

Breeding and Genetics: Considerations for Organic Dairy Farms

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WCROC Dairy Pastures



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WCROC Dairy Herds

- **Organic herd**
 - 96 cows (32 are "old" 1964 Holstein genetics)
 - 1/3 fall calving, 2/3 spring calving
- **Conventional herd**
 - 130 cows
 - 1/3 fall calving, 2/3 spring calving



Cow wanted by all dairy producers

- Early maturing
- Easy calving
- High milk production
- Superior fertility
- Functional udder
- Sound feet and legs
- Disease resistance

If all of these things → Longevity

Inbreeding depression

- From mating bulls and cows that are related (within breed)
- Expressed mostly for mortality, fertility, health, and survival

Heterosis (Hybrid vigor)

- From mating bulls and cows that are unrelated (crossbreeding)
- Expressed mostly for mortality, fertility, health, and survival

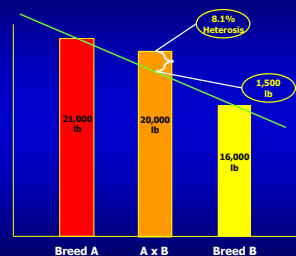
Overview of California study

- Six cooperating dairies in central California
 - plus a 7th dairy for calving difficulty and stillbirth
- Holstein cows bred to A.I. sires from numerous breeds
 - Holstein
 - Normande
 - Montbeliarde
 - Scandinavian Red (Swedish Red and Norwegian Red)

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

Heterosis for milk production



Number of cows

Breed	Original cows	Revised cows	Sires
Holstein	380	416	71
Normande-Holstein	242	251	24
Montbeliarde-Holstein	491	503	23
Scandinavian Red-Holstein	314	321	13
Total cows	1,427	1,491	131

All cows have sires and maternal grandsires with A.I. codes in the U.S.



Calving difficulty and stillbirth for Holstein dams at 2nd to 5th calving

Breed of sire	Calves	Calving difficulty	Stillbirth
		----- (%) -----	
Holstein	303	8.4	12.7
Normande	326	8.7	7.3 *
Montbeliarde	2,373	5.4	5.0 **
Scandinavian Red	515	2.1 **	4.7 **

** p < .01, * p < .05



Calving difficulty and stillbirth for Holstein dams at 1st calving

Breed of sire	Calves	Calving difficulty	Stillbirth
		----- (%) -----	
Holstein	371	16.4	15.1
Montbeliarde	158	11.6	12.7
Scandinavian Red	855	5.5 **	7.7 **

All dams of calves were 1st calf Holsteins

** p < .01

Calving difficulty and stillbirth for breed of dam at 1st calving

Breed of dam	Number of calves	Calving difficulty	Stillbirth
		----- (%) -----	
Holstein	676	17.7	14.0
Normande-Holstein	262	11.6 *	9.9
Montbeliarde-Holstein	370	7.2 **	6.2 **
Scandinavian Red-Holstein	264	3.7 **	5.1 **

Breeds of sire of calves were Brown Swiss, Montbeliarde, and Scandinavian Red.

** p < .01, * p < .05

Deaths during first lactation

Breed	Cows	Prior to 1 st milk recording ----- (%) -----	Calving to 305 days -----
Holstein	416	3.6	5.3
All Crossbreds	1075	0.9 **	1.7 **
Normande-Holstein	251	0.8 *	1.2 **
Montbéliarde-Holstein	503	1.0 **	2.0 **
Scandinavian Red-Holstein	321	0.9 *	1.6 **

** p < .01, * p < .05

Days open

	Pure Holstein	Normande- Holstein	Montbéliarde- Holstein	Scand. Red- Holstein
(days)				
1 st lactation	(380) 148	(232) -21 **	(477) -16 *	(395) -14 *
2 nd lactation	(275) 144	(196) -17 *	(396) -24 **	(254) -11 †
3 rd lactation	(180) 146	(146) -14 †	(302) -16 *	(181) -14 †
4 th lactation	(97) 147	(93) -16	(195) -27 **	(116) -1
5 th lactation	(37) 157	(43) -34 *	(72) -48 **	(33) -19
All lactations	148	-20 **	-26 **	-12 *

Cows were required to have 250 days in milk.

Number of cows in parentheses.

