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Retrospective analysis of dry period length in Italian Holstein cows

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ABSTRACT

This research studied the relevance of potential sources of variation for dry period length in Italian Holstein cows reared in northern Italy and investigated the effect of days dry (DD) on milk production and calving interval in the subsequent lactation. Field data of individual cow DD were merged: a) with information from the previous lactation (6832 lactations, 87 herds) and analysed to investigate factors influencing DD; b) with milk yield (MY) and calving interval (CI) of the subsequent lactation (≈ 4000 lactations, >80 herds) and analysed to investigate the effect of DD on subsequent lactation performance. Individual cow DD averaged 67 ± 27 d, with a median of 62d; nearly 20% of DD were greater than 80 d. Herd had the greatest impact on DD; average herd DD was 71 d and $>50\%$ of herds had a mean dry period length >70 d. Longer DD were associated with second or later parity cows, lower daily MY at dry-off, and extremes in the length of the previous lactation, either short or long. After an adjustment for MY genetic merit, dry periods <35 d resulted in losses in subsequent lactation yield of ≈ 500 kg and DD ranging between 35 and 55d were associated with a 200kg decrease when compared to DD that averaged 65d. $DD > 80$ d resulted in a 100kg increase in subsequent MY. However, yield lost in the subsequent lactation caused by average $DD < 65$ d might be offset completely by the higher yield obtained in the previous lactation due to its longer length. Conversely, dry period length did not significantly affect ensuing CI. Therefore, data from this study and literature analysis suggest that a decrease in the duration of DD could be profitable for most herds considered. A general recommendation towards dry periods between 45 to 60d could be advised.

Key words: Dairy cows, Dry period length, Milk yield, Calving interval.

RIASSUNTO

ANALISI RETROSPETTIVA DELLA DURATA DELL'ASCIUTTA IN VACCHE FRISONE ITALIANE

La presente ricerca si proponeva di caratterizzare la durata dell'asciutta (DD) in un consistente campione di aziende specializzate da latte di razza Frisone ubicate nel Veneto, di studiarne la variabilità e di valutare l'effetto di periodi diversi di durata dell'asciutta sulla produzione di latte e sull'interparto della lattazione successiva. A questo proposito sono stati utilizzati dati di campo provenienti da un archivio regionale gestito dal Dipartimento di Scienze Animali dell'Università di Padova. Nello specifico i record individuali di DD disponibili sono stati uniti a) con le informazioni relative alla lattazione precedente, otte-

nendo un data set di 6832 lattazioni da 87 allevamenti analizzato tramite GLM per studiare le fonti di variazione della DD; b) con i dati di produzione di latte nella lattazione successiva (MY) e l'interparto (CI), ottenendo data set di 4172 (MY) e 3987 (CI) lattazioni da oltre 80 allevamenti, analizzati per studiare l'effetto di durate diverse di DD sulle performance della lattazione successiva. Il periodo di asciutta individuale ha assunto una durata media di 67 ± 27 d, con una mediana di 62d; circa il 20% delle lattazioni è risultato caratterizzato da asciutte di durata superiore agli 80d. Tra le fonti di variabilità analizzate, l'allevamento ha presentato l'impatto più forte su DD. La durata media dell'asciutta a livello aziendale è risultata pari a 71d, e oltre la metà delle aziende controllate ha presentato una media di DD superiore a 70d. Vacche di secondo parto ed oltre, basse produzioni giornaliere di latte nel controllo funzionale precedente alla data dell'asciutta e durate della lattazione precedente estreme, sia corte che lunghe, sono risultate associate con un allungamento di DD. Dopo un aggiustamento per il merito genetico individuale per la produzione di latte, asciutte di durata inferiore a 35d hanno comportato una perdita media di latte nella lattazione successiva di circa 500kg (-5%) e asciutte di durata compresa tra 35 e 55d hanno causato una perdita media di latte nella lattazione successiva di circa 200kg (-2%) rispetto alle prestazioni ottenute dopo asciutte "tradizionali", di durata media vicina ai 65d. Il prolungamento della durata dell'asciutta oltre 80 d ha comportato un lievissimo (100kg) incremento della produzione di latte nella lattazione successiva rispetto all'opzione tradizionale. In linea generale, nelle asciutte di durata breve la produzione persa nella lattazione successiva appare sostanzialmente compensata dalla maggior produzione ottenuta nella lattazione precedente grazie al più esteso periodo di mungitura. Infine, la DD non ha significativamente influenzato le prestazioni riproduttive nella lattazione successiva. In conclusione, i risultati di questo studio e le indicazioni reperibili in letteratura suggeriscono che esiste un notevole margine di manovra rispetto ai valori attuali per ridurre la durata dell'asciutta nella maggioranza delle aziende controllate, individuando un intervallo obiettivo per la DD compreso tra 45 e 60d.

