or days to puberty (O, 28.4 ± 2.0; N, 28.3 ± 2.0). Litter origin affected age at puberty (P=.02) and days to puberty (P=.002). Results indicate that observed differences in lean growth performance during prepubertal development had no effect on the age at puberty in O and N gilts, nor was overall lean growth rate at stimulation associated with pubertal age (r=.001 P=.75).

Key Words: Gilt, Puberty, Growth

625 The importance of a high feed intake during lactation of primiparous sows nursing large litters. J.J. Eissen[1], J.W.M. Merks*[2], M.W.A. Verstegen[1], and K.H. de Greef[3], [1]*Wageningen Institute of Animal Sciences, Wageningen University, Wageningen, The Netherlands,* [2]*IPG, Insitute for Pig Genetics B.V., Beuningen, The Netherlands,* [3]*Institute for Animal Science and Health, ID-Lelystad, Lelystad , The Netherlands.*

The objective of this study was to investigate the effects of nursing a large number of piglets on lactation and post-weaning performance of primiparous sows and whether a larger feed intake can prevent possible negative effects. Data were recorded on 307 ad libitum fed sows of three genotypes in an experiment where litter size was standardized to 8, 11 or 14 piglets during a four-week lactation. Sows were fed ad libitum from day 10 after farrowing and piglets had no access to creep feed during lactation. Daily feed of sows was not affected by litter size for two genotypes, whereas it was curve-linearly affected for the third genotype (P<.05) with a maximum at 10.8 piglets. Backfat thickness loss of the sows increased linearly with litter size (P<.05) for two genotypes. In the third genotype backfat loss increased only at large litter sizes >9.8 piglets (P<.01). Body weight loss of the sow and litter weight gain increased linearly with litter size (P<.001). Differences in responses to increasing litter size found between the three genotypes may be related to differences in feed intake pattern during lactation, upper critical temperature and body composition of sows. Sows nursing more piglets during lactation had a higher probability of a prolonged weaning-to-estrus interval. A higher feed intake during lactation reduced tissue loss of the sow, increased litter weight gain (P<.01) and reduced the probability of a prolonged weaning-to-estrus interval. At high levels of litter size, a one-kg increase in feed intake resulted in a lower output, measured as reduced body tissue loss or increased litter weight gain, compared with low levels of litter size. This may be related to higher maintenance requirements of sows due to heat stress and (or) less optimal conditions for piglet weight gain at high levels of litter size. Selection for a larger feed intake during lactation and improvement of environment and diet factors to reduce occurence of heat stress is recommended.

Key Words: Feed intake, Primiparous sows, Litter size

626 Effect of increasing nutrient intake to sows from day 28-56 of gestation on subsequent progeny performance. P.C. Penny*[1], M.A. Varley[2], and S. Tibble[3], [1]*JSR Healthbred Ltd, Southburn, UK,* [2]*SCA Nutrition Ltd, Thirsk, UK,* [3]*SCA Iberica S.A. Mequinenza, Espana.*

Utilisation of consumed feed from 40-100 kg BW and it's conversion into pig growth is a major determinant of efficient pig meat production. Targeting specific time windows during gestation can potentially influence lean tissue deposition in subsequent progeny via changes to foetal development. The objective of this study was to examine the effect of increased nutrient intake during day 28-56 of gestation on progeny growth from weaning to slaughter. Twenty four multiparous sows (JSR Genepacker 90) were randomly allocated between two treatments, Standard (ST) 2.5 kg/d or Elevated (EL) 5.0 kg/d from d 28-56 of gestation. Three boars and gilts were weaned from each sow and were housed in groups of twelve from d 58 to slaughter. All pigs received identical nutrition and were weighed on d 58, 93, 128 and 159. Quantity of feed consumed during gestation was lower (P<.01) for ST than EL sows (322 vs 383 kg). There were no differences for born alive, litter weight at birth and weaning, or average daily feed intake (ADFI) between ST and EL sows. No significant performance response was observed from weaning to d 93. ST progeny produced a significantly lower average daily gain (ADG) from d 93-128 (P<.05) compared to progeny from EL fed sows (0.697 vs 0.743 kg). Gain/Feed (G/F) for ST progeny was also substantially reduced (P<.05) during this same time window (0.38 vs 0.41). Rib lean measurement (52.3 vs 54.4 mm) showed a positive response (P<.08) towards those progeny from EL fed sows. These results suggest performance benefits are obtainable from progeny which have been derived from sows that have received increased maternal nutrients during a specific foetal development window.

