in water improved pig performance in late but not early growth stage. Dressing percentage was reduced by sugar beet pulp supplementation in wean-to-finish diets.

Key Words: Wean -to - finish pigs, Inulin, Sugar beet pulp

300 Effect of ractopamine on the performance and carcass characteristics in finishing pigs. G. He*, S. K. Baidoo, Q. M. Yang, and R. D. Walker, *Southern Research and Outreach Center, University of Minnesota, Waseca*.

This study was designed to evaluate the effect of ractopamine on finishing pigs fed two levels of total lysine (0.81% vs. 1.11%) with and without ractopamine (0 vs. 10 ppm) in a two-way factorial arrangement. Three hundred and twenty crossbred barrows and gilts with body weight of 971.12 kg housed in an environmentally controlled facility were blocked and randomly allotted to the four dietary treatments. Pigs' weight and feed intake were recorded weekly until the average of the pen reached 115-kg body weight. Ractopamine significantly promoted growth rate (965 vs. 1110 g/day, S.E. =23.3, P<0.01) and improved Gain: Feed ratio (0.28 vs. 0.33, S.E. =0.0067, P<0.01). The improvement in growth rate by ractopamine was 133% higher at high lysine level than low lysine level. In addition, the improvement by ractopamine on growth rate decreased with time (1158 vs. 1441 g/day in week 1, 946 vs 1050 g/day in week 2 and 791 vs 839 g/day in week 3, S.E. =40.3, P=0.014). Average backfat depth was reduced by ractopamine supplementation only when high lysine diet was fed (0.76 vs 0.79 cm at 0.81% lysine and 0.80 vs 0.70 at 1.11% lysine, S.E. =0.025, P<0.01). Average loin depth was significantly increased by the addition of ractopamine (2.79 vs 2.90 cm, S.E. =0.021, P<0.01). Increased lean muscle percentage by ractopamine was only observed in high lysine group (55.2% vs 55.4% at 0.81% lysine and 55.1% vs 56.3% at 1.11% lysine, s.e. =0.22, P=0.026), whereas dressing percentage was significantly increased by ractopamine only in low lysine group (73.7% vs 75.6% at 0.81% lysine and 74.2% vs 74.6% at 1.11% lysine, s.e. =0.31, P=0.021). In conclusion, ractopamine improved growth performance and carcass characteristics in pigs fed the high lysine diet and increased dressing percentage in finishing pigs fed low lysine diet.

Key Words: Finishing pigs, Ractopamine, Carcass characteristics

301 Comparison of grain sources (barley, white corn, and yellow corn) for swine diets and their effect on fatty acid composition and fat quality. J. F. Lampe*, T. J. Baas, and J. W. Mabry, *Iowa State University*.

An experiment was conducted to evaluate the effect of energy source on fatty acid characteristics and fat quality of the longissimus muscle of pigs. Diet treatments (primary energy sources) were: 1) yellow corn, 2) white corn, 3) 1/3 yellow corn, 2/3 white corn, 4) 2/3 yellow corn, 1/3 white corn, and 5) barley. Pigs were from two genetic sire lines, Duroc and Hamp x Duroc sires (HD) on PIC 1055 females. A total of 999 pigs were included in the trial in a 2 x 2 x 5 factorial arrangement with two genetic types, two sexes (barrows and gilts) and five dietary treatments. Eight pigs were randomly selected from each pen of 26 (n= 319) for meat, eating quality, and fatty acid evaluation. Pigs were placed on test at 27.6 kg and fed to 130.2 kg. In a four-phase diet regimen, the final two phases of the finishing diets (67.2 to 130.2 kg) included 1% supplemented choice white grease. All animals were held overnight at a commercial abattoir before harvest. One whole skin-on, boneless loin was collected from each carcass and held at -1 degree Celsius in a vacuum-sealed bag at the Iowa State University Meat Lab. At 25 to 27 days post-harvest, loins were analyzed for meat and eating quality and samples were collected from the 10^{th} rib for fatty acid analysis. Fatty acid composition was determined by standard gas chromatographic procedures. Pigs were given an individual subjective fat color score. Pigs fed diet 5 had a lower (P < 0.05) iodine value than pigs fed all other diets. Dietary treatments had no effect on (P > 0.05) subjective fat color scores. Pigs fed diet 5 had higher (P < 0.05) saturated and monounsaturated fatty acids than pigs fed all other diets. Results suggest that different energy sources evaluated in this study do not have an effect on subjective fat color but do have an effect on fat firmness.

