

POSITION PAPER

One calf per cow and year – not a sensible goal for high-yielding cows from either an economic or an animal welfare perspective

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Received: September 30, 2019

Revised: December 4, 2019

Accepted: January 31, 2020



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KEYWORDS calving interval, lactation period, first service conception rate, animal welfare, economics

1 Problem description

Modern dairy cows deliver a very high performance, which manifests in high daily milk yields all the way through to dry-off. While many farmers are able to successfully minimise cows' metabolic loads during the early weeks of lactation through good transition management, the postpartum (pp.) risk of ketosis, abomasal displacement and mastitis remains high, among others due to cows' immune systems being impaired post calving. This raises questions such as: Do we need to have each cow have a calf each and every year, or does this in fact drive restocking rates up? Can we deliberately delay the timing of artificial insemination, or will this result in reduced pregnancy rates? Will these cows then gain excessive weight towards the end of lactation?

When artificial insemination was introduced, maximal calving intervals were used for determining insemination times. In the early 1970s, Liebenberg (1974) stated that "the calving interval should be about one year". At the time, cows produced about 3,500 kg milk per lactation, i.e. less than half of today's yields. With increasing milk production, it was often no longer possible to remain within this recommended time-frame, and a period of 400 days was consequently determined to be the maximum for good herd-level fertility. "Good" and

"poor" fertility management continues to be defined on the basis of this parameter (among others) even today. "Cow fertility deteriorates" with increasing performance. But does fertility actually deteriorate, or does it merely adapt more closely to biological processes? Is it a disadvantage if cows become pregnant again later after calving? From an economic point of view, it was previously accepted – and continues to be widely accepted even today – that each day above a calving interval (CI) of 400 days costs farmers between 2.50 Euro and 3.75 Euro (Lührmann, 2013; Weber, 2019). These numbers were calculated from the herd's average daily milk yield and a voluntary waiting period (VWP) of 42 days. However, the result is reversed if one looks beyond the costs per herd milking day and examines the costs per day of life for example. This paper aims to present this revised perspective. Deliberately extending the VWP (i.e. the period after parturition during which cows are not yet to be inseminated) in high-yielding cows allows the lactation curve to be maintained at a significantly higher level. At the same time, the resulting longer lactation (= longer calving interval) means fewer unproductive days per cow and year, i.e. fewer dry cows and more lactating cows on average over the year. Also, this means

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fewer calvings over a cow's lifetime and thus fewer critical periods. Furthermore, lactation persistency, an issue subject to intense discussion among breeders, increases due to delayed insemination alone, resulting in greater milk yields per milking day.

At the State Research Center of Agriculture and Fisheries Mecklenburg-Vorpommern, extended lactation has come to be a major research focus within the context of overall milk production processes. Expected benefits for cows include not only a higher lifetime productivity per day of life and a longer length of productive life, but also reduced morbidity (lower risk of metabolic diseases and fewer calvings per unit of time). Other expected outcomes are lower rates of reproduction with fewer calves, greater calf value and reduced environmental impacts due to smaller numbers of animals reared and the reduced use of antibiotics both in drying cows off (lower milk volumes at dry-off) and at the beginning of lactation.

If, however, calves (e.g. cross-breeds) deliver higher profits than increased milk yields obtained from longer lactation, or if young cattle can be sold at excellent profits, then short calving intervals can make economic sense, as Kaske et al. (2019) explicitly state. Conversely, substantially longer lactation periods can also deliver economic benefits in terms of rates of reproduction, animal welfare and length of productive life in the context of the cow's lifespan or live-stock place respectively.

The results presented here are based on data on the functional characteristics of cows in Mecklenburg-Vorpommernian trial herds included in the ProFit programme of the Rinder-Allianz cattle breeding company. The 30 farms included in the programme have been documenting all herd management

interventions as well as oestrus and insemination data since 2005. To date, more than 2 million intervention and diagnostic data on over 120,000 German Holstein cows (DH svt.) have been evaluated. Special investigations were conducted on one of the trial herd farms, where milk samples were taken from 678 DH cows for progesterone analysis. The samples were analysed using an eProCheck® on-farm device manufactured by Minitüb (Boldt et al., 2015). Measurements of progesterone levels in milk have shown that the start of the oestrus cycle after calving is delayed with increased 100-day yields. At the trial farm, which has an average herd yield in excess of 10,000 kg milk per cow and year, corpus luteum activity only started on the 42nd day pp. in 34% of the cows (*Figure 1*), indicating that the cows would not be able to become pregnant again at this early stage as they are still acyclic. Early insemination would therefore not be expedient.

