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Extended lactations to overcome reproduction problems in mountain low-input dairy systems

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Abstract. With the end of milk quotas, dairy mountain farmers cannot compete with low-land farmers because of higher costs and lower productivity. So they have to maximize the use of local forages, reduce their inputs and make quality products like PDO cheeses. To study this new context, we designed since 2011 two low-input innovative farming systems at an INRA experimental farm (1100 m asl): 12 Holstein and 12 Montbéliarde cows in each; a short calving season (~77 days) before turning-out to pasture to superimpose lactation curve on grass growth; no concentrate or 4 kg/d during 200 days. Unfortunately, those systems led to poor reproductive performances, with only 35% of adult cows calving during the following season, without difference between systems or breeds. To overcome the low number of pregnant cows, we decided to extend of ~10 months the lactation of some non-pregnant cows (7 to 23 each year), in order to have always 24 lactating cows by system during summer. The 53 cows involved in extended lactations (~568 d) produced 70% more milk by lactation (8026 vs. 4715 kg) than cows with 'standard' lactations of 289 days, without significant difference between systems or breeds. In addition, these cows had better reproductive performances, with 79% of pregnant cows and 72% of calving the following spring. Even if these results must be completed by an economic study, extended lactations seem to be an interesting practice to reinforce the sustainability of seasonal low-input dairy mountain systems.

Keywords. Dairy cow – Low-input system – Reproductive performances – Extended lactation.

Des lactations prolongées pour remédier aux problèmes de reproduction dans les systèmes laitiers bas-intrants de montagne

Résumé. Avec la fin des quotas laitiers, les éleveurs de montagne ne peuvent plus rivaliser avec ceux de plaine sans maximiser l'utilisation de leurs fourrages, réduire leurs intrants et fabriquer des produits de qualité comme les fromages AOP. Pour étudier ce nouveau contexte, nous avons conçu depuis 2011 deux systèmes d'élevage bas-intrants innovants, dans une ferme expérimentale INRA (1100 m d'altitude) : 12 Holstein et 12 Montbéliarde chacun ; saison de vêlage réduite (~77 jours) avant la mise à l'herbe pour superposer courbe de lactation et croissance de l'herbe ; zéro concentré ou 4 kg/j pendant 200 jours. Malheureusement, ces systèmes ont entraîné de mauvaises performances de reproduction avec seulement 35 % des vaches adultes vêlant la saison suivante, sans différence entre systèmes ni entre races. Pour pallier ce faible nombre de vaches gestantes, nous avons décidé de prolonger de ~10 mois la lactation de certaines vaches « vides » (7 à 23 par an), afin d'avoir toujours 24 vaches traites par système l'été. Ces 53 vaches en lactation prolongée (~568 jours) ont produit 70% de lait en plus par lactation (8026 vs. 4715 kg) que les vaches en lactation « standard » (~289 jours), sans différence significative entre systèmes ou entre races. De plus, ces vaches ont eu de meilleures performances de reproduction, avec 79% de gestation et 72% de vêlage l'année suivante. Même si ces résultats doivent être complétés par une étude économique, les lactations prolongées semblent être une pratique intéressante pour assurer la durabilité des systèmes bas-intrants, saisonnés, de montagne.

Mots-clés. Vache laitière – Système bas-intrants – Performances de reproduction – Lactation prolongée.

I – Introduction

With the end of milk quotas in 2015, mountain areas cannot compete with low-land because of the higher cost of inputs (cereals, fertilizers...) and their lower productivity. So, as evoked by Horn *et al.* (2013), these farmers have to implement seasonal pasture-based milk production systems to reduce their inputs, reinforce their link to terroir and meet consumers' expectations with quality products like PDO cheeses. To study this new context, we designed and implement since 2011 two low-input innovative farming systems (called Bota and Pepi) for a long term 'system experiment' at the INRA experimental farm of Marcenat (French Massif-Central, 1100 m asl). These two farming systems, as self-sufficient as possible (12 Holstein [**Ho**] and 12 Montbéliarde [**Mo**] cows each; a short mating season of ~77 days; a calving season before turning-out to pasture to superimpose lactation curve on grass growth; no concentrate [**Bota**] or 4 kg/d at pasture [**Pepi**]; >180 days at pasture on permanent grassland) were described in detail by Pomiès *et al.* (2013). Unfortunately, these low-input systems led to poor reproductive performances, with only 35% of adult cows calving during the following season, without difference between systems or breeds. To overcome this low number of pregnant cows and in order to have always 24 lactating cows by system during summer, we decided to extend of ~10 months the lactation of some non-pregnant cows (7 to 23 each year) to put them to reproduction a second time the next spring. This study aims to compare the lactation and reproductive performances of these cows over the 4th first years of the experiment.