Parole chiave: Vacche da latte, Durata dell'asciutta, Produzione di latte, Intervallo interparto.

Introduction

Dairy cows need a dry period before calving to ensure an adequate turnover of mammary tissue and to restore the functionality of mammary parenchyma (Capuco *et al.*, 1997; Annen *et al.*, 2004). Indeed, several studies showed that omission of the dry period caused a 20 to 40% decrease in milk yield (MY) during the subsequent lactation relative to a 60d dry period independently of the milk production potential of the cows (Remond *et al.*, 1997; Andersen *et al.*, 2005; Rastani *et al.*, 2005).

Although research has established the managerial importance of dry off, the optimal length of this period is currently under debate. Past research has mostly supported the conclusion that a 50 to 60d dry period will ensure optimal milk production in the following lactation (O'Connor and Oltenacu, 1988; Bachman and Schairer,

2003; Grummer and Rastani, 2004; Kuhn *et al.*, 2006a), and the 60-d dry period has been the generally adopted management goal of modern dairy farms (Annen *et al.*, 2004). However, recent studies have re-evaluated optimal dry period length, in view of the considerable changes that have occurred in the genetics, management, and feeding of the dairy animal population. There is rising interest towards a reduction in the length of dry period because a reduction in days dry (DD) could increase income from milk production and simplify dry cow management (Grummer and Rastani, 2004). Moreover, a reduction of dry period length may reduce variation in cow feeding that occurs during dry and transition periods, with favourable effects on ruminal microbial population and, as a consequence, on stress and health status post-partum (Goff and Horst, 1997; Gulay *et al.*, 2003).

Bachman and Schairer (2003) reviewing results from a number of studies highlighted that a reduction of dry period from 60 to 30d caused variable responses in subsequent MY that ranged from -10% to +1%. In recent trials, a reduction of dry period length from 60 to 30 d did not significantly affect milk production, dry matter intake, and body condition score in the subsequent lactation (Gulay *et al.*, 2003) and, when combined with feeding one high energy diet, improved energy balance and decreased the amount of body reserves mobilized in early lactation (Rastani *et al.*, 2005). Conversely, other studies found lower MY for cows with fewer than 50-60 DD (Gulay *et al.*, 2005; Kuhn *et al.*, 2005a), although Gulay *et al.* (2005) cautioned that the half-udder model used in their study was of questionable value for the comparison of dry period lengths.

This research studied the relevance of potential sources of variation for dry period length in Italian Holstein cows reared in northern of Italy and investigated the effect of DD on milk production and calving interval in the subsequent lactation.

Material and methods

Sources of data

Data used in this study were extracted from a regional database arranged by the Department of Animal Science at the University of Padova in cooperation with provincial cattle breeder associations of Veneto. This database extended the routine scheme of milk recording by collecting additional data related to functional and health traits. In this study information concerning dry off, calving date, parity, test day milk yield, somatic cell score, body condition score, and the occurrence of clinical mastitis and lameness for a large Holstein Friesian dairy cows and herds sample were considered. Lactations with valid dry-off and sub-

sequent calving dates were extracted from the database in order to compute individual cow DD. The resultant 11,150 lactation records were edited to create the data sets described below.

Editing procedures and statistical analysis

a) Data set from lactations preceding the dry period

Records of dry period length were merged with information concerning the previous lactation. Only records that fulfilled the following requirements were retained: calving date recorded; first test day ≤ 60 DIM; ≥ 3 test days in the first 150DIM; distance between the date of the last test day and the date of dry off ≤ 60 d. Moreover, if a herd had less than 10 eligible cow records, the entire herd was eliminated. After this edit, 6832 lactations fulfilling the above conditions (2687-1st parity dry period; 1939-2nd parity dry period; 2206-3rd parity dry period) from 87 herds were available.