** p < .01, * p < .05, † p < .10

Somatic cell count

	Pure Holstein	Normande- Holstein	Montbéliarde- Holstein	Scand. Red- Holstein
(thousands)				
1 st lactation	(380) 83	(242) -3	(491) -15 **	(314) -11 *
2 nd lactation	(310) 90	(215) +15 *	(432) -4	(269) -2
3 rd lactation	(220) 116	(164) +11	(344) -14 †	(213) -8
4 th lactation	(127) 148	(121) +1	(247) -30 **	(145) -9
5 th lactation	(63) 203	(65) -53 **	(139) -70 **	(76) -40 *
All lactations	121	-2	-23 **	-13 *

Number of cows in parentheses.

** p < .01, * p < .05, † p < .10

Total removals during first lactation

Breed	Cows	Prior to 1 st milk recording ----- (%) -----	Calving to 305 days -----
Holstein	416	8.7	15.9
All Crossbreds	1,075	2.6 **	7.4 **
Normande-Holstein	251	3.6 *	9.6 *
Montbéliarde-Holstein	503	2.4 **	7.0 **
Scandinavian Red-Holstein	321	2.2 **	6.2 **

** p < .01, * p < .05

Average of all 305-day lactations

Trait	Pure Holstein	Normande- Holstein	Montbéliarde- Holstein	Scand. Red- Holstein
Lactations	1,100	807	1,653	1,107
Milk (lb)	25,169	-3468 **	-1483 **	-1920 **
% Fat	3.58	+0.14	+0.11	+0.15
Fat (lb)	902	-93 **	-27 **	-33 **
% Protein	3.09	+0.17	+0.09	+0.13
Protein (lb)	777	-71 **	-25 **	-30 **
Fat (lb) + Protein (lb)	1679	-164 **	-52 **	-63 **
% of Holstein		-9.8 %	-3.1 %	-3.8 %

** p < .01

Lifetime survival, production, and profit

Data were restricted to 3 of the 6 dairy herds that had at least 30 cows in each of the breed groups

Number of cows by breed group for the 3 dairy herds

Herd	Pure Holstein	Normande- Holstein	Montbéliarde- Holstein	Scand. Red- Holstein
A	51	60	94	84
B	74	75	182	81
C	40	33	93	53
Total	165	168	369	218

Lifetime survival

Subsequent calving	Pure Holstein	Normande-Holstein	Montbéliarde-Holstein	Scand. Red-Holstein
	(%)			
1 st calving	(165) ---	(168) ---	(369) ---	(218) ---
2 nd calving	(124) 75	(148) +13 **	(328) +14 **	(186) +10 **
3 rd calving	(84) 51	(123) +22 **	(276) +24 **	(155) +20 **
4 th calving	(48) 29	(89) +24 **	(203) +26 **	(110) +21 **

Number of cows in parentheses.

** p < .01

Input values for lifetime profit

- **\$1200** – replacement cost
- **\$250** – live heifer calf
- **\$100** – live bull calf
- **\$125** – dead cow disposal
- **\$525** – cull cow
- **\$40** – breeding cost
- Feed costs for **daily fat-corrected milk of each cow** with fixed body weight of 1200 lb (first lactation) and 1500 lb (later lactations)
 - **\$5.33** – average daily feed cost
- Actual value of all solids and SCC in milk for U.S. from 2007 to 2009
 - **\$15.61/cwt** – average milk price

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

Trait	Pure Holstein	Normande-Holstein	Montbéliarde-Holstein	Scand. Red-Holstein
Cows	165	168	369	218
Profit per day	\$4.17	\$3.89	\$4.39	\$4.32
Difference from Holstein		-\$0.28 **	+0.22 **	+0.15 **
% of Holstein daily profit		-6.7 %	+5.3 %	+3.6 %

** p < .01

Lifetime production within 4 years of first calving

Trait	Pure Holstein	Normande-Holstein	Montbéliarde-Holstein	Scand. Red-Holstein
Cows	165	168	369	218
Milk (lb)	61,918	+3,703	+10,592 **	+7,033 *
Fat (lb)	2,195	+238 *	+488 **	+349 **
Protein (lb)	1,921	+210 *	+395 **	+291 **
Fat (lb) + Protein (lb)	4,117	+448 *	+883 **	+640 **
% of Holstein		+11 %	+21 %	+16 %

