to mitigate the effects of heat stress on lactating dairy cattle in the southeastern US.

Key Words: Tunnel Ventilation, Dairy, Heat Stress

Breeding and Genetics: Dairy Crossbreeding and Breeding Objectives

524 Comparison of first-parity Holstein, Normande-Holstein crossbred, Montbeliarde-Holstein crossbred and Scandinavian-Holstein crossbred cows for dystocia and stillbirths.

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First-parity Holstein (H), Normande-Holstein (NxH) crossbred, Montbeliarde-Holstein (MxH) crossbred and Scandinavian-Holstein (SxH) crossbred cows calving from June 2001 to December 2003 were compared for dystocia and stillbirths from seven California herds. Dystocia scores ranging from 1 (no assistance) to 5 (hard pull) and stillbirths (1 for alive and 0 for dead) were recorded for 1695 Holstein cows, 205 Normande-Holstein cows, 157 Montbeliarde-Holstein cows and 110 Scandinavian-Holstein cows. Cows were bred to Brown Swiss, Holstein, Jersey, Normande, Montbeliarde and Scandinavian sires. Investigated were effects of calf sex, breed composition of cow, age at calving, breed of service sire, calving year and herd. For dystocia, sex of calf, calving year, breed of dam, breed of service sire and herd were significantly different ($P<.05$). The least squares mean for calf sex were 1.55 for males and 1.19 for females. Mean scores for dystocia for breed of dam were 1.59 (H), 1.44 (NxH), 1.26 (MxH) and 1.19 (SxH). Holstein sired calves (1.52) differed significantly ($P<.05$) from Jersey sires (1.11), and Holstein sires differed ($P<.01$) from Scandinavian sires (1.30). For stillbirths, sex of calf, calving year, breed of dam, breed of service sire and herd were significantly different ($P<.01$). Male calves (12%) had higher stillbirths than females (2%). Mean scores for stillbirths for breed of dam were 12% (H), 8% (NxH), 3% (MxH) and 5% (SxH). Holstein sires had the highest rate of stillbirths (12%), and rates for the other breeds of sires were 10% for Brown Swiss, 3% for Jersey, 7% for Montbeliarde, 4% for Normande, and 5% for Scandinavian sires. Holstein sires differed significantly from Jersey ($P<.05$) and Scandinavian sires ($P<.01$). Brown Swiss differed significantly from Scandinavian sires ($P<.05$).

Key Words: Crossbreeding, Dystocia, Stillbirths

525 Comparison of the fertility of pure Holstein sires and F1 Jersey x Holstein sires mated to pure Holstein cows in an experimental herd.

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The objective of this study was to compare the male fertility of pure Holstein service sires and crossbred F1 Jersey x Holstein service sires in artificial insemination (AI) matings to pure Holstein cows. Approximately 60% of matings involving Holstein cows in the University of Wisconsin Experimental Herd were randomly allocated to F1 Jersey x Holstein young sires (N=7) from Alta Genetics, Select Sires, ABS Global, and Accelerated Genetics. The remaining matings were allocated to pure Holstein young sires (N=52) from seven commercial AI companies. Our analysis included 429 inseminations (166 cows) to crossbred sires and 288 inseminations (124 cows) to Holstein sires between February 3, 2003 and January 28, 2004. Pregnancy status was determined by ultrasound at 28 to 33 d after breeding. All pregnant cows were re-checked twice, at approximately 63 d and 100 d after breeding. Mean conception rates were 29.2% (84/288) for matings to pure Holstein sires and 30.3% (130/429) for matings to F1 Jersey x Holstein sires. Conception rates for individual crossbred sires were 27.4%, 27.6%, 30.7%, 29.1%, 34.7%, 35.4%, and 0.0% based on 73, 69, 75, 55, 45, 99, and 9 matings, respectively. Abortion rates (after a positive ultrasound at 28-33 d) were 7.1% (6/84) for pregnancies from Holstein sires and 14.6% (19/130) for pregnancies from crossbred sires. Based on Chi-Squared test statistics, corrected for days in milk and year-month of insemination, neither differences in conception rates nor differences in abortion rates between purebred and crossbred sires were statistically significant ($P < 0.05$). Based on the results of this study, it does not appear that crossbred Jersey x Holstein sires can provide a significant improvement in male fertility relative to their pure Holstein contemporaries.

