Crossbreeding Dairy Cattle for Improved Milk Production on Dairy Farms

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Why the interest in crossbreeding?

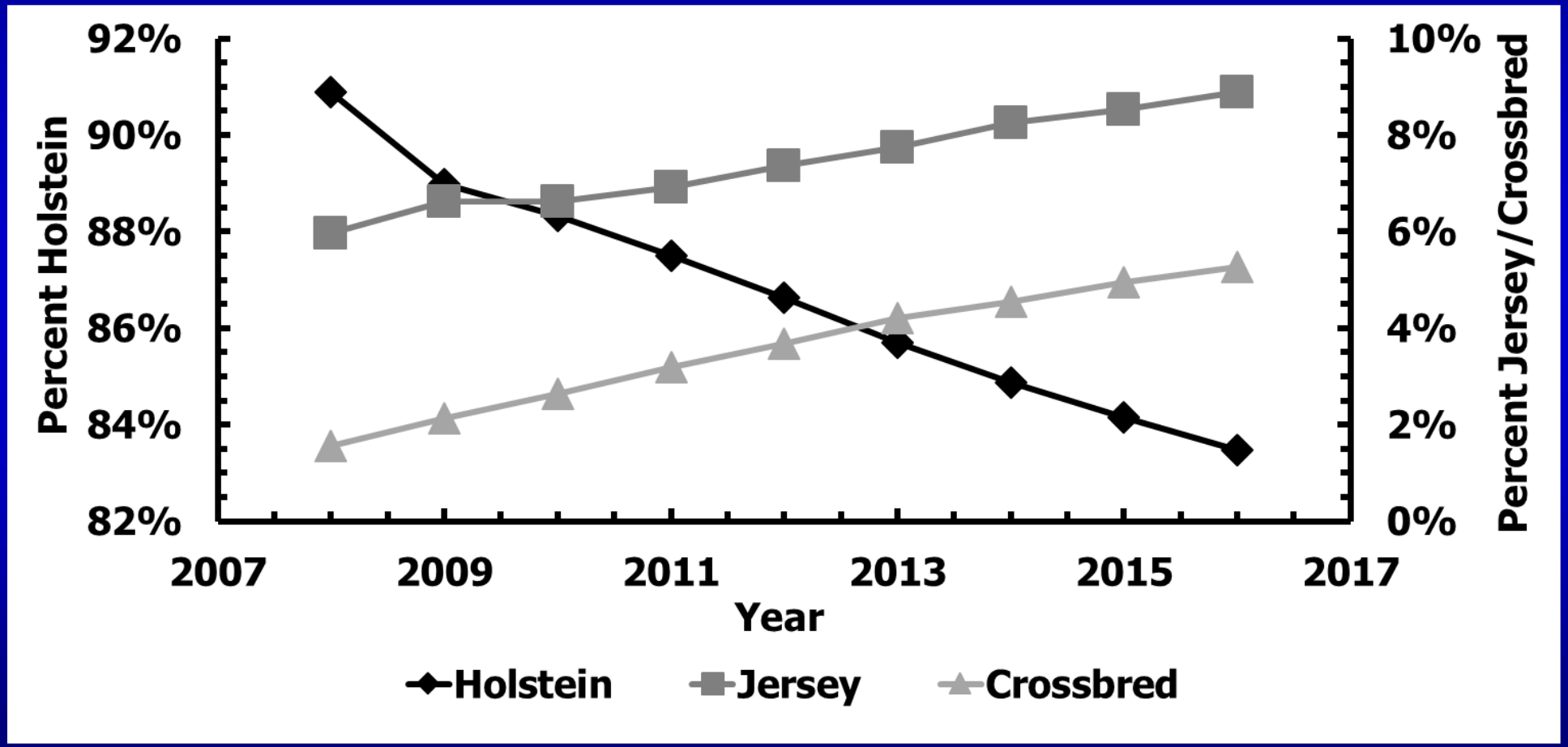
- Calving difficulty continues to hinder first-calf heifers
- Fertility of Holsteins has declined in most environments
- Health problems of Holsteins are more frequent
- More Holsteins are dying on farms (> 8% in USA)
- Cows are calving fewer times during their lives

Inbreeding of the HO breed

Birth years of cows	Average pedigree inbreeding (%)	Average annual increase in inbreeding (%)
2010	5.66	+0.11
2011	5.76	+0.10
2012	5.89	+0.13
2013	6.11	+0.22
2014	6.35	+0.24
2015	6.60	+0.25
2016	6.85	+0.25
2017	7.22	+0.37
2018	7.60	(very early births)

Council on Dairy Cattle Breeding, 2019

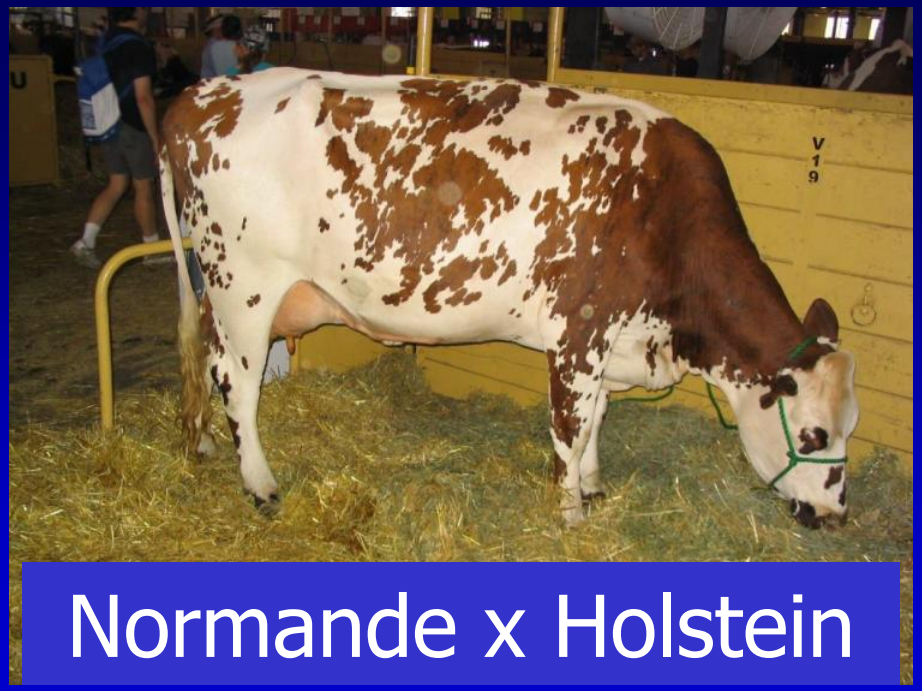
Breed composition of U.S. cows



Norman et al., 2017

The California Crossbreeding Experience

Brad Heins and Les Hansen



Normande x Holstein

Scandinavian Red x Holstein

Montbeliarde x Holstein

Profit per day in the herd
(ignoring differences in health costs)

Trait	Pure Holstein	Normande-Holstein	Montbeliarde-Holstein	Scand. Red-Holstein
Cows	165	168	369	218
Profit per day	€3.69	€3.44	€3.89	€3.83
Difference from Holstein		– €0.25 **	+0.20 **	+0.14 **
% of Holstein daily profit		–6.7 %	+5.3 %	+3.6 %

** p < .01

Comparison of 2-breed crossbred cows sired by Montbeliarde and Viking Red compared with pure Holstein cows during first lactation in high-performance Minnesota dairy herds

Amy Hazel, Les Hansen, Brad Heins

Experimental design

- 8 herds enrolled during 2008
  - All herds committed at least 250 pure Holstein cows
  - In total, 3,550 pure Holstein heifers and cows enrolled
    - 44% bred to Holstein A.I. bulls
    - 28% bred to Montbeliarde A.I. bulls
    - 28% bred to Viking Red A.I. bulls
- 7 herds available for the final analysis
  - 2 herds from the same owner combined in 2016

Number of first lactation cows

Year	Pure Holstein	Montbeliarde × Holstein	Viking Red × Holstein
2010	4	2	1
2011	333	208	238
2012	288	187	190
2013	307	102	101
2014	46	14	10
Total	978	513	540

305-d production of 1st lactation cows

	Breed of cow			
Trait	Holstein	2-breed crosses	MO × HO	VR × HO
Cows	978	1,053	513	540
Age at first calving	23.9	−0.1	−0.1	−0.2
Fat + Protein (kg)	741	+14*	+19*	+8
% Difference from pure HO	–	+2%	+3%	+1%
SCS	2.10	+0.06	+0.07	+0.04

* $P < 0.05$ for difference from Holstein.