Key Words: Pigs, Fatty acid composition, Energy sources

Production, Management, and the Environment

302 Effect of scraping frequency in a free stall barn on volatile N loss from dairy manure during summer. V. R. Moreira*[2] and L. D. Satter[1,2], [1]*U.S. Dairy Forage Research Center, Madison, USDA - Agricultural Research Service,* [2]*Department of Dairy Science, University of Wisconsin - Madison*.

The difference between estimated nitrogen:phosphorus ratio (**N:P**) of fresh excreta and measured **N:P** in scraped manure was used to estimate N loss when manure was scraped 2× (0800 and 1900h) or 6× (0900, 1200, 1500, 1800, 2300, and 0400h) daily, during each of two 24h-periods in late August. Mid-lactation cows (n=137), milking 31.6 kg/cow/d, were distributed among 4 pens for an ongoing feeding trial with diets containing two levels of P (.38 and .55% of DM) and similar CP (19.3% of DM). Each pen had a back (stall) and a front (feedbunk) alley from which manure was scraped and sampled separately. The NRC (2001) model was used to estimate dry matter intake. Excretion of N and P was calculated as kg of ingested nutrients minus the amount of nutrients secreted in milk. Volatile N loss as a percent of excreted N was estimated as: **1 - (manure N:P ÷ excreta N:P)**. Average air temperature outside the barn throughout the sampling period was 18^{o}C (max=27^{o}C and min=11^{o}C). Statistical analysis was performed as Repeated Measures within alley using a first order autoregressive covariate structure (Mixed Procedures - SAS 8.0). It was expected that frequent manure removal from the barn floor would result in lower N volatilization by reducing the time of manure exposure. This was not observed. Frequent scraping could have an offsetting effect by enhancing volatile N loss through spreading urine over a larger floor area. Volatile N loss was estimated to range between 37.5 and 43.1% of excreted N.

	Scraping frequency (**Freq**)							
	2×	2×	6×	6×		Effects ($P\leq$)		
Manure analyses	Front alley	Back alley	Front alley	Back alley	SEM	**Freq**	Alley	Day ∗**Freq**
pH	7.73	8.15	7.84	8.04	0.14	1.00	0.01	0.43
Temp., ^{o}C	21.7	23.2	22.0	22.3	0.52	0.48	0.29	0.23
Dry i matter, %	10.7	11.6	11.4	11.9	0.48	0.26	0.01	0.71
N, %DM	4.09	4.04	3.86	3.86	0.10	0.03	0.75	0.32
Ash, %DM	16.5	17.9	16.1	16.7	0.51	0.11	0.01	0.05
P, %DM	0.95	0.93	0.96	0.95	0.04	0.67	0.54	0.05
N:P	4.44	4.62	4.16	4.19	0.17	0.03	0.36	0.04

Key Words: Dairy manure, Ammonia, Nitrogen

303 The effect of dietary calcium and phosphorus on water extractable phosphorus in feces of dairy cows. J. D. Ferguson[1], S. R. Michelone*[1], C. F. Ramberg, Jr.[1], and Z. Dou, [1]*University of Pennsylvania, School of Veterinary Medicine*.

Four TMR rations varying in Ca and P content were fed to two groups of mid-late lactation cows (15/ per group) to examine the effect on water extractable phosphorus in feed and feces. The study was a Latin Square design with three, four week periods with diet switches between groups every two weeks. The rations had the following Ca, P content (%DM basis): Con: Ca .69, P .38; HighCa: Ca 1.2, P .38; HighCa$_P$: Ca 1.2, P .60; HighP: Ca .69, P .60. On three consecutive days of the second week of each dietary block, daily samples of feed and feces were collected for analysis of DM, Ca and P. Fecal samples were collected from each cow, mixed thoroughly, and composited daily by group. Wet samples of feces (2 g, approximately .3 g of DM) and dried, ground samples of TMR

(.3 g DM) were analyzed in replicate for total P and water extractable P. Samples were mixed with ninety eight ml of water, shaken for one hour at room temperature and then filtered. The filtrate was analyzed for inorganic P (Pi) and total P (Pt) using the phosphomolybdate blue method of Murphy and Riley (1962) and ICP methodology, respectively. All variables were analyzed as a repeated measures with dietary treatment nested within group using PROC GLM in SAS statistical software.