Key Words: Male Fertility, Crossbreeding

526 A comparison of reproductive efficiency in four breeds of dairy cow and two cross breeds under seasonal grass-based production systems in Ireland.

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The objective of this study was to compare the reproductive performance of four dairy cow breeds, and two cross breeds; Holstein-Friesian (HF), French Montbeliarde (MB), MBxHF, French Normande (NM), NMxHF, and Norwegian Red (NRF), over a three year period, on two seasonal grass-based milk production systems. The study included a total of 402 cows: 95 HF, 72 MB, 63 MBxHF, 36 NM, 58 NMxHF, and 78 NRF. The mean calving date was February 18. In mid-April each year cows were assigned (within breed) to a low level of concentrate supplementation (LC: 650kg/cow/lactation) or a high level of concentrate supplementation (HC: 1,250kg/cow/lactation) based on calving date and pre-experimental milk yield. Breeding started in late April and lasted 13 weeks (all AI). No difference in the interval to commencement of luteal activity (as determined by thrice weekly milk progesterone measurement), submission rate in the first 24 days of breeding, or number of services per cow were observed between the groups investigated. Significant differences in pregnancy rate to first service (PREG1), pregnancy rate after 42 days of breeding (PR42) and calving to conception interval (CCI) were observed. Overall, the highest reproductive efficiency was observed with the NRF breed (PREG1 = 59%, PR42 = 75% and CCI = 88 days). The lowest reproductive performance was observed with the HF breed (PREG1 = 42%, PR42 = 56% and CCI = 96 days). The reproductive performance of both the MBxHF and the NMxHF was higher than the average of the respective parent breed groups. Feeding system had no influence on any of the fertility traits investigated. In conclusion, the results of the current study highlight the benefit of the NRF breeding program where improved health and fertility have been selection criteria since the early 1970's. The results also suggest that dairy crossbreeding will lead to improved reproductive performance through hybrid vigour.

Key Words: Dairy Breeds, Fertility, Hybdrid Vigour

527 Effect of Holstein females carrying Holstein versus Jersey sired calves on subsequent MEMilk, days open and involuntary culling.

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From September 2001 to June 2003, 163 Holstein and 180 Jersey-Holstein crossbred calves were born at the University of Minnesota research herds at the St. Paul campus and at the West Central Research and Outreach Center, Morris. Cows and heifers had been randomly assigned to either Holstein or Jersey service sires. Dystocia was scored with a range of 1 (no assistance) to 5 (hard pull). Independent variables for analysis were herd, parity (1st, 2nd and 3rd and greater), sex of calf, and breed of sire. Differences between Holstein and Jersey sires were significant for dystocia score, calf weight, and retained placenta ($P<.05$). Least squares means for Holstein and Jersey sires, respectively, were dystocia score, 1.97 versus 1.36; calf weight, 43.6 kg versus 35.7 kg; and retained placenta, 8.2% versus 3.6%. Stillbirth rate was 7.2% for Holstein sires and 5.2% for Jersey sires, but not significantly different ($P>.05$). There were no significant differences in the subsequent MEMilk, days open or chance of early culling (culled less than 100 days into lactation) for cows having Holstein versus Jersey sired calves. For all cows, cows that had been bred to Holsteins averaged 10,430 $\pm$158 kg MEMilk versus 10156 $\pm$155 kg for cows bred to Jerseys. Days open also favored the cows that had had Holstein sired calves: 138 $\pm$8 days versus 143 $\pm$8 days. Relative to early culling, 16.6 $\pm$3.9% of cows having Holstein calves were culled vs. 14.1 $\pm$3.7% of cows having Jersey sired calves. The analysis was repeated for just the first lactation cows.