Fertility of 1st lactation cows

Trait	Breed of cow			
	Holstein	2-breed crosses	MO × HO	VR × HO
Breed of service sire	Holstein	MO or VR	Viking Red	Montbeliarde
Number of Services (max 5)	2.30 (959)	−0.19** (1,043)	−0.23** (506)	−0.15 (537)
Days open (max 250 d)	125 (901)	−10** (994)	−12** (480)	−8* (514)
Pregnancy rate[1] (%)	28 (901)	+4** (994)	+5** (480)	+3* (514)

[1] Transformation of LS Means for days open

** $P < 0.01$, * $P < 0.05$, † $P < 0.10$ for difference from Holstein.

Survival of 1st lactation cows

Trait	Breed of cow			
	Holstein	2-breed crosses	MO × HO	VR × HO
Breed of service sire	Holstein	MO or VR	Viking Red	Montbeliarde
Survival to 60 DIM (%)	96 (1,033)	0 (1,096)	0 (536)	+1 (560)
Calved again within 14 mo. (%)	63 (1,021)	+8** (1,082)	+9** (530)	+7* (552)
Calved again within 17 mo. (%)	76 (1,021)	+6** (1,080)	+7** (529)	+5† (551)
Survival to 2nd calving (%)	80 (1,014)	+4* (1,080)	+4 (529)	+3 (551)

** $P < 0.01$, * $P < 0.05$, † $P < 0.10$ for difference from Holstein.

Comparison of ProCROSS and Holstein cows for dry matter intake, body weight, cow height, body condition score, production, feed efficiency, income over feed cost, and residual feed intake

Brittany Shonka-Martin, Brad Heins, Les Hansen

Objectives

Compare ProCROSS and Holstein cows for

- **Dry matter intake (DMI)**
- **Production**
- **Body weight (BW)**
- **Cow height**
- **Body condition score (BCS)**

Holstein

Viking Red

ProCROSS

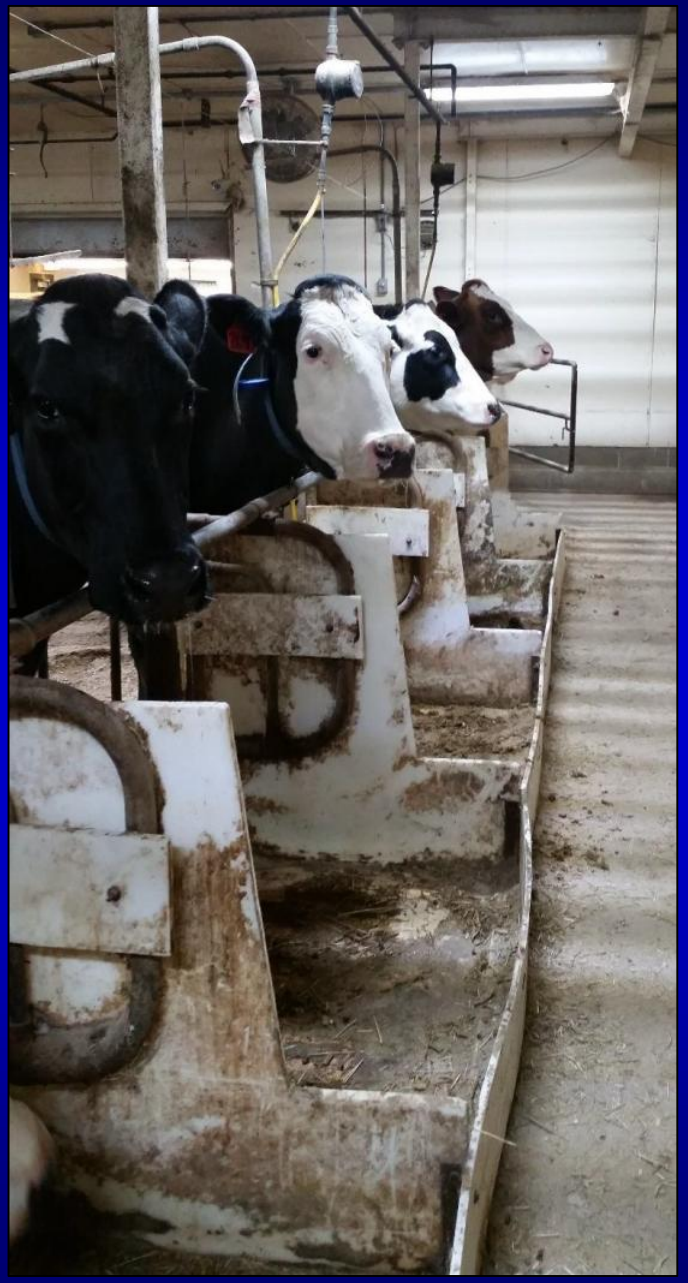
Montbeliarde

Data

- Holstein versus ProCROSS (Holstein, Montbeliarde, Viking Red) cows
- Data collection from 4 to 150 days in milk for the first 3 lactations of cows
- Cows calved for the first time from September 2014 to April 2017
- Cows that left the herd before 150 days in milk were deleted (8.6% of cows that began the project)

Recording of individual feed intakes

- Cows were fed the same TMR on a daily basis
  - Delivered twice daily
  - Feed refusals were weighed once daily
- Feed samples were taken twice weekly
  - Pooled weekly samples analyzed for dry matter content
  - Pooled monthly samples analyzed for nutrient composition



Mean DMI and production from 4 to 150 DIM for primiparous cows

Trait	Breed of cow: Holstein (n = 60)	Breed of cow: ProCROSS (n = 63)	Difference from Holstein
Dry matter intake (kg)	2,948	2,807	–141 (–4.8%) **
Milk volume (kg)	4,770	4,564	–206 (–4.3%) **
Fat + protein (kg)	329	331	+2 (+0.5%)

** $P < 0.01$ difference from Holstein

Mean DMI and production from 4 to 150 DIM for multiparous cows

Trait	Breed of cow		Difference from Holstein
	Holstein (n = 37)	ProCROSS (n = 43)	
Dry matter intake (kg)	3,592	3,360	–232 (–6.5%) *
Milk volume (kg)	6,636	6,264	–372 (–5.6%) *
Fat + protein (kg)	441	445	+4 (+0.9%)

* $P < 0.05$ difference from Holstein

Means for body traits from 4 to 150 DIM for primiparous cows

Trait	Breed of cow		
	Holstein (n = 60)	ProCROSS (n = 63)	Difference from Holstein
Body weight (kg)	556	562	+6
Wither height (cm)	139.4	135.4	–4.0 **
Hip height (cm)	144.3	142.3	–2.0 **
Body condition score	3.20	3.46	+0.26 **