	Period One			Period Two			Period Three		
Item (%DM)	Con	High-Ca	SE	Con	High CaP	SE	Con	High-P	SE
TMR-Ca	.78^a	1.25^b	.04	.74^a	.90^b	.06	.80^a	.83^a	.0 3
TMR-P	.37^a	.36^a	.01	.40^a	.52^b	.02	.42^a	.68^b	.03
Fec-Ca	1.72^a	2.78^b	.05	1.76^a	2.50^b	.07	1.68^a	1.73^a	.03
Fec-P	.64^a	.63^a	.02	.73^a	1.17^b	.01	.72^a	1.17^b	.0 3
Water	Extract-able P	TMR		(%total P)					
TMR	57.6^a	58.8^a	1.91	62.3^b	84.9^d	1.91	63.0^b	70.0^c	1.91
Feces	47.6^a	23.4^b	4.9	52.2^a	50.0^a	4.9	57.5^a	78.7^b	4.9

Key Words: Phosphorus, Calcium, Feces

304 Slow-release thyme oil granules for control of odor and pathogens in feedlot cattle waste.

V. Varel*, D. Miller, and E. Berry, *USDA, ARS, Roman L. Hruska U.S. Meat Animal Research Center.*

Confined animal feeding operations can be a source of odor emissions, global warming gases, water pollution, and food contamination. Laboratory studies have indicated plant oils with antimicrobial activity can be used to control pathogens and odor emissions from cattle and swine wastes. However, these oils are volatile and were ineffective when topically applied to a feedlot surface. Our objective was to evaluate the effectiveness of topically applying thyme oil incorporated into corncob granules, added once per week, to control odor emissions and fecal coliforms in feedlot manure. Manure samples from six locations in each pen were collected from three control and three treated pens (15 x 150 m; 50 400-kg cattle/pen), three times per week for eight weeks. Samples were analyzed for thyme oil concentration, VFA and branched-chain VFA (odor), and number of *Escherichia coli* and total coliform bacteria. Over the eight weeks, with the exception of wk 7, the desired concentration of 0.15 to 0.2% thyme oil was maintained in the manure. Concentrations of VFA and branched chain-VFA increased over time in control and treated pens. However, production of VFA in treated pens, 7.5 $\pm$ 1.3 μmol·g DM^{-1}·wk^{-1}, was less than the rate of production in control pens, 18.0 $\pm$ 2.1 μmol·g DM^{-1}·wk^{-1} ($P < 0.01$). Likewise, production of branched-chain VFA in treated pens, 0.31 $\pm$ 0.04 μmol·g DM^{-1}·wk^{-1}, was less than control pens, 0.55 $\pm$ 0.06 μmol·g DM^{-1}·wk^{-1} ($P < 0.01$). Treatments did not differ in time for concentrations of *E. coli* and coliforms; although the concentrations of *E. coli* in treated pens, 2.9 $\pm$ 1.2 cfu x 10^5·g DM^{-1}, were 91% less than control pens, 31.1 $\pm$ 4.0 cfu x 10^5·g DM^{-1} ($P < 0.04$). Similarly, concentrations of coliforms in treated pens, 3.7 $\pm$ 1.3 cfu x 10^5·g DM^{-1}, were 89% less than control pens, 35.3 $\pm$ 4.2 cfu x 10^5·g DM^{-1} ($P < 0.04$). These results indicate odor emissions and fecal coliforms can be reduced in feedlot manure with a once per week application of thyme oil in a granular form.

Key Words: Plant oils, Feedlot waste, Odor

305 Changes in concentrations of selected malodorous compounds from dairy manures associated with storage and composting.