Investigations of the relationship between the days to first service (interval from calving to first insemination), the services (number of inseminations) per pregnancy and the interval from first to successful insemination conducted on 21,616 DH cows from 28 farms in Mecklenburg-Vorpommern between 2007 and 2015 identified major differences depending on milk production. With 305-day milk yields of up to 7,000 kg, cows should ideally become pregnant again as soon as possible from the 40th day of lactation onwards (*Figure 2*). Earlier, commonly held beliefs that outcomes would be better the sooner cows were inseminated are therefore unsurprising.

Even with yields of 7,000 to 9,000 kg milk, an interval of 40 to 80 days should be allowed to first service in order to minimise both the number of services per pregnancy and the first to successful insemination interval (see *Figure 3*). However,

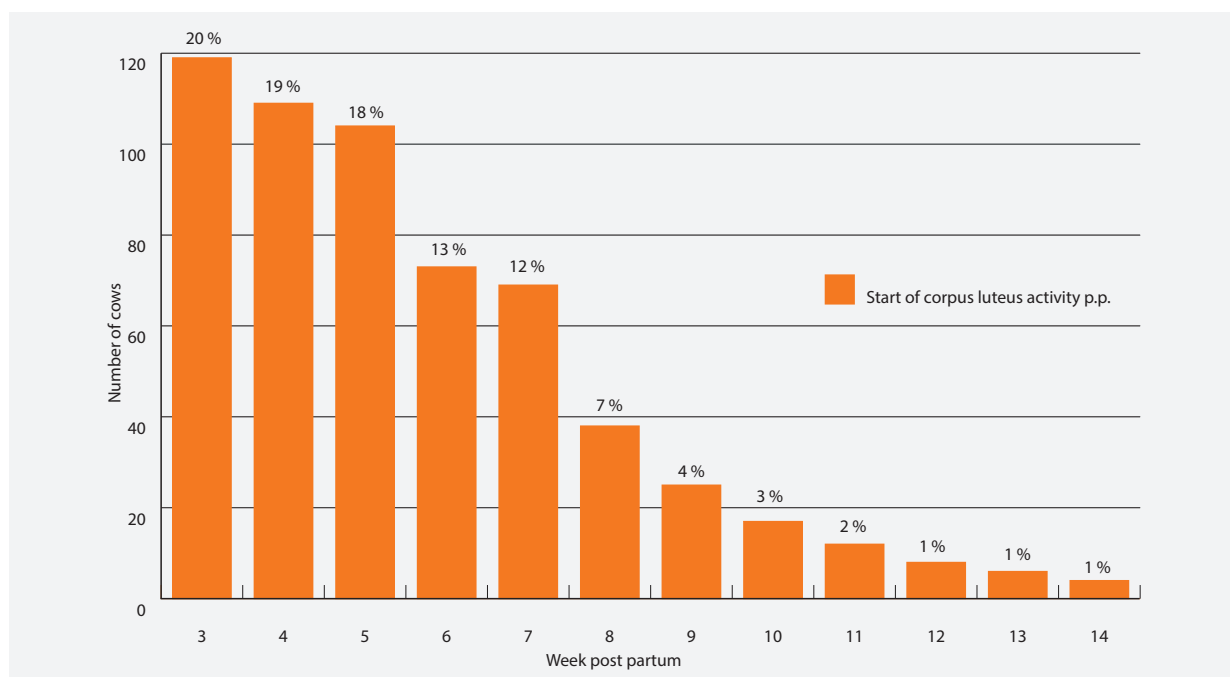


FIGURE 1

Distribution of the start of postpartum oestrous cycle activity based on progesterone levels in the milk of 678 DH cows (Boldt et al., 2015)