Again breed of calf did not significantly affect MEMilk, days open, or chance of early culling.

Key Words: Crossbreeding, Dystocia, Fertility

528 Overview of different breeding objectives in various countries for Holsteins.

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For many years, most Holstein breeding schemes worldwide focused exclusively towards increasing milk production. In the last five years selection goals have evolved worldwide, shifting the focus on production to a more balanced selection goal of improving production, especially protein yield and percentage, as well as longevity, udder health, functional conformation and fertility. Selection indexes and top bull listings from 15 countries were compared. Average relative emphasis for Production, Durability and Health & Fertility, across all countries, was 59.5%, 27.9% and 12.6%, respectively. The largest difference was the relative emphasis on Production in various countries. Overall, the Danish S-Index appeared to be the most balanced across the three components, with 34% emphasis on Production, 29% on Durability and 37% on Health and Fertility. The broadening of selection goals through recent changes to selection indexes had a clear effect on decreasing the similarities of top bull listings in various countries.

Key Words: Dairy Cattle, Breeding Objective, Selection Index

529 Effect of inbreeding on female reproduction in Jerseys.

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The objective was to determine effects of inbreeding in Jerseys on age at first calving, days to first observed estrus, days to first insemination, conception rate, services to conception, days open, and survival to second lactation. Inbreeding has been increasing rapidly in U.S. Jerseys as documented by the Animal Improvement Programs Laboratory (http://www.aipl.arsusda.gov/eval.htm). Inbreeding in Jerseys has more than doubled from 3.4% in 1990 to 7.1% in 2003. Experimental data included first lactation records between 1970 and 1993 of 900 Jersey females raised in the North Carolina State Randleigh herd. These animals were from two selection experiments. One experimental line used only highly proven sires and the second experimental line used pedigree selected young sires. As a result, cows studied were daughters of popular Jersey sires. Thus, results are expected to be relevant to commercial Jersey herds. For statistical analyses, calculated inbreeding values for each animal were rounded to the nearest whole percentage. Data were adjusted for effects of selection line, birth year of the dam, calving month, calving year, MEMilk, and MEFat. Inbreeding did not significantly affect age at first calving, days to first observed estrus, days to first insemination, or survival to second lactation. However, increased inbreeding had significant, deleterious effects on first service conception rate, services to conception, and days open. A 1% increase in inbreeding reduced 1st service conception rate by 2 percentage points, increased services to conception by 0.05 services, and increased days open by 1.8 days. Jersey breeders should implement a selection program that increases productivity and minimizes inbreeding. Effective mating programs to guide Jersey breeders in accomplishing these goals are recommended.

Key Words: Dairy, Inbreeding, Reproduction

530 Effect of synchronization protocols on days open and pregnancy rate at 120 days in dairy cattle.

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Data were from herds in an AI progeny testing program that were utilizing Dairy Comp 305 and had at least 75% of recorded breeding events classified as standing heat or synchronized. A total of 16,374 records from 64 herds were analyzed. Data subsets were based on individual cow synchronization categories and herd management categories. Statistical models for days open (DO) included herd-year-season, age at calving, and parity as fixed effects, and sire or animal and residual as random effects. The pregnancy rate at 120 days (PR120) data were analyzed with a threshold sire model with similar fixed and random effects to DO. Models including a fixed effect for synchronization and a random interaction for sire by herd management also were investigated. Producers who used synchronization, 47 herds in these data, were applying it selectively to problem cows. Records synchronized after the first breeding (later-synchronized) had 71 d longer DO and 24% lower PR120 than records synchronized at first breeding (first-synchronized). First synchronized records had 23 d longer DO and 10% lower PR120 than non-synchronized records. The 11 herds adhering strictly to synchronized first inseminations had 17 fewer DO and 10% higher PR120 than other herd management groups. Heritabilities ranged from 0.03 to 0.07 for DO and 0.10 to 0.26 for PR120. Sire variance was 40% lower for DO and 25% lower for PR120 in first synchronized records than either later-synchronized or non-synchronized records. Residual variances for DO varied by 3% between cow treatment categories and 14% for herd management categories. Including a fixed effect for synchronization in the DO model reduced sire variance by 33% and residual variance by 10%. Sire by herd management interaction accounted for less than 1% of the total variance for DO and 2% of the total variance for PR120. Synchronization had important, but similar, effects on sire and residual variances with only modest effect on heritability.

