How to Produce Forage Mixtures with Better Energy-to-Protein Balance

Agriculture and Agri-Food Canada | Agriculture et Agroalimentaire Canada

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Legume-based forage mixtures are an important source of energy and protein in dairy cattle nutrition. Research conducted at sites across Canada has been investigating methods to improve the energy-to-protein balance of alfalfa through genetic selection, crop management, and species selection.

Why is Energy-to-Protein Balance Important?

When there is sufficient energy in the rumen, nitrogen (N) compounds from forages can be incorporated into microbial proteins used by lactating cows to produce milk.

Alfalfa is the most commonly used forage legume because of its high yield, persistence, drought tolerance and high protein concentration. Low nitrogen use efficiency **(NUE)** leads to N being excreted through urine into the nearby environment. NUE can be improved by increasing the energy-to-protein balance of alfalfa-based mixtures.

This can be achieved in alfalfa-based mixtures by:

INCREASING THE ENERGY CONCENTRATION
(non-fibre carbohydrates; NFC)

REDUCING PROTEIN CONCENTRATION

REDUCING PROTEIN DEGRADABILITY
in the rumen

Key Points

- **Using energy-rich cultivars, cutting crops in the afternoon, and combining selective types of forages** can increase the energy-to-protein balance of forages
- **Improving the energy-to-protein balance of alfalfa** can increase its nitrogen use efficiency as assessed *in vitro*
- **Better nitrogen use efficiency** could lead to improve animal performance and reduce environmental impact

Improving the energy-to-protein balance of alfalfa-based mixtures is important for maximizing the nutritive value of rations fed to dairy cattle.

Producing forages that have a better balance of non-fibre carbohydrates (energy) and crude protein translates to improved NUE, increased milk yield and milk protein, and reduced loss of N to the environment.

Strategies for Increasing Forage Mixture Energy Content

Genetic Selection

Four cycles of selection for high non-fibre carbohydrates were performed in alfalfa to improve its energy concentration.

Four alfalfa populations (NFC1, NFC2, NFC3, and NFC4) were selectively bred to target superior genotypes for high energy and vigour. In order to see an improvement in animal performance, a minimal increase of 4% of Dry Matter (DM) in energy is required. The NFC4 population showed an increase of about 5% DM in NFC compared to the base alfalfa population, indicating that selectively breeding for higher energy is an effective approach.

Species Selection

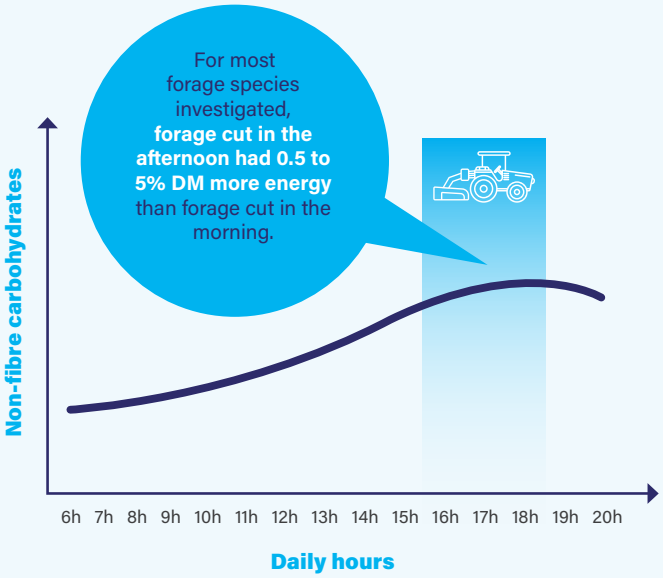
Red clover, birdsfoot trefoil, and/or grass species, such as timothy or tall fescue, were added to alfalfa to determine the effect on the energy-to-protein balance.

The addition of about 25-30% of red clover or birdsfoot trefoil increased the non-fibre carbohydrates (NFC) by 1% DM and decreased the crude protein by 0.63 to 0.75% DM. Adding red clover showed a greater reduction in protein degradability than birdsfoot trefoil in the alfalfa-based mixture. The addition of about 15% of grass species also showed decreases in crude protein by 1% DM. Therefore, adding red clover, birdsfoot trefoil or grass are effective ways to improve energy-to-protein balance of alfalfa-based mixtures.

Crop Management

Forages were cut at various time points throughout the day to determine the effect of cutting time on the energy concentration.

Time-of-day cutting strategy



Combining Efforts to Increase the Energy-to-Protein Balance

Based on these results, a combination of genetic selection, crop management, and species selection can be used to optimize the energy-to-protein balance.

Thus, a forage mixture that combines high-energy alfalfa, 25-30% red clover or birdsfoot trefoil, 15% grass species, which is cut in the afternoon could see its NFC increased by 10% DM and its crude protein decreased by 1.5% DM.

What's the Impact?

Alfalfa forage with a more balanced energy-to-protein ratio, obtained by using alfalfa with increased energy, cutting in afternoon, and/or adding red clover or birdsfoot trefoil, demonstrate better NUE.

By improving NUE, animal performance could be improved and N loss in the environment could be lessened, which helps to reduce the environmental footprint of dairy products. This research helps to improve dairy cattle nutrition, while creating a more sustainable and efficient dairy industry moving forward.

Funding Partners

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