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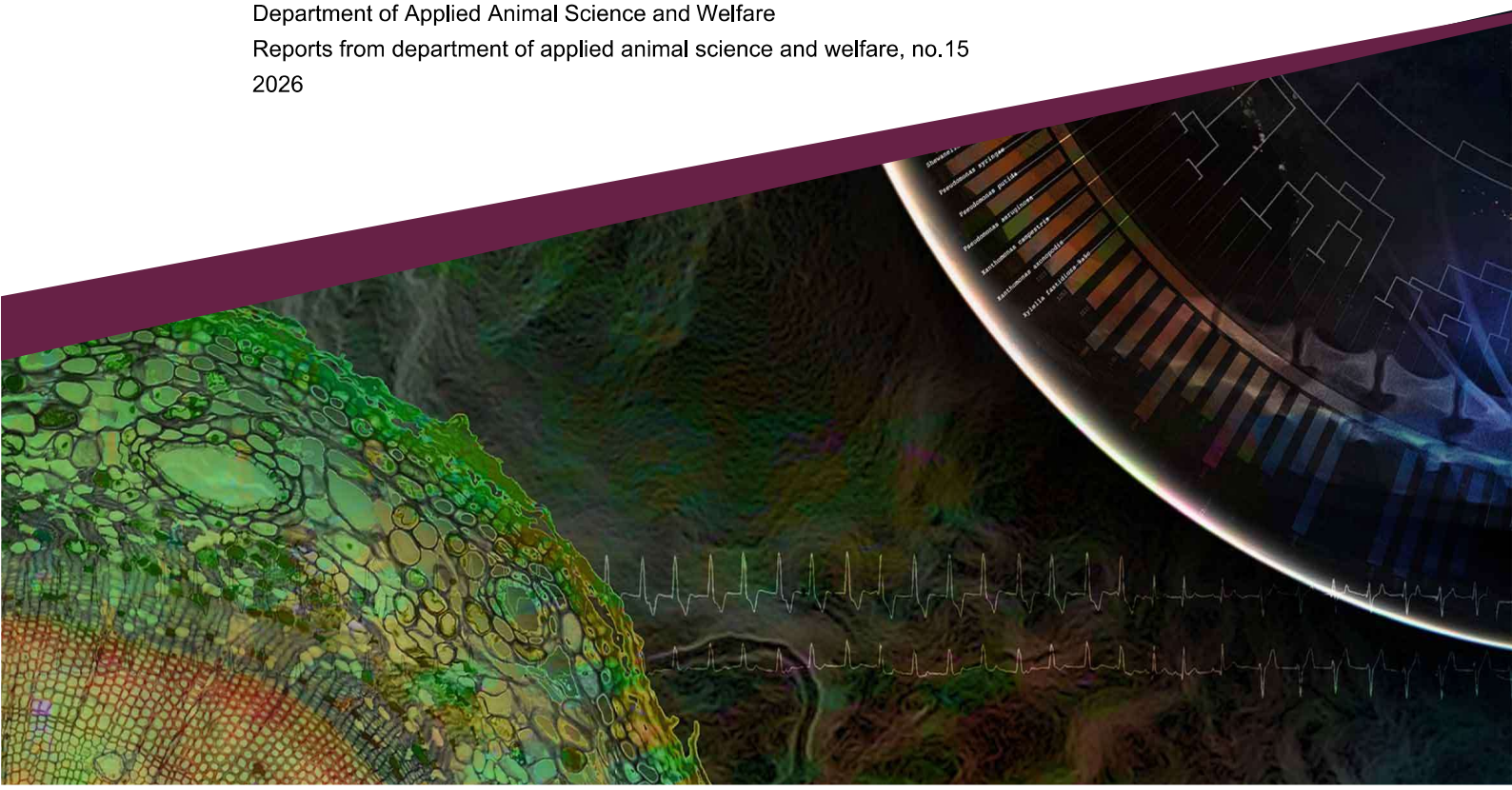

NorFor – status and future development

N. I. Nielsen[1], M. Åkerlind[2] & J. Karlsson[2]
[1]SEGES Innovation, 8200 Aarhus N, Denmark. [2]Växa Sverige, Box 288, 751 05 Uppsala, Sweden.
Correspondence: ncn@seges.dk

Introduction

NorFor is a feed evaluation system and ration formulation model for dairy and beef cattle developed in the Nordics. It combines scientifically based biological knowledge of digestion and metabolism with practical ration optimisation in IT-tools, supporting efficient, profitable, and climate-smart feeding strategies.