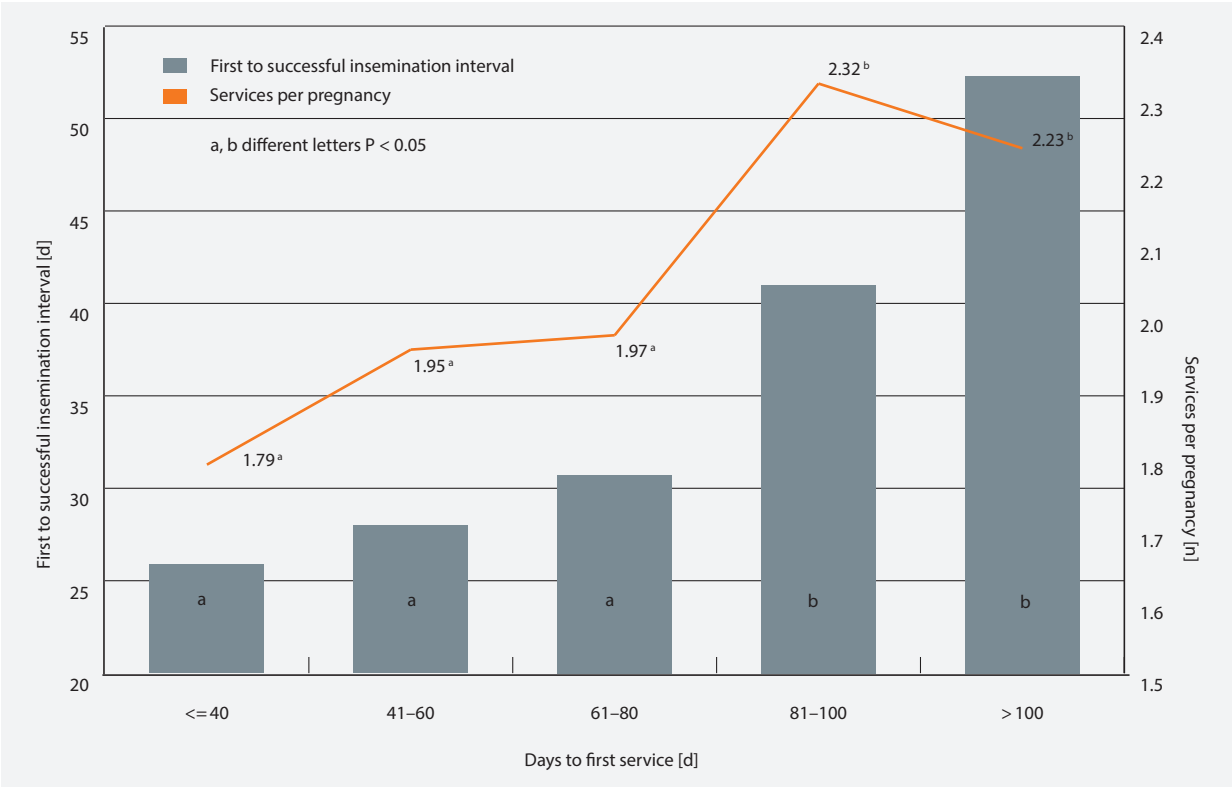


FIGURE 2
First to successful insemination interval and services per pregnancy relative to the days to first service in cows with a milk production of ≤ 7,000 kg; LSMEANS; fixed effects: farm, lactation number, health status, month and year of calving (Röhle, 2016)