Key Words: Sows, Gestation, Performance

HORSE SPECIES

627 Correlation of real-time ultrasonic measurement of longissimus muscle area of thoroughbred horses with lifetime earnings and average earnings per win. R. L. Dobec*, M. L. Borger, and D. B. Foye, *The Ohio State University Agricultural Technical Institute, Wooster.*

The primary objective of this study was to estimate the relationship of real-time sonoray measurements of fat depth and longissimus muscle area of thoroughbred horses with lifetime earnings and average earnings per win. Mares with racing records at the Keeneland 1998 November sale (n=44) were randomly selected and scanned for longissimus muscle area (LEA) and center loin fat depth (BR) posterior to the last rib (18th rib). An Aloka 500V console (Animal Ultrasound Services, Inc. Ithaca, N.Y.) with a 17.0 cm 3.0 megahertz linear probe was used for scanning. Age, earnings, average earnings per win, and total wins were obtained from catalog data. Longissimus muscle tracing and loin fat depth measurement were estimated using the Critical Vision Technology (CVT). Data were analyzed using SAS. Correlations of LEA with lifetime earnings and average/win were .18 and .13. The value of LEA as a predictor of racing success was significant (p≤.04). Mean LEA for this study was 23.4, std. dev. = 2.2. There was enough relationship to racing ability to merit further research with larger sample size.

Key Words: Racehorses, Thoroughbred, Ultrasonics

628 Tibial optical bone density is positively correlated with bone strength. K.L. Waite*, B.D. Nielsen, D.S. Rosenstein, and K.D. Roberson[1], *Michigan State University, East Lansing.*

Radiographic photodensitometry is a non-invasive method of estimating optical bone density in the horse. There is concern in the equine research community, however, that optical bone density is not correlated with bone strength. The objective of this study was to determine the correlation between optical bone density as determined by radiographic photodensitometry and bone strength. The hypothesis was that there is a significant positive correlation between optical bone density and bone strength. Tibiae, humeri and femurs were removed from turkeys euthanized as part of a separate study. Dorso-palmar radiographs were taken (57 KV, 400 mA, 4 msec, 1.6 mAs) to determine radiographic bone aluminum equivalence (RBAE). An aluminum stepwedge penetrometer was exposed with each radiograph as a standard. Radiographs were scanned at two locations on the bone and logarithmic regression was used to determine the lateral and medial RBAE using the thickness of the stepwedge and the maximum optical bone density readings of these cortices. Total RBAE was determined using the total area of the bone divided by the total area of the stepwedge. Shear tests were conducted with a double block test fixture designed to exert a shear force on a 5 mm section of the mid-diaphysis of each bone, with a load rate of 5 mm/min. Correlations between RBAE (mm ^{2}) and load (N) were calculated using the correlation procedure of SAS (6.12). There was no correlation between RBAE and strength in any of the femur and humerus measurements taken. No difference was found between tibial RBAE taken at the mid-diaphysis or the nutrient foramen, and tibial data were pooled. Total tibia RBAE was correlated with bone strength (r=.56, P=.0009), as was medial RBAE (r=.47, P=.0073) and lateral RBAE (r=.56, P=.0009). These data suggest there is a positive correlation between optical bone density and bone strength in the tibia and support radiographic photodensitometry as an effective, non-invasive means of detecting potential differences in bone strength in the live animal.

Key Words: Radiographic photdensitometry, Bone strength, Correlation

629 Effects of Matua hay on gestating and lactating mares and their foals. K. A. Ball*[1], H. A. Brady[1], V. G. Allen[1], K. R. Pond[1], and M. L. Galyean[1], *Texas Tech University*.

The use and safety of Matua bromegrass (*Bromus willdenowii*) has not been documented previously for use in diets of gestating and lactating mares. Objectives were to evaluate effects of Matua hay on intake, gestational length, foal weights, milk composition and reproductive parameters compared to alfalfa (*Medicago sativa L*). Eight, 3-yr old and four, aged (7 to12-yr old) gravid mares were used. Days on trial pre-partum for each mare were variable (mean 59 d), but all mares were on trial 70 d post-partum. Mares were blocked by age, expected foaling date, and weight, and were assigned randomly to either Matua or alfalfa treatments (n=6 per treatment). Mares were individually fed at 2% of BW pre-partum, and increased to 3% of BW post-partum. Diet ratios were 1.5% of BW hay and 0.5% of BW concentrate pre-partum, and 1.55% of BW hay and 1.45% of BW concentrate post-partum. Refusals were collected every 24 h; if all feed was consumed, the feed allowance was increased 0.10% of BW. Mares were weighed every 2 wk until 70 d post-partum. Crude protein averaged 15.1% for Matua and 20.4% for alfalfa. No negative effects were observed from feeding Matua hay. Dry matter intake of forage averaged 6.8 kg/d for Matua and 7.0 kg/d (SE= 0.4) for alfalfa pre-partum. Post-partum intake averaged 7.9 and 8.3 kg/d (SE=0.7) for Matua and alfalfa respectively. Mean gestational length of mares fed Matua (342.4 d) did not differ from those fed alfalfa (340.7 d). Neither foal birth weights nor average daily gain differed between the two treatments. Live foal births were 100% for each treatment. The difference of percentage protein in milk between treatments depended on day of sampling; percent protein on day 1 was lower in milk from the alfalfa treatment ($P<0.03$). Throughout the remainder of the trial, milk protein decreased similarly in both treatment groups. Our results suggest that Matua is a satisfactory hay for mares during late gestation and early lactation.

Key Words: Matua, Gestation, Lactation

630 Nutrient utilization of various grasses by grazing horses. L. A. Vogedes*, H. S. Hussein, J. P. Tanner, H. Tokuyama, and H. Han, *University of Nevada, Reno*.

