Canadian TwoPlus Project Report: Crossbreeding To Norwegian Red (NRF) Sires Improves Calving Ease, Reproduction, Survival and Maintains Production

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The TwoPlus research study was initiated by an AI Industry group led by Gencor Inc., Westgen Inc. and EBI Inc, the Semex Alliance, and Geno Global, Norway, with support from an Agriculture Canada CanAdvance grant. It was called TwoPlus, as it was envisaged to be a two-breed rotational crossing program using Holsteins and Norwegian Reds.

Crossbreeding is a tool that can be used in dairy production to eliminate the effects of rising levels of inbreeding in purebreds in order to reduce calving problems, improve fertility, maintain production, improve disease resistance, and increase survival. The breeding goal for Norwegian Reds has emphasized these traits over many decades compared to North American Holsteins, so the breed complements the Canadian Holstein and was chosen to provide positive improvement for these low heritability traits as well as hybrid vigour. By definition, all crossbred F1 animals are not inbred, i.e., the parents are not related.

The Norwegian Red complements the Holstein and a two-breed rotation would provide 67% of maximum hybrid vigour and also provide genes in the crossbreds which the Holstein breed needs, i.e. genes for calf liveability, fertility of females, mastitis and other disease resistance, survival and high milk solids yields. Semen from 10 Norwegian Red (NRF) sires was imported from Norway beginning in 2003, and used in 70 dairy herds in Ontario and Western Canada. Data on fertility, calving ease and stillbirths, production, health and conformation have been collected by Canwest DHI, and Holstein Canada, which registered all F1 heifers. Data on Norwegian Red x Holstein (NRF x HO) F1 heifers and their Holstein (HO) herd-mates were received from the project herds, after editing by the CDN, and analysed at the Centre for Genetic Improvement of Livestock, University of Guelph.

Matings between Norwegian Red elite AI proven sires and purebred Holstein dams aimed at getting 20 NRF x HO heifers per herd in 60 or more herds. Numbers of records and other details for the study are shown in Table 1. The total number of crossbred heifers was 1018 in 61 herds that were still on the project after 5 years. Immune responses of a subset of the NRF x HO and HO heifer calves and first lactation cows were also compared in a separate study. These results will be reported separately.

EARLY EXPERIENCE WITH NRF SIRES & CALVING EASE

In November, 2006, the Canadian Dairy Network summarized the 56-day Non-Return Rates (NRR) for 1623 AI matings of Holstein females to the first 6 imported Norwegian Red sires. Overall NRR % was 65.7 % for all services, compared to an NRR of 58.5 % when Holstein females were bred to Holstein service sires in the same herds and months, for a 7.2 % advantage for breed crossing matings. The 697 first services of Norwegian Red sires to Holstein females yielded 70.2 % NRR vs. 60.6% NRR for the 4,902 first services of Holstein sires to Holstein mates in the same herds and months, for an advantage

of nearly 10 % on first services.

When the first calves by Norwegian Red sires began to arrive in 2006, the Canadian Dairy Network made an analysis of Calving Performance records in the herds that calved out both HO x HO matings and NRF x HO matings from January 2006 through October 2007, analysing a total of 15,820 HO x HO calvings and 859 NRF x HO calvings. The Norwegian Red service sires, when mated to Holstein yearling heifers gave 93% live calves at birth, vs. 88.1 % live calves when Holstein service sires were mated to yearling Holstein heifers, an advantage of 5.6 % more live calves. The NRF x HO calves were smaller; 7.7% more of the calves were categorized as small, and 6.3% more of the NRF x HO calvings were unassisted or unobserved. In second and later parity calvings 95.4 % of the NRF x HO matings produced live calves vs. 94.3% for HO x HO matings. Taken overall the crossbred calvings produced 2.4% more live calves at birth, with 2.4 % more unassisted / unobserved calvings, which means more heifers to rear or sell and less labour use at calving time.

FERTILITY AND CALVING PERFORMANCE

Reproduction ability of the NRF x HO yearling heifers and their calving and reproductive performance in first lactation were compared to their HO herd-mates in the project herds (Tables 2, 3, and 4).

As yearling heifers, the NRF x HO heifers were first bred 7 days earlier than their HO herdmates, and their non-return rate was 81.8% compared to 76.6% for HO yearling heifers. Thus, the NFR x HO heifers had slightly fewer inseminations, and their interval from first service to conception was about 2 days less than for HO heifers. Gestation length was 2 days shorter for NRF x HO heifers (Table 2).

When the heifers calved for the first time, the NRF x HO heifers gave a 8.3% higher percentage of unassisted calvings than HO heifers, and 5.3% lower stillbirth rate. This was likely due to the slightly smaller size of the calves compared to calves from HO heifers (Table 3).

