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Rearing conditions and lifetime milk revenues in Swedish dairy cows

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ABSTRACT

Associations between replacement heifer rearing conditions and lifetime milk revenues were studied throughout the productive life of Swedish dairy cows. Data were collected from 2127 cows, mainly Swedish Reds and Swedish Holsteins, representing all female animals born during 1998 in 110 herds and followed until May 2006. Lifetime net milk revenues were calculated for each cow based on the length of productive life, lifetime milk production, a fixed milk price of 0.3 €/kg ECM, and estimated costs for heifer rearing and cow feed. Median observed productive lifetime to culling, death, selling off or terminated recording was 26.9 mo. Mean lifetime production was 9209 kg ECM/cow-yr, calculated from monthly test-day yields. Rearing costs (median 631 €) were estimated using a template developed for Swedish advisory services, including costs related to purchase, feeding, labour, building investment, building maintenance and breeding. Net milk revenues had a median of 1169 €/cow-yr during productive life and were heavily skewed. Diarrhea and respiratory disease before 7 mo of age had occurred in 11 and 11% of the cows, respectively, the majority cases being mild. The mean prepubertal growth rate was 670 g/day. Cow net revenue values were transformed to achieve normality and analysed by a linear mixed model including fixed effects of breed, calf housing system from 3 to 7 mo of age, body condition score at 1st breeding, year of 1st calving, age at 1st calving, cow housing system, mean milk cell count, the interaction between calf housing and breed, the interaction between cow housing and breed, and the random effect of herd. The model predicted net revenues to decrease with age at 1st calving and with body condition score at breeding over 4. Our results show that replacement rearing factors influence net milk revenues of a dairy operation and suggest that current recommendations to breed dairy heifers for calving at 24 mo are economically justified.

1. Introduction

The profitability of a dairy operation is largely determined by milk revenues and feed costs. Strandberg (1992) reported that almost 95% of the variation in income and cost during a cow lifetime was due to these two items. Profitability can be achieved by a high milk production or by low feed costs. Studies of factors affecting milk production have mainly focused on the adult cow, largely overlooking rearing factors that might have had an influence on later performance in the cow herd. Considering rising production levels, it seems reasonable that cows are increasingly susceptible to factors limiting the expression of the genetic potential for milk production.

A calving age of 24 mo or less has been recommended for maximized profit, despite a lower production during first lactation (Lin et al., 1988; Pirlo et al., 2000). However, few farms achieve recommended targets and considerably higher calving ages are generally reported. In Sweden, the average age at 1st calving is approximately 28 mo (Swedish Dairy Association, 2009).

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There is substantial evidence of a negative effect of high weight gains during the period of allometric mammary growth (i.e., from approximately 90 to 300 kg of body weight; Sejrsen et al., 1982). At an early calving, accelerated postpubertal growth was found to be associated with lower first-lactation milk production (Hoffman et al., 1996). Contradicting results have, however, been reported (Gardner et al., 1988; Pirlo et al., 1997). From experimental studies, prepubertal growth rates up to 799 g/days have been associated with increasing milk production, whereas higher rates have been reported to have a detrimental effect on udder parenchyma and production (Sejrsen et al., 2000; Zanton and Heinrichs, 2005).

Few studies have focused on the influence of calfhood health on subsequent milk production and most have used small numbers of animals (Britney et al., 1985). Numerous experimental studies have reported on effects of feeding regimes and daily weight gains, but these have mostly dealt with first-lactation production and few explore associations with multi-lactational production. Epidemiological data might help to clarify discrepancies between studies. By combining observations on heifer rearing, cow housing, management, milk production and life length at commercial operations, relationships between rearing factors, calving age and lifetime milk production and revenues can be revealed and expressed in monetary terms.

Our objective was to study associations between factors related to heifer rearing and lifetime milk revenues in Swedish commercial dairy herds. Focus was on the influence of calfhood housing and disease, prepubertal growth, feeding around 1st calving and age at 1st calving.

