was sampled at 0000 and 1200 h at day-5 of week-5 via rumen cannula from four cannulated cows (3 primi- and 1 multiparous) and using oral probe from four non-cannulated cows. Cows were milked twice daily at 0430 and 1630 h. Nutrient digestibility was measured using total fecal collection technique during week-4. Results were analyzed with SAS (v. 9.1) as a linear mixed model including the fixed effects of time of feeding, parity, and time of feeding × parity; and the random effects of cow within parity and period. Provision of fresh TMR at 2100 h instead of 0900 h enhanced dry matter intake in primiparous cows (20.7 vs. 18.5 ± 0.96 kg/d, $P < 0.05$) but not in multiparous cows (20.6 vs. 21.0 kg/d), and improved the apparent total tract digestibility of dry mater (63.4 vs. 60.6 ± 0.63%, $P < 0.01$), NDF (50 vs. 45 ± 0.6%, $P < 0.001$), and ADF (45 vs. 41 ± 1.3%, $P < 0.05$) in all cows. Time of feed delivery did not affect milk yield, milk protein yield, and rumen pH. Milk fat yield tended to increase (1.1 vs. 0.96 ± 0.05 kg/d, $P = 0.07$) when cows were fed at 2100 h instead of 0900 h. Rumen pH was lower at 3 h postfeeding than at 15 h postfeeding (6.21 vs. 6.40, $P = 0.01$). No interactions were found between the time of feed delivery and time of rumen sampling on rumen pH. Results suggest that evening rather than morning provision of fresh TMR can improve feed intake, milk fat, and nutrient digestibility. Parity appears to affect the impact of time of feeding on cow performance, notably feed intake and milk protein.

Key Words: Time of feeding, Productivity, Lactating Holsteins

415 Beef cattle diets and forage optimization strategies on western rangelands. T. DelCurto*, *Oregon State University*, *Union*.

Ruminant Nutrition: Identifying Opportunities for Maximizing Forage Utilization?

Beef cattle distribution and use patterns are a continual challenge for livestock and land managers in the western US. Designing grazing management plans that optimize animal performance while maintaining or improving native vegetation are critical goals of land managers. To achieve these goals, the manager needs to understand how biotic (cow age, breed, stage of production, experience, etc) and abiotic (slope, aspect, vegetation type, soil depth, etc.) factors influence grazing distribution and diet selection. Pasture distribution and diet selection of beef cattle are influenced by the animal's nutritional requirements and the availability, palatability, and nutritional quality of the vegetation. The availability of water and the diurnal pattern of grazing relative to water location clearly illustrate the importance of water and associated vegetation in beef cattle thermal regulation and grazing distribution. However, the role of vegetation quality (CP, NDF, ADF, IVDMD, and DM), in predicting beef cattle distribution and use patterns, is less clear. In comparison to other herbivores, cattle have strong preferences for herbaceous vegetation even when woody vegetation is superior in nutrient density. Changes in vegetation are a function of landscape characteristics and, as a result, are often confounded with attributes such as elevation, topography, aspect, slope, and surface water. Past research has documented grazing behavior differences due to breed, age, and lactation status, suggesting that beef cattle nutrient requirements also influence grazing distribution and use patterns.

Key Words: Beef cattle, Rangelands, Diet quality

416 Nutritional management strategies for effcient utilization of forage resources. F. T. McCollum*, *Texas A&M University*, *College Station*.

The descriptors efficient and sustainable are used in the narrative describing this symposium. Efficiency and sustainability can be discussed in both biological and economical terms. Because of the inter- and intra-year fluctuations in climate, the quantity and quality of forage and the environmental stressors on grazing cattle are never identical from one year to the next. Hence it is a complex and difficult task to optimize efficiency. Perhaps a more important objective is to manage production risk so that actual production outcomes may approximate projections and over time the business enterprise is economically sustainable. Nutritional management is a key part of a production risk management program in beef cattle systems that rely upon grazed forage. Supplemental feeding is the most common means of managing risk associated with variations in forage quality and availability. Strategic supplementation decisions should address quantity and quality of available forage, timing of supplementation within the year to achieve the greatest response, method of delivery, and herd management to reduce supplement inputs. In addition, efficient use of the forage resource may also address landscape utilization issues. Placement and delivery of supplements can be used to influence grazing patterns and therefore efficient landscape use. With increased land values, labor, equipment and fuel costs, cattle producers must begin to address nutritional management with more year-to-year flexibility in order to attempt to optimize their programs.ced on a landscape.

Key Words: Nutrition, Beef, Forage

417 Nutritional wisdom revisited: From instinct to experience with implications for use of forages by herbivores. F. D. Provenza*, *Utah State University*, *Logan*.

