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PROTEIN SUPPLEMENTATION TO PREGNANT HEIFERS AND GRAZING MANAGEMENT EFFECTS ON COW DIET QUALITY

by

Hubert H. Patterson. III

A DISSERTATION

Presented to the Faculty of

The Graduate College at the University of Nebraska

In Partial Fulfillment of Requirements

For the Degree of Doctor of Philosophy

Major: Animal Science

Under the Supervision of Professor Don C. Adams

and Professor Terry J. Klopfenstein

Lincoln, Nebraska

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DISSERTATION TITLE

Protein Supplementation To Pregnant Heifers and Grazing Management

Effects On Cow Diet Quality

BY

Hubert Henry Patterson, III

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GRADUATE COLLEGE
UNIVERSITY OF NEBRASKA

PROTEIN SUPPLEMENTATION TO PREGNANT HEIFERS AND GRAZING MANAGEMENT EFFECTS ON COW DIET QUALITY

Hubert H. Patterson, III, Ph.D.

University of Nebraska, 2000

Advisors: Don C. Adams and Terry J. Klopfenstein

Two experiments were conducted in Trial 1 to determine effects of summer grazing date and fall grazing pressure on the CP content and in vitro organic matter digestibility (IVOMD) of the diets of cows grazing fall range in the Nebraska Sandhills. In both experiments, pastures were grazed in June, July, or deferred from summer grazing. The pastures were then grazed the following fall at various levels of grazing pressure, and diets were collected by esophageally fistulated cows as forage was removed. In the first experiment, pastures grazed in June had higher diet CP in the fall than pastures grazed in July. Diet CP and IVOMD declined quadratically with increased grazing pressure. In the second experiment, pastures deferred from summer grazing had higher CP content than pastures grazed in June or July. Fall diet CP and IVOMD did not decline with increased grazing pressure.

Trial 2 was conducted to determine the effects of supplementing pregnant heifers (March-calving) grazing winter range to meet metabolizable protein (MP) requirements versus CP requirements on forage intake and production traits, and to determine effects of hay supplementation during the last two months of gestation. Heifer body weight and

body condition score change during the winter were not markedly different between MP and CP supplemented heifers, but hay supplementation reduced body weight and condition score loss. Grazed forage intake was not affected by treatment, but intake declined from November through February.

Trial 3 was conducted to determine effects of supplementing pregnant heifers to meet MP or CP requirements on 2-yr-old pregnancy and profitability. March calving heifers were supplemented from September to February at two locations across 2 yr. Supplementing to meet MP requirements improved pregnancy and profitability in three of four situations.

Grazing system affected fall diet nutrient content. Grazed forage intake of March-calving heifers declined over the winter, and supplementing heifers to meed MP requirements during gestation increased 2-yr-old pregnancy.

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Summer by fall grazing interaction effects in the Sandhills on cow diet protein and digestibility during the dormant season

Supplementation to meet metabolizable protein requirements of primiparous beef heifers: I. Performance, forage intake, and nutrient balance

Introduction

Over the past three decades, average beef production per cow in the United States has increased (Blach, 1999). The increased productivity has not resulted in increased profitability. Beef producers, on average, lose greater than $70.00 per head when cyclic lows in market prices occur (Blach, 1999). There is a need for managers, researchers, and consultants to approach beef production decisions using a systems approach. A systems approach is basing management decisions on careful analysis of the interrelationships in production systems (Senge, 1990). Decisions should be made to optimize production traits and sustain resources (Taylor, 1994), resulting in low-cost, high-profit cattle that produce a product desirable to consumers.

Supplementation to cows grazing winter range is a common practice in the Nebraska Sandhills that adds substantial costs to production systems. Adams et al. (1994) demonstrated that ranch profitability could be improved by minimizing the use of harvested or purchased feedstuffs. Protein and digestibility of range forage may vary with different grazing systems, changing the need for supplementation. Defining grazing management effects on the nutrient content of range forage would allow for more accurate supplementation protocols to be developed and eliminate inefficiencies associated with over- or under-feeding supplements.

The heifer is an integral part of beef production systems, and decisions affecting reproductive performance of young females can have substantial effects on profitability. Taking a systems approach to decision making, Meek et al. (1999) hypothesized that nutritional inputs used to develop young cows may return more if applied to the pregnant

heifer rather than the yearling heifer prior to first conception. This is due to the time value of money and the fact that pregnant heifers have less risk of reproductive failure than yearling heifers.

The Beef Cattle NRC (1996) adopted the use of the Metabolizable Protein System. This systems separates the protein requirements of rumen microbes from the metabolizable protein requirement of cattle. Because pregnant heifers have a high requirement for metabolizable protein, these animals may benefit from supplementation protocols designed to balance metabolizable protein requirements. This is especially true during the winter when metabolizable protein supply from winter range is low (Lardy, 1997). Data have not been published relating reproductive performance and profitability to balancing metabolizable protein to the pregnant heifer during the winter.

The objectives of this research were to 1) determine the effects of summer grazing date and winter grazing pressure on the protein content and digestibility of diets collected by cows grazing dormant Sandhills range, 2) determine the forage intake and nutrient balance of heifers grazing Sandhills range in the winter, and 3) determine the effects of supplementing pregnant heifers grazing winter range to meet metabolizable or crude protein requirements on production traits, reproduction, and economics. The experiments were designed to investigate integral components of beef production systems, and they were developed in a systems approach to add information important to improving the profitability of beef production in the Nebraska Sandhills.