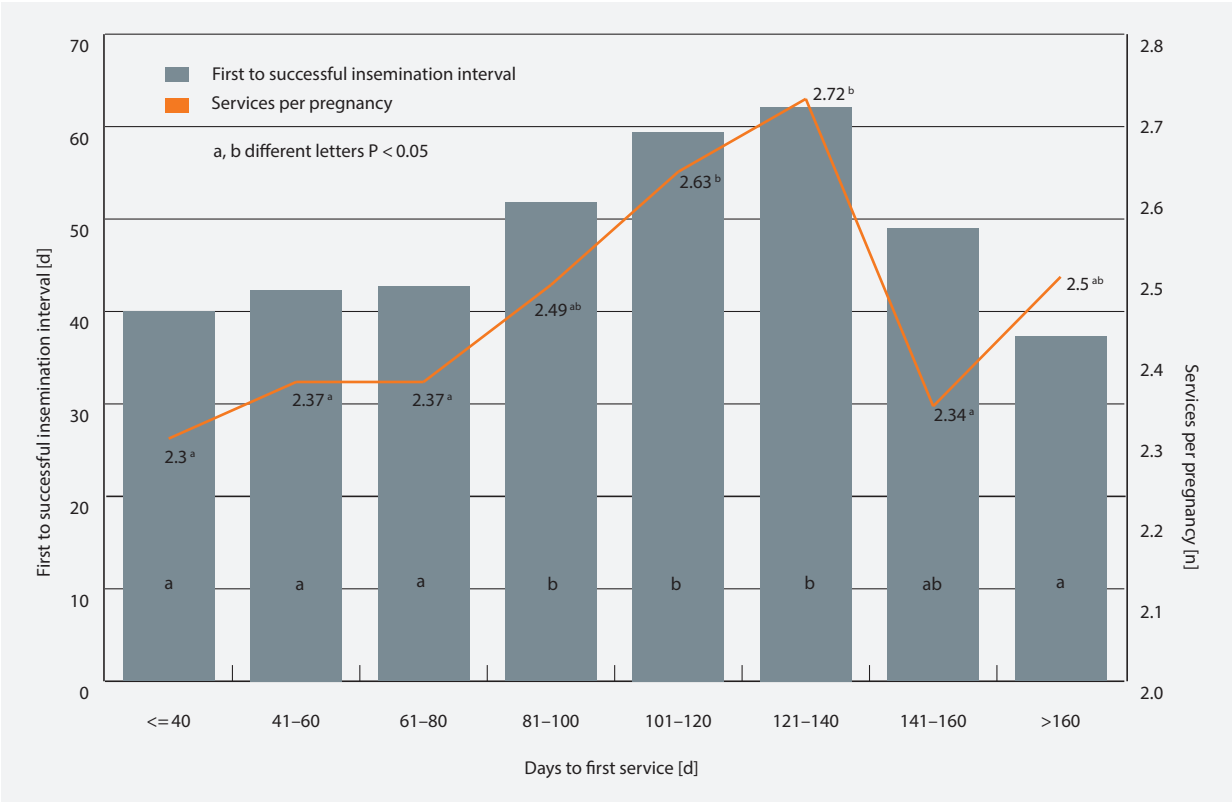


FIGURE 3
Effect of days to first service on the first to successful insemination interval and the number of services per pregnancy in cows yielding 7,001–9,000 kg milk; LSMEANS; fixed effects: farm, lactation number, health status, month and year of calving (Röhle, 2016)