During the breedings in the first lactation, NRF x HO heifers had an 11.1% higher non-return rate, slightly fewer services, but a little longer intervals from calving to first service, and first service to conception than HO heifers. Their subsequent gestation lengths were essentially equal with no differences in calving ease or calf size, but NR x HO heifers gave 4.3% lower stillbirth rates (Table 4).

The NRF x HO female clearly has a fertility and calving advantage over HO heifers, which were factors in the choice of Norwegian Reds for this project. The long history of Norway to select for higher fertility/reproduction and the possible deleterious effects of inbreeding levels in Holsteins, give the NRF x HO crossbred a distinct advantage over purebred HO in this area.

PRODUCTION LEVELS IN FIRST LACTATION

Test day records for milk, fat, protein, and somatic cell score were analyzed for all NRF x HO heifers, in comparison to their Holstein herd-mates in the project herds (Table 5). Data were analyzed via a test day model similar to that for regular sire and cow genetic evaluations in Canada, but records were not adjusted for the impact of pregnancy on production.

NRF x HO heifers had slightly, but not significantly, lower yields of milk and protein, as well as slightly, but not significantly, higher yields of fat through 305 days, compared to their HO herd-mates. Similarly, there was no significant difference between the NRF x HO heifers in their 305 day yields of milk and protein, with HO higher by 361 kg of milk and 2.6 kg protein, and NRF x HO higher by 2.5 kg of fat. There were no significant differences between NRF x HO heifers and HO herd-mates for somatic cell score throughout the lactation, although the NRF x HO crosses had lower SCS at the start and end of their lactations (Figure 1).

CONFORMATION PERFORMANCE

Heifers were scored for conformation on the All-Breeds classification system in Canada, using Holstein classifiers and Holstein breed standards. There were no existing standards for classification of crossbred animals. The measurement data were deemed appropriate for comparisons between NRF x HO heifers and their HO herd-mates, but subjective traits will naturally favour purebred HO because crossbred animals are different in appearance. Table 6 contains the comparisons for measured and subjectively scored traits.

The NRF x HO heifers were approximately 2” shorter at the hip, and their pin width was slightly narrower. Udders were slightly deeper, being 3/4” closer to the point of their hocks, and the rear udder attachment height and width were also reduced by 1/2” and 1/4”, respectively. In many commercial dairy operations, a medium sized cow is preferred. The NRF x HO crossbred heifers are comparable to medium-sized Holstein cows, and considerably larger than Jersey x HO heifers.

While the measured traits did not show great differences between breeds, the subjectively scored traits clearly favoured purebred Holsteins (Table 6). Crossbred animals scored significantly lower for three of the four major categories (dairy strength, rump, and mammary system) as well as for median suspensory ligament. The NRF x HO heifers were lower set, and carried more flesh throughout their lactation so they scored lower for dairy strength or character. The USDA places negative emphasis on stature and dairy character in ranking sires for $ Net Merit, but not in Canada. Dairy producers must decide if taller, sharper heifers are desired. Lower scores for udder and rump are directly related to the measurement data. Consequently crossbreds were significantly lower for final score. There were no significant differences between NRF x HO and HO for feet and legs, fore udder attachment, or locomotion. The crossbreds were slightly smaller, and the Holstein standards favour larger cows.

In a commercial setting, crossbred animals would likely not be classified because their scores do not help them to increase their value as a potential sale to another producer. However, the crossbreds were classified in this project to obtain a complete picture relative to HO counterparts.

SURVIVAL

The CDN reported in 2007 that 5% more live NRF x HO calves were born alive from first calf HO heifers and 1% more were born from later parity HO cows in the TwoPlus study. In a herd with 30% heifers calving for the first time and 70% older cows calving, the advantage in extra live calves at birth is then 2.2%.

Survival of the NRF x HO female calves from birth to first breeding was about 6.8% higher than for Holstein female calves. Subsequently, survival of NRF x HO yearlings from first breeding to first

calving was 10.9% more than HO yearlings. Combined that means from birth to first calving there were 20% more NRF x HO females remaining than HO females (Table 7). This survival reflects liveability, desire to live, and fewer problems for the producer. There would be greater returns from the investment in the crossbreds than in the HO from the greater survival rate.

Survival to second and later lactations is not yet known, nor the ability of the udders of the crossbred animals to hold up in the next lactation. Survival data through 2nd and 3rd lactations will determine if the crosses are truly profitable in all aspects of dairy production.