Production within the 4-year period (1,461 days) after first calving

** p < .01, * p < .05

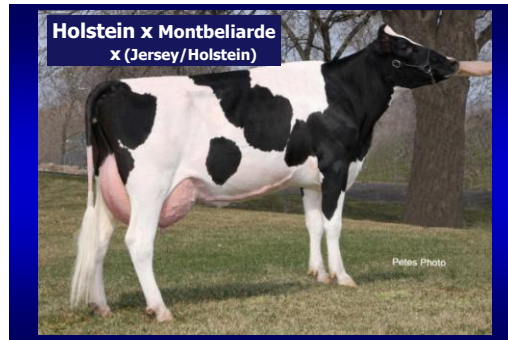
Projected lifetime profit (ignoring differences in health costs)

Trait	Pure Holstein	Normande-Holstein	Montbéliarde-Holstein	Scand. Red-Holstein
Cows	165	168	369	218
Days in the herd	946 d	1263 d	1358 d	1305 d
Lifetime profit	\$4347	\$5467	\$6503	\$6272
Difference		+\$1120 **	+\$2156 **	+\$1925 **
% of Holstein		+26 %	+50 %	+44 %

** p < .01

University of Minnesota crossbreeding research

- Crossbreeding initiated in 2000 with two research herds of Holsteins – the campus herd at St. Paul and the low input research herd at Morris, MN
- **2000 to 2002:**
 - ½ bred to Holstein AI sires
 - ½ bred to Jersey AI sires
- **2003 to 2007:**
 - Pure Holsteins bred to Holstein and Montbéliarde AI sires
 - Jersey x Holstein crossbreds bred to Montbéliarde AI sires
- **2008 forward:**
 - Swedish Red replaced Jersey in the 3-breed rotation



Holstein versus Jersey x Holstein cows calving a 2nd and 3rd time

	Pure Holstein	Jersey x Holstein
Calved a first time	77	80
Calved a second time	55 (71%)	64 (80%)
Calved a third time	38 (49%)	51 (64%) †

† p < 0.10



Jersey x Holstein crossbreds compared to pure Holsteins at the University of Minnesota

Trait	Pure Holstein	Jersey x Holstein	Difference
1 st lactation	n = 73	n = 76	
Body weight (lb)	1,155	1,032	-123.0 **
BCS	2.8	2.9	+0.1 **
Days open	148	124	-24 **
2 nd lactation	n = 55	n = 61	
Body weight (lb)	1,285	1,138	-147.0 **
BCS	2.8	2.9	+0.1 **
Days open	163	121	-42 **
3 rd lactation	n = 37	n = 50	
Body weight (lb)	1,365	1,184	-181.0 **
BCS	2.9	3.0	+0.1 **
Days open	200	158	-42 **

** p < 0.01

Jersey x Holstein crossbreds compared to pure Holsteins at the University of Minnesota

Trait	Pure Holstein	Jersey x Holstein	Difference
1st lactation n = 73 n = 76			
Fat + Protein (lb)	1,160	1,142	-18.0
SCS	2.9	3.1	+0.2
Udder clearance (in)	21.6	18.8	-2.8 **
2nd lactation n = 55 n = 61			
Fat + Protein (lb)	1,389	1,333	-56.0 *
SCS	2.9	3.1	+0.2
Udder clearance (in)	20.2	16.7	-3.5 **
3rd lactation n = 37 n = 50			
Fat + Protein (lb)	1,455	1,343	-112.0 **
SCS	3.4	3.8	+0.4 †
Udder clearance (in)	19.6	15.9	-3.7 **

** p < 0.01, * p < 0.05, † p < 0.10

Morris 1st lactation 305-day production

Trait	Pure Holstein	Montbeliarde-Holstein	Montbeliarde-(Jersey x Holstein)
Cows	66	25	39
Milk (lb)	14,322	13,799	13,480
Fat (lb) + Protein (lb)	914	907	918
% of Holstein		-1%	0%
Somatic Cell Score	3.06	3.15	3.02

No significant differences ($P > 0.05$)

Morris 3rd lactation 305-day production

Trait	Pure Holstein	Montbeliarde-Holstein	Montbeliarde-(Jersey x Holstein)
Cows	10	11	16
Milk (lb)	19,820 ^a	22,467 ^b	19,046 ^a
Fat (lb) + Protein (lb)	1,222 ^a	1,390 ^b	1,262 ^a
% of Holstein		+12%	+3%
Somatic Cell Score	3.68 ^a	2.62 ^b	2.89 ^a

Different superscripts signify $P < 0.05$



Morris 2nd lactation 305-day production

Trait	Pure Holstein	Montbeliarde-Holstein	Montbeliarde-(Jersey x Holstein)
Cows	31	19	29
Milk (lb)	17,646	17,787	17,248
Fat (lb) + Protein (lb)	1,106	1,146	1,153
% of Holstein		+3%	+4%
Somatic Cell Score	2.82	2.32	2.30

