term but high increases in FFA recorded during this period, but the general tendency for increased FFA content in late pregnancy is consistent with previous observations (Kitchen, 1981; Bachman et al, 1988).

Protein content (33 g/kg over the first 300 days; 31 g/kg in the 2nd month) was 1 to 2 g/kg higher than that previously recorded (Faverdin et al, 1987; Anonymous, 1993). Our measurements in evening samples were reliable estimations of the contents in daily milk, because in 158 comparisons between both categories of samples the difference was only 0.13 g/kg, in agreement with Lee and Wardrop (1984). High protein content in the milk of M and P cows may be related to the high level of feeding (Coulon and Rémond, 1991). In M cows, and more particularly in early lactation, the high protein content could also be due in part to omission of the dry period, as previously observed (Sorensen and Enevoldsen, 1991; Rémond et al, 1992a), operating either through an improvement of the energy balance (see later) or through a greater reduction of the capacity of lactose synthesis (milk volume) than of protein synthesis.

The SC count is considered to reflect microbial infection in the udder. The majority of uninfected milks show a SC count lower than 200 000/mL, and often 100 000/mL (Harmon, 1994). The relatively high SC count recorded in our study (ca 330 000/mL and 500 000/mL for P and M cows, respectively) is coherent with the low proportion (21%) of negative milks from quarters measured in the 13 cows analyzed. This percentage contrasts with the 47% negative milks (from the whole udder) recorded by Faye et al (1994) using similar methods of measurement in a survey on 7 852 individual samples of milk from 47 farms in the Brittany area. An upward trend for SC count with dry period reduction or omission has already been observed (Farries and Hoheisel, 1989; Rémond et al, 1992a). Systematic treatment of the udder with antibiotics in the dry period, commonly implemented in the standard management of cows, cannot be applied when the dry period is omitted, which could contribute to the chronic infection of a part of the udders.

The increase in FFA with SC count, which was relatively low and not very clear during the normal part of the lactation, as noted by Chilliard and Lamberet (1984), is consistent with previous findings (Bachman et al, 1988).

Changes in body reserves in early lactation

Even if the first weighing of the cows was not just after calving but on day 7 of lactation in mean, the body weight gain of P cows (13 kg) over the first 2 months after calving is uncommon, particularly in animals peaking at more than 32 kg of milk. Feeding (management and feed quality) and relative light body weight (517 kg) at calving are possible explanations for this. In M cows that peaked at 44 kg of milk, body weight loss (29 kg) over the same period was lower than that commonly recorded in cows with similar production (47 kg body weight loss between week 1 and 8 in 166 M cows fed on maize silage and peaking at 38 kg of milk; P Faverdin, personal communication). Again, feeding may play a major role, but an observation by Swanson (1965) of lower body weight loss in non-dried off cows than in their normally managed counterparts suggests a specific effect of dry period omission. This could operate in two different, and possibly complementary, ways: i) by decreasing the capacity of secretion of the udder without immediate (in the first few weeks of lactation) decrease of the feed intake capacity; delayed adaptation of feed intake to change of milk yield has been observed after bovine somatotropin administration (see Chilliard, 1988) or reduction of milking frequency (Rémond et al, 1992b); ii) by maintaining a higher feed intake than in dry cows, in late pregnancy, because of continual milk secretion and, thereby, a more functional rumen enabling a sharper increase of food intake in the following early lactation, as advocated by Dirksen et al (1984). These two modes of action, presently speculative and in need of confirmation, could contribute to maintaining a more satisfactory energy status in M cows in early lactation, which is a principal management goal.

CONCLUSION

Known for its management without the dry period, the herd we studied also appears to be characterized by a permanent high level of feeding, which may have offset the effect of dry period omission on the yield of milk. The relative high SC count during the normal part of lactation (in agreement with the literature), and the occurrence of defects in milk in the last few weeks of pregnancy, lead to wonder if such a management practice should not be reserved, when used, for udders in good health or if a reduced dry period (3 to 5 weeks?) would not partly maintain the advantages of the dry period omission (see Introduction), while enabling antibiotic treatment in late pregnancy.

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