OTHER ANALYSES OF CROSSBRED DATA

Data from the TwoPlus herds were combined with data from Canadian non-project herds which had been experimenting with crossbreeding using sires of other dairy breeds on HO dams, with birthdates from 2003 onwards. All F1 heifers were compared to their Holstein first lactation herd-mates. There were sufficient numbers of Ayrshire (94), Brown Swiss (224), Jersey (240) and Norwegian Red (408) F1 heifers with test day records and plenty of Holstein herd-mates (61,436) to afford accurate comparisons for milk, fat and protein yields. All of the F1 heifers out of Holstein dams had comparable fat and protein production with their HO herd-mates, based on average test day and 305-day records. All but the Jersey X Holstein F1's were above the HO herd-mates in milk yield. The four F1 heifer groups produced between 2 kg and 14 kg more than their Holstein herd-mates for 305 day protein yield, and between 10 kg and 16 kg more for 305 day fat yield. Three of the four breed crosses, excluding the Jersey F1's, exceeded their Holstein herdmates by between 50 and 205 kg for milk yield at 305 days in first lactations (Results not shown).

Survival from birth to first breeding, and from first breeding to first calving were significantly superior for NRF x HO heifers, while JE x HO F1's had significantly reduced survival to first breeding compared to HO herd-mates. Incentives were offered for all NRF x HO heifers when they completed a milk record of 3 or more months, but not for other crossbred animals. The incentives of $25.00/heifer record for the crossbreds may have affected survival rates to first and second calving, but are not different from incentives paid for daughters of young purebred HO sires in progeny testing. Some producers have indicated that the $25 incentive was a non-factor in their decision to keep or cull an animal.

CONCLUSIONS

Results to date indicate that crossbreeding may be a profitable alternative for commercial dairies. A number of Canadian dairy breeds could complement the high producing Canadian Holstein for health, reproduction, milk solids yield, survival and vitality. The Norwegian Red breed has been effectively selected with heavy emphasis on calving ease, calf liveability, female reproduction, health traits, udders and feet and legs conformation and solids yield for over 30 years. The future direction for the TwoPlus project will look at evaluating and comparing crossbreds and purebreds for survival, milking speed, and temperament, as well as production and reproductive performance in later lactations.

Crossbreeding of purebred HO females to any other breed of sire will immediately reduce inbreeding levels to zero in the F1 cross and eliminate problems associated with inbreeding depression. However, crossbreeding, as a total package, can also provide financial benefits in terms of improved fertility,

fewer calving problems, better disease resistance, higher survival and with no significant decrease in milk production. Choosing non-HO sires for crossing to HO females should use the same degree of care as choosing HO sires. This report presents the advantages of using Norwegian Red genetics. Crossbred animals are not going to win in the show ring nor bring large prices for individual animals at auctions, but through their performance may prove to be very profitable for commercial enterprises.

Table 1. Numbers of herds, sires, calves, and records collected in TwoPlus Project Herds as of Dec./09.

Item	**Norwegian Red**	**Holstein**
Herds	79	79
Sires	7	1156
Female calves produced(2003-2008) with known dams	1018	16,091

Table 2. FERTILITY DIFFERENCES BETWEEN NRF x HO AND PUREBRED HO YEARLING HEIFERS.

Item	**Norwegian Red, NRF**	**Holstein, HO**	**NR - HO**
Number of females	419	3,600	
Age at first service, days	478	485	-7
Non-return rate %	81.8	76.6	+5.2
Number of services	1.42	1.54	-.12
First service to conception, days	15.4	17.6	-2.2
Gestation length	277	279	-2

Table 3. CALVING EASE DIFFERENCES BETWEEN NRF x HO AND PUREBRED HO HEIFERS AT FIRST CALVING.

Item	**Norwegian Red, NRF**	**Holstein, HO**	**NR – HO**
Number of observations	419	3,600	
Percentages of calvings			
-Unassisted	63.2	54.9	8.3
-Easy pull	27.7	33.3	-5.6
-Hard pull	8.8	11.5	-2.7
-Surgery	0.2	0.2	0.0
Stillbirths	9.2	14.5	-5.3
Calving Ease	1.41	1.52	- 0.11
Calf Size Score	1.93	2.00	-0.07
-Small	0.0	0.1	-0.1
-Below average	20.5	16.1	4.4
-Above average	70.6	68.1	2.5
-Large	8.9	15.8	-6.9

Table 4. FERTILITY DIFFERENCES BETWEEN NRF x HO AND PUREBRED HO HEIFERS DURING FIRST LACTATION AND 2nd LACTATION CALVING PERFORMANCE

Item	**Norwegian Red, NRF**	**Holstein, HO**	**NR - HO**
Herds	60	60	
Animals	117	3,036	
Non-return rate %	69.4	58.5	+11.1
Number of services	1.67	2.00	-0.33
Calving to First Service, days	81.7	80.1	+1.6
First service to conception, days	37.4	33.9	+3.5
Gestation length, days	279.8	279.2	+0.6
Calving ease score (1-4)	1.31	1.37	-0.06
Stillbirth %	1.6	5.9	-4.3
Calf size (1-4)	2.0	2.1	-0.1

Table 5. FIRST LACTATION PRODUCTION DIFFERENCES BETWEEN NRF x HO AND PUREBRED HO.