Before statistical analysis, lactations were classified as follows: 1) length of previous lactation, 4 classes: < 280 d ($n=1019$); 281-330 ($n=2463$); 331-400 ($n=2041$); and > 400 DIM ($n=1309$); 2) cumulated MY at 100DIM; MY at the last test day before dry off; average lactation somatic cell score (SCS); SCS at the last test day before dry off; and BCS at the last test day before dry off, 3 classes for each trait: low, medium, high. The definitions of classes were based on residual standard deviations estimated by analysis of variance performed for all variables with a model that considered herd, calving year, calving season, parity, and lactation length and class size ranged between 834 to 915, 4722 to 5146 and 845 to 1004 lactations for low, medium and high classes, respectively; and 3) mastitis and lameness occurrence, 2 classes: no or yes, if clinical mastitis ($n=1215$) or lameness ($n=845$) required specific treatment during

the lactation.

Dry period length was analysed as a dependent variable with a linear model which included the following effects: herd (n=87); dry-off year (n=3); dry-off season (n=4); calving season (n=4); parity (PA, n=3, dry period after a 1st, 2nd and 3rd or later lactation); length of previous lactation (PLL, n=4, as defined above); PAXPLL; cumulated MY at 100DIM; MY at the last test day before dry off (L_Milk); average lactation SCS; SCS at the last test day before dry off; BCS at the last test day before dry off (n=3, as defined above); PAXL_Milk; and first mastitis and/or lameness occurrence in the previous lactation (n=2, as described above).

b) Data set from lactations after the dry period

Records of dry period length were merged with information related to the subsequent lactation. Only records that fulfilled the following requirements were retained: lactation ended with DIM at the last test day ≥ 220 d and < 450 d; first test day ≤ 60 DIM; ≥ 6 test days available in the lactation; cow estimated breeding value for MY available; and subsequent calving date recorded (only for data set concerning calving interval). Moreover, if a herd had less than 10 eligible records, the entire herd was eliminated. Thereafter, cumulated MY at the last test day available and calving interval were calculated.

With this edit, 4172 lactations with complete records (1859-2nd parity and 2313-3rd parity lactations) from 85 herds were available for cumulated MY and 3987 lactations with complete records (1832-2nd parity and 2155-3rd parity lactations) from 81 herds were available for calving interval (CI). Before statistical analysis, lactations were allotted into 4 dry period classes based on the preceding DD: 1) short (≤ 35 DD, 26 ± 8 d, n=265), 2) medium-short (36-55DD, 48 ± 5 d, n=1109), 3) traditional (56-80DD, 65 ± 7 d,

n=1986), and 4) long (> 80 DD, 109 ± 28 d, n=812).

Cumulated milk yield at the last test day before the lactation ended (CMY) and CI were analysed as dependent variables with a linear model which included the following effects: herd (n=85 for CMY; n=81 for CI); calving year (n=3); calving season (n=4); dry-off season (n=4); parity (PA, n=2); class of dry period length (DP, n=4); and PAXDP. Moreover, DIM at the last test day before dry off and estimated breeding value for MY were considered as covariates in the analysis of CMY. To evaluate the effect of dry period length, the means estimated for the short, medium-short, and long DD classes were contrasted against the mean estimated for the traditional DD class.

Results and discussion

Descriptive statistics and variation in days dry

Table 1 shows the distribution of dry period lengths. Average length of individual cow dry periods was 67d with a standard deviation of 27d; median dry period length approached 62d. The highest frequency class for DD length was between 56 to 60d which comprised nearly 15% of the sample while nearly 45% of all dry periods were between 50 and 70d. Fewer than 4% of dry periods were ≤ 30 d, and nearly 20% of dry periods were > 80 d. In a recent study which characterized DD for US Holstein herds, Kuhn *et al.* (2005b) found a shorter individual cow dry period length (60.5d) and a less variable distribution of DD in that about 65% of all dry periods were between 50 to 70d, 2% were < 30 d, and 10% were longer than 80d.

Descriptive statistics for production and functional traits taken into consideration from the lactations that preceded and followed the dry period are given in Table 2.

Table 1. Frequency distribution of individual dry period lengths (6832 records; mean 67 ± 27 d; median 62d).

