



J. Dairy Sci. 100:1–11
<https://doi.org/10.3168/jds.2016-12018>
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The relationship between Norwegian Red heifer growth and their first-lactation test-day milk yield: A field study

K. S. Storli,* G. Klemetsdal,* H. Volden,*† and R. Salte*¹

*Department of Animal and Aquacultural Sciences, Norwegian University of Life Sciences, NO-1432 Ås, Norway

†Tine SA, NO-1431 Ås, Norway

ABSTRACT

Today's Norwegian Red (NR) is markedly different from the one that existed 25 yr ago due to the continuous genetic improvement of economically important traits. Still, current national recommendations on replacement heifer rearing largely are based on results from Danish studies from the late 1980s to the mid 1990s. The objectives of the present study were to gain information on (1) growth and growth profiles of modern NR replacement heifers in commercial dairy herds and (2) how growth during the rearing period affects the heifers' milk yield during their first lactation. To this end, we conducted a field study on 5 high-producing and 5 low-producing commercial dairy farms from each of 3 geographical regions in Norway. On these 30 farms, we combined repeated onsite registrations of growth on all available females from newborn to calving with registrations deriving from the Norwegian Dairy Herd Recording System. Each herd was visited 6 to 8 times over a period of 2 yr. At each visit, heart girth circumference on all available young females was measured. Registrations were made on a total of 3,110 heifers. After imposing restrictions on the data, growth parameters were estimated based on information from 536 animals, whereas 350 of these animals had the required information needed to estimate the relationship between growth and test-day milk yield. Our findings pointed toward an optimal ADG of 830 g/d from 10 to 15 mo of age that would optimize first-lactation yield of heifers in an average Norwegian dairy herd. The optimum will likely increase from selection over time. Utilizing simple proportionality, the ADG between 5 and 10 mo of age ideally should be 879 g/d, taking into account the fact that animal growth rate is higher at low ages and that a high prepubertal growth rate had no negative effect on first-lactation yield. When such a rearing practice is used to meet the requirements of today's genetically improved NR heifer, heifers can

both optimize production in their first lactation and enter the milking herd earlier than the current average age of 24.8 mo.

Key words: heifer, prepubertal growth, postpubertal growth, milk yield

INTRODUCTION

For dairy farming to remain sustainable, it is imperative to rear replacement heifers in a manner that maximizes their lifetime production in terms of yield and profitability (Brickell et al., 2009). The annual replacement rate in a Norwegian dairy herd is 35 to 40%. Current national recommendations on replacement heifer rearing are still largely based on results from studies on Danish dairy breeds from the late 1980s to the mid 1990s (Foldager and Sejrsen, 1991; Sejrsen and Purup, 1997). The Norwegian Red (NR), the dominant breed in Norway, is a dual-purpose breed that is bred for milk and meat production. Today's NR is markedly different from the one that existed 25 yr ago due to continuous genetic improvement of economically important traits (Geno SA, 2015). It is unclear whether rearing and, in particular, feeding practices have been updated accordingly. The effects of recommended rearing practices on growth rate and subsequent milk yield of modern NR heifers have not been analyzed. The objectives of the present study were to gain information on growth and growth profiles of modern NR replacement heifers in commercial dairy herds and on how growth during the rearing period affects the heifers' milk yield during their first lactation. To this end, we conducted a field study on 5 high-producing and 5 low-producing commercial dairy farms from each of 3 geographical regions in Norway. On these 30 farms, we combined repeated onsite registrations of growth on all available females from newborn to calving with registrations deriving from the Norwegian Dairy Herd Recording System.

MATERIALS AND METHODS

A total of 30 herds from 3 geographical regions in Norway (mid, southwest, and southeast; Figure 1), 10

Received September 20, 2016.

Accepted May 11, 2017.

¹Corresponding author: ragnar.salte@nmbu.no

from each region, were selected for the study based on the following criteria: more than 30 cow equivalents, freestall barns, unmodified heifer management from 2010 to 2012, NR as the main breed, membership in the Norwegian Dairy Herd Recording System, and farmers' willingness to commit to the trial. To ensure variation in milk yield, average first-lactation 305-d milk yield in 2010 and 2011 should have been greater than 7,500 kg of ECM for 5 herds from each region and less than 6,500 kg of ECM for the other 5 herds from each region.

An advisor from Tine SA (Ås, Norway), the dairy advisory team, visited each herd 6 to 8 times from May 2012 to May 2014. On 2 of these visits, about 1 yr apart, the advisor together with the farmer filled in a question sheet on farm management practices. On each visit, heart girth circumference was measured on all available young females from newborn to calving. Only heifers born into the herd with NR AI sires were included in the data. Twins were excluded. Measurements were conducted by 8 different but equally trained people from the dairy advisory team, with scorer confined by region. The same person performed all measurements within a herd except in one region that experienced a change halfway through the study. In this case, the successor calibrated herself against her predecessor by measuring 10 cows. The total data set included 11,066 quality-controlled heart girth measurements from 3,110 heifers ranging in age from 0 to 1,175 d. Heart girth measurements (cm) were converted to BW (kg) using the equation applied by Tine SA in their herd management program:

$$\text{BW} = 0.000468816 \times \text{heart girth}^{2.67}.$$

This model is adapted from Bekkevold and Helberg (2009), who developed and validated a curvilinear regression model in NR (BW = 108–633 kg; comprising nonpregnant and pregnant animals). We compared the 2 models in an independent study consisting of 80 heifers from the university herd (2–777 d of age; 36–685 kg; 2,909 observations) and found a first-order regression coefficient of 1.0031 between the models. This would mean that for an increase in BW of 100 kg, the models produce a weight difference of only 300 g, demonstrating that the 2 equations give close to identical live weights.

To calculate individual BW (iBW) curves (with model 3), we required all animals to have no fewer than 2 observations. Specifically, we required heifers to have measurements over a period of at least 300 d, with the first measurement taken before 275 d of age and the last taken after 575 d. Measurements taken after calving were excluded. After imposing these restrictions,



Figure 1. Map of Europe with Norway shown in gray. Inset shows the (1) mid, (2) southwest, and (3) southeast regions. The longitude and latitude of the regional offices of Tine SA, the advisory team, are (1) N 63°47'01.254" E 11°27'18.429", (2) N 58°45'38.612" E 05°39'05.980", and (3) N 59°40'09.850" E 10°47'42.769". The size of the 10 farms in region 1 varied from 31 to 69 cows and production level (first lactation) varied from 5,906 to 7,955 kg of ECM, in region 2 varied from 32 to 72 cows and 5,622 to 9,650 kg of ECM, and in region 3 varied from 32 to 114 cows and 5,161 to 8,200 kg of ECM.

the weight data set contained 3,144 measurements from 536 heifers; the youngest was 17 d and the oldest was 872 d (Figure 2). Numbers of measurements varied from 2 to 8 per heifer, and 95% of the animals had 4 or more measurements. All further calculations were based on this data set. All procedures were performed in compliance with the regulatory requirements that apply to the use of animals for scientific purposes in Norway and were approved by the National Animal Research Authority (FOTS ID no. 2955, reference no. 2010/203231).

Herd Mean BW (Model 1)

The model was used to calculate herd mean BW (hBW) at 4 selected heifer ages: 5, 10, 15, and 21 mo of age. First, the average age at first heart girth measurement was 4.7 mo (thus hBW₅). Second, NR females reach puberty at around 280 kg of BW and usually between 9 and 11 mo of age (hBW₁₀). Third, historically it has been recommended to breed heifers at 15 mo of age (hBW₁₅). Finally, 21 mo of age (hBW₂₁)

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