Item	Norwegian Red, NRF	Holstein, HO	NR - HO
Heifers	154	1964	
Sires	7	551	
305-d Milk, kg	9521	9882	-361 ns
305-d Fat, kg	334	332	+2 ns
305-d Protein, kg	291	294	-3 ns
Somatic cell score			ns

ns = not statistically significant

Figure 1 Test day Somatic Cell Score trends for NRF x HO and purebred HO Heifers in first lactation

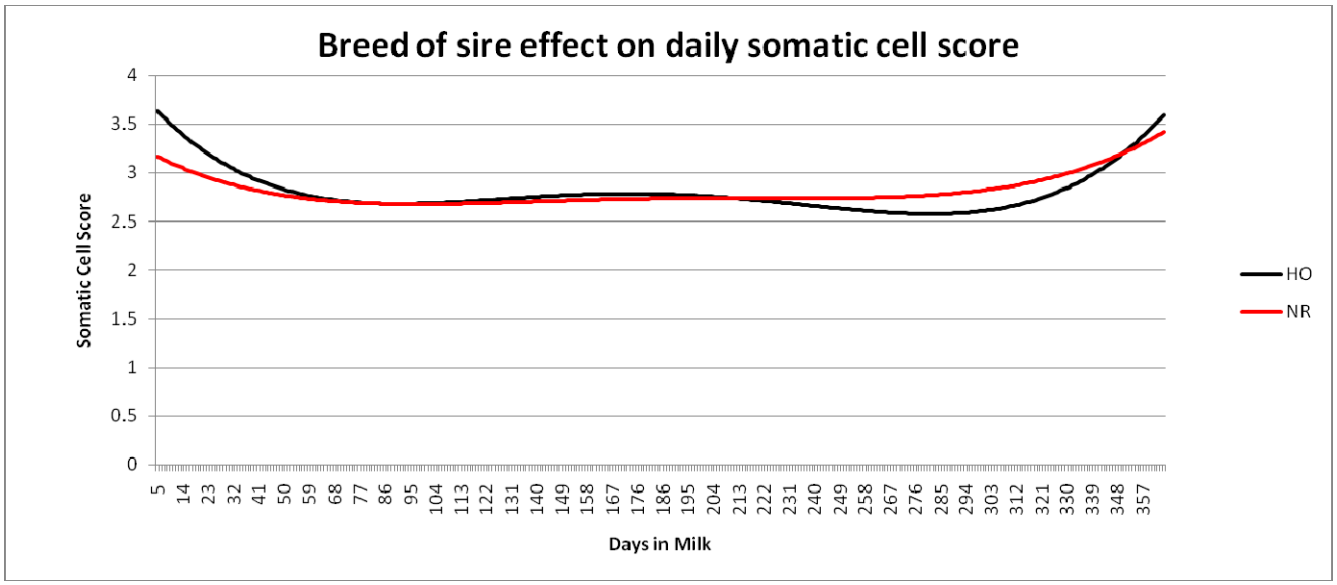

Table 6. TYPE CONFORMATION DIFFERENCES BETWEEN NRF x HO AND PUREBRED HO HEIFERS IN FIRST LACTATION.

Item	**Norwegian Red, NRF**	**Holstein, HO**	**NR-HO**
Classified heifers	254	2936	
Measured traits			
-Rump angle	-4.5	-4.2	-0.3
-Pin width	18.1	18.9	-0.8 *
-Udder depth	8.1	10.0	-1.9 *
-Rear attach height	23.4	22.3	+1.1 *
-Rear attach width	12.8	13.4	-0.6 *
-Teat length	3.6	3.7	-0.1
-Stature	142.9	147.3	-4.6 *
Subjective traits			
-Final score	76	78	-2 *
-Dairy strength	76	80	-4 *
-Rump	77	79	-2 *
-Feet & legs	78	79	-1
-Mammary system	75	78	-3 *
-Median suspensory	5.6	5.9	-.3 *
-Fore udder attach.	4.4	4.9	-0.5
-Locomotion	3.4	3.4	0.0

* statistically significant

Table 7. SURVIVAL DIFFERENCES (%) BETWEEN NRF x HO AND PUREBRED HO FEMALES.

Item	**Norwegian Red, NRF**	**Holstein, HO**	**NR-HO**
Birth to first breeding	85.4	78.6	+6.8
First breeding to first calving	82.4	71.5	+10.9