STØTTET AF

Kvægafgiftsfonden

Vejene til en mere klimavenlig kalve- og oksekødsproduktion udgår fra malkekvægholdet

SEGES, December 2023

Arbejdspakke 2: Avlsmål for kødkvægstyre anvendt til krydsning med malkekøer

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1. Fastlæggelse af forudsætninger for produktion af slagtekalve ved stigende værdi af metanreduktion og ressourceudnyttelse. De økonomiske værdier skal fastsættes under intensive og ekstensive produktionsforhold.
   - Here we can calculate the economic values for saved feed, marbling score, and produce an estimate for Methane. Otherwise consider low, medium, and high weight ratio.
   - The economic value of saved feed can be the price of feed per kg for beef cattle in Denmark.
   - The economic value of marbling score can be predicted as extra price that the Slaughter houses can provide for extra lean meat.
   - The economic value of methane is difficult to calculate, however, it could be the tax on the meat. Or a weight can be considered rather than the actual value.
   - https://www.sciencedirect.com/science/article/pii/S175173111900154X estimated the economic values of DMI and methane in cattle for Canadian dollars. It can be used as a reference for this study.

2. Beregning af vægte på metanproduktion under intensive og ekstensive produktionsforhold med forskellige forudsætninger.
   - Here we produce an index that includes methane, saved feed, and marbling score. The index will be tested using different weights on methane. It will produce 3 different scenarios and can be tested like sensitivity analysis.

3. Beregning af effekten af de fastsatte avlsmål på kort sigt ud fra økonomiske værdier og sammenhæng mellem egenskaber.
   - The correlation between the methane and other important traits in the index will be produced to see the response to selection and also include the effect of selection against methane on other traits.

Economic Values

Saved feed

Economic Values (EV) for genetic or phenotypic residual feed intake (saved feed) is the same as it does not rely on the methodology. Stephensen et al. (2021) estimated the EV of saved feed for dairy cattle using SimHerd program to range from 0.16 to 0.18 €/kg dry matter, corresponding to 0.16 to 0.18 €/Scandinavian feed unit (SFU – 1 SFU corresponds to 0.97 kg dry matter and 6.7 MJ of net energy).

In beef cattle, the energy is used for deposition of fat, protein, and maintenance, and this composition changes during fattening of the cattle. This may indicate that the relationship between saved feed and the direct feed price may change during fattening period. EV for maintenance is the same as feed price as there is a linear relationship between metabolic body weight ($BW^{0.75}$, MBW) and the feed used to maintain the body (Volden, 2011; VandeHaar et al., 2016). In beef cattle, changes to body weight (ΔBW, kg) account for mobilization in RFI models. Therefore, assuming the same energy costs for each kg of body weight change might not be a fair assumption (Veerkamp, 2002). However, since we are looking at 200 to 260 days of age period in FBC project, the changes may not be substantial as indicated by heritability to be stable in this period for weight and feed intake. Therefore, it could be safe to assume a linear relationship between saved feed and feed price for beef cattle.

SimHerd calculates EV as change in profit divided by change in phenotypic mean per annual cow. This gives a value of euro per trait unit per annual cow. The results of Stephensen et al. (2021) suggested that calculated EV for RFI of 0.16 to 0.18 €/kg DMI, corresponding to 0.16 to 0.18 €/SFU is equivalent to Applied feed prices in below table. This study concluded that the EV of RFI is not dependent on the method used to estimate EBV for RFI but is equal to feed price.

Applied prices/costs and other estimates for traits in SimHerd simulations. Currency conversion factor of 7.5 DKK/€ where applied in simulations.

Prices/costs	Value
Standard milk excl. extra payment (€[1]/kg)	0.35
Concentrates (€[1]/SFU[2])	0.238
Roughage (€[1]/SFU[2])	0.149
Applied feed price[3] (€[1]/SFU[2])	0.18

Methane

Richardson et al. (2019) calculated EV for feed efficiency and methane emissions in dairy cow, however, she assumed the relative methane emissions reduction from genetic improvements in feed efficiency. Therefore, the EV for feed efficiency also included the EV for methane emissions. The focus of this study was to propose a method which can be used to estimate the economic value of daily dry matter intake and associated methane production. Estimated values may be applied to determine the traits economic weight within selection, a key aspect of including traits in future breeding programs.