Key Words: Days Open, Estrus Synchronization, Heritability

531 Level of metabolic trait of glucose by young bulls and cows.

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The breeders are interested in premature information about the evaluation of growing young bulls. The common contemplation of genetic and physiological aspects is offered. In the lactation, the milk performance influences the demand for glucose. Insulin has a central position in the regulation of the energy metabolism of cattle. Methodically, the insulin function can be measured using the glucose tolerance test (GTT, Reinicke,1993). 58 cows in the stage of partus to 15 weeks post parturition was compared with 392 young bulls in the third life half-year. The goal of the examination was, to establish a comparable test level for cows and growing young cattle. By an infusion of 1g glucose per $kg^{0,75}$ of metabolic body weight in the GTT was kept the urine threshold of Burkert (1998) and Reinicke (1993). By the constant glucose base concentration (G_0), the glucose half-life (G_{HWZ}) of the young bulls at 48 min is comparable with the eighth week of the lactation of the cow (see Tab.). Exactly in this time period has been proved by Cassel (2001) the highest genetic correlation between energy balance and yield r_g = -0.84 and the highest heritability for the energy balance h^2 = 0.20. Thus, by the infusion quantity and the expelled test time under performance the young bulls imitate the genetic equipment of their daughters for the metabolism capability.
Results of the Glucose Tolerance Test (GTT) in young bulls according to test in the third life half year and cows by partus and later 4, 8 and 15 weeks

		Wt. kg	Wt. kg	G_0 mmol/l*	G_0 mmol/l*	G_M mmol/l**	G_M mmol//l**	G_{HWZ} min #	G_{HWZ} min #
year	n	x	s	x	s	x	s	x	s
Bulls 1999	96	460	48	4.4	0.6	13.4	1.4	49.9	14.4
Bulls 2000	105	447	46	4.4	0.7	13.7	1.8	47.6	15.7
Bulls 2001	91	443	37	4.6	0.5	14.1	1.5	45.7	10.5
Cows by partus	28	551.6	38.7	4.0	0.4	11.1	1.4	43.1	8.5
4 w.p.p.	10	542.5	38.7	3.4	0.4	11.2	1.6	37.7	5.6
8 w.p.p.	10	566.0	23.2	4.0	0.5	11.7	1.9	48.9	18.0
15 w.p.p.	10	542.0	31.9	3.9	0.3	12.0	1.8	55.5	24.4

*G_0 = glucose basis; **G_M = maximal value;
#G_{HWZ} = glucose half life time; x=mean value; s=standard deviation

