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Measuring the growth rate of UK dairy heifers to improve future productivity

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ABSTRACT

Sub-optimal heifer growth is associated with higher disease rates and reduced future performance and longevity in the dairy herd. This report describes a system for measuring heifer growth from birth to first calving that was used on commercial dairy farms in South West England, in order to gather benchmarking data to feed back to farmers. Weights ($n = 8443$) were collected from 20 farms.

There was a marked variation in individual and herd mean growth rates. Overall, calves gained no weight in the first 8 days after birth and had a very low growth rate (median 0.12 kg/day) up to 30 days, a period when feed conversion efficiency is high and calves are vulnerable to disease. Heifers whose growth rate up to 180 days was low were significantly less likely to achieve target service weight (374 kg) by 420 days. Monitoring heifer growth during the rearing period enables farmers to improve heifer growth rates and so impact both the efficiency of heifer rearing and, potentially, the productivity and performance of the adult herd.

Introduction

Heifer rearing is the weak link in many dairy enterprises, leading to high mortality and future poor performance in the milking herd. In the UK, 58% of live-born heifers fail to reach their third lactation (Brickell and Wathes, 2011). The cost of rearing heifers is high, representing about 20% of dairy farm expenses, and making it the highest variable cost after feed (Tozer and Heinrichs, 2001). The cost of rearing heifers is variable, with a mean in the UK of £1819[1] (AHDB Dairy, 2015), so that replacement costs average around 2.6 pence per litre (ppL). For many herds, costs may be as high as 3.2 ppL of milk produced (AHDB Dairy[2]). It has been estimated that most farmers should be able to reduce replacement costs to 2.0 ppL, resulting in a financial benefit of £14,400 per annum for a 160-cow herd. Replacement rate and age at first calving (AFC) are also concerns, as these factors are known to affect the carbon footprint of the herd (Hermanson and Kristenson, 2011).

Poor heifer management represents a major loss in both economic and welfare terms. In order to achieve optimal lifetime performance, it is important for heifers to remain healthy, to meet target growth rates and to be well-grown before they calve for the first time (Le Cozler et al., 2008). In the USA, only 2.7% of dairy heifers were found to achieve target AFC of less than 24 months, weighing more than 560 kg post-calving (Losinger and Heinrichs, 1997), so there is great potential for improvement. Veterinarians are often called upon to help dairy farmers improve heifer performance, and these clinicians require data to identify problems and their causes in the same way that they require data for investigation of mastitis problems or poor fertility. A variety of key performance indicators for heifer rearing exist, including cull rate of primiparous cows, AFC, mortality rate, number of treatments and growth rate.

Culling of primiparous cows represents a significant loss. The target culling rate is less than 10% (Breen et al., 2012), but in the UK, 19% of primiparous cows have been reported to be culled during their first lactation (Brickell and Wathes, 2011). Primiparous cow cull rate is related to pre-calving performance (Bach, 2011), but does not, in itself, indicate how the heifer rearing process is failing.

Age at first calving is also an important determinant of performance within the herd, with optimal future performance in heifers calving at 23–25 months of age (Ettema and Santos, 2004; Wathes et al., 2008). Rearing costs are also directly linked to AFC (AHDB Dairy, 2015), but, like primiparous cow cull rate, measurement of AFC cannot identify how the rearing process is going wrong, and may be influenced by factors other than a heifer's innate potential (e.g. bull fertility, oestrus detection rate).

A target heifer mortality rate to first calving has been cited as 7% (Breen et al., 2012), although a survey of UK dairy herds has shown that, on average, 15% of live-born heifer calves fail to survive

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[1] £1 = approx. US $1.47, €1.40 at 15 March 2015.
[2] See: www.dairy.ahdb.org.uk (accessed 3 November 2015).

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to first calving (Wathes et al., 2008). Heifer mortality is highly variable between herds at all stages from birth to calving (Brickell et al., 2009a). While heifer mortality is a useful indicator of disastrous heifer management, it is a blunt instrument, since herds may achieve low mortality rates despite significant under-performance.

Treatment rates or medicines use can be used as a proxy for heifer disease. Target incidence of disease is fewer than 10% of pre-weaned calves requiring treatment (Breen et al., 2012), and treatment rates can be linked to heifer growth rate and future performance (Stanton et al., 2010, 2012). Bach (2011) showed that heifers suffering four or more episodes of bovine respiratory disease (BRD) were 1.9 times more likely to fail to complete first lactation than those with no recorded BRD. However, treatment rate and medicine use is difficult to compare between units because of differences in recording accuracy, criteria for treatment and skill of stockpersons at identification of sick animals.

Heifer growth provides the most direct evidence of heifer performance throughout the rearing process from birth to calving. Published data are available to provide target weights and growth rates for animals of different ages (Drew, 1998; Heinrichs and Losinger, 1998; Le Cozler et al., 2008). The optimal weight for Holstein–Friesian heifers at first service has been estimated by different authors: Le Cozler et al. (2008) suggested 55–60% mature weight, Heinrichs and Lammers (2008) cite 341–364 kg, Bach (personal communication, 2013) estimated 400 kg at 400 days and Hoffman (1997) recommended 363–390 kg at 14 months.