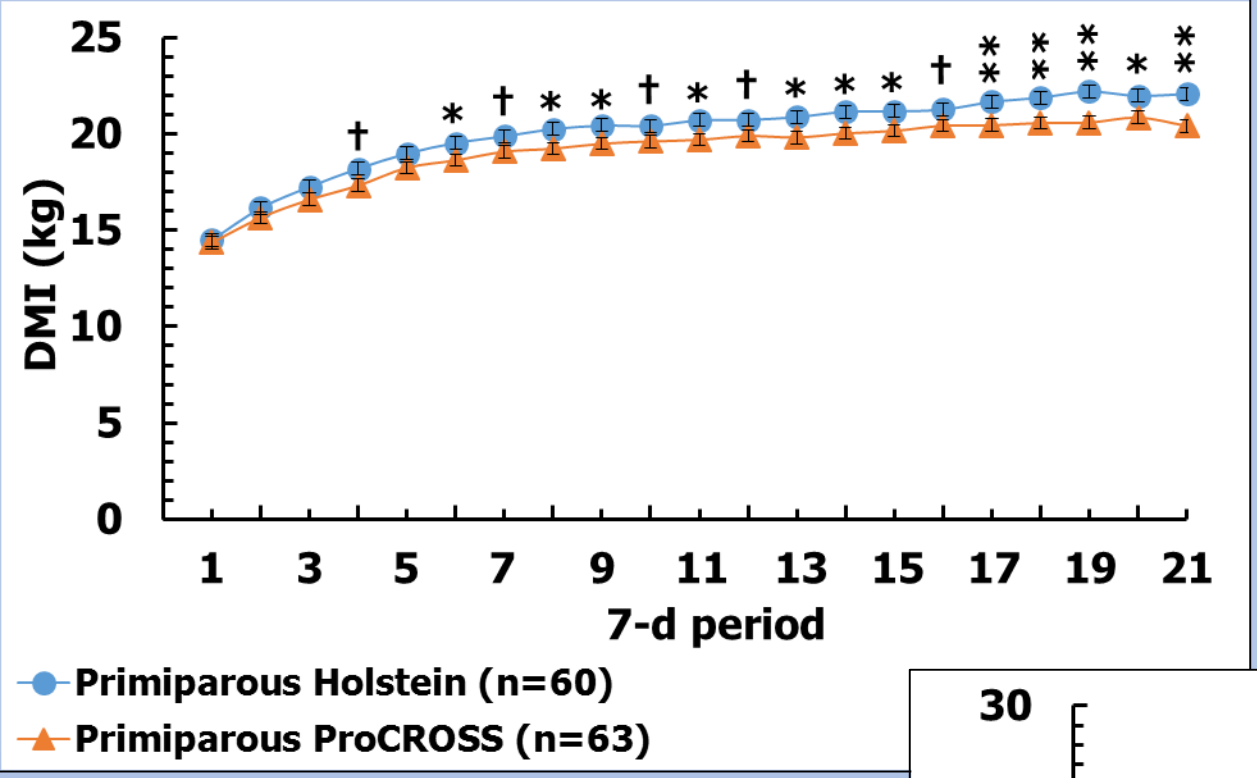
** $P < 0.01$ difference from Holstein

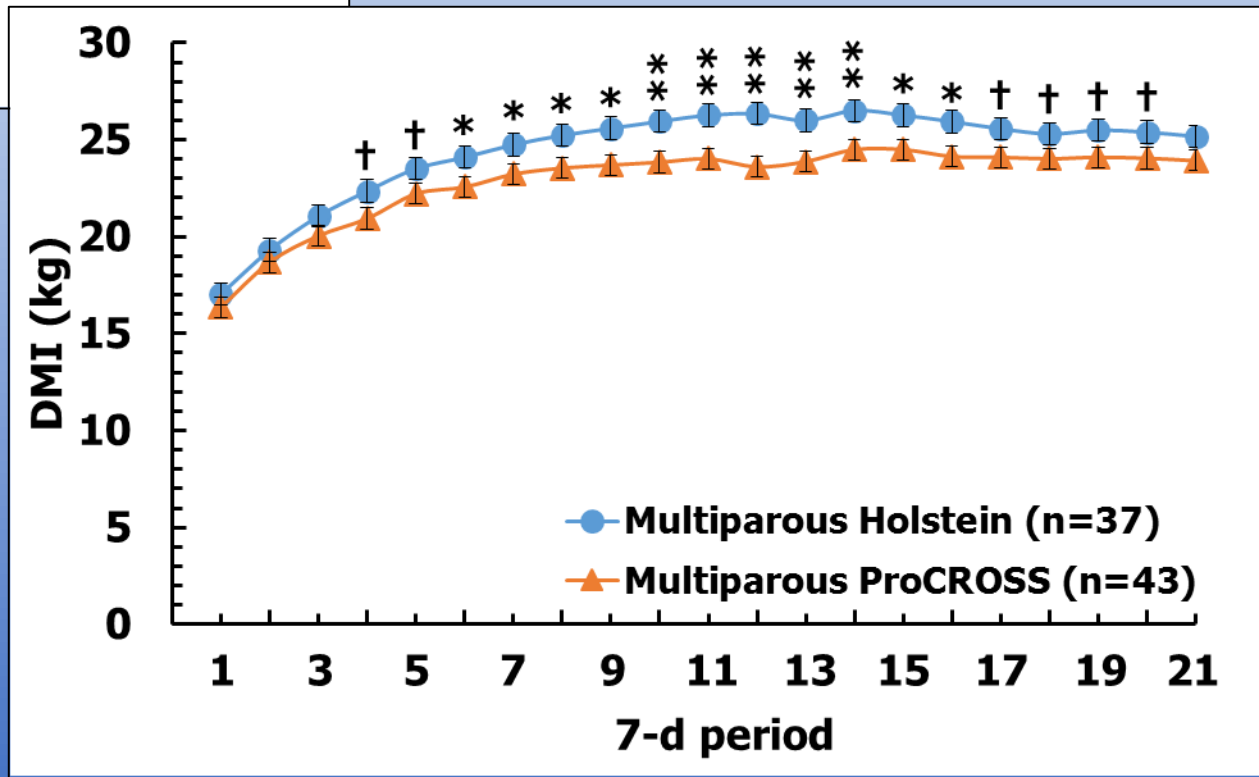
Means for body traits from 4 to 150 DIM for multiparous cows

Trait	Breed of cow		
	Holstein (n = 37)	ProCROSS (n = 43)	Difference from Holstein
Body weight (kg)	644	636	–8
Wither height (cm)	143.7	140.2	–3.5 **
Hip height (cm)	146.4	145.2	–1.2
Body condition score	3.06	3.25	+0.19 **

** $P < 0.01$ difference from Holstein

Dry matter intake (kg)