Key Words: Cattle, Breeding Value, Glucose

532 Heterosis and breed differences for daughter pregnancy rate of crossbred dairy cows.

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Fertility of crossbred and purebred dairy cows was compared based on daughter pregnancy rate (DPR) as defined and introduced in February 2003 by the USDA. Heterosis and breed differences were estimated from first parity records of 11,708 F1 crossbred cows and 195,123 purebred contemporaries born after 1987 in 5775 herds. A second analysis for parities 1 through 5 included 485,297 records. Lactations were required to be >250 days in milk. Records with >250 days open were set to 250 days open and records with <50 days open were set to 50 days open. Numbers of purebred contemporaries were 1,679 Ayrshires (AY), 1,259 Brown Swiss (BS), 1,926 Guernseys (GU), 191,872 Holsteins (HO), 8,812 Jerseys (JE), and 396 Milking Shorthorns (MS). The most numerous F1 cross was 5,563 progeny of JE sires mated to HO dams. Days open records were converted to DPR by the linear approximation DPR = .25 (233 days open). To compare base cows born in 2000, sire predicted transmitting abilities for DPR were adjusted to the 2000 genetic base and subtracted from DPR records. The model for adjusted DPR included age at first calving, herd-year-season of calving with three seasons per year, parity, heterosis, and breed effects as compared to purebred HO. Estimates of heterosis for DPR were +2.4 ±0.6 for first parity and +1.8 ±0.5 for all parities. Within herd-year-season estimates of breed differences and standard errors were AY +0.9 ±0.9, BS +0.9 ±0.8, GU +2.2 ±1.2, JE +3.9 ±0.5, MS +4.5 ±1.8 for first parities and AY +1.8 ±0.5, BS +0.1 ±0.4, GU +2.0 ±0.7, JE +4.6 ±0.3, MS +4.3 ±1.0 for all parities. Those estimates were similar to differences obtained from national breed averages for first parity DPR, which were AY 22.8, BS 21.9, GU 21.3, HO 22.3, JE 27.0, and MS 26.0 for cows born in 2000. JE x HO crossbreds are as fertile as purebred JE, and heterosis for DPR is about 10% of mean DPR. Crossbred cows have significant advantages over their purebred parents for daughter fertility.

Key Words: Crossbreeding, Heterosis, Fertility

533 Calving difficulty in Holsteins and Jerseys and their crossbreeds.

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Calving traits for frequently used dairy breeds and crossbreeds were investigated for primiparous and multiparous calvings, using 402,116 calving records collected in Australia for a period of 18 years. The incidence of dystocia was highest for Holstein Friesian primiparous cows, and Jersey-Holstein crosses had the least dystocia. There was a strong interaction between calf sex and breed: male calves from Holstein-Friesian cows resulted in more dystocia and greater calf mortality than female calves, whereas male and female Jersey-sired calves with cross bred or Holstein dams had less difference in dystocia and calf mortality between the sexes. There was no significant difference between sexes in dystocia in Jersey calves. Logit transformation of proportion suffering dystocia reduced but failed to eliminate these significant interactions. Incidence of dystocia in Holsteins was influenced by the season (gestation lengths were longer in winter, resulting in larger calves and more dystocia) and by the age of the cow, but these fixed effects were not apparent in Jersey calvings, and less noticeable in Jersey cross calvings. Though there was a major breed difference for calving ease between Jersey and Holstein bulls, the bull standard deviations of the two breeds for this trait were sufficiently large, relative to the breed differences, that there will be a small percentage of Holstein bulls that may be as easy calving as many Jersey bulls.