Days dry	Frequency	Percentage	Cumulative percentage
0-10	22	0.32	0.32
11-20	66	0.97	1.29
21-30	175	2.58	3.87
31-40	373	5.46	9.31
41-45	352	5.15	14.46
46-50	454	6.65	21.11
51-55	761	11.14	32.25
56-60	950	13.91	46.15
61-65	848	12.41	58.56
66-70	635	9.29	67.86
70-75	467	6.84	74.69
76-80	320	4.68	79.38
81-90	434	6.35	85.73
91-100	316	4.63	90.35
101-110	191	2.80	93.15
111-120	137	2.01	95.16
121-130	87	1.27	96.43
>130	244	3.57	100

Average length of the lactation preceding the dry period was 343d. Daily milk yield at the last test date prior to dry-off was close to 20kg. However, for nearly 15% of cows this value was close to 30kg, a value that might lead to increased risk of udder problems (Bertilsson *et al.*, 1997). Cumulated MY at the last test day before dry-off (314 ± 53 DIM) in the lactation that followed dry off exceeded 10,000kg; CI was 415 ± 74 d. Production and functional traits taken into account depicted a sample representative of the well-managed and modern Holstein herds of northern Italy (AIA, 2006).

Table 3 shows the analysis of variance of dry period length in relation to the traits of the preceding lactation. Despite the inclusion of multiple potential sources of variation, the coefficient of determina-

tion of the model did not exceed 0.2, which confirmed the difficulty to fully characterize, and therefore to control, the variation sources for DD (Bachman and Schairer, 2003).

Herd effect explained >50% of the model sum of squares. The overall mean DD was 71d, and the standard deviation among herd means was 9d. On average, herds studied had an average DD nearly 10d longer and standard deviation among herd means that was 3 days greater than the corresponding values reported by Kuhn *et al.* (2005b) for US Holstein herds. The

lowest and highest herd mean values for DD were 47 and 89d. Only 4 herds had a mean for DD shorter than 55d, whereas the majority (56%) had mean DD values that exceeded 70d. The mean of the within-herd standard deviations for DD, which ranged from 10 to 50d, was 25d. Kuhn *et al.* (2005b) also found a significant range in within-herd standard deviation values. They attributed this variation to differences in management of the dry period, distinguishing between herd managers who dry off all cows at a specific gestation length and others who regulate DD on an individual cow basis by taking into account other factors in addition to the days until calving.

Parity and preceding lactation length significantly affected DD ($P < 0.01$), and

Table 2. Descriptive statistics for some selected traits from lactations preceding and following a dry period.

		N.	Mean	SD
Records from lactations preceding the dry period :				
Previous lactation length	d	6837	343	64
Milk100 ¹	kg	6825	3373	716
L Milk ²	"	6663	20.3	6.9
L SCS ³		6439	3.64	1.76
AV SCS ⁴		6824	2.99	1.42
L BCS ⁵		6691	3.48	0.59
Records from lactations following the dry period:				
Cumulated milk yield ⁶	kg	4172	10107	2283
Calving interval	d	3987	415	74

¹Cumulated milk yield in the first 100 days in milk (DIM).

²Daily milk yield at the last test day before dry-off (average DIM: 319±64).

³Somatic cell score at the last test day before dry-off.

⁴Average somatic cell score during the lactation.

⁵Body condition score at the last test day before dry-off.

⁶Cumulated milk yield at the last test day before dry-off (average DIM: 314±53).

these effects had a significant interaction ($P < 0.05$). As depicted in Figure 1, on average cows had shorter DD (9 to 10d) after their first than after their second or later lactations. Shorter DD for first parity cows than for second or later parity cows has been found also in US Holstein (Kuhn *et al.*, 2005b) and Jersey cows (Kuhn *et al.*, 2007). Longer dry periods (8 to 10d) were observed after short (<280d) and long (>400d) lactations. Also Kuhn *et al.* (2005b) found that longer lactations resulted in longer dry periods, whereas DD length did not appear different after short or medium lactations. The association between long lactations and long dry periods is probably related to days open in the previous lactation: in their analysis Kuhn *et al.* (2005b) reported that days open accounted for most variation in DD, and

lactation length was largely confounded with days open. In the present study days open has not been taken into account as a source of variation of DD mainly because a reliable measure of days open was not available. Variation due to previous lactation length appeared stronger for cows dried off after their second or later parity than for cows dried off after their first parity, especially if a long lactation was experienced. This finding can probably be attributed to the

higher persistency of first lactation than later parity cows, which could lead managers to keep them milking longer (Kuhn *et al.*, 2005b). This behaviour is in contrast with the general recommendation that cows completing their first lactation benefit more from greater DD than do older cows (Bachman and Schairer, 2003; Grummer and Rastani, 2004). However, average DD value observed for 1st parity cows always exceeded 60d (Figure 1), thus fitting with DD length generally recommended for cows completing their first lactation.