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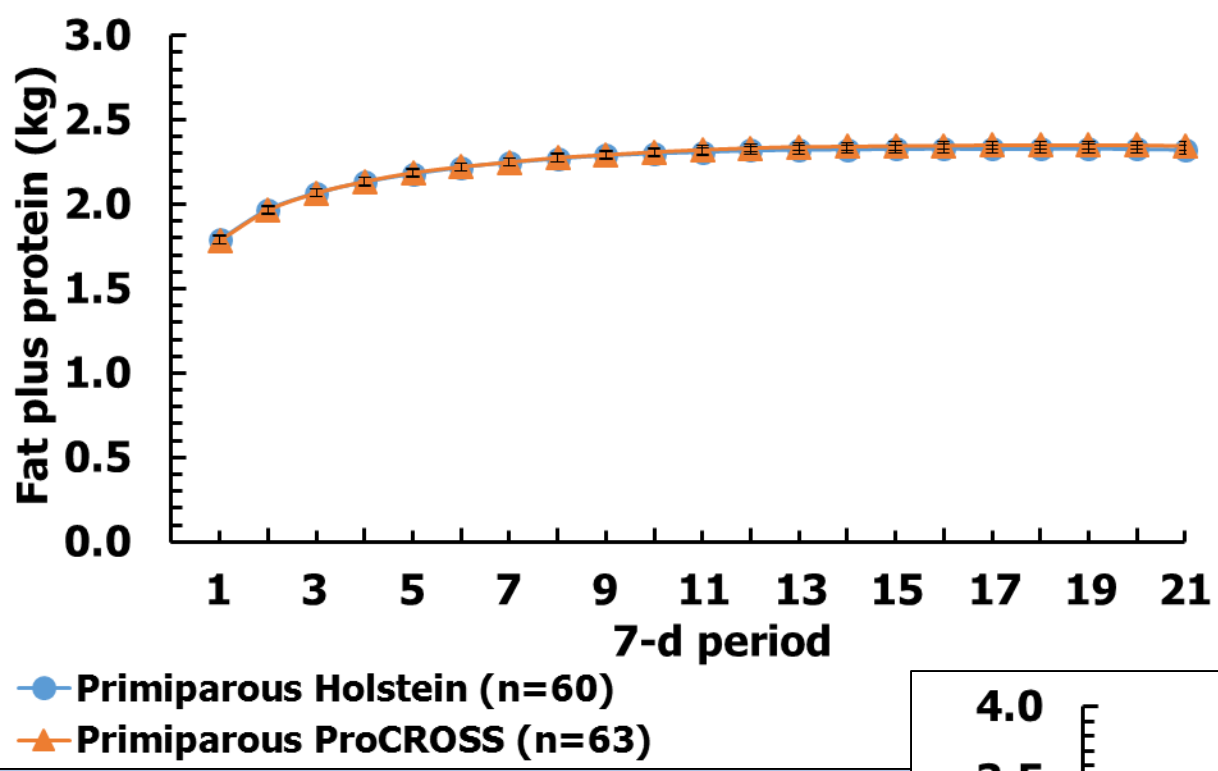
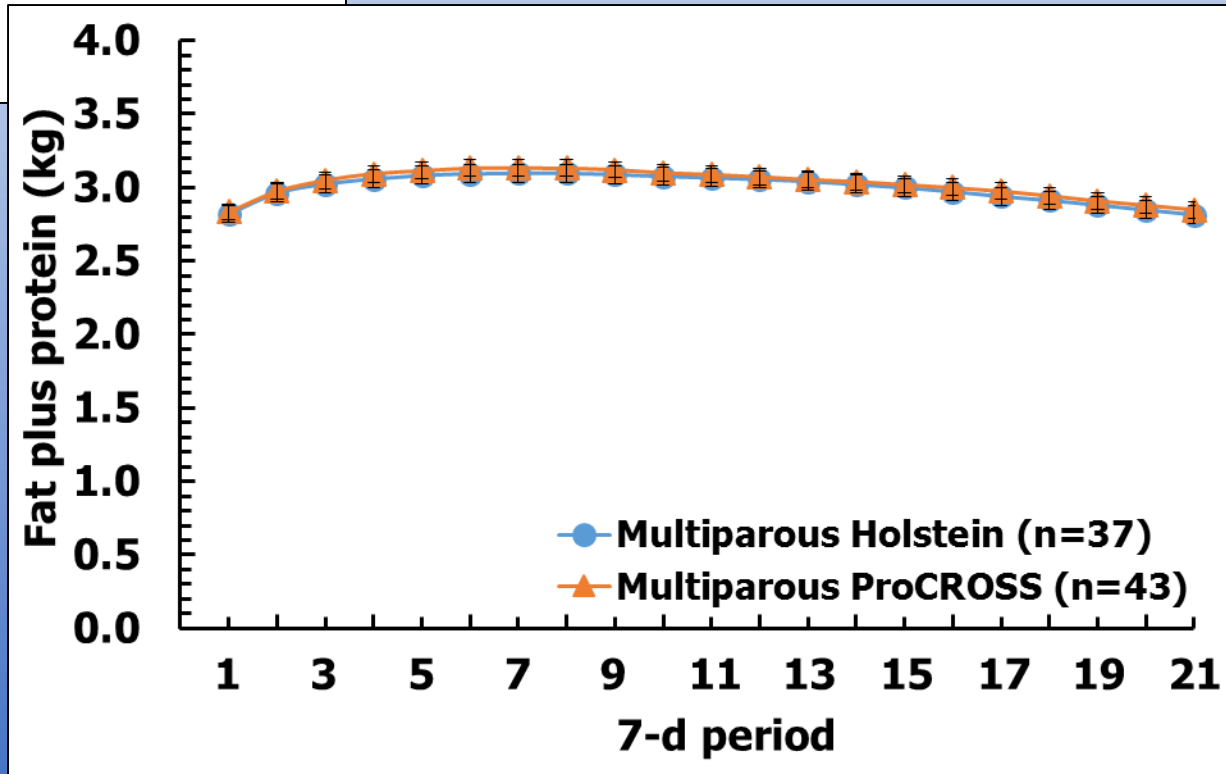
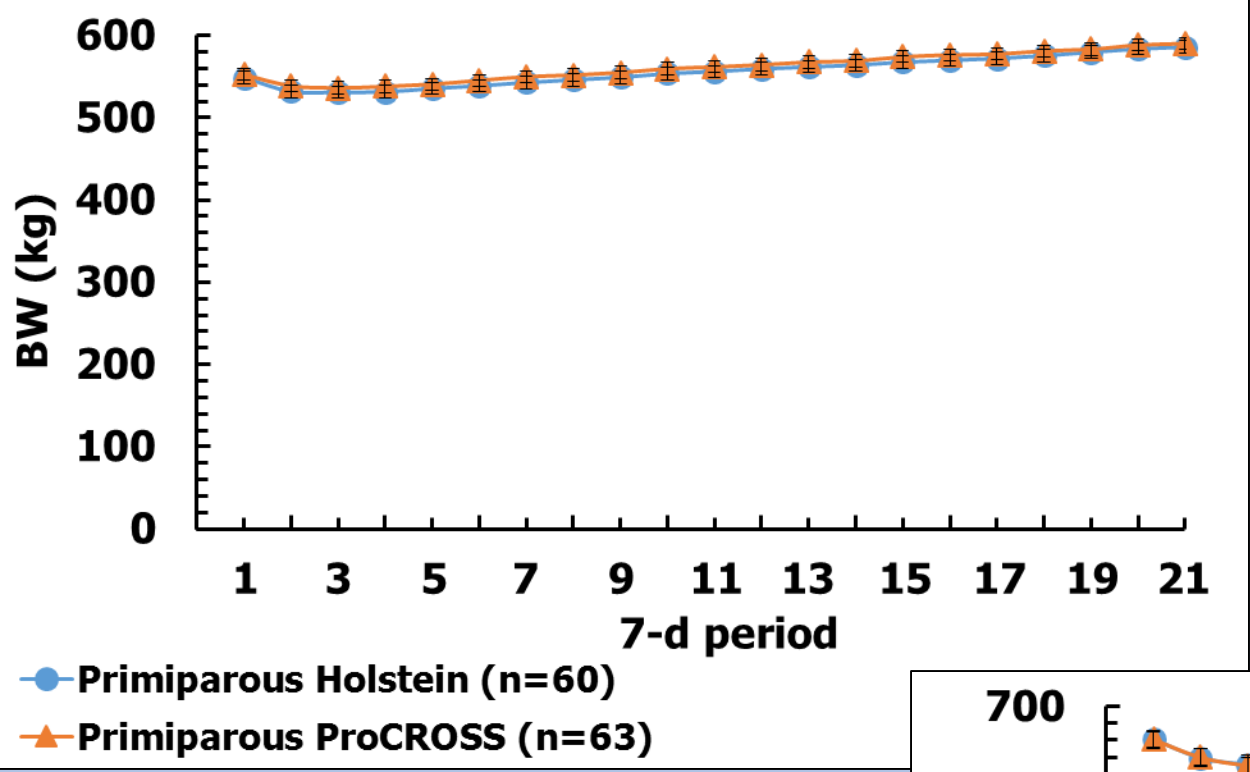
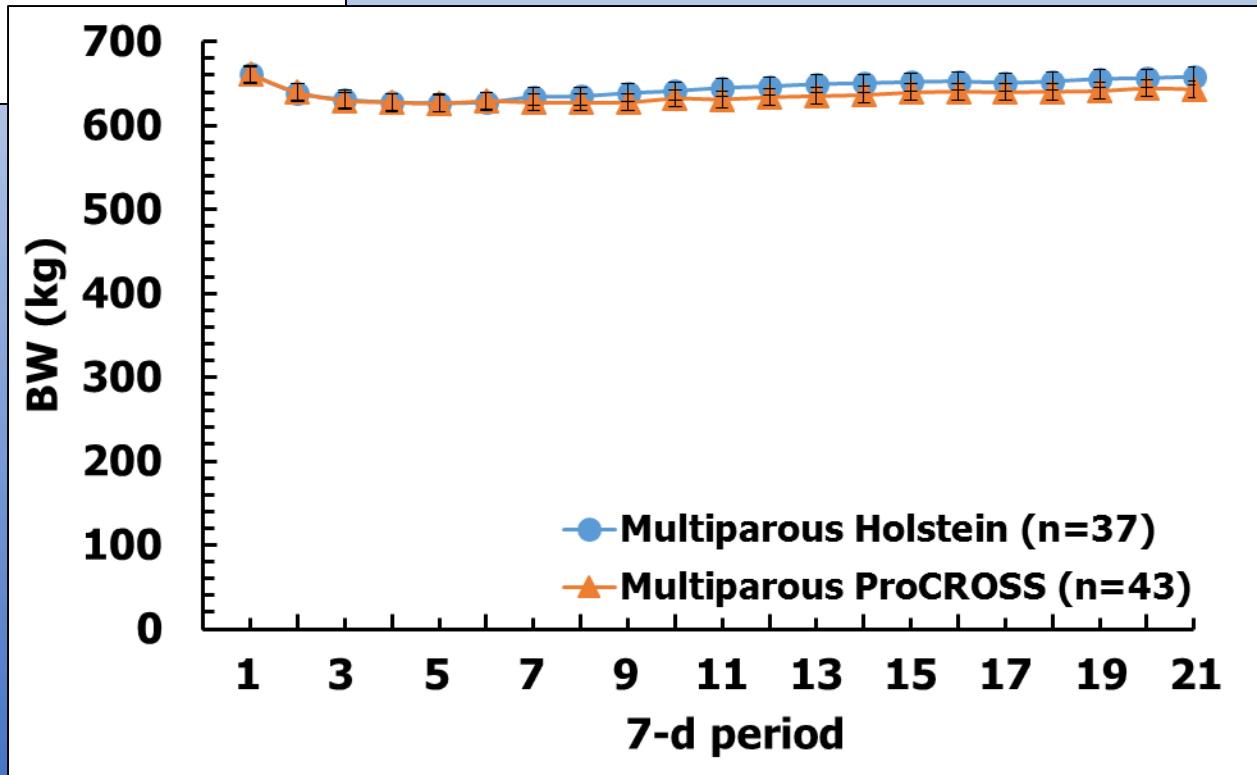
Fat plus protein production (kg)