Organisation and usage

NorFor is jointly owned by farmer-based organisations in four Nordic countries:

- Växa Sverige (Advisory service/R&D, Sweden)
- TINE (Dairy company Norway)
- Landbrug & Fødevarer (Agricultural Industry Association, Denmark)
- Ráðgjafarmiðstöð landbúnaðarins (RML) (Advisory service/R&D, Iceland)

The system was developed through Nordic collaboration starting in the early 2000s. The purpose was to create a common Nordic feed evaluation system to maximize the benefit for dairy farmers. The overall aim of NorFor was to create an identical, common feed evaluation system for the Nordic countries to facilitate communication between farmers, consultants, feed industry and researchers.

NorFor is fully implemented in the four owner countries, where it is used through national advisory software systems (e.g. FoderOpti in Sweden, DMS in Denmark, OptiFôr in Norway and Iceland) for optimizing and evaluating feed rations. These tools integrate the NorFor model into daily advisory work and farm-level decision support.

In terms of scale, NorFor is used on the majority of dairy farms that use feed planning and on many beef farms in Denmark, Norway, Sweden and Iceland. Beyond the owner countries, NorFor is also used internationally, in countries such as Estonia, Latvia, Lithuania, Germany, Croatia, Slovenia, Slovakia, and Serbia. The biological model and feed stuff table is accessible globally through the NorFor Feed Ration Optimizer™ (NFRO), which is an IT tool that allows nutritionists outside the Nordics to apply the NorFor system on farm.

The NorFor system is a model designed to predict digestion of nutrients in the GI-tract by integrating animal characteristics and feed composition to estimate digestion in the rumen and intestines (see Figure 1). The NorFor system also contains submodels for feed intake regulation and dietary physical structure (Volden, 2011).

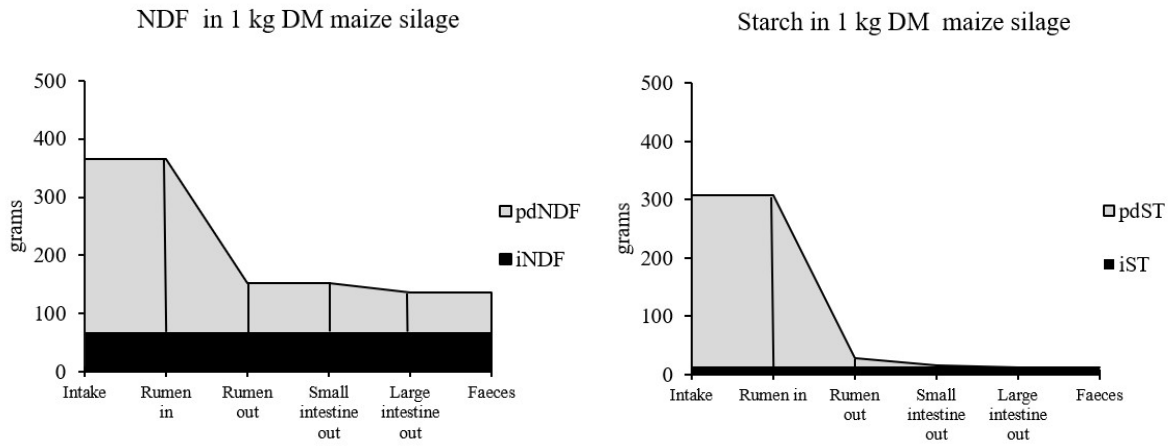

Figure 1 Illustration of digestion of NDF and starch (ST) of their potential digestible (pd) and indigestible (i) fractions in maize silage in different parts of the gastrointestinal tract of cows estimated by the NorFor model.

The NorFor calculation core used by the national advisory software systems and NFRO use a non-linear optimization to suggest diet formulation with the lowest cost while at the same time fulfilling the nutritional requirements for the selected production level.
Overall, NorFor represents a well-established example of long-term Nordic collaboration, combining research, advisory services, and digital tools into a unified system that is widely used both within and beyond its owner organisations.

Cooperation with feed laboratories and feed companies

The NorFor system rely on a close and structured cooperation with both feed companies and feed laboratories. This collaboration ensures that the system remains highly applicable in practical feeding and advisory work.

Feed laboratories play a key role in the NorFor system. Accurate feed evaluation in NorFor relies on detailed chemical analyses, mainly from calibrated prediction methods such as NIR (near-infrared spectroscopy). Feed analysis results are automatically integrated in the NorFor system by the NorFor Feed Analysis System (NorFor FAS). Feed laboratories send the results to NorFor FAS digitally making the analysis results available for specific herds as soon as they have been analysed.