To investigate the effect of previous MY on DD, two production traits were used: the cumulated MY in the first 100 DIM (Milk100) and the MY at the last test day before dry-off (L_Milk). Milk100 was used instead of lactational yield because in a

Table 3. Analysis of variance for dry period length ($R^2:0.202$).

Sources of variation	df	MS	P
Herd	86	5238.65	<0.001
Dry-off year	2	13595.79	<0.001
Dry-off season	3	19524.96	<0.001
Calving season	3	1231.55	ns
Parity (PA)	2	40170.60	<0.001
Previous lactation length (PLL)	3	29220.03	<0.001
Milk100 ¹	2	683.13	ns
PA x PLL	6	1424.34	0.025
L Milk ²	2	18324.02	<0.001
PA x L Milk	4	2039.60	0.008
AV SCS ³	2	1876.03	0.042
L SCS ⁴	2	433.61	ns
L BCS ⁵	2	13331.93	<0.001
MAS ⁶	1	521.72	ns
LAM ⁷	1	989.68	ns
MSE	6168	592.56	

¹Cumulated milk yield in the first 100 days in milk.

²Daily milk yield at the last test day before dry-off.

³Average somatic cell score in the previous lactation.

⁴Somatic cell score at the last test day before dry-off.

⁵Body condition score at the last test day before dry-off.

⁶Occurrence of clinical mastitis in the previous lactation.

⁷Occurrence of clinical lameness in the previous lactation.

df: degree of freedom; ns: not significant.

preliminary analysis of our data it showed to be a reliable predictor of lactational yield and was available for a higher number of lactations than lactational yield.

Results from analysis showed that only L_milk significantly affected DD ($P<0.01$), and it interacted with parity. As depicted in Figure 2, shorter dry periods were associated with higher last test-day MY, but this effect was stronger in second or later parity dry periods than in first parity dry periods. Average differences in DD between lowest and highest last test day milk yield was 4-5d for the dry period that followed a first lactation and 10-12d for dry periods that

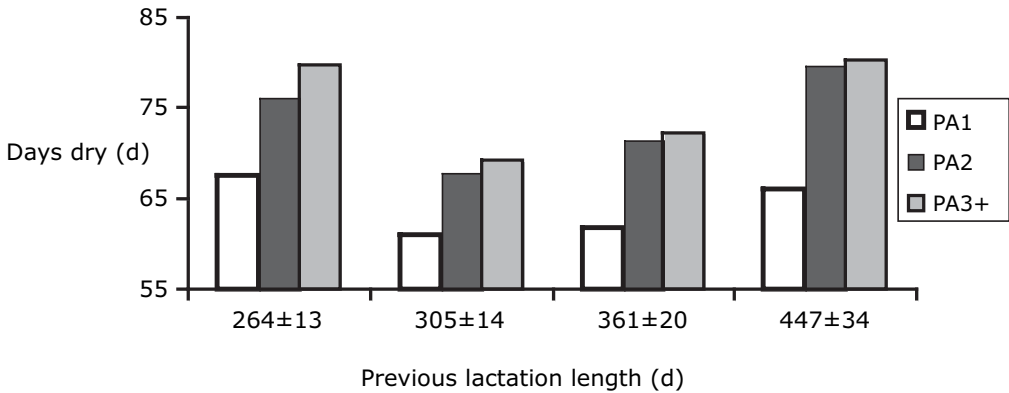
followed second or later lactations. Kuhn *et al.* (2005b) also found a significant relationship between MY in the previous lactation and dry period length, but in their study the association with DD was stronger for lactational yield than for last test day MY.

Dry period length increased as average SCS in previous lactation increased. A 3DD difference existed between the lowest and highest SCS classes, whereas DD did not appear to be associated with SCS on last test day. Conversely, Kuhn *et al.* (2005b) found that last SCS accounted for more variation of DD than lactational SCS. BCS before dry off was associated with DD ($P<0.01$). Dry period lengths of 67, 71 and 75d were found for cows with a BCS at the last test day that averaged 2.75, 3.50 and 4.25, respectively. Occurrence of clinical mastitis or lameness in the previous lactation did not affect dry period length.