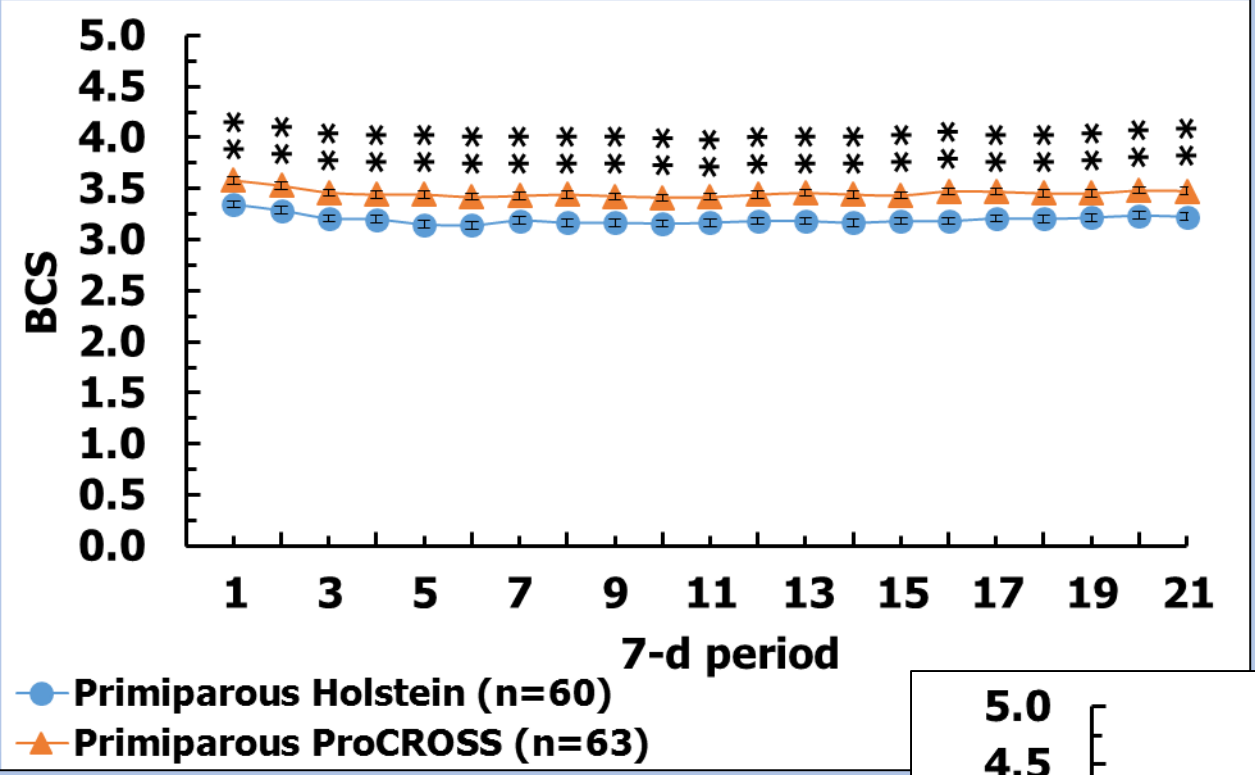


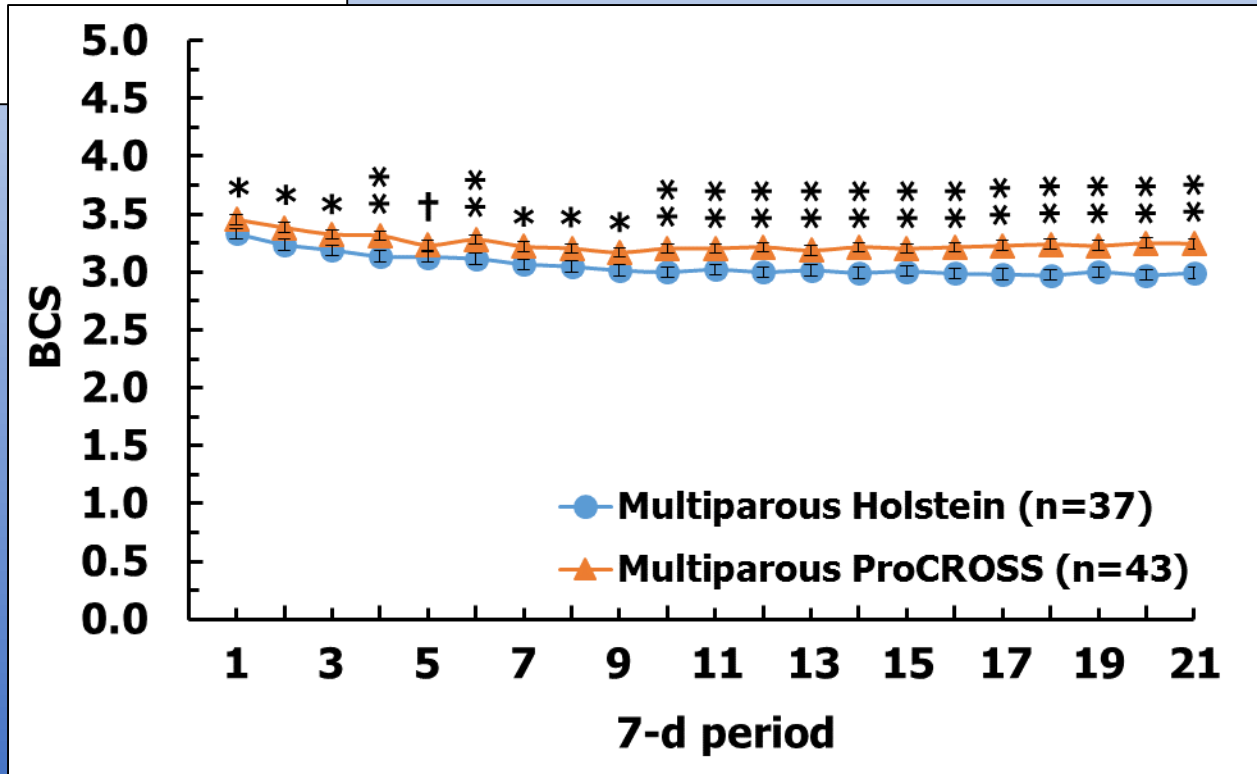
Body weight (kg)





Body condition score





** $P < 0.01$; * $P < 0.05$; † $P < 0.10$ difference from Holstein

Fat plus protein production (kg) divided by DMI (kg)

Parity	Breed of cow		Difference from Holstein
	Holstein	ProCROSS	
Primiparous	0.113 (n=60)	0.119 (n=63)	+6% **
Multiparous	0.124 (n=37)	0.134 (n=43)	+8% **

** $P < 0.01$ difference from Holstein

Mean income over feed cost

Trait	Breed of cow		Difference from Holstein	
	Holstein	ProCROSS		
Primiparous	n = 60	n = 63		
IOFC (€)	731	775	+€44	+6% **
Daily IOFC (€)	4.97	5.27	+€0.30	
Multiparous	n = 37	n = 43		
IOFC (€)	1,070	1,148	+€78	+7% *
Daily IOFC (€)	7.28	7.81	+€0.53	