No significant differences ($P > 0.05$)

Morris crossbreeding (2003 – 2011)

Breed	Number	Milk (lb)	F+P (lb)	Mastitis (%)
Holstein	183	17,451	1,123	51.4
SJH	51	14,191*	991*	30.5**
JMH	32	15,336*	1,067*	39.0
HMJH	47	18,118	1,185*	44.4
HSJH	18	13,962**	954**	30.8*
NZSJH	20	13,778**	981**	28.4*

** p < .01, * p < .05

Days open

	Pure Holstein	Montbéliarde-Holstein	Montbéliarde-(Jersey x Holstein)
	(days)		
1 st Lactation	(108) 170	(54) 133	(68) 122
Difference from Holstein		-37 **	-48 **
2 nd Lactation	(69) 179	(39) 141	(52) 140
Difference from Holstein		-38 *	-39 *
3 rd Lactation	(25) 166	(30) 131	(25) 153
Difference from Holstein		-35	-13

Cows were required to have 250 days in milk.
Number of cows in parentheses.
** $p < .01$, * $p < .05$

Survival of cows within three years of first calving

Trait	Pure Holstein	Montbéliarde-Holstein	Montbéliarde-(Jersey x Holstein)
n	77	54	48
Survival (months)	24.8	28.0	29.9
Difference from Holstein		+3.2 †	+5.1 **
Mortality Rate (%)	17	4 *	4 *

** $p < .01$, * $p < .05$, † $p < .10$
Several cows have not had opportunity to reach 3 years after first calving

Pure Jersey versus Normande-Jersey crossbreds

Variable	Jersey	Normande-Jersey	Difference
Cows	26	49	
Milk (lb)	50.5	53.9	+3.4 *
Fat (lb)	2.3	2.5	+0.2
Protein (lb)	1.7	1.8	+0.1
Fat + Protein (lb)	4.0	4.3	+0.3
% of Jersey		+5.0%	

* $p < .05$

Survival to the subsequent lactation

	Pure Holstein	Montbéliarde-Holstein	Montbéliarde-(Jersey x Holstein)
	(%)		
Survived to 2 nd calving	68	83 *	83 *
Survived to 3 rd calving	39	62 **	52 †
Survived to 4 th calving	16	44 **	39 **
Survived to 5 th calving	8	32 **	13

** $p < .01$, * $p < .05$, † $p < .10$



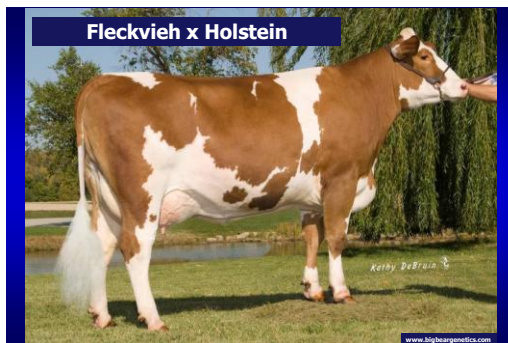


Pure Holstein versus Fleckvieh-Holstein crossbreds

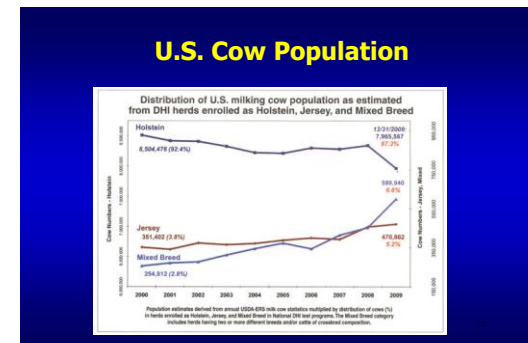
Trait	Pure Holstein	Fleckvieh x Holstein	Difference
Cows	128	178	
Milk (lb)	16,433	15,681	-752
Fat +Prot (lb)	1,290	1,265	-25
SCC	113	97	-16
Non-return rate	71	56	+15
Calving Diff. (%)	8.8	9.5	-0.7
Stillbirth (%)	16.3	11.8	-4.5

First lactation results, Ouweltjes (2011), WUR Livestock Research, Holland

- ### 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



- ### 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



Brown Breeds



Duncan Belle
(Jersey)



Snickerdoodle
(Brown Swiss)