There is also a digital collaboration with feed companies as NorFor provides a software platform where feed companies can add their compound feeds to the NorFor FeedStuff Table (FST). This way compound feeds and their nutritional composition is easily accessible for ration formulation for advisors and farmers using the national advisory software systems or the NorFor Feed Ration Optimizer™. The compound feeds and feed ingredients that are administered by feed companies are not openly displayed in the NorFor FST online (https://feedstuffs.norfor.info/).

Feed companies can also assess NorFor software in product development, documentation, and advisory support. By applying the same biological model as used in farm advisory services, feed companies can formulate and evaluate feeds in a way that is fully aligned with on-farm ration planning.

Research and development

NorFor works continuously internally and together with researchers to develop new methods and biological features. Some examples are given in the following:

Method for evaluating energy content in concentrates

NorFor developed a model to estimate NEL20 (net energy for lactation at a standardized intake level of 20 kg DM) of compound feeds based on chemical composition and in vitro digestibility, without requiring detailed ingredient information (Álvarez et al., 2022). This provides a practical and standardized way to compare energy values across compound feeds within the NorFor system, despite its otherwise dynamic nature. The work improves transparency of energy content in commercial compound feeds. Overall, the method bridges the gap between mechanistic feed evaluation and routine feed analysis, making energy assessment more operational in practice.

Milk responses to AAT

AAT supply (absorbed amino acids in the small intestine or metabolisable protein) has been evaluated in relation to milk production responses using a meta-analysis of Nordic and international feeding trials (Sommerseth et al., 2026). Results show that increases in AAT supply relative to energy (AAT/NEL) lead to higher ECM and protein yield up to a plateau around 15 g AAT/MJ NEL, with only marginal production gains beyond this level. This indicates that production responses are primarily driven by the balance between ruminal nitrogen availability and energy supply, rather than absolute amino acid supply. Overall, the findings support current NorFor AAT recommendations and suggest that slight reductions in AAT supply could be possible without significantly affecting production, particularly under stricter nitrogen constraints.

Digestion model

In 2021, NorFor introduced several structural changes to the digestion model that resulted in minor adjustments to optimized rations but improved biological realism. The most notable modification is the shift from a curvilinear to a linear ruminal passage rate for forage NDF, leading to slightly higher passage rates, reduced ruminal NDF degradation, and consequently marginal decreases in energy availability and microbial synthesis, while simplifying the model and improving predictions of apparent NDF digestibility. In addition, a unified degradation rate of 60% per hour is applied to the ‘rest carbohydrate fraction’ across both forage and concentrates. The update also reduces endogenous and microbial nitrogen losses in feces, increasing apparent crude protein digestibility and energy values, although slightly decreasing microbial crude protein synthesis and metabolisable protein (AAT). These changes were based on evaluations against a large set of feeding trials (Åkerlind et al., 2019).

Climate

The debate around cows and climate the last 10 years has also had impact on the NorFor system. NorFor can therefore support estimation of the carbon footprint of milk production by providing a biologically consistent and data-driven description of feed intake, nutrient utilisation, and emissions at animal level.

NorFor predicts feed intake and ration composition, which are key inputs for calculating upstream emissions from feed production. By accurately describing what and how much the cows consume, NorFor enables more precise linkage to life cycle assessment (LCA) databases for feed-related emissions. NorFor quantifies nitrogen intake and excretion, which can be used to estimate emissions of nitrous oxide (N_2O) and ammonia (NH_3) from manure management. Since nitrogen efficiency is tightly linked to environmental impact, this provides an important component of whole-farm greenhouse gas assessments.

NorFor includes models for enteric methane emissions, allowing estimation of CH_4 production based on diet composition, intake level, and rumen fermentation characteristics. In recent years, NorFor has focused on improving the prediction of enteric methane emissions. In 2023, models were implemented to quantify the methane-reducing effects of 3-nitrooxypropanol (3-NOP) and nitrate (Karlsson et al., 2024). For both additives, the mitigation effect was modelled as dose dependent. For 3-NOP, the effect is further modulated by diet composition, with a decreasing mitigation response observed at higher levels of roughage NDF per kg of total dry matter intake.

In 2025, an updated methane prediction model for lactating dairy cows was implemented in NorFor. This model improves predictive accuracy by incorporating a broader set of feed-related parameters compared to previous Nordic models. Relative to the earlier NorFor model (Nielsen et al., 2013), the new equation generally predicts lower methane emissions, in line with more recent scientific findings.