The objective of this study was to determine the effects of forage species on digestibility of nutrients by grazing horses. Eight geldings (Quarter Horse; averaging 455 kg in weight and 14 years in age) were used in a 3 3 Latin Square Design experiment (3 treatments in 3 experimental periods [2 weeks each]). Treatments were pastures of 3 forage species (i.e., tall fescue [*Festuca arundinacea*], orchardgrass [*Dactylis glomerata*], and ryegrass [*Lolium perenne*]) at similar initial stage of maturity (i.e., vegetative stage). Two or three horses were assigned randomly to graze each pasture and were rotated every two weeks to the other pastures. Each experimental period included one week adaptation to the forage species to be grazed and one week for daily collection of forage (clip) and fecal (total) samples. Daily forage DM intakes were estimated from digestibility of DM (from concentrations of ADL in forage and feces) and total fecal DM output. Results indicate that horses are able to utilize orchardgrass more efficiently than tall fescue or ryegrass which appear to be utilized at the same efficiency.

Item	Tall fescue	Orchardgrass	Ryegrass	SEM
DMI, kg/d	9.67^{b}	10.20^{ab}	10.72^{a}	.33
		Digestibility(%)		
DM	48.93^{b}	59.07^{a}	49.26^{b}	.98
OM	53.17^{b}	62.47^{a}	53.01^{b}	.99
CP	64.91^{b}	71.46^{a}	60.10^{b}	1.66
NDF	42.30^{c}	51.57^{a}	44.95^{b}	.81
ADF	38.60^{c}	48.47^{a}	42.57^{b}	.66
Cellulose	54.30^{c}	62.98^{a}	57.25^{b}	.82
Hemicellulose	49.31^{b}	57.48^{a}	49.73^{b}	1.54

^{a,b,c} Means with uncommon superscripts differ (P < .05).

Key Words: Horses, Forages, Nutrient utilization

631 Michigan 4-H Horse Judges Program Exhibits Quality and Continuing Education. S.A. Doumit* and C.G. McLachlan, *Michigan State University, East Lansing*.

The Michigan 4-H Horse Program has offered a list of horse judges to its industry for over 25 y. The program has evolved to a system that offers 125 educated, quality evaluators that are required to maintain an active 4-H show judging profession and attendance at educational workshops and seminars. The primary objective is to provide a quality source of judges to the Michigan horse industry, educated in a variety of disciplines, emphasizing the development of life skills through horses. The program is maintained in philosophy and education by the Equine Extension Youth Specialist and Michigan 4-H Horse Judges Advisory Committee. Record keeping and file maintenance is serviced in the Extension Specialists office. Potential applicants are sent a package including a cover letter, guidelines for judges, a description of qualities desired in judges, recommendation forms, a preparation sheet, a current judges list, judges evaluation forms for applicants, and the application. Once applications are received, applicant files are reviewed and those qualified are selected for personal interviews. When applicants are selected to enter the program, most are placed on a Conditional List. This is a provisional list where the judges performance is evaluated by assigned current senior judges. If conditional judges receive ratings to advance to the regular list, they are advanced and expected to maintain good standing. Good standing status includes having judged 3 shows in 2 y, attending the Michigan 4-H Horse Judges and Superintendents Conference once every 3 y, and attending an approved clinic annually. This maintains quality judges that are being educated in subject matter and youth development. The list is distributed to Michigan county extension offices, Michigan judges, and anyone requesting the list. The list is a resource providing educated evaluators helping to ensure quality in Michigans 4-H Horse Program. The program is currently involved in a multi-state equine alliance in the midwest reviewing each states programs and creating opportunities to potentially streamline programs and create new regional opportunities for the industry.

Key Words: Horse, Youth, Judge

632 Identification of the toxic compounds in *Acer rubrum*. J Boyer*, D Breeden, and D Brown, *Cornell University, Ithaca, NY*.

Wilted or dried red maple leaves are toxic to horses, and when ingested cause oxidative damage resulting in methemoglobin formation, hemolytic anemia, and often death. This study identified the toxic compounds found in wilted red maple leaves. An in vitro assay was used to measure the amount of equine methemoglobin formed by exposure to maple leaf extract and fractions obtained by thin line chromatography (TLC). Four hundred μl of maple leaf extract were spotted on a silica gel plate, and the plate was developed in an ethyl acetate:methanol:water (100:13.5:10) solvent system. Each identified band was scraped from the TLC plate and extracted with methanol. After evaporating off the methanol, each fraction was placed in 250 μl of equine blood and incubated for two hours. The compounds from the band with an Rf of .46 - .54 caused a significant amount of methemoglobin formation (35%, p< .001). The compounds from the active band were analyzed using gas chromatography and mass spectrometry (GC/MS). A significant peak from both the active TLC fraction and the red maple leaf extract occurred at 8.1 minutes and was identified by mass spectrometry as 1,2,3-trihydroxybenzene, more commonly known as pyrogallol. Further gas chromatographic analysis revealed that the concentration of pyrogallol in the maple leaf extract was .55 mg/ml extract. When 200 μl of a .55 mg pyrogallol/ml methanol solution were added to 500 μl of equine blood and incubated for two hours, 42% of the total hemoglobin was oxidized to form methemoglobin. Silver maple (*Acer saccharinum*), sugar maple (*Acer saccharum*), and Norway maple (*Acer platanoides*) extracts also resulted in methemoglobin formation in the in vitro assay. GC/MS analysis indicated that these leaves contained pyrogallol, but in lower concentrations than in the red maples. Based on these results, pyrogallol appeared to be the major oxidative compound in red maple leaves. The role of other compounds in the active TLC fraction is still under investigation.