L. B. Willett*, D. C. Borger, and D. L. Elwell, *The Ohio State University/OARDC, Wooster, OH. USA.*

Emissions of malodorous compounds from livestock manures are offensive and can cause health hazards to humans and cattle. Changes of manure storage and handling methods may prevent the formation and/or enhance the degradation of odors. Volatile fatty acids (VFAs), phenol, cresols, indoles and NH_3 were quantified with fresh (n=12) and 12-day-aged (n=12) manures during pilot-scale composting in 205 L vessels either aerated continuously (AC) with high (2.3 kg/hr)/low (0.8 kg/hr) air flow controlled by thermostats or intermittently (AI) on a 5 min high air flow 55 min off cycle. Manures were mixed with sawdust (3:1, w/w) to yield C:N ratios between 21 and 32. GLC/FID was used to analyze VFAs in emissions and pH 2 water extracts of composting masses. Ether extracts of phenolics and indolics were quantified by GLC/MS. Aeration (P=0.012), and not manure age (P=0.883) influenced NH_3 emissions. Mean NH_3 emissions from fresh and aged manure AI were 50 and 60 g. Fresh and aged manure AC emitted 121 and 110 g NH_3. NH_3 peaked early and decreased to undetectable by day 17. Aged, compared to fresh manure, contained greater varieties and amounts of VFAs, phenols and indoles with the most offensive odors. Fresh manures contained acetate, propionate, isobutyrate, isovalerate, phenol, p-cresol, and indole (5000, 500, 40, 70, 35, 200 and 5 μg/g). Aged manures contained acetate, propionate, isobutyrate, butyrate, isovalerate, valerate, phenol, p-cresol, indole and skatole (9000, 2700, 200, 2500, 2800, 350, 50, 350, 10 and 30 μg/g). By day 8, trace quantities of acetate remained in fresh manure, while acetate, propionate and butyrate (900,120 and 130 μg/g) were in aged manure. Disappearance of VFAs, phenolics and indolics was similar in manure/sawdust windrows that were turned weekly or turned weekly with forced subsurface aeration (10 m^3/min). Avoiding anaerobic aging of dairy manures and composting with minimum air flow to maintain an aerobic environment was important in reducing concentrations of the chemicals studied and reducing NH_3 emissions.

Key Words: Manure, Odors, Ammonia

306 Adding potassium, clinoptilolite zeolite and yucca extract to feedlot diets to reduce nitrogen losses from manure .

K. S. Eng*[1], R. Bectel[2], and D. P. Hutcheson[3], [1]*Eng, Inc., San Antoino, Texas, USA,* [2]*Advance Agricultural Testing, Baden, Ont. Canada,* [3]*Animal-Agricultural Consulting, Inc., Amarillo, Texas, USA.*

Rapid loss of nitrogen (N) from manure and resulting nitrogen emissions is a major environmental concern. It is possible that a potassium clinoptilolite zeolite (CZ) because of its cation exchange capacity may bind ammonia, thus reducing manure N loss. Furthermore, yucca extract (YP) is believed to have anti-urease activity, which could reduce urea breakdown to ammonia in manure. In this study, the CZ was added to feedlot diets at 1.2 and 2.5% (DMB) in place of steam flaked corn. YP was added in addition to the 1.2% CZ level in Treatment 3. Experimental cattle were heavy yearling Angus-Continental cross steers. The experimental control diet consisted of 86% steam flaked corn, 6.5% corn silage and 7.5% premix (DMB). There were 8 reps/treatment and 8 steers/rep. They were fed on concrete floor pens and at approximately 100 days, on feed, the pens were cleaned and no bedding added. After one week of manure accumulation, the manure was collected from each treatment, mixed and stacked and analyzed for N and DM initially and at 3,5,7,14,21 and 28 days. Previous studies had indicated that the majority of the N loss occurs within the first 28-days. Manure N losses for the four treatments are shown in Table 1. CZ 1.2%, CZ 1.2% + YP and the CZ 2.4% treatments each reduced N loss compared to the control. The CZ 2.4% treatment was not better than the CZ 1.2% treatment. The combination of CZ 1.2% + YP was extremely effective in reducing N loss at the 3, 7 and 14 day sampling periods, but not better than CZ alone at 21 and 28 days. It was concluded that the CZ or CZ + YP resulted in a substantial reduction in manure N losses compared to the control.

