UNIVERSITY OF ALBERTA
Rangeland Research Institute

# Using DNA Barcoding to Characterize Free-Range Beef Cattle Diets

*Prepared by Valentine Udeh, Drs. Carolyn Fitzsimmons, Leluo Guan, James Cahill and Edward Bork*

Cattle exhibit complex foraging behavior in rangeland, with dietary selection influencing nutritive intake, and therefore animal performance. With complex rangeland habitats containing hundreds of plant species, understanding the relative selection and avoidance by beef cattle of different plants is important to both optimize animal use of rangelands, while also maintaining range condition through the process of balancing plant defoliation with subsequent recovery. For example, studies from the University of Alberta Mattheis Ranch in SE Alberta indicate that cattle diets and associated plant selection vary from summer to fall, and differ depending on cattle genomic markers for high and low feed efficiency.

Unfortunately, conventional methods to characterize the diets of commercial cattle are either time consuming (passive observation of grazing animals), invasive to the animal and difficult to scale (esophageal fistulation), or are very expensive and therefore limited to small sample sizes (fecal histology). As a result, novel tools are needed to conduct more comprehensive investigations into the role of dietary selection during grazing, particularly those dietary behaviors likely to regulate the economic and environmental outcomes of open-range livestock grazing.

DNA barcoding is a potential tool that may be used to characterize the diets of free-ranging animals, and is most commonly used in wildlife studies, with limited application thus far in livestock. Barcoding utilizes fecal samples obtained from cattle consuming a mixture of plants, the extraction and sequencing of plant DNA from those fecal samples, and finally comparison to a DNA reference library of various plant species. This comparison has the potential to determine the presence and relative composition of various plant species (or plant functional groups; e.g., graminoids, legumes, browse) in the diet. When combined with degradation coefficients for different plant species in the digestive tract, estimates of plant intake rates may also be attainable.

*Right: Cattle feeding on diverse native rangeland at the University of Alberta Kinsella Research Ranch.*

This University of Alberta study is quantifying the diets of free-ranging cattle and their contribution to cow/calf weight gain, as well as other important metrics such as methane emissions. This process involves 3 steps, including: 1) Development of a comprehensive DNA reference library for plant species found in native rangelands of the Aspen Parkland, 2) Drylot trials to calibrate and validate the use of DNA barcoding of fecal samples taken from cattle fed a predetermined diet to detect the presence of added novel plant species in the diet, including at different levels, and 3) Collection of fecal samples from free-ranging cattle, subsequent plant DNA extraction, and then comparison to a reference library for the rangelands in question to quantify plant species presence, abundance, and dietary diversity.

Once the methodology is refined, this process will be applied to up to 200 free-ranging beef cattle to characterize their diets in summer and fall, as well as over multiple grazing seasons, which in turn, will be related to important traits such as cattle weight gain. The assessment of diets for large numbers of cattle will ultimately enable additional tools to be developed to aid the beef cattle industry. For example, we will pursue the exploration of cattle DNA markers that reflect dietary selection. While a long-term process to undertake, this approach could one day be used to select for cattle that are uniquely adapted to local foraging conditions (e.g., rangelands with proportionally higher forest or browse, or wetland plant species), all the while simultaneously maintaining animal performance and the environmental sustainability of grazing activities.


*Left: Custom feed rations being prepared for heifers fed in drylot to calibrate and validate diet composition using fecal DNA barcoding. Right: Heifers in GrowSafe being used to conduct the calibration-validation trial to characterize cattle diets.*

***This study is supported by the Smart Agriculture and Food Digitalization and Automation Program of Alberta Innovates, Results Driven Agricultural Research (RDAR), the Canadian Agricultural Partnership (CAP), and the Alberta Beef Producers.***

**Contacts:**

Valentine Udeh
Graduate Student
University of Alberta
vudeh@ualberta.ca

Dr. Edward Bork
University of Alberta
Rangeland Research Institute
edward.bork@ualberta.ca