Key Words: *Acer rubrum*, Horses, Poisonous plants

633 Dose dependent decrease in feed intake following intravenous injection of urocortin into pony mares. P. R. Buff*[1], N. C. Whitley[2], E. L. McFadin-Buff[1], and D. H. Keisler[1], [1]*University of Missouri, Columbia,* [2]*University of Maryland-Eastern Shore, Princess Anne.*

Our objective was to determine if intravenous injection of urocortin would alter feed intake and serum cortisol concentrations in ponies. Ten jugular vein - cannulated pony mares averaging 257.7 ñ 6.6 kg BW were used in two experiments (Exp). After an overnight fast (18 hours), ponies were randomly chosen for intravenous injection of 50 μg/pony (Exp 1) or 5 μg/kg BW (Exp 2) rat urocortin or an equivalent volume of saline (treatment = time 0). Thirty minutes after treatment (and at times when feed intake was measured) ponies were given their usual ration of alfalfa pellets in 300 g increments, such that each pony had feed present at all times. Cumulative feed intake was determined by weighing the amount of unconsumed feed at 50, 80, 110, 140, 200, and 350 minutes after treatment and was expressed as g/kg BW, so as to account for differences in pony body weights. Blood samples were collected every 10 minutes from -20 to 30 minutes and then at 30, 60, 90, 120, 180, 240, and 360 minutes after treatment. Serum concentrations of cortisol were assessed at times 0, 30, 60, 120, 240, and 360 min in samples collected during both replications from 7 randomly selected ponies. In Exp 1, cumulative feed intake was influenced by a treatment by time interaction ($P < .0003$) in which feed intake was lower ($P < .02$) beginning 110 min after urocortin compared to saline treatment. However, in Exp 2, cumulative feed intake was not influenced by treatment. Serum concentrations of cortisol were influenced by urocortin in both Exp 1 and 2 (treatment by time period interactions, $P < .0008$). Cortisol was greater ($P < .005$) at 30, 60, and 120 min after treatment compared to saline for both Exp 1 and 2. In these studies, intravenous injection of urocortin decreased feed intake dependent upon dose, but increased cortisol regardless of dose. In conclusion, urocortin may modulate food intake independently of serum cortisol in pony mares and therefore may be a potential tool for managing obesity in horses.

Key Words: Urocortin, Horse, Feed intake

634 Fecal output, digestibility and pasture intake predicted by marker methods in grazing horses. J.L. Holland*[1], D.S. Kronfeld[1], W.L. Cooper[1], and P.A. Harris[2], [1]*Virginia Polytechnic Institute and State University, Middleburg AREC, Middleburg,* [2]*Equine Studies Group, WALTHAM Centre for Pet Nutrition, Melton Mowbray, Leics, UK.*

Marker methods have provided accurate and precise estimates of fecal output (FO), dry matter digestibility (D), and dry matter intake (DMI) in stalled horses. These methods needed to be validated in grazing horses. Two groups of 4 Thoroughbred geldings were placed on bluegrass/white clover (BC) and tall fescue/alfalfa (FA) pastures in a replicated 2x2 Latin Square design. Balance experiments were conducted in 15 d periods with a 14 d diet accommodation prior to the beginning of balance experiments. The external marker, Cr, was administered in "greenola bars" containing 6.0 $\pm$ .5 g Cr/bar, at 0700, 1300 and 1900 each day for 8 d. Dry matter, Cr, and yttrium (Y) were analyzed in pasture and fecal samples using AOAC procedures. Alkane concentrations in pasture and feces were analyzed using gas chromatography. Daily fecal concentrations of Cr (C_t, g/kg DM) were fit to a simple monoexponential equation with one rate constant (k) rising to an asymptote (C_a). Equations included a delay (d), which represented the time needed for Cr to enter the prefecal pool. Delays were 4.7 h and 5.4 h for BC and TA respectively. Yttrium and odd-chain alkanes were evaluated as internal markers to estimate D. Fecal output was measured in geldings with total fecal collection harnesses, and was estimated by the following equation FO = Cr dose (d^{-1}) / C_a. Fecal output was used in combination with D predictions to estimate DMI: DMI = FO / (1 - D). Yttrium gave higher estimates of D than previously reported, and alkanes gave lower D values than expected. Fecal output estimated from C_a gave values similar to weighed FO ($P > .20$). When estimated D from Y was used with either TC or estimated FO to predict DMI, the predicted intake was approximately 3.3% of BW. These results encourage further development of marker methods for estimating FO, D and DMI in grazing horses.