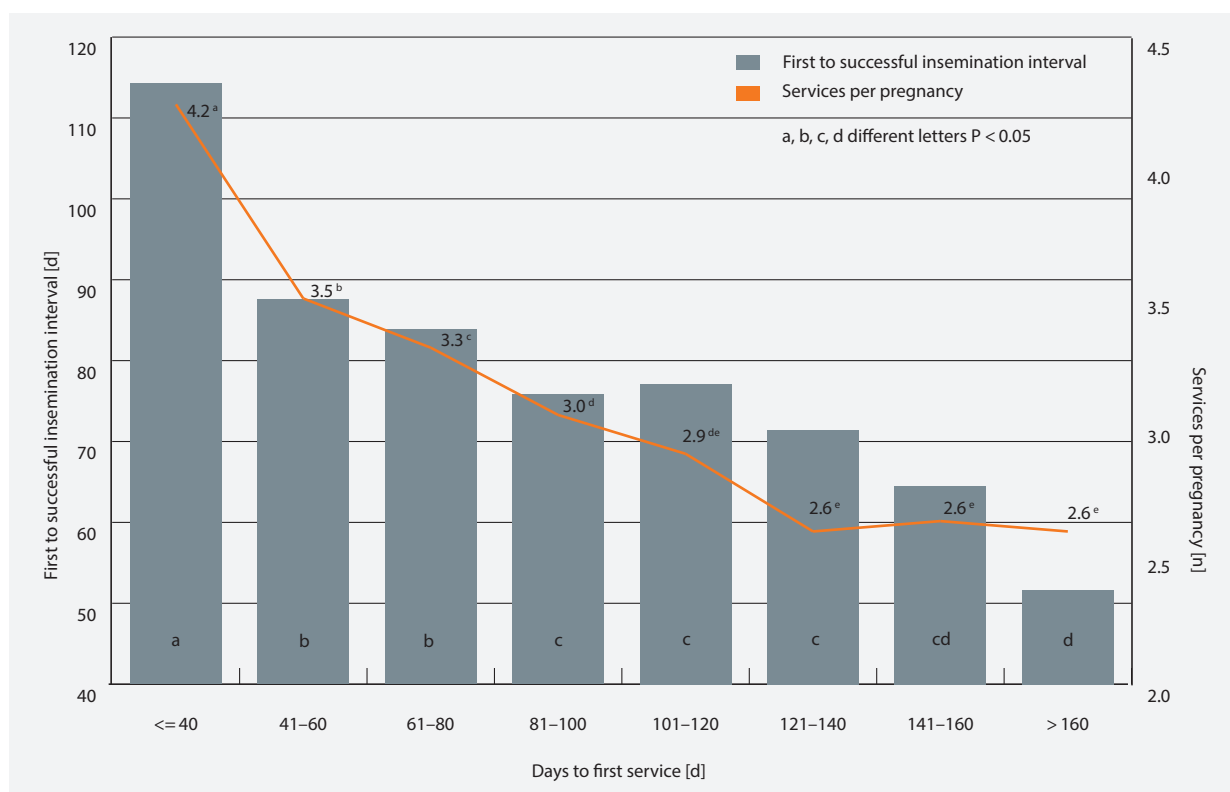


FIGURE 4

First to successful insemination interval and services per pregnancy relative to the days to first service in cows with a milk production of >12,000 kg; LSMEANS; fixed effects: farm, lactation number, health status, month and year of calving (Röhle, 2016)

cows yielding $\geq 12,000$ kg milk exhibited the lowest number of services per pregnancy and shortest first to successful insemination interval if they were only inseminated after 120 days pp. (Figure 4), and their results were consequently precisely the opposite.

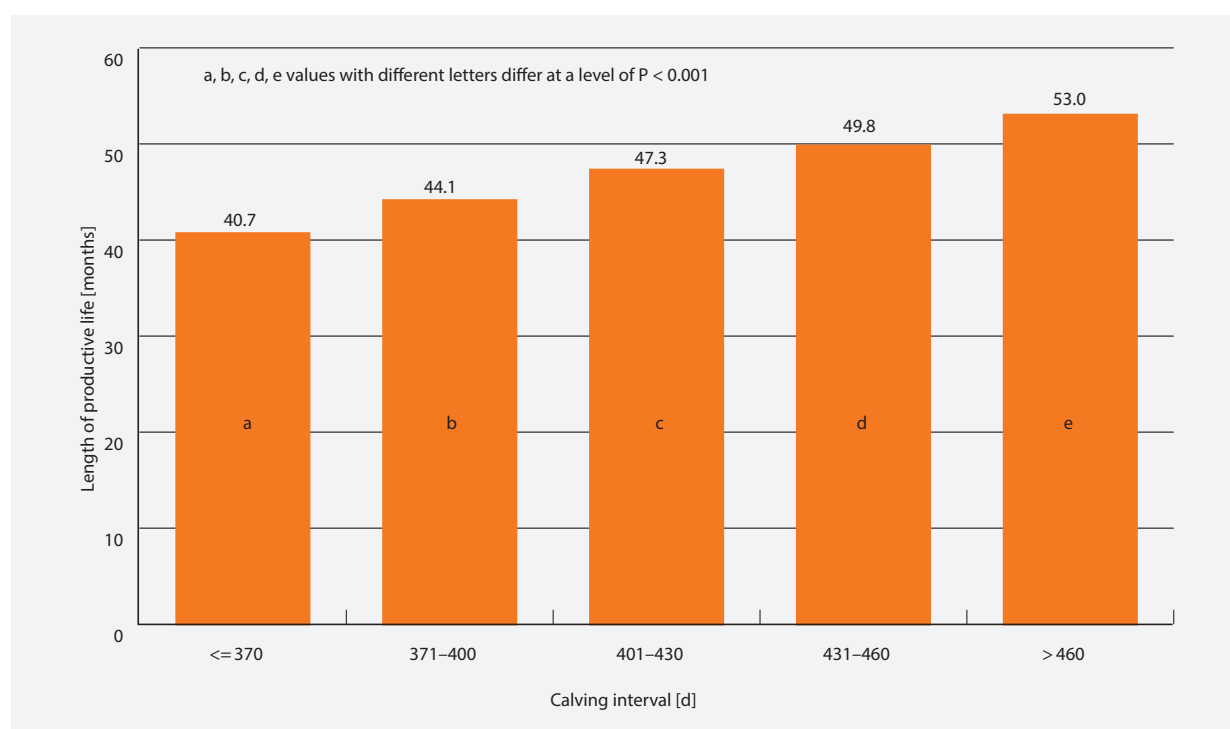
A study from Saxony, where cows were specifically grouped into categories of 40, 120 or 180 days of VWP independently of their milk production, yielded similar results (Niozas et al., 2019). The average herd yield was 11,000 kg. Cows with a 180-day VWP not only produced 1,000 kg more milk in their 305-day milk yield, but also had substantially better heat detection and a first service conception rate of 50% (vs. 37% in the cows with a 40-day VWP), and inactive ovaries were found in only 2% of animals (vs. 16% in the cows with a 40-day VWP).

