533 Effects of space on individual- and group-kept dry sows: behavior and immune status. J. L. Salak-Johnson*, M. A. Sutherland, M. J. Horsman, S. L. Rodriguez-Zas, and S. R. Niekamp, *University of Illinois*, *Urbana*.

The effect of grouping pregnant primiparous and multiparous sows at different space allowances was studied to determine impacts of space on sow behavior and immune status. Six replicates of 5 sows per treatment were allotted to each of 4 experimental treatments: groups 5 at (a) 1.4, (b) 2.3, or (c) 3.3 m2/sow or (d) individual stall (1.3 m2/sow) for two successive parities. Behavior data were collected between gestation d 90 and 110. Blood samples were taken 1-h post-feeding (0800 h) on gestation d 25, 30, 60, 90, 108, and 110. Data were analyzed using PROC MIXED with repeated measures. Gestation environment influenced number of times a sow was observed lying, sitting, and drinking. Frequencies of sitting (P<0.001) and drinking (P<0.05) were higher among sows kept in stalls than those in groups. Lying was highest (P<0.05) among sows grouped at 3.3 m2/sow. Frequencies of walking and oral-nasal-facial behavior (ONF) were influenced by space. As space increased, walking increased among group-kept sows (P<0.01). A quadratic trend for frequency of ONF occurred among group-kept sows (P<0.05.) such that ONF was higher in sows kept at 2.3 m2/sow. Sow BW influenced lying and standing behaviors; as BW increased the frequency of lying increased (P<0.05). Conversely, heavier sows spent less time standing (P<0.05). Gestation environment influenced cortisol and immune status. Sows kept in stalls had higher cortisol (P=0.08), N:L ratio (P<0.05), phagocytosis (P<0.05), and B-cell proliferation (P<0.05) than did those in groups. Conversely, those kept in groups had higher (P<0.01) lymphocytes. Among group-kept sows, space allowance influenced B-cell proliferation and NK cytotoxicity. As space increased, B-cell proliferation increased (P=0.01) and NK decreased (P=0.01). Several other immune measures (e. g., total WBC, N:L ratio, T-cell proliferation, phagocytosis) were influenced by sow BW (P<0.05). Also, immune status was influenced by gestational period. Overall, gestation environment had limited impact on behavior and immune traits studied.

Key Words: Environment, Immune, Behavior

ADSA Production Division Symposium: Forage Analysis: Concept to Application

534 Dairy nutritionist survey on forage carbohydrate analysis: Implications for methodology application. L. Chase*[1], M. Raeth-Knight[2], J. Linn[2], and W. Mahanna[3], [1]*Cornell University*, *Ithaca, NY*, [2]*University of Minnesota*, *St.Paul*, [3]*Pioneer Hi-Bred International*, *Des Moines, IA*.

A survey of field dairy nutritionists was conducted to assess their current use of carbohydrate analysis in feed programming. This survey was specific to NDFD (NDF digestibility), starch and sugar analyses. The information in this abstract is based on about 200 returned surveys. NDFD analysis was never used by 14% of the respondents. Occassional use of NDFD was reported by 52% of respondents and routine use by 33%. Corn silage and haycrop silages were the primary forages analyzed for NDFD (>90% of survey responses). Analytical methods used to obtain NDFD values were wet chemistry (26%), NIR (14%) or both (54%); however, preferences of analytical method for NDFD were wet chemistry (50%), NIR (16%) or no preference (34%). The analytical time points used to determine NDFD were 24 hours (29%), 30 hours (40%) and 48 hours (36%). Respondents indicated a preference for 24 hours (49%) followed by 30 hours (39%) and 48 hours (12%). The most common uses of NDFD results were to make crop feeding decisions (50%), to adjust fiber digestion rates in models (49%) and to compare against similar forages in previous years (46%). The use of a certified lab was indicated as important by 85% of the respondents. The use of either NFC or NSC in ration formulation was indicated by 91% of the respondents. Over half of the respondents (54%) indicated that an NFC (or NSC) value was as good as individual starch or sugar values for ration formulation. The results of this survey have significant implications for forage testing labs. There is a strong preference that forage labs be certified. There are also preferences for the use of wet chemistry methods to obtain NDFD values. This will require forage labs to obtain better standardization of NDFD analytical procedures and measurement time points. These results also indicate that additional education is needed regarding the applicability of NIR for NDFD analysis.

Key Words: NDFD, Forage Analysis, NIR

535 Starches and sugars: conceptual and analytical challenges. M. B. Hall*, *U. S. Dairy Forage Research Center, USDA-ARS*, *Madison, WI*.