* $P < 0.05$, ** $P < 0.01$ difference from Holstein

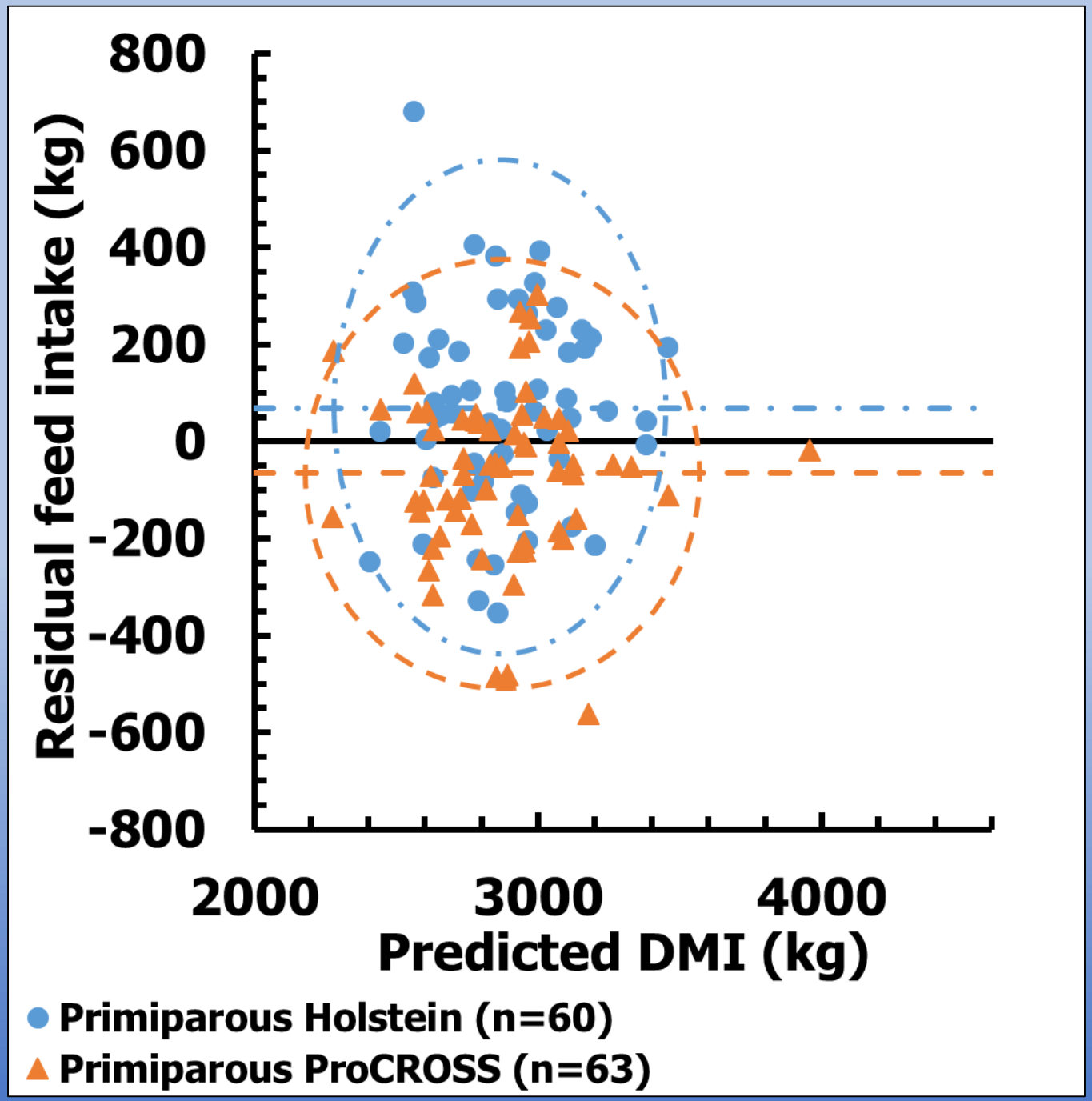
Residual feed intake

- Difference of actual and predicted feed intake
- Estimated by error from regression of DMI on energy sinks
  - Production (milk energy output)
  - Body maintenance (metabolic body weight; $BW^{0.75}$)
  - Change in body energy (change in body weight and BCS)
- Lower number (negative) is more desirable
  - Because a cow actually consumed less than predicted

Mean residual feed intake (kg) from 4 to 150 days in milk

Parity	Breed of cow		Difference from Holstein
	Holstein	ProCROSS	
Primiparous	+68.8 (n=60)	–65.5 (n=63)	–134.3 **
Multiparous	+75.0 (n=37)	–64.5 (n=43)	–139.5 *

* $P < 0.05$, ** $P < 0.01$ difference from Holstein


800
600
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-200