Relationship of dry period length with milk yield and calving interval in the subsequent lactation

As determined by the analysis of variance given in Table 4, dry period length significantly affected the cumulated MY of the subsequent lactation ($P<0.01$). Estimates of this effect have been expressed relative to the MY obtained after a "traditional" (65DD) dry period (Figure 3). Subsequent

Figure 1. Effect of parity (PA1, PA2, PA3+ for 1st, 2nd and 3rd or more parity, respectively) and of previous lactation length on dry period length.



milk yield appeared to be positively associated with DD; however, the increase in milk production for a given increase in DD did not appear to be linear over the range of DD considered. Dry period lengths <35d (average length 26±8d) were associated with a ≈500kg loss of MY in the subsequent lactation, whereas medium-short DD (36 to 55d,

average 48d) had a 200kg decrease. DD>80d showed a slight increase (100kg) in MY during the following lactation.

Estimates were corrected for lactation length, and this adjustment influenced the magnitude, but not the pattern, of DD effect. Indeed, in a preliminary analysis of our data where actual unadjusted milk yields were

Figure 2. Effect of parity (PA1, PA2, PA3+ for 1st, 2nd and 3rd or more parity, respectively) and of milk yield at the last test day before dry-off on dry period length.

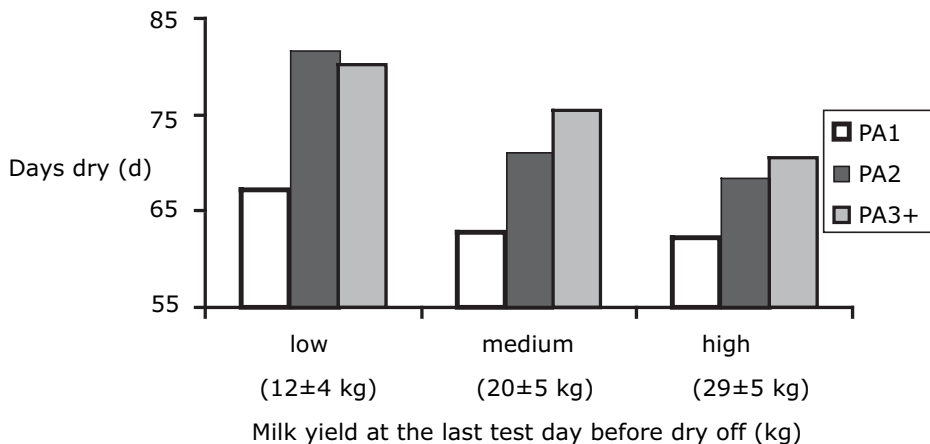
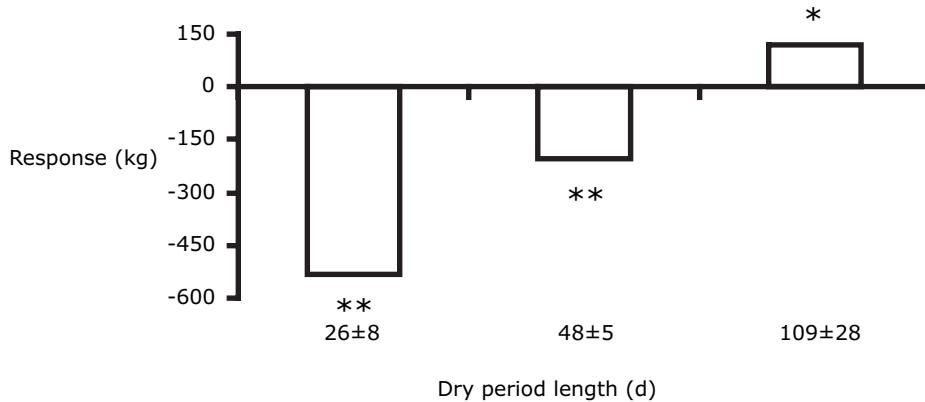


Figure 3. Effect of dry period length on milk yield obtained in the ensuing lactation.



Response has been computed as difference between least squares means of cumulated milk yield at the last test day of each dry period length class and that of the traditional - 65±7d - dry period length. **: P<0.01; *: P<0.05.

processed, the loss in milk yield resulted slightly higher for DD shorter and increase in milk yield appeared slightly lower for DD longer than traditional 65DD, respectively, when compared to results obtained after an adjustment for lactation length.