2. Material and methods

2.1. Data

Data were collected from heifer calves born during 1998 in 122 southwest Swedish dairy herds. Totally 3081 heifer calves were enrolled, out of which 2243 were later reported to calve as heifers in the study herds. Recordings continued until May 2006. After editing and exclusion of incomplete data, 2127 complete cow lifetime records from 110 herds were possible to include. The animals were Swedish Red cows (49%), Swedish Holsteins (49%) or cows of other or mixed breeds. Their health until calving was described by Svensson et al. (2003, 2006a) and Hultgren et al. (2008), based on the same data. Herd selection, data collection and herd management were described by Svensson and Hultgren (2008) and by Hultgren and Svensson (2009).

Calf housing was represented by two different categories each for slatted and litter pens (small and large pens; large denoting pens with >7 and >12 calves, respectively), and a separate category for calves in other systems (tie-stalls or, in one large herd, cubicles). The categories were chosen based on current housing practices.

Body weight was estimated from heart girth at weaning and at 1st breeding, and daily growth rate between these to time points was calculated as previously described by Hessle et al. (2004) and denoted prepubertal growth rate. In lactations with missing values (11% of cows), the growth rate was set to the overall mean within breed.

The costs of rearing a heifer until calving (depending on calving age) were estimated by a calculus template developed in advisory services offered by the Swedish Dairy Association, including fixed items listed in Table 1. Building costs per year during rearing were calculated as: $(\text{interest} \times \text{investment}_{2\text{–}12\ \text{mo}}/2 + \text{investment}_{2\text{–}12\ \text{mo}}/\text{depreciation period}) \times 10/12 + (\text{interest} \times \text{investment}_{>12\ \text{mo}}/2 + \text{investment}_{>12\ \text{mo}}/\text{depreciation period}) \times (\textit{calving age} - 1)$, where only *calving age* (expressed in years) was allowed to vary. The calculus was previously validated through extensive practice. For each cow, yearly lifetime rearing costs were calculated by dividing estimated rearing costs by the length of productive life.

Daily milk yields for each cow and day from 1st calving to culling, spontaneous death or selling live, or to end of recording on 31 May 2006, were estimated from monthly test-day recordings obtained from the Swedish official milk recording scheme (Olsson et al., 2001). Between calving and the 1st test day of a lactation, daily yields were calculated using a polynomial of lactation day based on all test-day recordings from 4 to 305 d post calving in all project cows, estimated by least-squares regression within each breed (Swedish Red, Swedish Holstein, or other) and parity (1, 2 or ≥3) separately. After exploring simpler models, a sixth-degree polynomial was used. Between test days and on test days with missing recordings, daily milk yields were set to the latest recorded value. Yields were set to 0 during the dry period, assumed to start 50 days pre calving, if milk recordings did not indicate differently. Each cow's yearly lifetime milk production was calculated as the sum of all daily yields during her productive life, including dry periods, divided by the total number of days and multiplied by 365. Composite somatic milk cell counts were summarized on cow level as the geometric mean of all test-day values, and on herd level as the geometric mean of all individual cow values in 2001.

For each cow, lifetime net milk revenues were calculated as the estimated yearly lifetime milk production multiplied by a fixed milk price of 0.3 €/kg ECM, and subtracted by estimated yearly lifetime rearing costs per year, and by estimated cow feed costs corresponding to 1/3 of the milk revenues. The Swedish University of Agricultural Sciences has estimated feed costs to equal on average 30–40% of gross milk

Table 1
Fixed items included in calculation of heifer rearing costs until 1st calving at 22 to 35 mo of age.

Item	Amount
Purchase cost of baby calf (€)	137
Mean feed consumption (kg dry matter/day)	6.7
Feed price (€/kg dry matter)	0.125
Labour time during rearing (h)	12
Labour price (€/h)	19
Building investment cost age 2–12 mo (€)	1500
Building investment cost age >12 mo (€)	1000
Depreciation period for building investments (yr)	18
Yearly interest (%)	5
Maintenance of building (€/yr)	15
Breeding services (€)	40
Miscellaneous costs age 2–12 mo[a] (€/mo)	3.50

[a] Including bedding material, milk recording and advisory services, veterinary treatments and drugs, electric power, animal insurances, maintenance of housing equipment, and fuel and maintenance of a tractor.