For use in diet formulation, partitioning of carbohydrates should reflect differences in digestion and fermentation characteristics and effects on animal performance. Indices of digestibility would be useful. Partitioning of NFC has been problematic in terms of designating fractions based upon nutritional characteristics, and selecting analytical methods to separate them. The relative dearth of information on digestion characteristics of various NFC and their interactions in diets means that fractions will not soon be perfectly established. Starch and sugars are fractions for which there is some consensus. Native starch is an α-(1-4)-linked-glucan with α-(1-6) linked branch points. In feedstuffs, it can be analyzed by specific enzymatic hydrolysis and detection of glucose, or by polarimetry, though sugars can interfere with both analyses. Key challenges with starch analysis include reliability of estimates (varies by lab and method) and description of digestibility; the latter is greatly affected by processing and source. “Sugars” are an ill-defined fraction. They may include mono-. di-, and oligosaccharides (80% ethanol- and water-soluble) and water-soluble polysaccharides such as fructans. The nutritional equivalence of fructans, sucrose, glucose, and fructose has not been well explored. Resolution is needed as to which carbohydrates comprise sugars before a definitive analytical method can be chosen. Another challenge when dealing with carbohydrates that vary greatly in molecular weight is the basis on which to express them to reflect their value to animal and microbes. The greater the degree of polymerization, the greater the proportional content of hexose after accounting for water incorporated for hydrolysis. For example, 1 kg of glucose (monosaccharide) = 1 kg of hexose, whereas 1 kg of sucrose (disaccharide) or starch (polysaccharide) yield 1.05 and 1.11 kg of hexoses released upon hydrolysis, respectively. Expressing carbohydrates on a hexose basis would seem to be more reflective of equivalence than is current practice. Improved methods and nutritionally relevant definitions will improve the utility of these carbohydrate fractions in ruminant nutrition.

Key Words: Sugar, Starch, Analysis

536 Applying starch and sugar analyses in dairy nutrition. S. Emanuele*, *Land O’ Lakes Inc.*, *Caledonia, NY*.

The objective is to review why and how starch and sugar analyses are used in routine dairy ration formulation. If one balances dairy diets based on crude protein, NDF and NEl concentration, it is not necessary to analyze feeds for starch and sugar. It has become necessary to utilize these analyses because of the adoption of a metabolizable energy and protein system for balancing dairy diets. Published research indicates that the metabolizable energy and protein yield of a specific diet is influenced by the fermentation of carbohydrates. When feeds are analyzed for starch and sugar we observe the following: 1. Starch and sugar content of corn silage are highly variable and influenced by variety, growing season, maturity and type of fermentation undergone by the plant material. Starch content of corn silage will be 25 to 40% on a DM basis; 2. Starch content of alfalfa hay or silage is low, less than 5% but the sugar content of alfalfa is variable and influenced by growing season, moisture, sunlight, and plant maturity. Alfalfa hay grown in the western U.S. routinely contains 5 to 9% sugar on a DM basis; 3. It is necessary to assay citrus pulp, beet pulp, distiller's grain, bakery meal and corn gluten feed because of variability in starch and sugar content. The rumen ecosystem does not always respond positively to extra starch or sugar in the diet. This ecosystem will respond positively when ruminal conditions favor the use of starch and sugar for growth of rumen bacteria and yeasts. Physical factors of the diet will influence response to starch or sugar. In diets with less than 27% NDF, and small particle size, increasing dietary sugar concentration to 5%- 6% diet DM may not increase feed intake and milk production. Excess starch can reduce the ME and MP of a diet because of inefficient energy use by rumen bacteria and a decrease in NDF digestion (Russell, 2002). Starch and sugar analyses are useful in dairy ration formulation because starch and sugar alter rumen microbial population and growth and impact ME and MP predictions.

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Key Words: Starch, Sugar, Dairy

537 NDF digestibility: conceptual and analytical challenges. M. S. Allen*, *Michigan State University*, *East Lansing*.

Demonstration of the beneficial effects of NDF digestibility on feed intake and milk yield has created demand for analytical services by forage testing laboratories and for recommendations for utilizing NDF digestibility information. Variation in the methods used and proficiency at determining NDF digestibility across laboratories limit successful application of NDF digestibility information. Laboratories should provide information regarding intra- and inter-assay variation and validation of their method by showing relationships between NDF digestibility and lignin concentration as a percent of NDF (generally $r \geq 0.7$ within forage type). Analytical methods should identify limitations to NDF digestibility inherent in the feed rather than those imposed by the method which will compress differences among feeds. Grinding is necessary to increase surface area of potentially fermentable fiber exposed by chewing in vivo but it overestimates rate of digestion because the increase in surface area is at the beginning of fermentation rather than gradually over time. Incubation time should reflect residence time in the rumen, which is inversely related to feed intake, but shortened to account for effect of grinding on rate of digestion. It is unrealistic to use laboratory NDF digestibility values to adjust energy content of feeds because digestion characteristics of feeds affect retention time in the rumen and feed intake response. Feed intake response to forages with greater in vitro NDF digestibility is positively related to milk yield across cows and affects the relationship between in vitro and in vivo NDF digestibility. Comparisons of NDF digestibility across forages should be limited to within forage type; retention times for perennial grasses are generally greater than for legumes. Laboratory NDF digestibility values are best used as an index of filling effect of NDF and forages with high NDF digestibility should be targeted to cows with high milk yield for which feed intake is most limited by physical fill.