Key Words: Dystocia, Crossbreed, Sex

534 Early results of Holstein-Jersey crossbreeding at Virginia Tech and Kentucky.

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The joint Virginia Tech - Kentucky crossbreeding project produced 88 calves at Virginia Tech and 18 at Kentucky by mid-February 2004. Limited data from Kentucky precluded its use here, but data from both institutions will be combined in coming months. The project was initiated using a heterospermic insemination trial, whereby females were inseminated with a mixture of semen from one Holstein and one Jersey bull in a single straw. Dams were purebred Holsteins and Jerseys, ranging in age from heifers through fifth lactation cows when bred. Six sets of twins (excluded from analysis) were among the first 88 births, including three sets of mixed sex (females all freemartin), two sets of heifers, and one set of bulls. Five of the twins were stillborn or died by 24 hrs, and only two reproductively sound females survived. Dystocia scores (1-5) were recorded at birth. Calf mortality included stillbirths and calves dead by 48 hours. Calf weights were recorded periodically, but only birth weights are reported here. Breed combinations (HH, HJ, JH, and JJ, sire first) included 30, 21, 11, and 14 calves respectively. Over 80% of births were unassisted, dystocia score 1, with an average score of 1.42. Death losses were 6.7% for the 76 single births. A fixed model including effects of sex of calf, breed group, and lactation number of the dam evaluated dystocia, calf mortality, and birth weight. No significant differences existed for any effects for dystocia or calf mortality. Thus, we found no difference in dystocia for Holstein sired calves born to Jersey dams or Jersey sired calves born to Holstein dams. Birth weight differed significantly ($P<0.05$) for sex (males heavier than females by 2.6 kg) and breed combination (HH calves heavier by 15.3 kg, HJ by 6.7 kg, and JH by 8.2 kg than JJ calves). Calves born to first calf heifers were 3.7 kg lighter than calves born to third and later lactation cows. The project is designed to produce 40 females per breed group at Virginia Tech and an additional 20 animals per breed group at Kentucky. To date, the Virginia Tech project has produced 16 HH, 8 HJ, 8 JH, and 8 JJ females after death and freemartin losses.

Key Words: Crossbreeding, Holstein-Jersey, Calfhood Survival

535 Normande-Holstein crossbreds versus pure Holsteins for conception, days open, calving interval and survival.

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Normande-Holstein first parity crossbreds (n=32) were compared to pure Holsteins (n=161) for first service conception rate, services per conception, days open and survival to second lactation. Cows were housed in five commercial dairies in California and calved in a six-month period from June 2002 through November 2002. All cows in the study had A.I. sires and maternal grandsires. Cows having Days open greater than 270 days were truncated to 270 days. Independent variables were breed (Holstein, Normande-Holstein crossbred), age at calving (linear, months) and herd (5). Normande-Holstein crossbreds had a higher first service conception rate (34% ±8) compared to Holsteins (20% ±4). Holstein cows had more days open (135 ±8) compared to Normande-Holstein crossbreds (109 ±14). One-hundred percent of the Normande-Holstein crossbreds became pregnant and 97% of the Holsteins became pregnant. Of the cows that became pregnant, Normande-Holstein crossbreds had fewer services per conception compared to Holsteins. Least squares means were 2.52 ±.32 (Normande-Holstein) and 2.91 ±.18 (Holstein). For the cows that calved a second time, least squares means for calving interval were 383-d ±17 (Normande-Holstein) and 419-d ±10 (Holstein). Sixteen Holstein cows and one Normande-Holstein crossbred cow were culled during first lactation.

Key Words: Crossbreeding, Fertility, Days Open

536 Breed composition codes for crossbred dairy cattle in the United States.

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Crossbred animals in the US dairy cattle population do not currently receive genetic evaluations. A system for storing breed composition data was developed and the software implemented. Crossbreds are animals whose sire and dam breeds are known but different. Two ways that crossbred animals may be handled in an evaluation are: they may be included in the breed-of-sire evaluation, or all animals may be combined into a single evaluation. For each crossbred cow (n=431,432) the database stores animal identification, breed of animal registry, breed fractions for 18 dairy breeds and an unknown category, a four-generation breed stack, a sire breed stack, and a heterosis value. Standard two-letter breed codes are used in the breed stacks. Breed fractions were calculated from pedigree information in the USDA database as far back as data were available. As a result, the crossbred table includes >70,000 crosses that occurred >4 generations back in pedigrees, resulting in one breed with a very large contribution (e.g. 96.9% HO) to the breed composition and the other with a very small contribution (e.g. 3.1% JE). To avoid confusion the data may be reformatted for presentation (e.g. 97HO3JE), which would involve a small loss of precision. When purebred sires are used, the sire breed stack completely describes the mating system and may be used to identify rotational breeding programs. If crossbred sires are used, a four-generation breed stack is needed to identify reciprocal crosses that cannot be denoted by the breed composition alone. Consider a purebred Holstein sire mated to a purebred Jersey cow. Breed composition of a daughter would be 50HO50JE with a sire breed stack of HOJE and heterosis of 1.0. If that daughter were backcrossed to a Jersey bull, the resulting calf would have a breed composition of 75JE25HO, a sire breed stack of JEHOJE, and heterosis of 0.50. This system is necessary to facilitate implementation of across-breed genetic evaluations.

