92 Improving lowly heritable traits in dairy cattle by crossbreeding.
T. Steine* and A. G. Larsgard, *Geno Breeding and A.I. Association*, *Hamar, N-2326, Norway*.

Crossbreeding is not the common breeding practice in dairy cattle. Most improvement programs are based on selection within pure breeds. There are some logical reasons for this. The dairy cow has a very low reproduction rate, and most of the female calves are needed for replacement. Therefore all dairy cows are potential dams of the next generation which makes it impossible to run crossbreeding systems in the same way as in swine and poultry.

There are three possible ways of utilizing crossbreeding in dairy cattle: Crossing through, rotational crossing or making a synthetic breed. Today most of the crossbreeding carried out in dairy cattle seem to focus only on the degree of heterosis for low heritable traits. In this presentation the effect on improving these traits by both heterosis and improved additive genetic merit is discussed, including a continous genetic improvement of the traits. If heterosis alone causes the superiority of the crosses, there will always be a drop if the F1s are crossed back to one of the start breeds. The results in this presentation are based on a program where the performance of the herd is estimated. This is without doubt the main interest of a farmer. We have simulated rotational crossing with two or three breeds to predict the composition of the herd or the population at any given time in a period of twenty years from the start. By using different levels of heterosis and additive genetic merit it is possible to follow the development of the herd for many traits during the whole period with different breeds involved. The results show that if additive genetic merit is playing a role and it is possible to find breeds with higher genetic merit for the low heritable traits than the breed to improve, heterosis is no longer of so vital importance alone. In most cases it seems that rotational crossing with two breeds is better than or at least equally good as using three breeds. This will be even more pronounced if it is possible to select sires for the desirable traits in the breed being used.

Key Words: Dairy Cattle, Crossbreeding, Heterosis

93 Comparison of the production, liveweight, feed intake, health and reproductive performance of Holstein and Jersey Holstein crossbred cows in Australian pasture-based herds.
M. Pyman*[1], M. Auldist[2], C. Grainger[2], and K. Macmillan[1], [1]*University of Melbourne*, *Werribee, Victoria, Australia*, [2]*University of Melbourne*, *Ellinbank, Victoria, Australia*.

Introduction of Holstein genetics into Australia has resulted in significant milk yield gains and a higher proportion of Holstein cattle (83%) at the expense of the Jersey (12%) and the Jersey x Holstein (JxH) crossbred (5%) based on 2003 figures. This is in direct contrast to New Zealand, where the national herd in 2002 comprised 48% Holsteins, 16% Jerseys and 35% JxH crossbreds.

There is little information on how crossbreds perform under Australian conditions although the New Zealand literature shows substantial and highly profitable benefits attributable to crossbreeding.

In this study an extensive assessment of crossbreeding was undertaken to provide direction on the profitability of crossbreeding under Australian seasonal calving conditions.

Assessment of the Australian Herd Improvement database showed the geometric mean somatic cell count for Holstein cows to be consistently higher compared to crossbreds throughout the lactation. In addition, the backcross Holstein x (Jersey x Holstein) cow outsurvives other breed types by at least 8%, nearly a full lactation beyond the fifth lactation, indirectly indicating superior reproductive performance, health and sustainability.

Data was also collected from 1300 straight and crossbred cows during a single lactation in 2003/2004. Reproductive parameters, milk yield and the liveweight of 400 cows were measured to compare breed differences under pasture-based seasonal calving conditions. Preliminary results indicate that the 39kg heavier Holsteins produced 2.1kg/cow/day more milk despite yields of fat and protein generally being not significantly different between the breeds. Furthermore, the reproductive performance of the crossbreds was superior, as measured by 6-week in-calf rate, the percentage of cows pregnant 6 weeks after mating start date (absolute difference of 15%, $p < 0.05$).

Acknowledgements: The study gratefully acknowledges the support of the Gardiner Foundation, the National Herd Improvement Association, GippsDairy and the University of Melbourne.