To briefly describe the proposed selection criterion, it will be calculated using breeding values of DMI in first parity cows while accounting for the amount of feed wasted on inefficient metabolism, digestibility and maintenance. We define this trait as Feed Performance (FP), defined as a kg of more efficiently used feed. In the current study, it is anticipated that total FP will be corrected at the index level for energy requirements associated with other EBVs linked to feed sinks (Meyer et al., 2017). For example, the energy required for maintenance, production, health, and fertility, as well as body condition score, are all feed sinks linked to existing EBVs considered in breeding programs.

This study calculated the EV for feed performance, which is the feed that is not used for maintenance and metabolism and digestibility, as EV for the first parity cow plus the EV for cumulated effect on other correlated traits plus the EV for the methane production. (The economic value for the feed that is saved throughout the lactation of a first parity cow, plus the cumulative economic value for more efficiently converted feed due to correlated responses in all other life stages, and plus the economic value for the saved methane production associated with the improvement in feed conversion over the animals' lifetime.) The value of methane associated with a one-unit gain in FP was CAD $0.07 per cow per lifetime, equivalent to 55 g of methane. The Canadian national cost of carbon used in this study, CAD $50/ton, is comparable to the social cost of carbon at USD $42/ton most recently reported by the United States

Board of Environmental Change and Society (2017). the total saving associated with improving FP was CAD $0.89 per cow per 1 kg increase in feed conversion performance in a first parity lactating cow. To put these values into perspective, it is expected that the average first parity lactating dairy cow consumes 6863.45 kg DM and produces an associated 116.7 kg methane in her lifetime (Table 1). Therefore, for every 1 kg increase in FP, 3.23 kg DMI and 55 g of methane are expected to be saved with every 1 kg increase in feed conversion performance in a first parity lactating cow.

The economic value of methane was calculated as the global warming potential conversion factor of methane to CO2 equivalents multiplied by a discount factor multiplied by methane yield, the kg methane production per unit of feed assumed to be a constant proportion of DMI, z accounts for the variation in methane yield between less and more efficient animals and takes a value less than 1 if higher feed efficient animals have lower digestion and therefore lower methane yield than the population average value of methane yield and multiplied by the average price of carbon per unit based on government policy. The Canadian government has proposed a carbon tax of CAD $50/ton which will be implemented by 2022 (Environment Canada, 2016).

$$EV_{Methane.FP} = \sum_{LS=1}^{9} b_{LS.1} \cdot B_{LS.1} \cdot DF_{LS} \cdot GWP \cdot MY \cdot z \cdot \frac{P_{LS}^{M}}{1000}$$

Table 2 *Constants used in calculation for all life stages in dairy cattle*

Variable	Value	Units
Global warming potential of methane[1]	25	kg CO_2/kg methane
Discount rate	7	%
Price of carbon[1]	50	CAD $/ton
Proportion of milking herd[2]		
First lactation	0.36	-
Second lactation	0.27	-
Third+ lactation[3]	0.37	-

[1] Provided through Environment Canada (2016).
[2] Based on data provided by Canadian Dairy Network (G. Kistemaker, Guelph, ON, personal communication).
[3] Third+ lactation and dry life stages include values obtain using animals in lactations 3, 4 and 5.

Marbling score:

Barwick and Henzell (1996) developed an equation for economic value of marbling score in beef cattle as follow: On a per cow joined basis the economic value (Ev), in $, of a 1 score marbling shift is then the fraction of a finished animal sold per cow multiplied by mean carcass weight multiplied by a discounting factor which accounts for the delay to expression of the trait improvement multiplied by the expected level of marbling in progeny, the c/kg carcass premium, for a shift in mean score is given by the predicted frequencies score before and after the shift multiplied by the corresponding c/kg carcass premiums relative to no marbling.

There are consumer social and behavioral aspects to the price of value of the marbling score, as more marbling can encourage consumers to purchase such products or pay a premium for that product.

Currently in the NAV system, the S index only contains the carcass score which could be carcass weight and EURP score. This indicates that carcass fatness score is not included into the system. carcass conformation score is recorded following the EUROP system in 15 ordered classes and carcass fat score is recorded in 15 classes in Finland and Sweden and 5 classes in Denmark.

One approach could be to include an average added values for fatness score for beef crosses as it was done in NTM in 2018 report (+3.50 for bull calves less than 10-month age at slaughter).

Otherwise, the economic value of fatness score can be calculated using the EU data for Denmark and combined with the equation of Barwick and Henzell (1996) to calculate the EV for marbling score.