Key Words: Crossbreeding, Genetic Evaluation, Dairy Cattle

537 Effect of strain of Holstein-Friesian cow and grass based feeding systems on milk production, body weight, body condition score and reproductive performance. P. Dillon*[1], B. Horan[1,2], F. Buckley[1], J. Mee[1], and M. Rath[2], [1]*Teagasc, Moorepark Research Centre, Fermoy, Co. Cork, Ireland,* [2]*Faculty of Agriculture, University College Dublin, Dublin, Ireland.*

The objective of this study was to assess the biological efficiency of three strains of Holstein- Friesian (HF) cows in three grass-based systems. For this purpose, 39 High production (HP) North American Holsteins, 39 High durability (HD) North American Holsteins, and 39 New Zealand (NZ) Holsteins were used in three consecutive years. Each strain was allocated to one of three feed systems (FS); high milk output per cow (MP), high concentrate (HC), and high milk output per unit area (HS). Concentrate supplementation averaged 384, 384 and 1,455 kg per cow for MP, HS and HC, respectively. Milk yields were recorded on five days per week, milk composition was determined in one successive morning and evening sample each week. Body weight (BW) was recorded weekly and body condition scores (BCS) every three weeks. Cows were inseminated using AI, over a 13-week period. Milk production, BW, BCS and reproductive data were analysed as a split-plot design, using statistical procedures of SAS. There was a significant strain of HF by FS interaction for milk (P<0.01), fat (P<0.01), protein (P<0.01) and lactose (P<0.001) yields. Milk yield response to increased concentrate supplementation was greater with the HP strain. The NZ strain maintained the highest BCS and lowest BW. The HD strain had similar BW to the HP strain, while the BCS of the HD strain was higher than the HP strain (P<0.05). Interaction between strain of HF and FS was not significant for the reproductive variables. The HP strain had greater number of services, lower conception rate to first service, and overall pregnancy rate, than both the NZ and HD. The NZ strain had higher conception rate to first and second service, and 6-week in-calf rate than both the HP and HD, while the HD was higher than the HP strain. FS had no effect on reproductive variables. The results indicate that the optimum system of milk production will vary with strain of HF.

Key Words: Dairy Cows, Grazing, Strain By Feed Interaction

Dairy Foods: Cheese

538 Use of reverse osmosis concentrated milk for the manufacture of Cheddar and Colby cheese: Impact on Ca equilibrium and functional properties. M.-R. Lee*, J. A. Lucey, and M. E. Johnson, *University of Wisconsin, Madison.*

The physical characteristics of cheese are governed by proteolysis and electrostatic and hydrophobic interactions as influenced by pH and casein bound Ca (INSOL CA). The objective of this study was to study of the role of Ca equilibrium and pH on functionality changes that occur during ripening. Reverse osmosis (RO) of milk was performed before cheese making which increased the total solids content of cheesemilk by 2%. The additional lactose (0.5%) in RO milk, if fermented, could greatly decrease cheese pH and increase solubilization of Ca. Cheddar and washed curd Colby cheeses were made from RO and non-RO milk with different renneting and draining pH to vary total Ca content of cheeses. Changes in INSOL CA were determined by titration and cheese juice methods. Rheological properties were determined by small amplitude oscillatory rheometry during heating from 5 to 80°C and meltability from UW-Melt Profiler test where the degree of flow at 60°C was determined. The texture of RO Cheddar cheese with low renneting and draining pH was very crumbly (pH dropped to #88044.7). The INSOL CA in cheese decreased during aging in all cheeses. INSOL CA in cheese was positively correlated with cheese pH in both RO (r = 0.89) and non-RO (r = 0.83) trials. Above pH 4.95, changes in INSOL CA in cheese during ripening were negatively correlated with the maximum loss tangent value (i.e., point when cheese was most fluid-like) (r = -0.54) and with degree of flow (r = -0.56). Below pH 4.95, there was no significant relation between melting and INSOL CA. These results suggest that for cheese at pH < 4.95, melt was limited and loss of insoluble Ca in cheese during ripening could not improve melt due to dominant effects of low pH on the casein network. In cheeses with pH > 4.95, the reduction of INSOL CA in cheese during ripening contributed to increased meltability.