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

Viking Red characteristics

- Medium-sized cows (1250 lbs.)
- 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
- NRF has a large dose (~30%) of Swedish Friesian, which might reduce heterosis for crossbreeding with Holsteins

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

Red Breeds



Norwegian Red
(242,000 cows)



Swedish Red
(146,000 cows)



Finnish Ayrshire
(171,000 cows)

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)



Redondo daughter

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

New Zealand Friesian Genetics

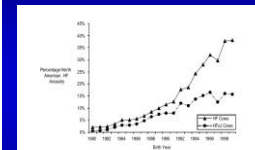
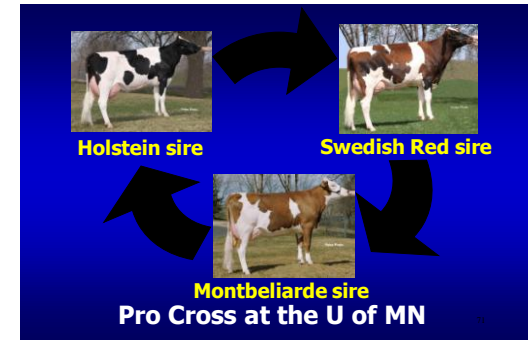
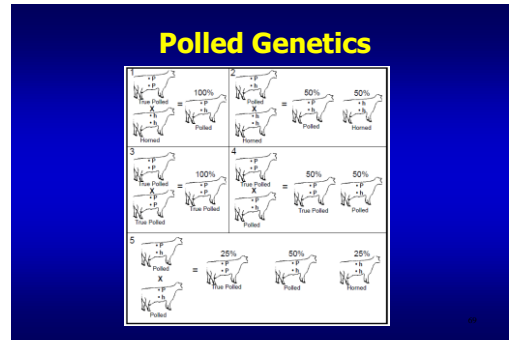


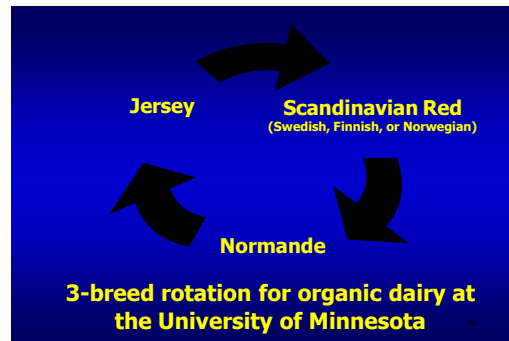
Figure 1. Percentage of North American Holstein ancestry present in New Zealand Holstein-Friesian (HF) and HF-Jersey crossbred cows by birth year.

- Medium-sized cows
- More fertile than US Holsteins
- Less milk volume
- Concentrate is rarely fed and hay and silage fed are low compared to USA
- More research under US management systems



Polled Genetics

- Growing interest in polled factor in dairy cattle
- All breeds have some polled (naturally hornless) cattle
- The gene for polled is a single dominant gene and the gene for horned is a single recessive
- Norwegian Red has high percentage of polled genes
- ~60% of calves born in Norway are polled



Ideal Grazing 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 grass to milk
- Breed depends on each producer's management system
- AI is a must!

Further Reading

- Crossbreeding of Dairy Cattle and 4th W. E. Peterson Symposium and Crossbreeding "The Science and the Impact"
 - <http://www.arsci.umn.edu/research/dairy-crossbreeding.html>
 - <http://www.arsci.umn.edu/dairygenetics/arsci-symposium-2012.pdf>
- Comparison of breed of dairy cow under grass-based production systems
 - <http://www.agresearch.knapton.umn.edu/Work/Project/Document.aspx?ID=40399.pdf>
- Effect of Holstein-Friesian genotype in grass-based systems in Ireland
 - <http://www.teagasc.ie/research/publications/dairygenetics/2008/0804.pdf>
- Animal Improvement Programs Laboratory publications – USDA
 - <http://aipl.arsusda.gov/Research/Research.htm?docid=3072>
- The Dairy Crossbred Blog
 - <http://dairyblog.umn.edu>
- Dairy Crossbreeding
 - <http://www.dairycrossbreeding.com/>
- Breeds for use in Crossbreeding
 - www.creativegeneticsofca.com
 - www.normandgenetics.com
 - <http://www.genoglobal.net/>
 - www.highbeargenetics.com
- Journal of Dairy Science (Author search: Heins, B.; Dechow, C.; Olson, K.; Bloettner, S.; Buckley, F.)

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