Key Words: Crossbreeding, Fertility, Sustainability

94 Birth weights, mortality, and dystocia in Holsteins, Jerseys, and their reciprocal crosses in the Virginia Tech and Kentucky crossbreeding project.
B. Cassell*[1], A. McAllister[2], R. Nebel[1], S. Franklin[2], K. Getzewich[1], J. Ware[2], J. Cornwell[1], and R. Pearson[1], [1]*Virginia Polytechnic Institute and State University*, *Blacksburg*, [2]*University of Kentucky*, *Lexington*.

Calves from crosses of Holstein and Jersey breeds were first born beginning June, 2003 at Virginia Tech and the University of Kentucky. Four Holstein and four Jersey bulls have been used as foundation sires at both facilities with matings to purebred dams to control inbreeding in offspring. Heterospermic inseminates of one Holstein and one Jersey bull initiated the project and provided data for a fertility trial. Data through early 2005 include 197 births at Virginia Tech and 99 births at the University of Kentucky. Dystocia scores (1-5) and birth weights were recorded at birth, and mortality was recorded (alive 0 or dead 1) at 48 hours. Dystocia scores of 1-5 were assigned to 79, 5, 11, 5, and 0.3% of births and death by 48 hours occurred in 10.5% of births. Birth weights averaged 36.0 kg (SD 15.4 kg). A fixed model analysis of the three traits considered effects of station, breed group (HH, HJ, JH, and JJ with breed of sire listed first), parity number 1-8 of the dam (67% lactation 1 and 2), sex, and twin status (7.4% twins) of the birth. For birth weights, all effects except station were significant ($P<0.05$), with least squares means of 38.5, 29.4, 31.3, and 22.5 kg for HH, JH, JH, and JJ breed groups. Birth weights were larger for single births to male calves from multi-lactation dams. Dystocia results from the linear model showed significant ($P<0.05$) effects for all terms including station with higher dystocia scores for male HH calves, born in twin births to first lactation dams at Kentucky. Mortality differences from the linear model were significant (higher) only for twin births. Logistic regression analysis of dystocia with scores 3-5 recoded as problem births revealed higher odds ratios for problem births in HH, HJ, and JH (in descending order) versus JJ calves. Heifers and single births faced significantly lower odds of difficult birth. Only twin status significantly affected mortality in logistics regression, with single births only 4.7% as likely to die in 48 hours as twins.

Key Words: Crossbreeding, Dystocia, Mortality

95 Crossbreds of Normande-Holstein, Montbeliarde-Holstein, and Scandinavian Red-Holstein compared to pure Holsteins for production during the first 150 days of first lactation.
B. J. Heins, L. B. Hansen*, and A. J. Seykora, *University of Minnesota*, *St. Paul*.

Normande-Holstein crossbreds (n = 231), Montbeliarde-Holstein crossbreds (n = 468), and Scandinavian Red-Holstein crossbreds (n = 305) were compared to pure Holsteins (n = 419) for milk, fat, and protein production during the first 150 days of first lactation. Cows were housed in seven commercial dairies in California and calved from June 2002 to December 2004. Dependent variables for analysis were test-day observations from DHI. All Holstein sires and all Holstein maternal grandsires were required to have an NAAB sire code to assure they were A.I. sires. Normande, Montbeliarde, and Scandinavian Red crossbreds were all daughters of A.I. sires via imported semen. Independent variables were breed (H, NxH, MxH, SxH), random effect of sire within breed, random effect of cow within sire and breed, stage of lactation (4-30 d, 31-60 d,

61-90 d, 91-120 d, 121-150 d), herd-year-season (3-mo seasons within the seven herds), age at calving (linear, months), and PTA of Holstein maternal grandsire (linear). Cows that had test day observations that were 3x-milking were pre-adjusted to 2x-milking using USDA-AIPL adjustment factors. Least squares means for fat plus protein were 1.97 kg (H), 1.83 kg (NxH), 1.94 kg (MxH), and 2.01 kg (SxH). Normande-Holstein crossbreds had significantly (P<.01) lower production (-7%) than pure Holsteins. Montbeliarde-Holstein (-1%) and Scandinavian Red-Holstein (+2%) crossbreds were not significantly different than pure Holsteins for production.

