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DOTT. GIOVANNI BUONAIUTO
TUTOR: PROF. ANDREA FORMIGONI

Modelling muscularity and body condition score curves of Italian Simmental in Emilia-Romagna dairy herds

Objective:
Model the variation of muscularity and BCS curves across lactation of Italian Simmental dairy cows in Emilia Romagna dairy herds.

Materials and Methods:
Data were collected from 2656 Italian Simmental dairy cows from 324 dairy herds located in Emilia Romagna region, Northern Italy. Cows involved in the study were linear classified between the 2002/2003 to 2019/2020 dairy seasons. Body condition score and muscularity lactation curves were developed according to the following random regression model using the software Echidna:

$$y_{jklm} = age_j + \sum_{i=1}^{n} \beta_n P_n + \sum_{i=1}^{n} \alpha_{nk} P_{nk} + herd\_year_l + e_{jklm},$$

where y_{jklm} is BCS or muscularity measured by linear classifier for the kth animal, age_j is the fixed effect of the jth age at linear scoring (30 classes), β_n is the nth (1 to 4) fixed regression coefficient of the Legendre polynomial modelling all records of muscularity or BCS throughout the lactation, α_{nk} is the nth (1 to 4) random regression coefficient of the Legendre polynomial modelling records of muscularity or BCS throughout the lactation for cow kth (2575 classes), $herd_{year_l}$ is the random effect of the lth herd-year of linear classification (937 classes), and e_{jklm} is the random residual term.
Moreover, age at linear scoring and herd-year of classification were fitted as fixed and random effects, respectively. The absolute growth rate (AGR) was calculated as:

$$AGR = \frac{(BTx - BTy)}{tx - ty}$$

where BT_x and BT_y are the corresponding predicted muscularity or BCS at DIM x and y, t_x is the initial age in days and t_y is the final cow's age in days.

Results:
Both average random lactation curves profiles indicated a nadir around the period corresponding to milk production peak. During this period cows usually have strong nutrient requirements which cannot be fully compensated with feed intake. Figure 2A indicates that the period of muscularity growth within lactation is approximately between 82 to 277 DIM. As regards to BCS, the AGR shows an earlier recovery of body fat reserves starting before the second month of lactation, with a continuous positive trend until the ninth month of lactation. These trends are similar to that reported in other studies (Berry et al., 2006; McCarthy et al., 2007). As stated previously, this moment corresponds to the period when the animal has a greater nutritional need, necessary to sustain milk production, maintenance requirements, and foetal growth. In fact, the nutritional needs of foetus have the priority over many metabolic functions of the mother.

Conclusions:
Result reported in the current research indicate that random regression using Legendre polynomials can be effectively employed to predict muscularity and body condition score of dairy cows.

Reference:

- Berry DP, Macdonald KA, Penno JW, Roche JR. 2006. Association between body condition score and live weight in pasture-based Holstein-Friesian dairy cows. J. Dairy Res. 73:487–491.
- McCarthy S, Berry DP, Dillon P, Rath M, Horan B. 2007. Influence of Holstein-Friesian strain and feed system on body weight and body condition score lactation profiles. J. Dairy Sci. 90:1859–1869.

Fig. 1 Lactation curve profiles for muscularity or Body Condition Score for cows calving at different age.

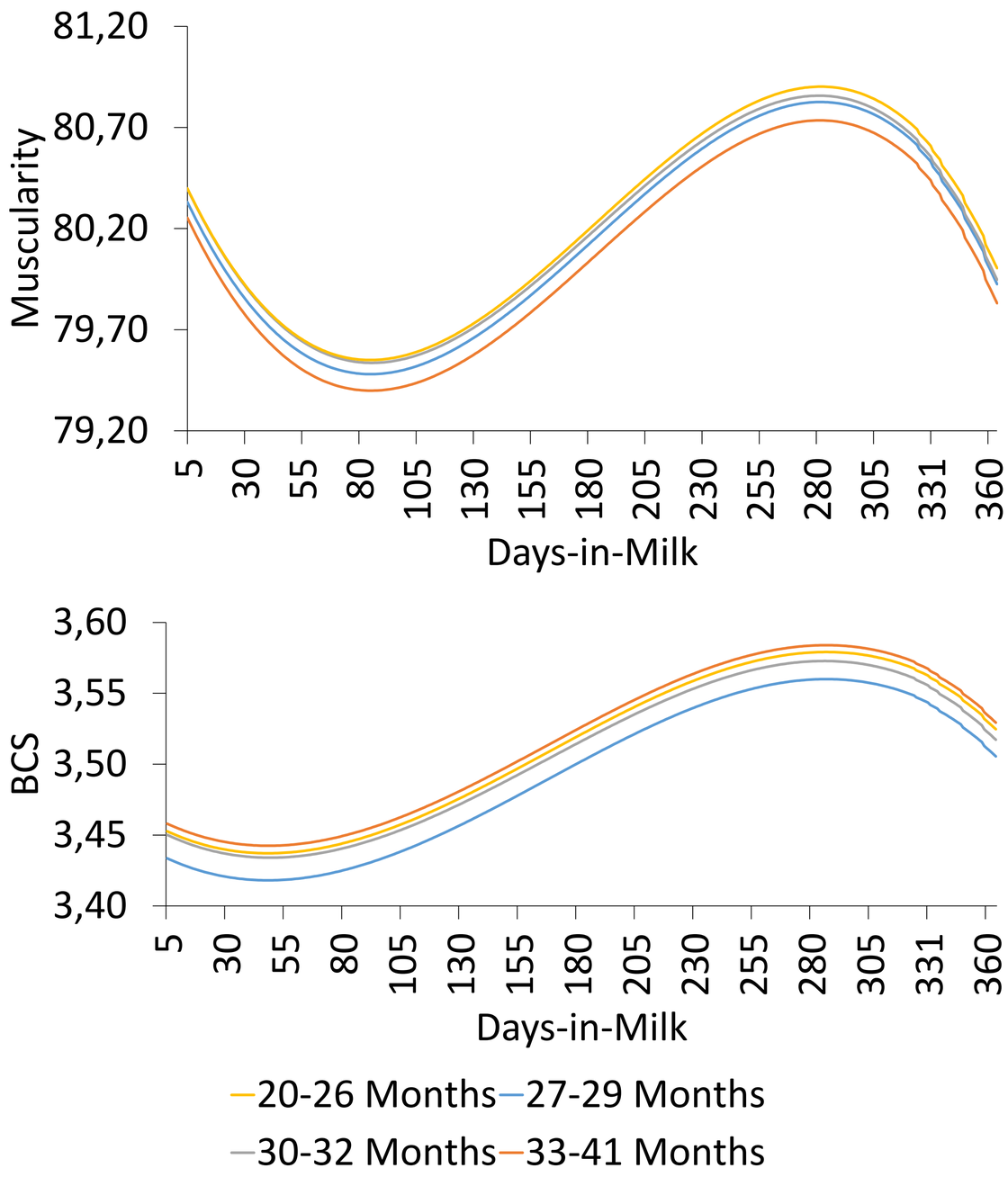

Fig. 2 Absolute growth rate (AGR) for muscularity and Body Condition Score for cows calving at different age.