II – Materials and methods

1. Data collection and calculations

Every year, for every cow, the milk production was measured twice a day, the milk composition (fat and protein contents) 4 times a week on 2 consecutive days, and all the reproduction events were registered: oestrus (when detected), insemination (artificial or by the bull), pregnancy (confirmed by echography at ~60 days), and calving. Over the 192 possible 'lactation data' (24 cows × 2 systems × 4 years), 186 were used for this study and 6 were removed (dead or culled in early lactation). For milk production and composition, we compared the data of 80 cows that had a 'standard' lactation (**ST**) of about one year with 53 cows that had an 'extended' lactation (**EX**) of about two years ($80 \text{ ST} + 53 \times 2 \text{ EX} = 186$). For reproductive performances we compared the data of all the cows put at reproduction just after calving (80 ST + 53 EX) with the data of the 53 EX cows put at reproduction a second time, after one year of lactation.

2. Statistical analysis

The measured data (milk production, composition, intervals between reproduction events) were analysed using the mixed procedure of SAS software (SAS Institute Inc., 2013). The model took into account the effects of the type of lactation (ST or EX), the system (Bota or Pepi), the breed (Ho or Mo), the rank of lactation (1, 2 or ≥ 3) and the interactions type × system, type × breed and system × breed. The counting data (number of cows inseminated, pregnant...) were analysed by chi-square tests according to the type of lactation, the system, the breed, and the rank.

III – Results and discussion

1. Milk production and composition

With 568 days on average (= 18.7 months), the duration of one EX lactation was only 10 days less than two ST lactations, with no significant difference between breed and rank (Table 1). The EX cows produced 70% more milk by lactation, with an expected effect of the system (+699 kg for Pepi), of

the breed (+574 kg for Holstein) and of the rank (-625 kg for primiparous), but with no interactions between these parameters and the type of lactation. Consequently, the average daily milk yield during lactation was 2.2 kg/d lower for EX cows. The shapes of the lactations curves were very similar during the 9 first months (Fig. 1A). The lactation peak of EX cows was lower (-1.2 kg/d from week 4 to 7) but during their last weeks of lactation ST cows produced less milk (-1.6 kg/d from week 36 to 44), partly due to pregnancy. After 44 weeks, the two groups of cows had produced exactly the same amount of milk; at this point, with the second turn-out to pasture, the milk production of the EX cows grew-up again. In the same way, the milk composition of the two types of lactation was very similar until week 36 (Figure 1B). From this point to the end of lactation, by concentration effect, fat and protein contents of ST milk were slightly higher (+1.7 and +0.9 g/kg, respectively). During the second half of EX cows' lactation, fat and protein contents increased continuously (+9.4 and +8.7 g/kg, respectively). Over the total lactation, it led to higher averaged fat (+1.3 g/kg) and protein (+2.2 g/kg) contents of EX milk compared to ST milk. The high protein and fat contents of EX cows during their 2nd summer also allowed to partly correct the low contents of new-calved cows in milk tank.

Table 1. Comparison of milk production, milk composition and reproductive performances between cows, according to type of lactation (standard or extended); adjusted values by system (Bota or Pepi), breed (Holstein or Montbéliarde) and rank of lactation (1, 2 or ≥ 3)

(Means ± standard error)	Type of lactation		Effect			
	Standard	Extended	Type	System	Breed	Rank
Duration of the lactation (d)	289 ± 5.1	568 ± 6.2	***	+	ns	ns
Lactation milk yield (kg)	4715 ± 103	8026 ± 124	***	***	***	***
Average daily milk yield (kg/d)	16.5 ± 0.21	14.3 ± 0.25	***	***	***	***
Average fat content (g/kg)	40.2 ± 0.41	41.5 ± 0.49	+	***	*	ns
Average protein content (g/kg)	31.6 ± 0.20	33.8 ± 0.24	***	*	***	ns
Length of previous dry-off (d)	104 ± 3.3	101 ± 5.7	ns	ns	ns	ns
Duration of the gestation (d)	285 ± 1.0	283 ± 1.2	ns	ns	*	ns
From calving to conception (d)	93 ± 4.6	422 ± 5.2	***	ns	ns	ns
Average date of conception	27 July ± 3.4 d	26 June ± 3.7 d	***	ns	ns	ns
Calving interval (d)	378 ± 4.8	705 ± 5.3	***	ns	ns	ns
Average daily milk yield during calving interval (kg/d)	12.6 ± 0.22	11.7 ± 0.25	**	***	**	***

Mean values ± standard errors ns (non-significant) $P \geq 0.10$; + $P < 0.10$; * $P < 0.05$; ** $P < 0.01$; *** $P < 0.001$.