Estimates were corrected for the producing ability of the cows also, by including the individual EBV as a covariate in the model to thereby avoid possible biases due to non-random assignment of cows to each dry-period category (Bachman and Schairer, 2003; Kuhn and Hutchison, 2005).

Effects of shortening DD on subsequent MY found in this study are in general agreement with previous studies (Bachman and Schairer, 2003; Grummer and Rastani, 2004), which frequently found a decrease in MY following dry periods shorter than 60d. From a recent observational study on US Holstein cows, Kuhn *et al.* (2005a) found that MY in the subsequent lactation was maximised with a 60 to 65d dry period regardless of parity; however, estimates of losses due to reduced DD in that study were higher than those observed in the present

research, particularly for dry periods close to or shorter than 30d. Moreover, a decrease in production has been reported for dry periods longer than 60d for both Holstein (Kuhn *et al.*, 2005a) and Jersey cows (Kuhn *et al.*, 2007). No explanation other than possible over-conditioning has been proposed for this observation (Kuhn *et al.*, 2005a).

Dry period length did not significantly affect reproductive performance expressed in terms of calving interval (Table 4), albeit P value approached significance (0.07). Days open of 411, 416, 422 and 421 were found for short, medium short, traditional and long dry period length, respectively. Although an important consideration, studies on the relationship between DD and subsequent reproductive performance are still scarce (Grummer and Rastani, 2004). From studies on Holstein cows, also Kuhn *et al.* (2006b) found that short dry periods resulted in fewer days open in the subsequent lactation; however, this relationship was entirely due to the lower MY associated with shortened dry period. When adjusted for MY, short dry periods resulted in

Table 4. Analysis of variance for cumulated milk yield at the last test day before dry-off (cumulated milk yield, R²: 0.76) and calving interval (R²: 0.10).

	Cumulated milk yield			Calving interval		
	df	MS	P	df	MS	P
Herd	84	49627611	<0.001	80	15726	<0.001
Dry-off season	3	1673201	ns	3	14484	0.03
Parity (PA)	1	219520818	<0.001	1	245	ns
Calving year	2	248049	ns	2	214926	<0.001
Calving season	3	24428094	<0.001	3	54941	<0.001
Dry period length (DP) ¹	3	30137322	<0.001	3	11978	0.07
DP x PA	3	1657409	ns	3	1685	ns
DIM at the last test day	1	7156243288	<0.001			
cow EBV ²	1	2628171874	<0.001			
MSE	4057	1269445		3891	4969	

ns: P>0.10.

¹four classes of dry period length: short (26±8d); medium-short (48±5d); traditional (65±7d); long (109±28d).

²cow estimated breeding value for milk yield.

poorer fertility in the subsequent lactation, particularly for DD<30d.

Conclusions

Data from this study provided a characterisation of dry period lengths of Holstein dairy cows and herds in northern Italy. Cows averaged 67DD, and nearly 20% of cows had a dry period longer than 80d. Among the factors considered in this study, herd had the greatest impact on DD; average herd DD was 71d and 56% of herds had a mean dry period length exceeding 70d. Longer DD were associated with second or later parity cows, lower daily milk yield at dry-off and extreme length of previous lactation, either short or long.

Dry periods <35 d resulted in a 5% loss in subsequent lactational milk yield while for DD that ranged between 35 to 55d a slight (-2%) decrease in MY occurred relative to the MY obtained after a traditional 65d dry period (10,000kg). Conversely, extending DD over

80d resulted in a very limited 1% increase in subsequent MY. Dry period length did not affect CI in the following lactation.

Based on results of the present research, the highest MY in the following lactation seems to be obtained by scheduling a dry period close to 60d. However, yield lost in the subsequent lactation caused by DD<60 d might be offset by the higher yield obtained in the previous lactation due to its longer length. From this perspective, given a daily MY at dry off of 20kg/d, which was the average daily yield at the last test day before drying cows observed in this study, the extra production obtained in the previous lactation from cows that experience short or medium-short DD would be sufficient to compensate for the milk yield lost in subsequent lactation as a result of the reduced dry period. In this regard Kuhn *et al.* (2006) found that the minimum DD required to maximise production across adjacent lactations were 40 to 45d for first parity and 55 to 65d for later parity dry

periods. Furthermore, lifetime production was maximised with 40 to 50 and 30 to 40DD, respectively, and dry periods longer than 70 to 80d were even more costly to lifetime yield than very short DD. Although the relationship between days dry and lifetime production has not been explored in the Italian Holstein population, data from this study and previous literature analysis suggest that a decrease in the duration of DD could be profitable for most herds considered, and a general recommendation towards dry period lengths between 45 to 60d could be advised.