Percent N/d loss/d	Treatments			
d	Control (%)	CZ1.2% (%)	CZ1.2% +YP (%)	CZ2.4% (%)
3	21.6	4.6	1.4	3.8
7	22.0	6.7	1.9	9.4
14	25.3	6.4	2.4	10.3
21	28.2	9.1	8.5	12.7

Key Words: Clinoptilolite zeolite, Nitrogen loss, Manure

307 Demonstrations to show the economic value of dairy manure as fertilizer. J. A. Pennington*[1], K. W. VanDevender[1], J. A. Hawkins[2], and R. L. Duncan[3], [1]*University of Arkansas Cooperative Extension Service, Little Rock,* [2]*University of Arkansas Cooperative Extension Service, Conway,* [3]*University of Arkansas Cooperative Extension Service, Berryville*.

Demonstrations were conducted on a dairy farm (DF) with a dry manure management system and on a dairy farm (WF) with a wet or liquid manure system to determine the economic value as fertilizer of manure collected around the milking center. Nitrogen (N), phosphorus (P), and potassium (K) were valued at $0.64, $0.53, and $0.31/kg. DF had 80 cows which were in a holding pen and scraped feeding floor for 5.5 h/d; it produced 197,000 L/yr of manure with 6.1, 4.8, and 5.6 g/L of N, P, and K in manure from the stacking shed. Total value of manure as fertilizer was $1610.23/yr for N, P, and K. WF had 120 cows in a holding pen for 3 h/d; it produced 1,700,000 L/yr of manure with 0.57, 0.22, and 0.52 g/L of N, P, and K. Total value of manure as fertilizer from WF was $1091.70/yr for N, P, and K. Assuming that P is not needed with no value and 20% of nitrogen is lost in application, net values of the manure near the milking center as fertilizer were $959.11/yr for 5.5 h/d on DF and $772.02/yr for 3 h/d on WF. Assuming uniform distribution of manure throughout the 24 h, net values of manure were $3541.33/yr for 80 cows on DF and $6176.16/yr for 120 cows on WF or $44.27/cow/yr and $51.47/cow/yr, about 50% of the expected total values of manure that primarily resulted from the decreased values of N and P. These data did not consider the costs to apply the manure as fertilizer but showed to dairy producers that cow manure had economic value as fertilizer.

Key Words: Dairy, Manure, Fertilizer

308 Production of eight byproducts over a ten-year period for California and seven countries with estimates of phosphorus and potential ethanol production. J. N. Asmus and J. G. Fadel*, *Univeristy of California, Davis, CA*.

Byproduct production from ten countries; Argentina, China, Egypt, Kenya, Republic of Korea, Mexico and the USA, plus world totals and California were determined from 1990-1999 for almond hulls, bagasse, brans, beet pulp, molasses, brewers grain, grain straws and cakes. Total DM tonnes, phosphorus and theoretical ethanol yields were examined over time. Simple linear regressions were used to test if slopes were significantly different from zero. Crop production data were from FAO and California state databases. Byproduct conversions were from published articles. Compositions were from NRC. Ethanol yields were determined from published conversions from cellulose and hemi-cellulose fractions. Ethanol DM yields were converted to liters assuming 1.14 liters of ethanol per kg of ethanol DM. Total world DM and phosphorus production showed an increase over time for bagasse, brewers grains, and brans with increases of 22%, 12% and 17% respectively. Slopes were different from zero (P=0.0001) for bagasse, brans, and brewers grains. China's production of brewers grain contributed 66% of the world's increase. Byproduct trends showed little change over time for all countries studied. However, production of brewers grains, wheat straw, and bagasse in China increased by 190%, 16% and 23% with slopes different from zero (P=0.05). California's production showed changes in cottonseed of #35% with a slope different from zero (P=0.01). Theoretical ethanol yields follow the same trends as metric tonnes of DM for each byproduct. Byproducts used as a feed in California had a higher economic value when compared to byproducts used for ethanol production. This is in contrast to straw byproducts that showed a higher value when used for ethanol production compared to their feed value. Byproducts production over a ten-year period showed stable trends except for China. Total worldwide byproduct use for feed is not reflected in this study. Under current California market conditions only straw byproducts should be considered as potential substrates for ethanol production.

Key Words: Byproduct

309 Gravity belt thickener with polymer assisted separation out-performs static gravity screen-roll press combination for separating the solid and liquid fractions of swine slurry. P.M. Walker[1], T.R. Kelley[1], K.E. Earing*[1], and J.E. Ringler, [1]*Illinois State University, Normal, IL/USA*.