Key Words: NDF Digestibility, Dairy Cows, Physical Fill

538 Collecting, interpreting and using corn silage NDF digestibility data as a consulting nutritionist for commercial dairies. W. Nelson*[1], C. Renken[1], C. Holtz[3], and B. Kloss[2], [1]*Nelson Dairy Consultants, Inc.*, *Lakeville, MN*, [2]*Nelson-Kloss Dairy Production Nutrition, LLC*, *Visalia, CA*, [3]*Holtz-Nelson Dairy Consultants, LLC*, *Dryden, NY*.

Corn silage has become the primary source of NDF in the diets of lactating cows throughout most of the United States. Our group of 25 nutrition consultants in the Upper Midwest, Central California, and New York State has been using corn silage NDF digestibility analyses to help consultants and clients for 6 years. I will explain the origin of our desire for anaylitical insight on corn silage fiber beyond that of traditional analysis packages. All data and discussion of samples, rations and cow responses originate from commercial dairies. Corn silage sample data will be presented comparing 20, 30 and 48-hour incubation times involving three different commercial laboratories over six years. Discussion will emphasize apparent shortcomings of traditional fiber analyses as well as shortcomings of the nutritional and agronomic conclusions derived from traditional analyses. I will share my experiences on the extent to which dairy producers and/or their contract growers are responding to the information provided by NDF digestibility analysis of corn silage and how they are or are not pursuing improvements in corn silage NDF digestibility from year to year. We are convinced that corn silage NDF digestibility is and will continue to be of primary importance to both nutritionists and dairy producers. Our group continues to pursue ways to better analyze and incorporate the added information that corn silage NDF digestibility data bring to the table when planning and formulating diets for commercial dairies.

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Key Words: Forage Quality, NDF Digestibility, Corn Silage

Animal Behavior and Well-being: Weaning and Animal Welfare

539 Effect maze task on salivary cortisol of pigs at weaning and on subsequent fear response. J. Siegford*, G. Rucker, and A. Zanella, *Michigan State University*, *East Lansing*.

Learning, memory and regulation of the stress response are mediated by the hippocampus. Biologically relevant hippocampal-dependent tasks that develop and integrate cognitive processing of this region may not be available to piglets in some current production systems. We measured the effects of a hippocampal-dependent maze task (MT) on the stress response at weaning (12 days of age) and subsequent fear response (at 50 days of age). Twenty-seven pigs from 4 litters were assigned to one of 3 treatments: hippocampal enhancement (HE), isolation control (IC), or control with sow (CS), then combined into same sex groups with each treatment represented. Each group worked 4 times per day in the morning, with 10 minutes between sessions from 5-11 days of age. Prior to the start of work, groups were removed from the sow for 30 seconds. HE animals navigated the MT to return to sow and litter. IC were isolated while HE navigated the MT. CS were returned to sow as HE entered the MT. Data were analyzed with mixed model repeated measures analyses of variance, and Bonferroni tests revealed differences in multiple comparisons. Saliva was collected immediately pre- and post-MT on day 11 to measure cortisol, which were lower pre-MT ($F(1,8)=5.65$, $P=0.04$). Weaning at 12 days of age increased cortisol levels 2h post-weaning ($F(4,75)=5.67$, $P<0.001$). On day 14 male IC pigs were slower than others ($F(2,21)=3.09$, $P=0.07$) to solve a modified Morris water maze (WM), examining spatial learning. Lower cortisol levels were seen pre-WM versus post-WM ($F(1,19)=27.62$, $P<0.001$). At 50 days of age, fear response of pigs was examined in 3 open field tests (OF: 1=alone, 2=w/ball, 3=w/person) consisting of 1 m acclimation and 4 m testing. Animals spent more time in OF center in OF3 than OF1 ($F(2,75)=8.75$, $P<0.001$) and time spent in OF periphery was greater in IC in OF1 than in IC or HE in OF3 ($F(2,75)=4.18$, $P=0.02$). In OF3, HE touched the person more times than other groups ($F(2,49)=6.31$, $P=0.008$). MT may result in less fear of novel persons and places suggesting benefits of hippocampal activation for young pigs.

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Key Words: Spatial Memory, Open Field, Stress Response