Key Words: Horse, Marker methods, Pasture

635 Glycemic response in thoroughbred mares fed a high fat and fiber or high sugar and starch pasture supplement. C.A. Williams*[1], D.S. Kronfeld[1], W.B. Staniar[1], and P.A. Harris[2], [1]*Virginia Polytechnic Institute and State University, Middleburg AREC, Middleburg,* [2]*Equine Studies Group, WALTHAM Centre for Pet Nutrition, Melton Mowbray, Leics, UK.*

A study was conducted to evaluate the glycemic response in two groups of six Thoroughbred mares at three stages (late gestation, and early and late lactation), one group fed a traditional sweet feed high in sugar and starch (SS), the other a feed high in fat and fiber (FF). The SS and FF supplements had similar DE (3.5 to 3.8 Mcal/kg) and CP (14 to 16%), but differed in fat (3.3 and 16.4% respectively), and NDF (18 and 36%, respectively). Mares were placed in stalls and fasted overnight (12 to 18 h). Blood was collected via a venous catheter at -30, 0, 30, 60, 120, 180, 240, 300 and 360 min after feeding 1.8 kg of feed. Baseline values, peak values and area under the curves (AUC) were evaluated as least squares means and standard errors. The mean baseline plasma glucose and insulin concentrations were similar for both groups at every stage being 4.0 $\pm$ 0.2 mmol/l and 5.3 $\pm$ 0.3 IU/l, respectively. During late gestation, and early and late lactation the plasma glucose peak was higher in SS than in FF ($P = .021$, $P = .002$, and $P = .048$, respectively). Peak insulin concentrations were higher in SS than in FF during early ($P = .006$) and late ($P = .009$) lactation, however there was no difference during late gestation. Glucose AUC's were higher in SS than in FF during late gestation ($P = .036$), early ($P = .0002$) and late ($P = .009$) lactation. Insulin AUC's were higher in SS than in FF during early ($P = .008$) and late ($P = .008$) lactation, but similar for late gestation. These data indicate that mares fed the FF supplement had a reduced glucose and insulin response compared to mares offered the SS supplement. Therefore, feeding a higher fat diet to mares throughout gestation and lactation may reduce the risk of certain digestive and metabolic disorders such as osteochondrosis, colic, rhabdomyolysis and laminitis, which may be linked to a pronounced glycemic response.

Key Words: Horse, Plasma glucose, Plasma insulin

636 Equi-Si^{TM} increases plasma and milk silicon levels and alters bone and collagen metabolism in horses. K. J. Lang*, B. D. Nielsen, M. W. Orth, G. M. Hill, H. C. Schott, and K. L. Waite, *Michigan State University, East Lansing.*

Supplemental silicon (Si) enhances bone and collagen metabolism in rats and appears to decrease the occurence of bone related injuries in racing Quarter Horses. Thus, Si may alter bone metabolism in horses. Our objectives were to determine if supplemental Si: 1) increases plasma and milk Si concentrations and 2) alters systemic markers of bone and collagen metabolism. Twelve Arabian mare/foal units were randomly assigned to: control (C) and Equi-Si^{TM} (Si source) treated (S). All mares were fed to meet NRC requirements (1989). The S group was fed Equi-Si^{TM}, at 2.0% of the diet, starting the first day after parturition. Blood samples from all mares and foals and milk samples were taken on d 0, 15, 30 and 45 following parturition. Plasma and milk were analyzed for Si concentrations, and serum was analyzed for osteocalcin (OC), carboxy-terminal pyridinoline cross-linked telopeptide region of type I collagen (ICTP), and pyridinoline and deoxypyridinoline (PYD). Mares treated with S had higher plasma Si levels than C mares on d 45. Mares in the S group tended to show higher OC values ($P = .07$) on d 30 and d 45 and lower PYD values ($P = .08$) on d 30 than C mares. In a second experiment, with 20 yearlings (10 Arabians and 10 Quarter Horses), five of each breed were S treated (2% of the diet as Equi-Si^{TM}), and the remaining yearlings served as controls. Blood samples were taken on d 0, 15, 30 and 45, and were analyzed for plasma Si levels and OC, ICTP and PYD. Yearlings treated with S had increased plasma Si levels on d 15, 30 and 45, relative to d 0. Also, treated yearlings had lower ICTP levels on d 45 than C yearlings. Thus in both studies, Equi-Si^{TM} increased plasma and milk Si concentrations. In conclusion, Equi-Si^{TM} may alter bone and collagen metabolism by enhancing bone formation and decreasing collagen degradation.

Key Words: Horses, Silicon, Bone Metabolism

637 Glycemic response of mares fed a typical pelleted horse feed. W. B. Staniar*[1], C. A. Williams[1], D. S. Kronfeld[1], and P. A. Harris[2], [1]*Virginia Polytechnic Institute and State University, Blacksburg,VA USA,* [2]*Equine Studies Group, WALTHAM Centre for Pet Nutrition, Melton Mowbray, UK*.