Two separation systems were evaluated for their ability to separate the solid and liquid fractions of co-mingled gestation, farrowing, nursery and grow-finish anaerobic swine slurry under field conditions. On each of eight occasions 26,496 L. of slurry were separated with each system. Samples of raw unprocessed slurry (RS), slurry separated with a gravity screen-roll press combination separator (SS), effluent collected after RS was separated with a polymer assisted gravity belt thickener (SE1) and effluent collected after SS was separated with a polymer assisted gravity belt thickener (SE2) were collected in duplicate with a 2.4 m probe from 2.44 m deep holding pits following agitation. Percol 755O flocculant was mixed with slurry at a concentration rate of .014% to coagulate slurry solids with the gravity belt thickener system. No polymer was used to assist the gravity screen-roll press system. For each collection 2-500 ml slurry or effluent samples were poured into settlelometers and diluted with 500 ml of de-ionized water. Following a 1 h settling time samples were analyzed for separable solids (SSS), total suspended solids (TSS), dissolved oxygen (DO), chemical oxygen demand (COD), nitrogen (N) and phosphorus (P). The mean solids concentration percents were 3.65 $\pm$ 0.06 RS, 2.65 $\pm$ 0.02 SS, 0.19 $\pm$ 0.01 SE 1 and 0.16 $\pm$ 0.01 SE2. Compared to RS, SSS (mL:L) were reduced 59.1% for SSand SE1 and SE2 reductions approached 100.0%. TSS were not different (P>0.05) between RS and SS but were reduced (P<0.05) in SE1 (94.7%) and SE2 93.9%. COD was not different (P>0.05) between RS and SS but was reduced (P<0.05) in SE1 (84.7%) and SE2 and 63.0%. No differences (P>0.05) were observed between slurry and effluents samples for NH_3 and DO. P concentrations were reduced (P<0.05) in SS, SE1 and SE2 but N concentrations were reduced (P<0.05) in only SE1 and SE2 compared to RS. N was reduced 79.5% and 70.8% in SE1 and SE2 while P was reduced 17.0%, 92.2% and 55.1% in SS, SE1 and SE2 compared to RS. Under field conditions a polymer assisted gravity belt thickener was more effective for removing nutrient concentrations and pollution indicators compared to a non-polymer assisted gravity screen-roll press combination separator.

Key Words: Separation, Swine, Slurry

310 Relationship between dystocia and calf morbidity and mortality. S. M. Tomlinson*[1], J. E. Lombard[1], F. B. Garry[1], V. Khunkhun[1], and L. P. Garber[2], [1]*Integrated Livestock Management, Colorado State University, Fort Collins, CO,* [2]*USDA:APHIS:VS, CEAH, Center for Animal Health Monitoring, Fort Collins, CO*.

The objectives of this year-long observational study were to obtain dystocia occurrence rates on three Colorado dairies and identify the relationship between dystocia and subsequent calf morbidity and mortality. Each delivery received a dystocia score (standard scale 1 to 5) based on calving ease. Calf viability and health data were collected for 6,690 calves from 6,528 dams. Odds ratios (OR) were calculated for calves born with any assistance (scores 2-5) compared to calves born without assistance (score 1). The odds of being stillborn were calculated for each calf sex. Subsequent OR's for calf morbidity, death greater than 1 day of age and overall calf death prior to weaning were calculated only for heifer calves since bull calves were sold soon after birth. Primiparous animals required significantly more assistance at calving (52.6%) compared to 28.7% of multiparous animals (P<0.0001). Overall, 7.2% of calves were stillborn. Calves that required birthing assistance were significantly more likely to be stillborn than those calves that did not require assistance (OR=5.3). The odds ratios for still births were 4.7 for bull calves and 6.8 for heifer calves that experienced dystocia, although this sex difference was not statistically significant. Calf morbidity was significantly increased for heifer calves that required assistance during birth (OR=1.3). Heifer calves that required assistance were more likely to experience a respiratory or digestive event compared to heifers that did not require assistance (OR=1.4). Overall, 13.4% of heifer calves were born dead or died prior to weaning. No significant increase in death rate was observed from 1 day of age until weaning. However, when still births plus mortality to weaning was evaluated, dystocia heifers were more likely to die (OR=2.3). Dystocia had a significant impact on calf morbidity and mortality.