Key Words: Insoluble Ca, Meltability, Rheology

539 A comparison of three different methods for measuring intact casein in cheese. P Lehtola* and L. E. Metzger, *MN-SD Dairy Foods Research Center, University of Minnesota, St. Paul.*

Intact casein is a fundamental constituent in process cheese because it has important emulsifying properties that significantly affect the texture, stability and melt characteristics of the final product. In the traditional method for measuring intact casein 0.75g of cheese is extracted twice with 25ml of a pH 4.6 buffer. The cheese is dispersed with a high shear mixer, extracted at room temperature for 30 min, and centrifuged. The supernatant obtained is then analyzed for soluble protein using the Kjeldahl method. Intact casein is determined by subtracting the amount of soluble protein from the total protein. The objective of this study was to develop two alternative procedures for measuring intact casein in cheese. In the first new method, 2.5 g of cheese is extracted once with 15 ml of pH 4.6 buffer. As in the traditional procedure, the cheese is dispersed using a high shear mixer, extracted for 30 minutes and centrifuged. Subsequently the supernatant and fat plug is removed and the amount of insoluble protein in the pellet is determined using the Dumas combustion method. In the second new method, .17 g of cheese is extracted once with 1 ml of pH 4.6 buffer. The extraction was performed in a micro centrifuge tube and the cheese was dispersed with a bead blaster. Following centrifugation the pellet was first washed with 1ml of a methanol/acetone solution (75:25) and then washed with 1 ml of acetone. The pellet was then dried in a heating block at 50°C for 1 hr. The final weight of the pellet was determined and used as a measure of insoluble protein. To compare the three methods eight samples of Cheddar cheese were analyzed at 2 wk, 2 months, and 4 months of ripening using each method. Each sample at each ripening time was analyzed in duplicate using each method. All methods observed a significant (P < .05) increase in soluble protein and a significant decrease (P < .05) in insoluble protein in all samples during ripening. The results of all three methods were highly correlated (>.90). This research has developed two alternative procedures for measuring intact casein in cheese.

540 Vatless manufacture of mozzarella cheese from 8X concentrated microfiltration retentate. A. V. Ardisson* and S. S. H. Rizvi, *Department of Food Science, Cornell University, Ithaca, NY.*

The objective was to compare the functional and viscoelastic properties of low-moisture part-skim LMPS Mozzarella cheeses made by direct acidification with glucono-δ-lactone (GDL) and with starter culture. Both made by a continuous cheese-making process from concentration factor (CF) 8, pH 6.0 skim milk microfiltration retentate (MFR).
Pasteurized skim milk was microfiltered to CF 8 at 50C using a 0.1μm nominal pore diameter microfiltration (MF) membrane unit with a total area of 9.2m^2. The system was equipped to maintain a uniform transmembrane pressure (UTMP) of 88.7 KPa. The milk was gradually acidified during MF to pH 6.0 using GDL (1.6g/kg skim milk) to adjust the calcium to casein ratio in the final retentate. The MFR was standardized with cream (40% fat) to produce a cheesemilk (CM) with