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REFERENCES

- AIA (Italian Breeders Association), 2006. Bollettino dei Controlli della Produttività del Latte. Home page address: <http://www.aia.it/bollettino/Bollettino.htm>.
- Andersen, J.B., Madsen, T.G., Larsen, T., Ingvarsten, K.L., Nielsen, M.O., 2005. The effects of dry period versus continuous lactation on metabolic status and performance in periparturient cows. *J. Dairy Sci.* 88:3530-3541.
- Annen, E.L., Collier, R.J., McGuire, M.A., Vicini, J.L., 2004. Effects of dry period length on milk yield and mammary epithelial cells. *J. Dairy Sci.* 87(Suppl. E):66-76.
- Bachman, K.C., Schairer, M.L., 2003. Invited review: bovine studies on optimal lengths of dry periods. *J. Dairy Sci.* 86:3027-3037.
- Bertilsson, J., Berglund, B., Ratnayake, G., Svennersten-Sjauna, K., Wiktorsson, H., 1997. Optimising lactation cycles for the high-yielding dairy cow. A European perspective. *Livest. Prod. Sci.* 50:5-13.
- Capuco, A.V., Akers, R.M., Smith, J.J., 1997. Mammary growth in Holstein cows during the dry period: quantification of nucleic acids and histology. *J. Dairy Sci.* 80:477-487.
- Goff, J.P., Horst, R.L., 1997. Physiological changes at parturition and their relationship to metabolic disorders. *J. Dairy Sci.* 80:1260-1268.
- Grummer, R.R., Rastani, R.R., 2004. Why reevaluate dry period length?. *J. Dairy Sci.* 87(Suppl. E):77-85.
- Gulay, M.S., Hayen, M.J., Bachman, K.C., Belloso, T., Liboni, M., Head, H.H., 2003. Milk production and feed intake of Holstein cows given short (30 d) or normal (60 d) dry periods. *J. Dairy Sci.* 86:2030-2038.
- Gulay, M.S., Hayen, M.J., Head, H.H., Wilcox, C.J., Bachman, K.C., 2005. Milk production from Holstein half-udders after concurrent thirty- and seventy-day dry periods. *J. Dairy Sci.* 88:3953-3962.
- Kuhn, M.T., Hutchison, J.L., 2005. Methodology for estimation of days dry effects. *J. Dairy Sci.* 88:1499-1508.
- Kuhn, M.T., Hutchison, J.L., Norman, H.D., 2005a. Minimum days dry to maximize milk yield in subsequent lactation. *Anim. Res.* 54:351-367.
- Kuhn, M.T., Hutchison, J.L., Norman, H.D., 2005b. Characterization of days dry for United States Holsteins. *J. Dairy Sci.* 88:1147-1155.
- Kuhn, M.T., Hutchison, J.L., Norman, H.D., 2006a. Dry period length to maximize production across adjacent lactations and lifetime production. *J. Dairy Sci.* 89:1713-1722.

- Kuhn, M.T., Hutchison, J.L., Norman, H.D., 2006b. Effects of length of dry period on yields of milk fat and protein, fertility, and milk somatic cell score in the subsequent lactation of dairy cows. *J. Dairy Res.* 73:154-162.
- Kuhn, M.T., Hutchison, J.L., Norman, H.D., 2007. Dry period length in US Jerseys: characterization and effects on performance. *J. Dairy Sci.* 90:2069-2081.
- O'Connor, J.J., Oltenacu, P.A., 1988. Determination of optimum drying off time for dairy cows using decision analysis and computer simulation. *J. Dairy Sci.* 71:3080-3091.
- Rastani, R.R., Grummer, R.R., Bertics, S.J., Gümen, A., Wiltbank, M.C., Mashek, D. G., Schwab, M.C., 2005. Reducing dry period length to simplify feeding transition cows: milk production, energy balance, and metabolic profiles. *J. Dairy Sci.* 88:1004-1014.
- Remond, B., Rouel, J., Pinson, N., Jabet, S., 1997. An attempt to omit the dry period over three consecutive lactations in dairy cows. *Ann. Zootech.* 46:399-408.