Key Words: Dystocia, Calf morbidity, Calf mortality

678 Biological considerations pertaining to use of the retinal vascular pattern for permanent identification of livestock. J.C. Whittier*[1], J. Doubet[2], D. Henrickson[2], J. Cobb[2], J. Shadduck[2], and B. L. Golden[1,2], [1]*Colorado State University,* [2]*Optibrand, Ltd LLC.*

Our objective was to characterize the retinal vascular pattern (RVP) as a stable biomarker for use in identification of livestock. The central retinal artery and vein enter the eye along the optic nerve and divide to supply the retinal surface. The geometric configuration of this vascular bed develops and is completed during fetal growth as vasculogenesis and angiogenesis occur. Other authors have reported that retinal angiogenesis is a Laplacian process which is ubiquitous in nature and follows branching patterns seen in rivers, trees, roots, and erosion channels. RVP images from livestock can be converted into a quantifiable format using a digital camera. Indexes can be created from the patterns resulting from a hashing function to allow rapid one-to-many searching. The number and position of branches, along with the diameter of each vessel combine to offer an information rich biomarker for use in animal identification. To evaluate each RVP the dominate trunk vessel of bovine RVP images was positioned vertically and branches on the right and left of the trunk and other branching points were counted. RVP images from 52 different cattle were evaluated. Branches from the left (LB=6.4, 2.2; mean, variance) and right (RB=6.4, 1.5) of the vascular trunk; total branches from the vascular trunk (TBVT=12.8, 4.3), and total branching points (TBP=20.0, 13.2) showed differences across animals. A paired comparison of RVP from both eyes of 30 other animals confirmed that eyes from the same animal differ. RVP images of 4 cloned sheep from the same parent line were evaluated to confirm the unique RVP in genetically identical animals. The uniqueness of the RVP allows for the unalterable association of animal with owner and premises improving the reliability of processes such as contaminated product recall, disease epidemic containment, and subsidy payment schemes.

Key Words: Retinal vascular pattern, Animal identification, Biomarker

Ruminant Nutrition: Minerals and vitamins

311 Role of trace minerals and vitamins in optimizing immune function of cattle. E. B. Kegley*, *University of Arkansas, Fayetteville.*

The immune system is a complex, multi-faceted response to challenge. Dysfunctions of this system result in significant annual losses to livestock producers; problems may, in part, be addressed by nutritional intervention. Enhancing the immune response through optimizing nutrition is a goal receiving increasing emphasis. Specifically, trace mineral and vitamin status alter various components of the immune system and will be the subject of this review. Research results indicate that trace minerals; including: Zn, Cu, Se, Cr, and Co; and vitamins E and A; impact immunocompetence. Many of these micronutrients have antioxidant activities that benefit animal health. Zinc plays a major role in disease resistance and immune responsiveness of many species. In lab animals, Zn deficiency impairs thymus activity, natural killer cell and neutrophil function, and cytokine production. Yet, research in ruminants has been more variable. Severe Zn deficiency impacts lymphocyte function and wound healing. In dairy cattle, high levels of supplemental Zn are generally associated with reduced somatic cell counts, possibly reflecting the importance of Zn in maintaining effective epithelial barriers. Copper and Se status affect several aspects of the immune system. In vitro, neutrophils isolated from ruminants deficient in Cu or Se have reduced ability to kill ingested bacteria, part of nonspecific immunity. Studies with ruminants indicate little effect of Cu deficiency on specific immune function. In contrast, supplemental Se has enhanced ruminant antibody response. Selenium deficiency is correlated with increased incidence of metritis and clinical mastitis in dairy cows. Supplemental vitamin E decreases morbidity in stressed calves. Research continues to determine the optimal concentrations and sources of micronutrients in the diets of ruminants, considering that dietary requirements for optimizing immune function may be greater than those needed for maximal growth or reproductive performance, and may be greater during periods of physiological stress.