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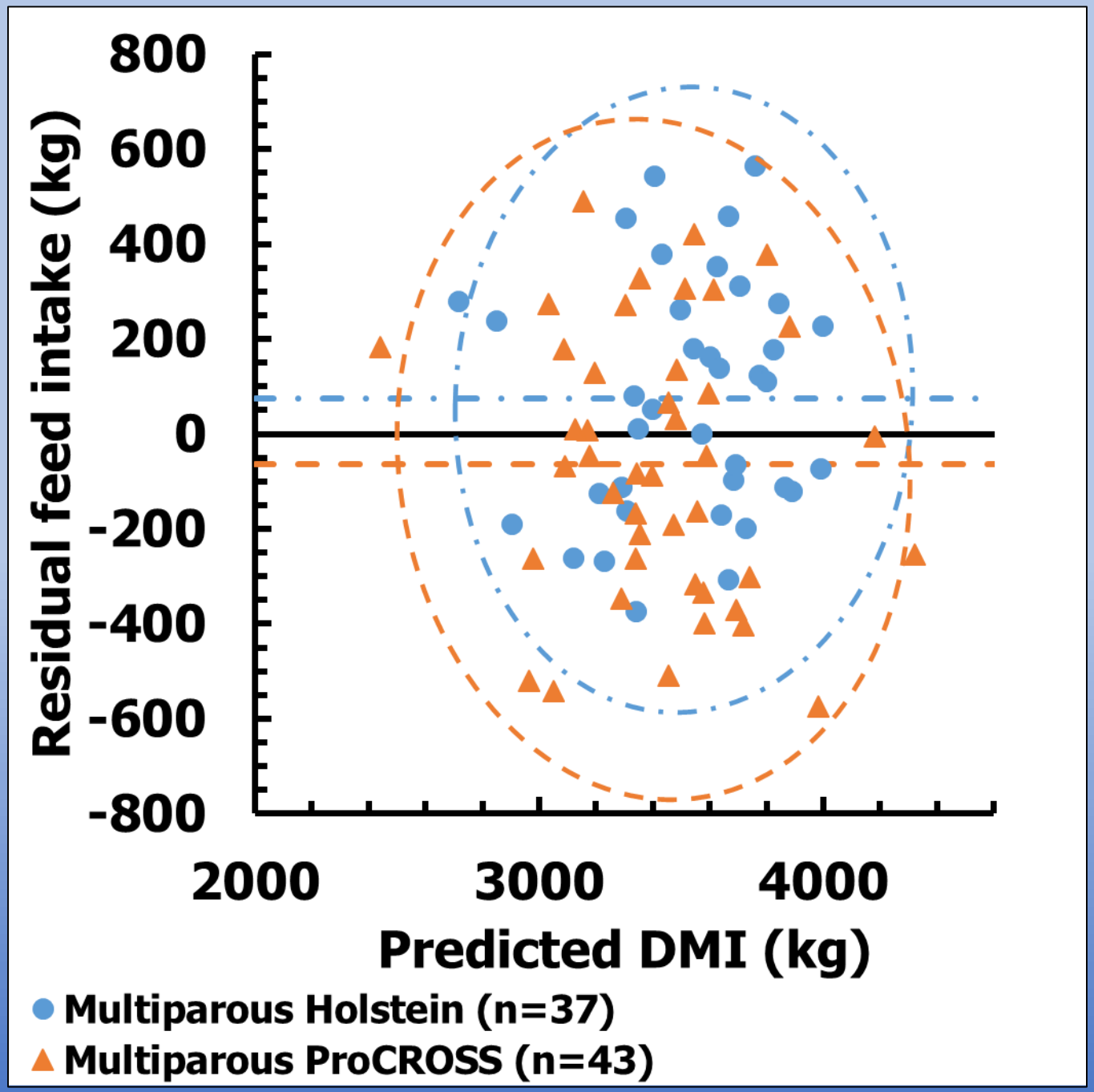
-800
Residual feed intake (kg)
2000
3000
4000
Predicted DMI (kg)
Primiparous Holstein (n=60)
Primiparous ProCROSS (n=63)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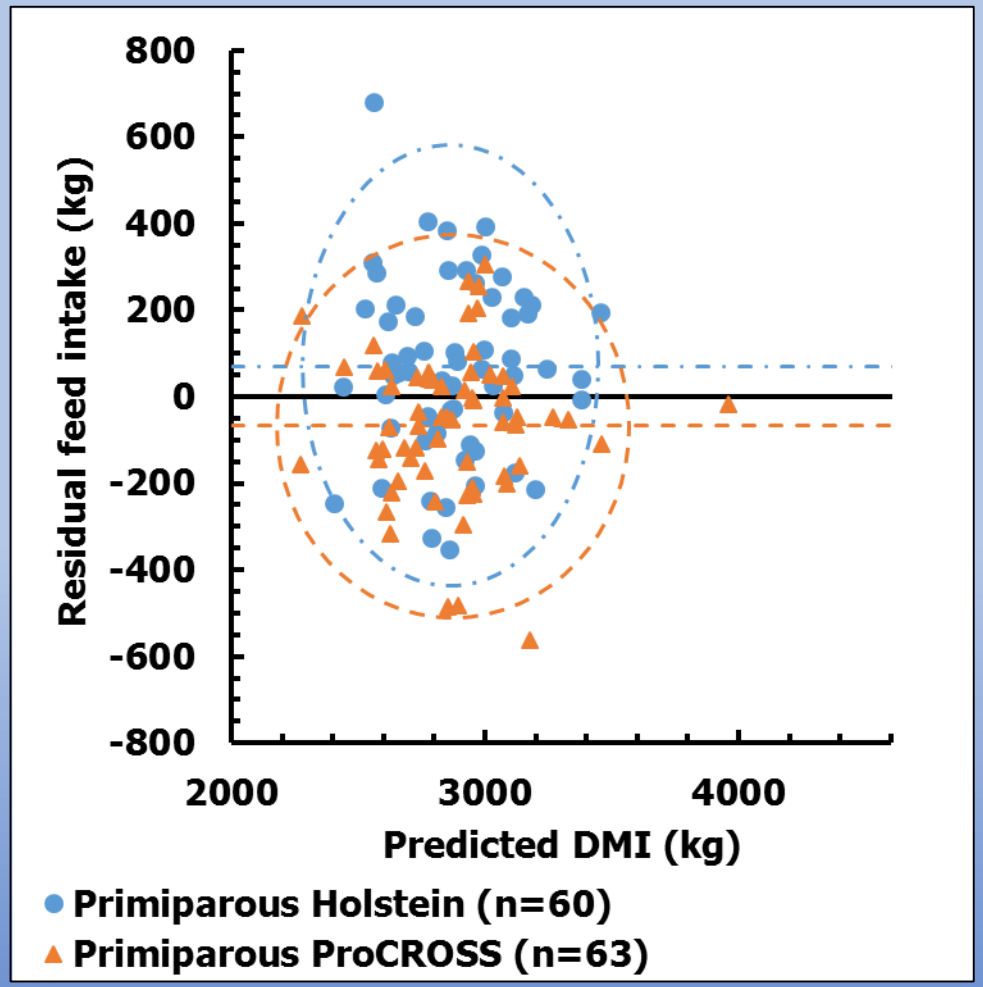
Multiparous Holstein (n=37)
Multiparous ProCROSS (n=43)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Residual feed intake (kg)
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Predicted DMI (kg)
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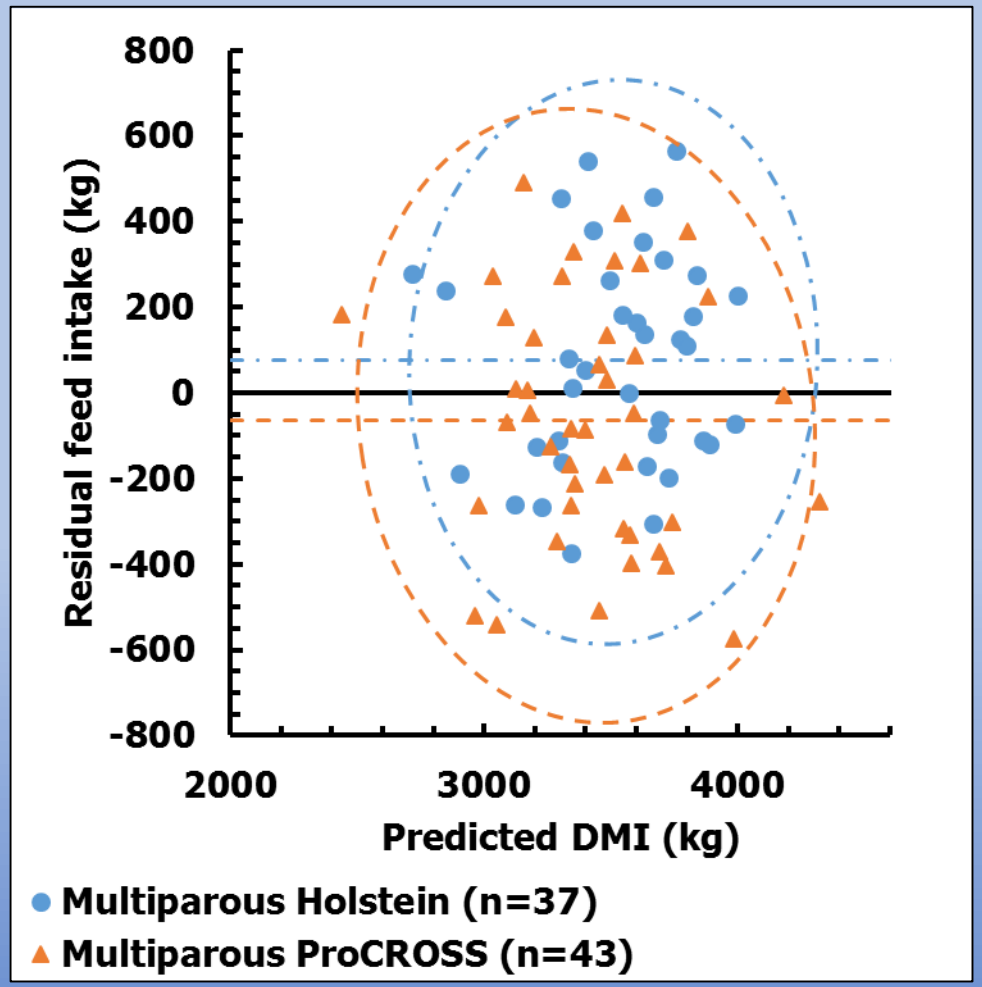
Primiparous ProCROSS (n=63)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-600
-800
Residual feed intake (kg)
2000
3000
4000
Predicted DMI (kg)
Multiparous Holstein (n=37)
Multiparous ProCROSS (n=43)