2 Possible solution

To date, fertility parameters have consistently been correlated to a single lactation only. Our investigations were aimed at studying cows' length of productive life and fertility holistically. Fewer parturitions with unchanged overall performance could indeed make sense from both an animal welfare and an ethical perspective, as cows stay healthier and live longer. Overall, this should also result in better economic success. Evidence of a longer length of productive life with higher average calving intervals has already been provided (Figure 5).

Lifetime efficiency was also highest among cows with calving intervals longer than 430 days. These cows achieved a milk yield per day of life of 16.7 kg, whereas cows calving annually (with a CI of 341 to 370 days) only achieved 15.0 kg milk per day of life.

The economic assessment conducted as part of this study was based on the results of revenue stream analyses carried out on State Research Institute reference farms between 2009 and 2011 (Harms et al., 2018). It should be noted that herd management was generally aimed at minimising calving intervals in these cases. Economic calculations revealed that higher lifetime productivity per day of life is associated with improved contribution margins, even if cows take longer to become pregnant again. Each day added to the calving interval resulted in an increase in lifetime yield by 87 kg ECM and an increase in length of productive life by 2.9 days. These results confirm that cows' performance in conjunction with their length of productive life has a much stronger impact on a herd's profitability than the calving interval, a lower number of calves for sale or a higher number of services per pregnancy. The issue to be clarified is whether there is a sound economic optimum for the calving interval relative to livestock performance. The business calculations performed for this study were based on livestock being classified according to 305-day milk yield. In the yield range up to 9,000 kg, economic success is greatest if cows calve within a period of 340 to 370 days pp.

**FIGURE 5**

Length of productive life of 26,212 culled DH cows with at least 3 lactations relative to the average calving interval; LSMEANS (fixed effects: farm, year of calving, lactation number) (Römer and Boldt, 2019)

TABLE 1

Contribution margin (Euro per place and year) with different calving intervals and milk yields (305-day milk yield) of 26,212 DH cows from 28 farms in Mecklenburg-Vorpommern (Harms et al., 2018)

Milk yield (kg)	Calving interval (days)					
	<340	340–370	371–400	401–430	431–460	>460
<8,000	215	325	308	304	296	294
>8,000–9,000	336	500	463	463	466	398
>9,000–10,000	567	566	572	533	526	459
>10,000–11,000	601	649	674	688	673	569

* Pale green cells indicate the highest contribution margins

Cows with a 305-day yield of up to 10,000 kg are more profitable if they calve again within a period of 371 to 400 days pp. Cows yielding between 10,000 kg and 11,000 kg milk deliver clear financial benefits with calving intervals between 400 and 430 days (Table 1).

Investigations from Denmark found the optimal lactation period (+ dry period = calving interval) in terms of productivity and length of productive life to be as long as 490 days, regardless of milk yield (Gaillard et al., 2016). Also the results obtained by Niozas et al. in 2018 and 2019 from a herd producing about 11,000 kg milk clearly show that deliberately extended lactation delivers positive outcomes in terms of both fertility and yields. Individual milk yields were not examined as part of that study.

3 Conclusion

Based on comprehensive data, this study shows that longer calving intervals are not necessarily unprofitable. There is a business optimum for the calving interval depending on individual cows' performance. Cows with 305-day milk yields below 9,000 kg are most profitable if they calve every year. In the yield range up to 10,000 kg, longer pauses of up to two cycles (42 days) result in longer lengths of productive life and deliver higher incomes for farmers. Cows with even higher lactation yields should be given more than 100 days' rest after calving before they are inseminated again. Results from the first milk performance recording allow cows to be allocated to the various yield ranges. However, longer VWPs

do not mean that high-yielding cows should be left unobserved. Seamless documentation of all oestruses is essential in order to achieve optimal insemination outcomes after a prolonged VWP, even if not all of the oestruses are used. Deliberately extending lactation requires deliberately delaying the first insemination and must be associated with high milk yield persistency. This can only be achieved if cows have a healthy start to lactation.

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