Key Words: Crossbreeding, Production, Hybrid Vigor

96 Crossbreds of Normande-Holstein, Montbeliarde-Holstein, and Scandinavian Red-Holstein compared to pure Holsteins for dystocia and stillbirths. B. J. Heins*, L. B. Hansen, and A. J. Seykora, *University of Minnesota*, *St. Paul*.

Holstein, Normande-Holstein, Montbeliarde-Holstein and Scandinavian Red-Holstein crossbred cows calving from June 2001 to August 2004 were compared for dystocia and stillbirths from seven California dairies. Dystocia scores were 1, 2, 3 (no calving difficulty) and 4, 5 (calving difficulty), and stillbirths scores were 1 (alive) and 0 (dead). Effects of calf sex, age at calving and herd-year-season were included in the general linear model. For the effect of breed of sire, 1769 first-parity Holsteins were bred to Holstein (n=31), Montbeliarde (n=22), Brown Swiss (n=13), and Scandinavian Red (n=17) sires. Calf sex and herd-year-season were included in the model and had significant effect (P<.01). Dystocia rates were 16% (H), 12% (M), 11.9% (BS) and 5.5% (SR). Stillbirth rates were 15.7% (H), 13.2% (M), 12.0% (BS), and 7.9% (SR). Scandinavian Red sires had significantly (P<.01) less dystocia and fewer stillbirths than Holstein sires. For 2nd to 5th parity Holstein dams, cows were bred to Normande sires in addition to the other breeds. Dystocia rates were 7.7% (H), 9.1% (N), 5.7% (M), 5.4% (BS) and 2.6% (SR). Stillbirth rates were 11.8% (H), 6.5% (N), 4.4% (M), 4.9% (BS), and 4.2% (SR). Scandinavian Red sires had significantly (P<.01) less dystocia than Holstein, Montbeliarde, and Normande sires. All breeds of sire other than Holstein had significantly (P<.01) fewer stillbirths than Holstein sires. For the effect of breed of dam, 1398 first-parity Holsteins, 269 Normande-Holstein, 370 Montbeliarde-Holstein, and 264 Scandinavian-Holstein cows were bred to Brown Swiss (n=15), Montbeliarde (n=26), and Scandinavian Red (n=17) sires. Mean dystocia rates for breed of dam were 9.3% (H), 9.2% (MxH), 8.1% (MxH) and 4.7% (SxH). For stillbirth rate, least squares means were 11.8% (H), 7.8% (NxH), 7.1% (MxH) and 4.9% (SxH). Scandinavian Red-Holstein crossbred cows had significantly (P<.10) less calving difficulty and significantly (P<.05) fewer stillbirths than pure Holsteins at first calving.

Key Words: Crossbreeding, Dystocia, Stillbirths

97 Crossbreds of Normande-Holstein, Montbeliarde-Holstein, and Scandinavian Red-Holstein compared to pure Holsteins for days to first breeding, first service conception rate, days open, and survival. B. J. Heins*, L. B. Hansen, and A. J. Seykora, *University of Minnesota*, *St. Paul*.