Ideal Dairy Cow

- High fat and protein
- Excellent fertility and ability to produce a calf regularly
- Longevity (~5 to 7 years)
- Low somatic cell count
- Smaller and functional cow
- Efficiently converts feed to milk
- Breed depends on each producer's management system
- AI is a must!

Holstein sire

Viking Red sire

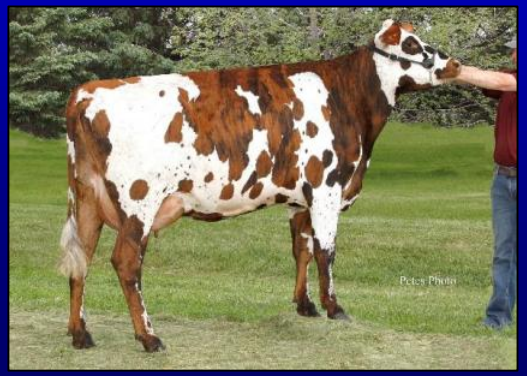
Montbeliarde sire

Pro Cross at the U of MN

Jersey

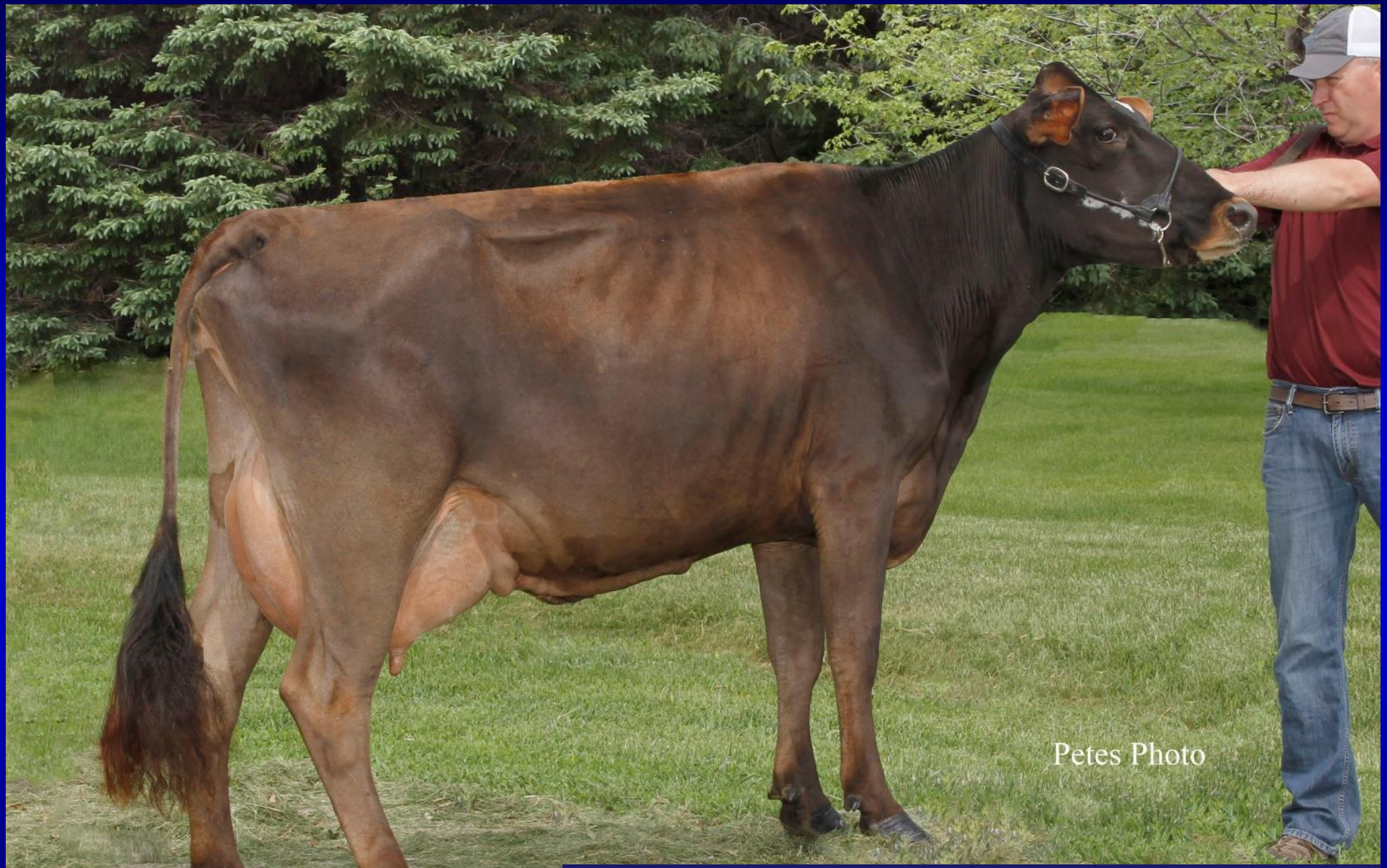
Viking Red

Normande



GrazeCross

Viking Red x Holstein x Montbéliarde



Jersey x Normande x Viking Red

Normande x Viking Red x Jersey

Montbéliarde x Holstein x Viking Red

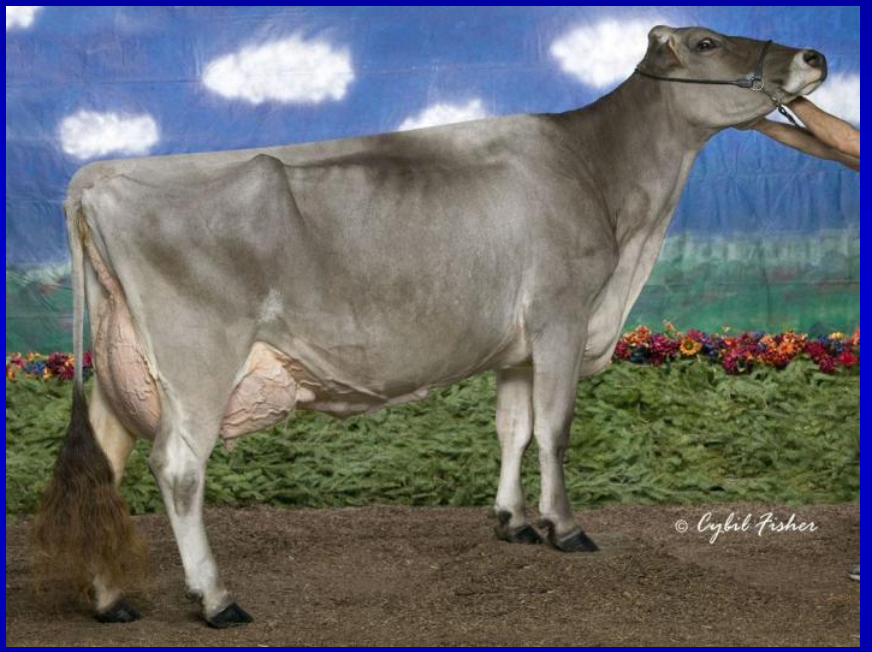
Preliminary results for first-lactation Holstein cows and crossbred cows at the University of Minnesota Morris organic dairy herd from 2010 to 2015

Trait	Number of Cows	Milk	Combined Fat and Protein	Somatic Cell Score	Pregnant by 150 DIM (%)
Pure Holstein	10	12,064	857	3.21	60
Holstein-sired crossbreds	25	11,375	810	3.41	52
Jersey-sired crossbreds	32	9,643*	719*	3.73	59
Viking Red-sired crossbreds	44	10,233*	756	3.43	73
Montbéliarde-sired crossbreds	14	10,664*	773	3.17	77
Normande-sired crossbreds	10	11,079	773	3.12	69

* $P < 0.05$ for contrast of difference from Holstein.

Brown Breeds

Duncan Belle
(Jersey)



Snickerdoodle
(Brown Swiss)

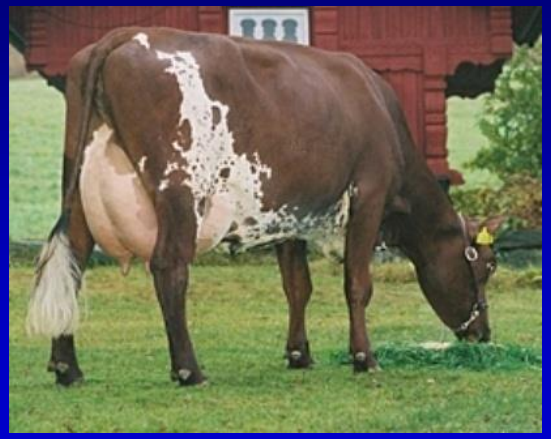
Jersey characteristics

- **Positives**
  - Outstanding calving ease
  - Increased solids content of milk
  - Lowered maintenance costs
  - Increase frequency of black hooves
- **Negatives**
  - Udders of mature cows become too deep
  - Reduced value of bull calves
  - Increased somatic cells in milk

Brown Swiss characteristics

- **Positives**
  - High production
  - Increased solids content of milk
  - Outstanding feet and legs
  - Lowered somatic cells in milk
- **Negatives**
  - Increase body size
  - Increased calf mortality
  - Some calves demand nipple feeding

Red Breeds



Norwegian Red
(242,000 cows)

Swedish Red
(146,000 cows)

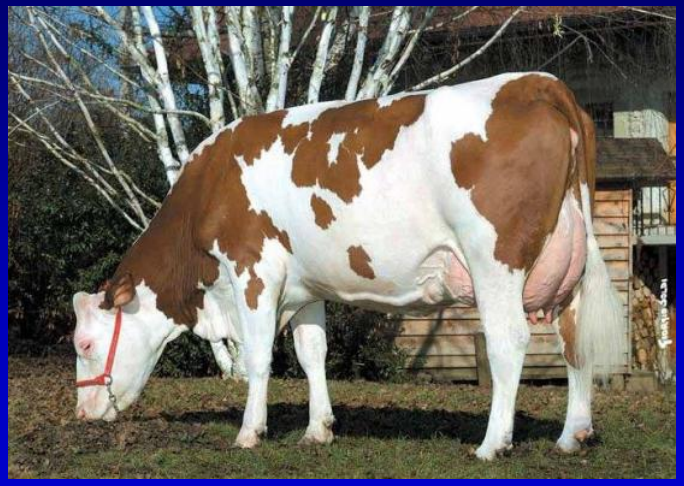
Finnish Ayrshire
(171,000 cows)

Viking Red characteristics

- Medium-sized cows (560 kg)
- High levels of milk and protein
- Excellent fertility and ability to produce a calf regularly
- Calving ease of the dams
- Low somatic cell score and high resistance to mastitis
- Long productive life
- Advanced disease recording

European "Alps" Breeds

- **Montbeliarde**
  - **390,000 cows in France**
  - **dairy breed (not dual purpose)**
- **Normande**
  - **280,000 cows in France**
  - **dairy breed (not dual purpose)**
  - **especially well suited for low-input systems**
- **Fleckvieh or Simmental**
  - **large numbers of cows in Austria, Germany, Switzerland, Italy, and France**
  - **dual-purpose breed**



Montbeliarde
(405,000 cows)

Normande
(265,000 cows)

Fleckvieh
(2,000,000 cows)

Montbeliarde characteristics

- High levels of milk and protein
- Excellent fertility and ability to produce a calf regularly
- Calving ease of the dams and vitality of calves at birth
- Few transition cows problems
- Strong resistance to mastitis
- Long productive life
- Excellent beef value by males and females at the end of their productive life

Normande characteristics

- High protein content of milk
- High proportion of kappa casein (BB)
- Exceptional fertility
- Ease of calving and docility
- Outstanding grazing ability
- Adapt to different environments (1.2 mil Colombia)
- Enhanced value of cull cows, bulls, and calves


Redondo daughter

Important points

- Crossbreeding is a mating system that complements genetic improvement of breeds
- Selection of best A.I. bulls within breed results in genetic improvement
- Heterosis from crossbreeding is a "bonus" on top of genetic improvement within breeds
  - 3 (northern Europe breeds) to 10% (Alps breeds) for production
  - Greater than 10% for fertility, health, and survival

Recommendations for crossbreeding

- Crossbreeding systems must use three breeds to optimize heterosis
- Two breeds limits the amount of heterosis
- Four breeds limits the influence of specific breeds
- Therefore, select three breeds for specific needs of herd

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https://wcroc.cfans.umn.edu/research-programs/dairy

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