Responses of plasma glucose, triglycerides, cholesterol, and insulin were examined in twelve late gestational mares after being fed a meal of a typical pelleted horse feed. Mares were accommodated to this product for 3 months. They were deprived of feed but not water for 12 h prior to the glycemic response test (GRT). Baseline heparinized blood samples were taken via a jugular vein catheter prior to mares being fed a 2 kg. meal. Meals were consumed in 20-30 min and time zero samples were taken on all mares at 30 min, with subsequent samples at 30, 60, 120, 180, 240, 300, and 360 min. Plasma concentrations of glucose, triglycerides, and cholesterol were assayed by enzyme kits, insulin by a radioimmunoassay kit. Tukeys multiple-comparison procedure showed no differences between periods for triglycerides and cholesterol, and a difference between baseline and peak serum levels of glucose and insulin ($P = .05$). Baseline and mean serum levels of triglycerides were 23.5 $\pm$ 3.7 and 27.3 $\pm$ 1 mg/dl, respectively, and corresponding values for cholesterol were 92.4 $\pm$ 2.8 and 91.4 $\pm$ .1 mg/dl, respectively. Postprandial insulin and glucose peaked at 60 min with a return to baseline at 360 min. Baseline and peak serum levels of glucose were 89.7 $\pm$ 9.6 and 164.2 $\pm$ 7.3 mg/dl, and corresponding values for insulin were 6.6 $\pm$ 2.1 and 47.0 $\pm$ 7.3 IU/l, respectively. These results were similar to those for other typical commercial pelleted or texturized horse feeds but substantially greater than responses to feeds rich in fat and fiber content. The latter type of feed may reduce the risk of disorders linked to high grain feeding.

Key Words: Equine, Glycemic Response, Insulin

638 The effect of fish oil supplementation on exercising horses. C.I. O'Connor*, L.M Lawrence, A.C. St. Lawrence, and S. Hayes, *University of Kentucky, Lexington*.

Thirteen horses of Thoroughbred or Standardbred breeding were used to study the effect of dietary fish oil supplementation on exercising horses. Horses were assigned to either fish oil (FO, n=7) or corn oil (CO, n=6) treatment groups. The fish oil (Omega Protein, Hammond, LA) contained 11.3% eicosapentaenoic acid and 7% docohexaenoic acid. All horses received timothy hay and a mixed grain concentrate at rates necessary to meet their energy needs. Oil was topdressed on the concentrate daily at a rate of 324 mg/kg BW. Horses were exercised 5 d/wk for 9 wk in a program of increasing intensity. Blood samples were obtained on d 0 (before supplementation), d 28 and d 63. Following the 9-week training period horses performed a standard exercise test on a high speed treadmill. The exercise test consisted of a 5-min warm-up at 1.9 m/s, 0% grade, followed by a step test on a 10% grade at incremental speeds of 2 to 8 m/s. Blood samples were obtained during exercise and recovery. Serum cholesterol and lipids decreased during conditioning ($P < .05$) and there was a time x treatment interaction ($P < .05$). Compared to horses receiving CO, horses receiving FO had lower serum lipids and cholesterol at week 4 ($P < .05$) and lower serum triglycerides at week 9 ($P < .05$). During exercise, heart rates were lower ($P < .05$) for horses receiving FO, but no differences in plasma lactate were detected ($P > .05$). Serum cholesterol was lower ($P < .05$) in horses receiving the FO treatment throughout exercise. Serum insulin and plasma free fatty acids were lower ($P < .10$) in horses receiving FO than in horses receiving CO during the initial stages of the exercise test (warm-up to 5 m/s). Plasma glucose was lower ($P < .05$) for the FO group during exercise recovery from 6 min to 30-min post exercise. Addition of fish oil to the diet altered plasma lipid characteristics of horses and may have affected insulin sensitivity and glucose metabolism in response to exercise.

Key Words: Horse, Fish Oil, Exercise

639 Forelimb kinematics and kinetics of the fox trot. M.C. Nicodemus*, J.L. Lanovaz, and H.M. Clayton, *Michigan State University, East Lansing*.

The temporal stride characteristics of the fox trot describe this gait as a fast, lateral sequence, diagonal couplets walk. Kinematic and kinetic analysis has not been applied, as to date, to the fox trot. Application of this analysis to other equine gaits has proven to be a valuable tool in the detection of lameness and the assessment of clinical treatments. Therefore, this study measured the carpal and fetlock flexion/extension, forelimb vertical and cranio-caudal ground reaction forces, and vertical and left-right head displacement. Kinematics were tracked using reflective markers attached to the following locations of the right forelimb: 1) the joint centers of the elbow, fetlock, and coffin joints, 2) the distal and proximal aspect of the carpal joint, and 3) the cranial end of the wing of atlas (poll). Joint angles were measured on the caudal side of the joint. Four fox trotting strides performed by six Missouri Fox Trotters were recorded at 60 Hz and simultaneous sampling of the ground reaction forces were made with a Kistler force plate embedded into the runway matting. During the fox trot, the forelimb carpus and fetlock extend during the stance phase to 186 degrees and 225 degrees and flex during the swing phase to 116 degrees and 151 degrees, respectively. At 50 percent of the stance phase, the vertical ground reaction forces peak at 10.62 N/kg. During the first half of stance, breaking forces peak at -1.26 N/kg, and then, shift to a propulsive force at 65 percent of the stance phase where there is two force peaks with the first at .73 N/kg and the second at .67 N/kg. During forelimb impact, the head reaches maximum vertical displacement and has a total range of motion during the stride of 14 cm. During right fore impact, the head displaces to the left side of the body and at left impact displaces to the right side. Total range of motion in left-right displacement is 10 cm. These kinematic and kinetic measurements can be compared to the locomotion of forelimb lameness during the fox trot.