During the past century, the notion of nutritional wisdom – referred to as "genetic programming" of ingestive behavior and as the "subconscious but irresistible desire" to restore biochemical equilibrium – was discounted when researchers found lactating dairy cows did not instinctively ingest recommended levels of calcium and phosphorus when offered dicalcium phosphate, sheep did not rectify a phosphorus deficit by consuming supplemental dicalcium phosphate, and dairy cows offered choices did not consistently select appropriate minerals and vitamins, though the cows fed different diets did not perform differently during 16-week trials. Finally, when lambs did not eat sufficient amounts of minerals, and because they tended to over-consume some minerals, researchers recommended feeding a complete ration, or if that is not possible, to offer free choice a complete mineral mix. Collectively, these studies fostered the notion that domestication had erased "nutritional wisdom" and the "innate ability" to select needed nutrients, a trait that through evolution still confers survival value to wild herbivores. These conclusions should be reconsidered in light of current understanding of how nutritional wisdom is likely to be manifest. It is unlikely several million years of evolution have been erased by a few thousand years of domestication. Acquiring nutrients and avoiding toxins is as important as breathing, which has not changed due to domestication. Indeed, mechanisms for detecting and correcting

amino acid imbalances appear to be conserved in animals ranging from single cell-organisms such as yeast, to invertebrates, to humans. To understand nutritional wisdom, and its implications for maximizing forage use in cattle diets, we must consider how animals learn flavor-feedback associations, including the roles of past experience and the familiar-novel dichotomy, discrimination and generalization, initial conditions, and the many dynamic contingencies that apply when animals learn flavor-feedback associations.

Key Words: Nutritional wisdom, Learning, Foraging

418 Forage intake, digestion and milk production by dairy cows. R. Shaver*, *University of Wisconsin*, *Madison*.

Intake by dairy cows is influenced by NDF content and in vitro NDF digestibility (NDFD, % of NDF). Data from the literature suggest that a one-percentage unit increase in NDFD at the same NDF content will increase DMI 0.12 to 0.17 kg/d. Neither NDF content nor NDFD are included in the Dairy NRC (2001) intake prediction equations. The Dairy NRC (2001) summative energy equations are based on fiber digestibility calculated using lignin, but in vitro NDFD measurements can be used directly also. Data from the literature suggest that at production levels of intake, NDFD has minimal impact on net energy content, but impacts net energy intake primarily through effects on DMI. Inclusion of NDFD in nutritional models will thus require a dynamic modeling approach. In vitro NDFD values are highly variable among and within forage types, and this variation will be reviewed. Introduction of low-lignin, brown midrib hybrids for production of corn and sorghum silages has widened the range for NDFD in these forage types. Data from the literature show milk production responses from varying forage NDFD, but trials were conducted primarily with corn or sorghum silages. There have been some recent trials conducted with wheat straw or alfalfa hays that report conflicting lactation performance results. Intake, digestion and milk production responses to NDFD among and within forage types will be reviewed.

Key Words: Forage, NDFD, Dairy cows

419 Forage feeding in relation to animal and human health. T. R. Dhiman*, *Utah State University*, *Logan*.

The current strategies of feeding high starch, low forage diets to maximize milk production and yields of milk components in dairy cows have led to higher cull rates, lower reproductive efficiency, lower milk components, and higher veterinary costs. On most dairy farms annual culling rates exceed 30-35% of the herd. About 85% of the cows are culled due to reproduction problems, disease or injury, mastitis or udder problems, feet and legs, or death. High quality forages are the key to achieving a healthy and productive cow. The objective of this presentation is to review the importance of feeding high quality forages or fibrous feeds on animal's life time production, health, reproductive performance and nutritional quality of milk and meat. Milk and meat from animals raised on forages has been shown to have high levels of vitamin E, beta-carotene, conjugated linoleic acid, omega fatty acids and have higher proportions of unsaturated fatty acids compared with milk and meat from animals raised on high grains. The effect of nutritional quality of milk and meat on human health will also be discussed. Consequences of feeding high forage diets on animal productivity will be compared with feeding high grain diets. Feeding strategies to maximize the use of forages while maintaining milk production and milk and meat quality will be suggested based on the review of literature.

Key Words: Forage, Cow, Milk

Teaching/Undergraduate and Graduate Education: Student Engagement: The Classroom and Beyond

420 Using the National Survey of Student Engagement to understand students' experiences in the agricultural and related sciences. T. Nelson Laird*, *Indiana University*, *Bloomington*.

After defining student engagement and explaining why it is important for undergraduate education, this presentation will draw on data collected through the National Survey of Student Engagement (NSSE) to better understand student engagement in the agricultural and related sciences and how it compares to student engagement in other fields of study. NSSE results suggest that on average agriculture students participate in active and collaborative learning experiences less than students in other fields and that their coursework emphasizes high-order thinking skills (e.g., analyzing and synthesizing course material) less than the coursework of students in other fields. However, agriculture students tend to report slightly greater levels of student-faculty interaction and a greater sense of support from the campus environment. The presentation will conclude with a discussion of implications from the NSSE findings and suggestions for improving student engagement in agriculture that draws on examples and "best practices" collected from campuses across the country.

Key Words: Student engagement, National Survey of Student Engagement, Disciplinary comparisons

421 Active and collaborative learning. J. Swanson* and J. McClaskey, *Kansas State University*, *Manhattan*.

Two types of teaching have traditionally dominated the agricultural sciences. The first is learning for the purpose of accumulating knowledge typically measured by student recall of teacher-presented information. The second type of teaching often takes place in a laboratory and is best described as learning by doing. In recent years there has been a revolution in college teaching spawned by discoveries made in the cognitive and neurosciences about learning. The primary pedagogical shift is from the language of teaching students to that of student learning. The development of active and collaborative learning