Key Words: Trace minerals, Vitamins, Cattle

312 Incidence of bovine respiratory disease in receiving heifers: effects on weight gain and carcass characteristics. S. P. Montgomery*, J. S. Drouillard, J. J. Sindt, M. A. Greenquist, W. F. Miller, J. N. Pike, E. J. Good, E. R. Loe, M. J. Sulpizio, and T. J. Kessen, *Kansas State University.*

Crossbred beef heifers (n = 665, BW = 225 ± 24 kg) were used in a completely randomized design to determine the effects of bovine respiratory disease (BRD) on ADG and carcass characteristics. Heifers were processed within 24 h of arrival and processing included vaccination against common viral and clostridial diseases, recording of rectal temperature, and measurement of plasma glucose and lactate concentrations. Heifers were subsequently monitored for clinical signs of BRD including depression, lethargy, anorexia, coughing, rapid breathing, and nasal or ocular discharge. Heifers exhibiting signs of BRD received antibiotic therapy and the number of times a heifer was treated for BRD was recorded and ranged between zero and three. Following the 36-d receiving period heifers were allowed to graze native range for 136 d and then transported to a commercial feedyard where they were fed a common series of diets throughout a 124-d finishing period. Plasma glucose and lactate concentrations measured at time of initial processing were greater ($P < 0.1$) for heifers not treated for BRD than the mean of heifers subsequently treated for BRD, and decreased (linear, $P < 0.01$) as treatment for BRD increased. Rectal temperature measured at time of initial processing increased (linear, $P < 0.03$) with increased treatment for BRD. Initial BW, ADG, and final BW during the receiving period decreased (linear, $P < 0.01$) as treatment for BRD increased, while grazing period ADG was increased (linear, $P < 0.01$). Finishing period ADG, final BW, hot carcass weight, fat thickness, and marbling score were decreased (linear, $P < 0.05$) with previous incidence of BRD. These data suggest that initial plasma glucose and lactate concentrations may be indicative of health status of newly arrived receiving cattle and that increased incidence of BRD in cattle decreases ADG and carcass quality.

Key Words: Health, Daily gain, Carcass quality

313 Effect of copper source and level on performance and copper status of cattle consuming molasses-based supplements. J. D. Arthington*[1], F. M. Pate[1], and J. W. Spears[2], [1]*University of Florida - IFAS, Ona,* [2]*North Carolina State University.*

Two studies were conducted to evaluate the availability of Cu offered to cattle consuming molasses-based supplements. In Exp. 1 (84 d), 24 Braford heifers were randomly assigned to 12 pastures (n = 2 heifers/pasture). Heifers were provided 1.5 kg of TDN and 0.3 kg of supplemental CP/heifer daily using a molasses-cottonseed meal slurry. Three treatments were randomly assigned to pastures (4 pastures/treatment), providing 100 mg of supplemental Cu daily in the form of 1) CuSO4 (inorganic Cu), or 2) organic-Cu (Availa-Cu; Zinpro Corporation, Eden Prairie, MN). A third treatment received no supplemental Cu. Heifer BW was collected at the start and conclusion of the study. Jugular blood and liver samples were collected on d 0, 29, 56, and 84. In Exp. 2 (72 d), 24 Brahman-crossbred steers were fed the same molasses-cottonseed meal supplement at the same rate used in Exp. 1. Steers were housed in individual pens (15 m2) with free-choice access to stargrass hay. Four Cu treatments were assigned to individual steers (6 pens/treatment) providing, 1) 10 ppm Cu from an organic source (Availa-Cu), 2) 10 ppm Cu from Tri-basic Cu chloride (TBCC; Micronutrients Inc., Indianapolis, IN), 3) 30 ppm Cu from TBCC, or 4) 30 ppm Cu, 50:50 ratio of TBCC and organic Cu. Body weights, blood, and liver samples were collected on d 0, 24, 48, and 72. In Exp. 1, liver Cu was similar between heifers supplemented with inorganic and organic Cu. Each source resulted in increased ($P < 0.05$) liver Cu concentrations compared with the unsupplemented control. Plasma ceruloplasmin concentrations were higher ($P < 0.05$) for Cu-supplemented heifers, independent of Cu source. Heifer ADG tended ($P = 0.11$) to increase with Cu supplementation compared with the non-supplemented control. In Exp. 2, liver Cu was greater ($P < 0.05$) on d 24, 48, and 72 for steers consuming 30 ppm compared with 10 ppm Cu. Steers supplemented with organic Cu had lower DMI compared with steers supplemented with 10 or 30 ppm of TBCC. The inorganic and organic Cu sources evaluated