First-lactation Normande-Holstein, Montbeliarde-Holstein, and Scandinavian Red-Holstein crossbred cows were compared to pure Holsteins for days to first breeding, first service conception rate, days open, and survival. Cows were in seven commercial dairies in California and calved from June 2002 to October 2004. Holstein cows were required to have sires with a NAAB code to assure they were sired by A.I. sires. Normande, Montbeliarde and Scandinavian Red crossbreds were all daughters of A.I. sires via imported semen. For days open, cows having greater than 250 days open were truncated to 250 days and cows were required to be at least 250 days in milk. Adjustment was made for herd-year-season. PROC GLM of SAS was used to analyze phenotypic differences. Least squares means for days to first breeding were 69(H), 62(NxH), 65(MxH), and 66(SxH). First service conceptions rates were 22%(H), 35%(NxH), 31%(MxH), and 30%(SxH). Least squares means for days open were 150(H), 123(NxH), 131(MxH), and 129(SxH). Normande-Holstein, Montbeliarde-Holstein and Scandinavian Red-Holstein crossbreds cows had fewer days to first breeding (P<.01), higher first service conception rates (P<.01), and fewer days open (P<.01) than pure Holsteins. Three measures of survival were used; survival to 30 days, 150 days, and 305 days postpartum. For survival to 30-d postpartum, 692 Holsteins were compared to 465 Normande-Holstein, 655 Montbeliarde-Holstein, and 434 Scandinvaian-Holstein crossbred cows. Least squares means for survival to 30 days were 95%(H), 98%(NxH), 98%(MxH), and 98%(SxH); for survival to 150 days were 91%(H), 96%(NxH), 96%(MxH), and 96%(SxH); and for survival to 305 days were 86%(H), 93%(NxH), 92%(MxH), and 93%(SxH). All crossbred breed groups survived significantly longer (P<.05) than pure Holsteins during first lactation.

Key Words: Crossbreeding, Survival, Days Open

Ruminant Nutrition: Dairy—Grazing

98 Genotype and feed effects on BW and BCS profiles for grazing dairy cows. J. R. Roche*[1], D. P. Berry[2], and E. S. Kolver[1], [1]*Dexcel*, *Hamilton, New Zealand*, [2]*Teagasc Moorepark*, *Ireland*.

To determine the effect of genotype and concentrate supplementation on BW and BCS (scale 1-10) lactation profiles, fortnightly data across 113 lactations from 2002 to 2004 were analyzed. New Zealand (NZ) and North American (NA) cows of equal estimated genetic merit for milk production were randomly allocated to three levels of concentrate supplementation (0, 3 or 6 kg DM/cow/d) on a basal pasture diet. The Wilmink exponential model ($Y_{DIM} = a+b*e^{(-0.05*DIM)}+c*DIM$) was fitted within lactation. Days to nadir were calculated by setting the first derivative of the function to zero, defining nadir as the corresponding value for that day. The function explained 73 and 62% of the variation in BW and BCS, respectively. There was a tendency (P<0.1) for NZ cows to reach BW (9d) and BCS (12d) nadir earlier. Concentrate supplementation tended (P<0.1) to shorten postpartum interval to nadir BW. New Zealand cows had a lower BW(P<0.001) but were in greater (P<0.001) BCS at nadir. Nadir BCS increased (P<0.01) with each increment of supplementation. New Zealand cows lost less BW (P<0.001) and BCS (P<0.1) between calving and nadir. Supplementation with concentrates reduced (P<0.1) the amount of BCS lost postpartum, but did not affect BW change. The *a* parameter (height of the curve) for BW and BCS was lower and higher, respectively, for NZ cows compared with NA cows (P<0.05). Feeding system did not affect the height of either BW or BCS curves. The *b* parameter (pre-nadir phase) for BW was affected (P<0.001) by genotype; the rate of postpartum decline being less in NZ cows. The *c* parameter (post-nadir phase) for BW was not affected by genotype, but rate of BW gain in cows offered 6 kg DM concentrates/d (0.39 kg/d) was greater (P<0.001) than cows offered 0kg DM/d (0.24kg/d) or 3kg DM/d (0.27kg/d). The NZ cows gained more (P<0.001) BCS post-nadir ($4.7x10^{-3}$ units/d) than NA cows (2.2x10}$^{-3}$ units/d). Rate of BCS replenishment increased (P<0.001) with concentrate supplementation from $1.9x10^{-3}$ at 0 kg DM/d to $3.1x10^{-3}$ and $5.3x10^{-3}$ units/d at 3 and 6 kg DM/d concentrates, respectively. No significant genotype by environment interactions were found.

Key Words: Pasture-based, Genotype × Environment, Body Condition Score

99 Genotype and feed effects on annual milk production and reproduction of grazing dairy cows. E. S. Kolver*, C. R. Burke, and J. R. Roche, *Dexcel Ltd.*, *Hamilton, New Zealand*.