Key Words: Equine locomotion, kinematics, kinetics

640 Natural partners: Land grant universities and state horse councils. C.M. Brady*[1], M.A. Russell[1], P.J. Naile[2], and C. McCormick[1], [1]*Purdue University, West Lafayette, IN,* [2]*Indiana Horse Council*.

The Indiana Horse Council (IHC) and Purdue University work closely together to provide better services to the Indiana horse industry. The Departments of Animal Sciences and 4-H Youth Development, and the School of Veterinary Medicine, are all involved in this collaboration, as well as the Indiana Horse Council Foundation. Each state has at least one land grant university with an extension mission, and most states have a horse council. Horse councils consist of members of the industry that work together, across breed and discipline, to educate and enact changes for the benefit of all members of the horse industry. The relationship between the universities and the horse councils may range from non-existent, to adversarial, to collaborative. The emphasis of the collaborative efforts of Purdue University and the IHC is in the offering of educational programs for horse industry participants. The School of Veterinary Medicine and the IHC annually co-host a Horseman's Conference. Attendance at the conference has increased from 50 in the first year (1998), to over 200 in 2000. Veterinarians from the SVM, as well as faculty and graduate students from the Departments of Animal Sciences, Agricultural and Biological Engineering, and 4-H Youth Development are featured speakers. The Department of 4-H Youth Development works closely with the IHC to provide 14 clinics and contests for more than 800 youth at the IHC's annual Hoosier Horse Fair. The Horse Council also supports the participation of 4-H teams qualifying for national contests in hippology, horse bowl, horse judging, public speaking, and demonstrations. Purdue University and the IHC have a truly collaborative relationship, where the two groups work together to identify needs in the industry, and then work together to meet those needs. This presentation will discuss not only existing programs, but describe the process which allows these two organizations to work together to benefit the Indiana horse industry.

Key Words: Horse Industry, Extension, State Horse Council

641 Using cooperative learning to teach horse science and management students with varying backgrounds. M.J. Wylie*, *University of Wisconsin, Madison*.

Horse Science and Management is a three credit spring undergraduate course with a typical enrollment of 20 to 30 students and no prerequisites. Students in the class represent varying backgrounds including both extensive and no horse experience. Approximately 60 to 65% are freshmen and sophomores with 35 to 40% being juniors and seniors. Approximately 50% are agricultural majors with other majors such as Spanish, Art, and Secondary Education not uncommon. Curriculum ranges from evolution and history of use to topics such as anatomy and physiology, feeds and nutrition, reproduction, genetics, behavior, and

exercise physiology. The challenge is to establish a common solid foundation of basic horse knowledge and build upon it. The non-science majors particularly need to learn basic biology as well as how it is applied to the horse. There is also a problem with dispelling horse folklore and learned misinformation. A questionnaire distributed at the beginning of each semester revealed that 40 to 50% considered their level of horse knowledge to be "Lots!!" with 35% selecting "Moderate". Only 5% or less considered their knowledge level as either "Expert", "A Little", or "None". A "pre-course knowledge exam" completed by the students within the first week assesses the types of horse knowledge and experiences represented in the class. An experiential learning model of do-apply-reflect is used throughout the semester with cooperative learning a key technique. Group work causes the students to work together and maximize their own and each other's learning. Specific cooperative learning examples include the use of Think-Partner-Share and ways to deal with contrasting information and misinformation. This mix of teaching techniques meets the needs of different student learning styles. A "post-course knowledge exam" has indicated that basic horse science knowledge is improved and a final exam practicum allows students to demonstrate that they can apply what they have learned. Horses attract interest from a variety of students and once exposed to an animal sciences course, some may become interested in additional agricultural courses. Most important, these students now have an understanding of a domestic farm animal and an overall improved agricultural literacy.

Key Words: Horse Science, Cooperative Learning, Teaching

642 Integration of an equine program in an animal science curriculum: the minor degree approach. G. R. Gallagher*, *Berry College, Mt. Berry, GA.*

Student interest has increased pressure toward incorporation or expansion of equine programs into traditional food animal production curriculum. Successful integration of the equine program during a 10-year period into the animal science program at Berry College provides a case study of methodology. Prior to 1989, equine were utilized for physical education activity credit and a senior level horse production course. In 1989, 4 equitation related courses listed under animal science were developed. In the same year, an 8-member intercollegiate equestrian team began competing in the Intercollegiate Horse Show Association (IHSA). Equine minor degree programs open to all academic majors were introducted in 1993, despite pressure to develop an equine option in the animal science major or an equine major. In the same year the equestrian team had to be limited to 65-members due to popularity. Changes in student enrollment in the freshman introduction to animal science course increased 394% from 1988 (n=18) to 1998 (n=71). The equine minor provided a flexible curriculum allowing students to design their program based on interests including: science, business or recreation. The department benefited by increased teaching credit hours generated, recruitment and retention of students, and public relations. The college also benefited in recruitment and retention of students. A survey of species interest was completed by freshman students enrolled in the introductory animal science course fall 1998 (n=71). Students ranked in descending order of interest (7=greatest, 0=least): beef, dairy, domestic pets, horse, sheep, swine, poultry, wildlife/exotics. Mean responses for species interest were: horse (6.1), domestic pets (5.1), wildlife/exotics (4.1), dairy (4.0), beef (3.7), sheep (2.3), swine (1.9) and poultry (1.0). Results indicate a strong preference of freshman toward equine and domestic pets. In 1998, the department maintained 132 animal science majors, 45 equine minors and 15 animal science minors.