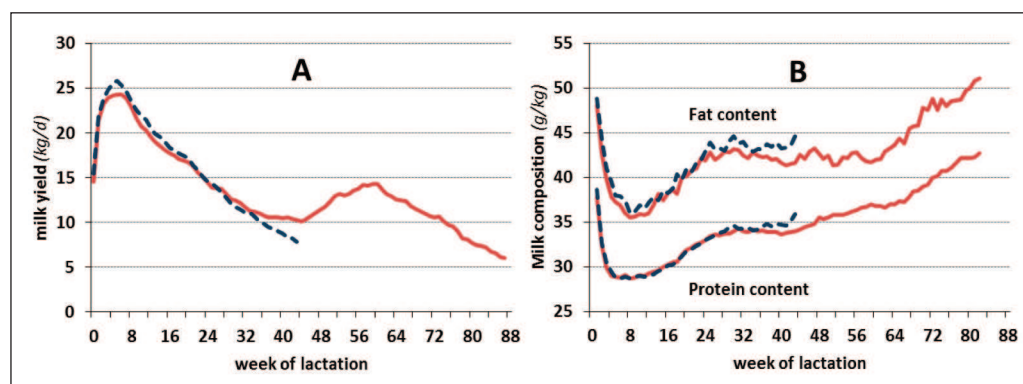


Fig. 1. Milk yield (A) and milk composition (B) of cows in standard (---) or extended (—) lactation.

2. Reproductive performances

The type of lactation, the system, the breed, and the rank of lactation were not correlated to the length of the previous dry-off (Table 1). The breed was the only parameter that affected the duration of gestation, which was 3.5 days longer for Mo cows, slightly less than expected (Guerrier *et al.*, 2007). The average calving-conception interval of 93 days for ST cows led to a calving interval 378 days, greater than one year, that penalise cows for the following reproduction period. On the opposite, EX cows had more opportunities to reproduce from the start of the ~77 days period, and in fact they did it on average 31 days earlier. This led to a calving interval 25 days shorter than two years, whatever the system, the breed or the rank. Thus, if we calculate the average daily milk yield during the calving interval, the difference between ST and EX cows was down to 0.9 kg/d ($P < 0.01$), even less for Mo (0.3 kg/d).

In addition, only 74% of the 133 ST cows were inseminated after calving (artificially on oestrus detection or by the bull), whereas 100% of the 53 EX cows were. On these inseminated cows, the conception rate (**CR** = number of pregnant cows divided by number of cows inseminated) was higher ($P < 0.01$) for EX cows than for ST cows (79 vs. 55%). This good CR was statistically independent of the system (77% for Bota vs. 81% for Pepi), of the breed (72% for Ho vs. 86% for Mo) and of the rank of lactation (81%, 77% and 79% for ranks 1, 2 and ≥ 3 , respectively). Similarly, the poor CR of ST cows was independent of the system, the breed or the rank of lactation. The percentage of calving after a positive echography was identical for ST and EX cows (87 vs. 90%). It resulted that on 133 cows in condition to be inseminated after calving only 47 calved one year after (35%) whereas on 53 cows at reproduction after one year of lactation, 38 calved the next year (72%).

IV – Conclusions

All those technical results suggest that the extension of the lactation of some selected non-pregnant cows could be a solution to overcome the problem of poor CR in seasonal low-input dairy systems. This solution must be confirmed by an economic study of the results, that takes into account specificities of the context: necessity to have the maximum of cows in lactation at pasture because of the best quality-price ratio of this feeding to produce milk; difficulty to buy new cows to replace the non-pregnant ones (obligation to find cows born in the PDO area, sanitary aspects...); interest of higher protein and fat contents from extended lactation cows for PDO cheese-making; veterinary costs (mainly linked to calving and dry-off periods); etc. If the economic performance is not favourable, the only way to maintain that type of pasture-based systems will be to switch to other breeds that reproduce easily even with low inputs, such as Jersey or Holstein-Friesian from Ireland or New-Zealand (Piccand *et al.*, 2013).

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