The growing heifer has a number of key stages of development, particularly growth rates to 60 days, which is linked to first lactation milk yield (Bach and Ahedo, 2008) and survival rate to second lactation (Bach, 2011). Weights at 180 days and at the beginning of the target service period (420 days) are also important (AHDB Dairy PD+)[3]. Optimal heifer growth rates have been studied in detail, with conflicting results (Le Cozler et al., 2008). Very high pre-pubertal growth rates led to deposition of udder fat (Sejrsen et al., 1982), and have been associated with reduced first lactation milk yield (Van Amburgh et al., 1998). Other studies (Carson et al., 2002) showed no deleterious effect of high plane of nutrition on first lactation yields in high genetic merit heifers. Zanton and Heinrichs (2005), through meta-analysis of eight studies, concluded that heifer growth should be limited to 0.8 kg/day prior to puberty for maximal first lactation milk production. Over-fatness at any stage may jeopardise future milk production (Le Cozler et al., 2008).

Bodyweight (BW) at 30, 180 and 450 days is linked to age at first service and AFC (Brickell et al., 2009b). Poorly grown heifers also require more services per conception, calve later and are more likely to be culled early (Wathes et al., 2008). Growth rate is easy to measure, and results from different rearing units can readily be compared. Various measures of growth can be used, including weight, withers or hip height, width of the pelvis between the left and right greater trochanter and girth around the chest (heart girth) (Heinrichs et al., 1992). However, Dingwell et al. (2006) concluded that weighing heifers on a calibrated electronic scale is the easiest and most accurate method of measuring growth.

Because of overriding concerns about the impact of heifer management on UK farms, a heifer-monitoring initiative was undertaken that aimed to develop a simple system for measuring heifer growth on commercial dairy farms. The goals of this data-gathering exercise were: (1) to describe the growth rates of a subset of youngstock enrolled in a heifer monitoring programme to inform future benchmarking initiatives; (2) to quantify the association between birth weight and growth rates from 8 to 60 days; (3) to quantify the association between birth weight and estimated weights at 60 days, 180 days and 300 days, and (4) to report probabilities of achieving pre-mating target weight for heifers growing at different rates to 31–180 days as well as the probability of achieving pre-mating target weight by overall performance of the group within which the heifer is reared.

[3] See: www.dairyco.org.uk (accessed15 March 2015).

Materials and methods

Farm selection

The source population was the clientele of a large farm animal veterinary practice (total 220 eligible dairy herds, 30,000+ cows) in South West England (mainly Somerset and Dorset). A variety of commercial dairy herds using different management systems were included, so there were no selection criteria and no exclusion criteria except that heifers were Holstein–Friesians. The study population comprised herds recruited by the practice into a heifer-monitoring programme, as well as three herds that provided their own heifer weight data. The sample population were herds that were rearing Holstein–Friesian breed heifers and where the herd-owner had agreed to contribute data to the study.

Data collection

Data were collected from May 2008 to September 2012. The equipment used was a Mobile Cattle Crate (David Ritchie) with Tru-Test MP600 load-bars, aluminium platform and Ezi-weigh Indicator (Tru-Test). The accuracy of the weigh scales was checked regularly by weighing the operator, whose weight was known. Three other farms provided weight data collected by farm staff using their own weighing equipment, with accuracy similarly checked on a regular basis.

Analysis

Data manipulation and statistical analyses were carried out using Microsoft Excel 2010 (Microsoft Corporation) and Stata/IC 12.0 (StataCorp). Calculated birth weight was the median BW for 348 calves (from six farms) with a weight recorded at 0–7 days of age. Daily growth rate (GR) from birth was calculated using recorded weight less calculated birth weight, divided by age in days since birth.

Correlations between weights and days of age were initially examined, and lines of best fit were calculated, using polynomial transformation if appropriate. The mean growth rate from birth, (using calculated birth weight) for all weights recorded for each herd was then calculated. Herds were categorised as Upper, Middle or Lower according to into which quartile their mean growth rate fell. Upper herds were those whose mean growth rate fell into the upper quartile, Middle herds were those whose growth rates fell into the middle two quartiles, and Lower herds were those whose growth rates fell into the lower quartile.

Expected weight calculations

Expected weight at 60 days was calculated for all heifers with a recorded weight at 42–78 days using the formula:

$$\text{Expected weight at 60 days} = \text{weight recorded} + [\text{GR} \times (60 - \text{age in days when weighed})].$$

Expected weight at 420 days was calculated in the same way, using all heifers with a recorded weight at 300–539 days:

$$\text{Expected weight at 420 days} = \text{weight recorded} + [\text{GR} \times (420 - \text{age in days when weighed})].$$

The link between early heifer growth and subsequent development to first service was explored using W1 for weight recorded at 31–180 days; W2 for weight measured at 300–539 days. For animals with a recorded W1 (31–180 days) and a recorded W2 (300–539 days) (582 heifers), the expected weight at 420 days was calculated as above, and heifers were grouped (at intervals of 0.1 kg/day) according to their recorded growth rate to W1. If animals had more than one recorded weight in any category, the two weights furthest apart were used in calculations. Data were checked for normality and equal variances, and one-way analysis of variance was performed using Scheffe's method.

Target weights

A target weight at first service was set at 374 kg, which was the 75th percentile expected weight at 420 days for all weights measured between 300 and 539 days. The likelihood of a heifer reaching this target weight by 420 days was calculated for each group (Upper, Middle and Lower herds), and compared using Pearson χ^2 tests. A multilevel univariable logistic regression model accounting for clustering by farm (similarity of animals within a farm as compared to animals between farms) was also used to compare the odds of heifers achieving this target weight between groups.