Key Words: Undergraduate, Equine, Minor degree

INTERNATIONAL ANIMAL AGRICULTURE

643 Genotype differences in heat-shock protein (Hsp70) expression in bovine lymphocytes exposed to temperature treatments. R. Banuelos-Valenzuela*[1], C. F. Arechiga[1], H. R. Vega-Carrillo[2], and S. H. Sanchez-Rodriguez[2], [1]*FMVZ-Universidad Autonoma de Zacatecas, Zacatecas, Zac. Mexico,* [2]*CREN-Universidad Autonoma de Zacatecas, Zacatecas, Zac. Mexico.*

In order to determine whether heat-shock protein (Hsp70) expression could be a potential indicator of animal adaptation to harsh environments and environmental stress, the present study determined heat-shock protein (Hsp70) expression in response to four temperature treatments in bovine lymphocytes from different breeds (Holstein, Australian-Holstein, Brown Swiss, Limousin and Criollo). Lymphocyte viability was above 98% in all eight replicates performed. Constitutive expression of Hsp25, 60, 75, 90 was determined at 38 C (homeothermic temperature), but only Hsp70 was expressed in lymphocytes. Bovine lymphocytes were then exposed to temperature treatments of 40, 42 and 44 C during 4 h. Exposure of lymphocytes to 40 C induces a slight increase in Hsp70 expression and a maximum expression at 42 C in all five different cattle breeds. There were statistical differences in protein expression due to temperature treatments ($P<0.05$), but no difference among cattle breeds, and neither the interaction. However, there was a tendency for differences in Hsp70 expression among breeds in a decreasing pattern as follows: Australian-Holstein, Brown Swiss, Criollo, Holstein, and Limousin. In all five cattle breeds, Hsp70 expression decreased at 44 C (lethal temperature for lymphocytes). In conclusion, elevated temperature act as a source of stress for bovine lymphocytes inducing Hsp70 expression, however, further research is required to determine whether Hsp70 expression in bovine lymphocytes could be use as a precise indicator of adaptation to environmental stress in bovines from arid regions or whether Hsp70 expression is correlated with animal adaptation.

Key Words: Hsp70, cow, adaptation

644 Management of tropical pastures renovated using the Barreiro system. C. D. U. Magnabosco*[1], R. D. Sainz[2], A. O. Barcellos[1], I. P. Oliveira[3], and D.O. Costa[3], [1]*Embrapa Cerrados, Planaltina,DF/Brasil,* [2]*University of California, Davis,* [3]*Embrapa Arroz e Feijão, Goiânia,GO/Brasil.*

Three systems of renovation and management of degraded tropical pastures were compared during two years following renovation using the Barreiro system, which involves establishment of a pasture stand in association with an annual crop, in this case upland rice. System 1 was establishment of Brachiaria decumbens; systems 2 and 3 were establishment of Brachiaria brizantha cv. Marandu, without and with a protein bank (Stylosanthes guyanensis cv Mineiro). Each system was established on 6 ha blocks. Yearling bulls of several breeds (Nellore, InduBrasil, Santa Gertrudis, and Canchim (5/8 Charolais x 3/8 Nellore)) were allowed to graze each area during the dry and wet seasons. Paddocks were rotated in a 35 day cycle, and animal weights and available forage measured at each cycle. Carrying capacity was greater in year 1 (636, 740 and 868 kg/ha/yr) than in year 2 (365, 448 and 480 kg/ha/yr) for systems 1, 2 and 3, respectively. Average daily gains (g/d) were also higher ($P<0.001$) in year 1 (538) than in year 2 (458). However, there were no differences between breeds, or between high and low 365-day weight EPD groups within the Nellore animals. Total weight gains for each system were 393, 449 and 500 kg/ha in year 1 and 210, 254 and 260 kg/ha in year 2 for systems 1, 2 and 3, respectively. The decline in carrying capacity from year 1 to year 2 was expected, due to disappearance of residual fertilizer from the crop. However, the decline in average daily gains was likely due to an abnormally wet and cold rainy season, which had adverse effects on pasture growth and quality, and on animal performance. In addition, sire EPD for 365-day weight was expected to affect animal performance. It is difficult to draw conclusions from such a small sample, but the lack of effect may have been due to the generally low performance allowed by the environment. Nevertheless, this project is ongoing and further work should help to elucidate some of these interactions.

Key Words: Beef Cattle, Pasture renovation, Forage production