Further developments include updated models for growing cattle. New equations for heifers and growing bulls were presented at the Nordic Feed Science Conference in 2026 (Karlsson et al., 2026), representing the latest step in refining methane prediction across animal categories within NorFor.

The NorFor system has the capacity to integrate climate-related parameters into ration evaluation and optimization. The introduction of climate parameters enables farm-specific estimation of greenhouse gas (GHG) emissions by incorporating factors such as forage yield, fertilizer use, carbon sequestration, and methane emissions, expressed as CO_2 equivalents. Additionally, the implementation of a carbon footprint calculator allows quantification of emissions originating from both animal metabolism and feed production, including cultivation, processing, transport, and nitrogen-related emissions. These emissions are aggregated and can be expressed per unit of dry matter intake, per animal, or per unit of production (e.g., energy-corrected milk), enabling comparative assessment of feeding strategies. NorFor provide a comprehensive framework for evaluating the environmental impact of rations. This supports simultaneous optimization of nutrition, productivity, and climate performance.

Future work

Dry matter

Dry matter (DM) concentration is one of the most fundamental feed analyses in ruminant nutrition, as it provides the basis for expressing nutrient concentrations, estimating feed intake, and formulating balanced rations. Because animals regulate intake primarily on a DM basis, inaccuracies in DM determination directly affect predictions of nutrient supply, feed efficiency,

and production responses. The NorFor feed evaluation system defines dry matter of forages as constant weight at 60°C corrected for loss of volatiles (Volden, 2011) to minimize losses of volatile compounds such as organic acids, alcohols, and ammonia, particularly in fermented feeds like silages that occur when drying at 103°C. Kristensen (2024) showed that grass-based forages have a large variation in residual weight loss when first pre-dried at 60°C and thereafter in 103°C, and concluded that correction for residual dry matter might be of importance to improve precision of OMD and chemical methods used in the NorFor feed evaluation system.

Rumen fistulated cows

The in sacco method is challenged in many European countries due to animal welfare reasons. This challenges feed evaluations systems based on the in sacco technique and in vitro methods based on rumen-fluid, such as IVOS (in vitro opløslighed af organisk stof), VOS (vomvätskelöslig organisk substans), Tilley & Terry. INRAe, e.g., has decided to face-out the use of rumen fistulated cows.

References

Álvarez, C., M. Åkerlind, H. Martinussen, E. Brodshaug, D. Clausen, & N. I. Nielsen, 2022. Screening of energy content of compound feeds using the new energy evaluation model, in: Proc.11th Nord. Feed Sci. Conf., Uppsala, Sweden, p. 135-137.

Karlsson, J., C. Alvarez, M. Åkerlind & N. I. Nielsen., 2024. The effect of the methane inhibitors nitrate and 3-NOP on enteric methane in dairy cow, in: Proc.12th Nord. Feed Sci. Conf., Uppsala, Sweden, p. 32-34.

Karlsson, J., F. H. Lau-Jensen, M. Åkerlind & N. I. Nielsen, 2026. Predicting enteric methane from growing cattle, in: Proc.13th Nord. Feed Sci. Conf., Uppsala, Sweden, p. xx-yy. Kristensen, N.B., 2024. Residual weight loss of grass and grass-clover silages dried at 103°C after pre- drying at 60°C., in: Proc.12th Nord. Feed Sci. Conf., Uppsala, Sweden, p. 122-124.

Nielsen, N.I., H. Volden, M. Åkerlind, M. Brask, A.L.F. Hellwing, T. Storlien, J. & Bertilsson, J., 2013. A prediction equation for enteric methane emissions from dairy cows for use in NorFor. Acta Agric. Scand, Sect. A – Anim. Sci., 126-130. https://doi.org/10.1080/09064702.2013.851275

Sommerseth, J.K., I. Schei, M. Åkerlind, A. M. H. Kjeldsen, H. Volden & N. I. Nielsen, 2026. Dietary AAT calculated in NorFor and its effects on responses in ECM- and protein yield in dairy cows. In: Proc.13th Nord. Feed Sci. Conf., Uppsala, Sweden, p. 42-46.

Volden, H. 2011. NorFor - The Nordic Feed Evaluation System. Eur. Assoc. Anim. Prod. Publ. 130. Wageningen Acad. Publ., Wageningen, The Netherlands.

Åkerlind, M. & N.I. Nielsen, 2019. Evaluation of NorFor's prediction of neutral detergent fibre digestibility in dairy cows, in: Proc.10th Nord. Feed Sci. Conf., Uppsala, Sweden, p. 109-116.