Literature Review

Forage Sampling Techniques

For nutritionists to properly design grazing systems and supplementation protocols, both the nutrient concentration and intake of grazed forage must be known or predicted (Adams and Short, 1988). Assessing diet quality of grazing ruminants and its relationship with available herbage can be a challenge, because grazing ruminants can select diets that differ from average composition of standing herbage. Methods for estimating chemical and botanical composition of ruminant diets have included: 1) clipping (Marsh, 1977; Jung and Sahlu, 1989), 2) plucking samples to represent selected diets of ruminants (Cook et al., 1953; Ash and McIvor, 1998), 3) use of fistulated animals (Van Dyne and Torell, 1964; Mohammad et al., 1995), 4) fecal analysis (McCollum and Gillen, 1988; Mohammad et al., 1995), and 5) use of cages to exclude grazing (Holechek et al., 1982). Cook et al. (1948) described a method to determine diet nutrient content by collecting specific parts of plants or whole plants along a transect both before and after grazing. Chemical analyses were conducted on samples collected before and after grazing and diet quality determined by difference. These clipping and plucking techniques are rather inexpensive and do not require special equipment, but they are labor intensive and may not accurately describe the diet selected by grazing livestock (Holechek et al., 1982).

Van Dyne and Torrell (1964) and Holechek et al. (1982) reviewed data indicating that samples collected from a fistula in cattle or sheep were more representative of the

animals' diet than clipping or plucking samples. Kiesling et al. (1969) sampled each of seven different feedstuffs and then hand-fed the feeds to three esophageally fistulated cows that had been fasted overnight. In general, protein content was similar between fistula and sampled forage, but ash content was higher in fistula extrusa. Kiesling et al. (1969) then collected diets with esophageally fistulated steers grazing seven different pastures. Samples of forage were hand plucked in each pasture by watching a steer graze for 15 min and then plucking a diet as near as possible to that consumed by the steer. The fistula samples contained more ash and protein than plucked samples. The authors concluded that salivary ash contamination reduced the organic matter (OM) in the fistula samples, and the steers were selecting diets with elevated protein content. Even with experienced technicians, plucking samples of range vegetation representative of ruminant diets can be difficult.

The ruminally fistulated animal has been used as a method to collect diets of grazing livestock (Lesperance et al., 1960). This procedure requires 1) evacuating the rumen, 2) letting the animal graze for 30 to 60 min, 3) collecting extrusa from the rumen, and 4) returning the rumen contents (Holechek et al., 1982). The esophageal fistula has also been used extensively to collect diets of grazing ruminants (Van Dyne and Torell, 1964). Use of the esophageal fistula was first reported in horses in the mid 1850's (Van Dyne and Torell, 1964) and was used in the famous dog studies of Pavlov (1897). The procedure has been used commonly in ruminants since the standard procedure was reported by Torell (1954). Early success in using the esophageal fistula was poor (Van Dyne and Torell, 1964) and failure was common due to problems maintaining the

fistulated animals (Lesperance et al., 1960). Advancements in pre- and post-operative care, better surgical procedures, and more effective cannula resulted in scientists reporting success with esophageal fistulations (Cook et al., 1961; Van Dyne, 1962).

Both ruminally fistulated and esophageally fistulated animals now are used commonly to collect diets. There are advantages and disadvantages to each procedure. Advantages of the rumen fistula are: 1) the fistula is more easily established and maintained, 2) there is complete recovery of extrusa, and 3) a larger sample can be collected (Holechek et al., 1982). However, the rumen fistula method is 1) not suitable for repeated sampling due to depression in digestibility of rumen contents, 2) more time consuming, and 3) not advantageous for the animals in cold conditions (Van Dyne and Torell, 1964). The esophageal fistula technique, compared to the rumen fistula technique, requires less time to collect a sample (considering rumen evacuation time), frequency of sampling can be greater, and the animals can be used in colder conditions. Regurgitation of rumen contents during sampling with esophageally fistulated animals can be problematic (Holechek et al., 1982).

A major concern with samples from both ruminally and esophageally fistulated animals is that of sample contamination. Wallace et al. (1972) compared hand-plucking diets of steers to esophageal collection on mixed Sandhills grasses and on blue grama pastures. The plucked samples were split, and part of the sample was soaked in saliva prior to chemical analyses. Ash content was greater for esophageal and soaked samples than for the un-soaked plucked samples. The authors attributed the difference to ash contamination from saliva. The ash content of esophageal extrusa increased with plant

dormancy, which was likely due to more saliva production in cattle collecting those diets (Lesperance et al., 1960). In the work of Wallace et al. (1972), the ash content was higher in esophageal samples collected on short blue grama pastures than on the taller mixed grass pastures. Apparently, the cattle consumed more soil while grazing the blue grama. The authors recommended reporting fistula extrusa data on an OM basis.

Some researchers have demonstrated salivary nitrogen (N) contamination in fistula samples (Holechek et al., 1982). The work of Lesperance et al. (1960), Kiesling et al. (1969), and Wallace et al. (1972) indicated that N contamination of fistula extrusa from saliva was not substantial, but mineral and(or) silica contamination was a concern. Hoehne et al. (1967) showed that fistula samples were lower in protein than feed samples if saliva was squeezed off, and squeezed samples were lower in protein than un-squeezed samples. It is possible that squeezing the samples resulted in loss of soluble nutrients (Holechek et al., 1982). Different results in N contamination could be due to techniques used to collect and handle samples. If samples that have been soaked in saliva are heated, such as in a laboratory DM oven, a Maillard reaction can occur and nutrient solubility reduced (Van Dyne and Torell, 1964).

Contamination of samples collected from ruminally fistulated cattle with N from the rumen can be a concern as well. Olson (1991) hand-fed ruminally and esophageally fistulated cattle grass hay in stalls. Samples collected from the rumen were higher in N than those collected through the esophagus. Acid detergent lignin (ADL) was increased in both ruminal and esophageal samples compared to core samples from the hay. The author concluded that N infusion into the empty rumen was a potential cause for the