Crossbreeding in Dairy Cattle: Pros and Cons

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Take Home Messages

- Crossbred cows can produce similar yields of milk solids as Holstein cows within low input grazing systems, while having improved health and fertility.
- Holstein cows tend to produce higher yields compared with Jersey crossbred cows within a high concentrate input system, with the latter partitioning additional energy consumed to body tissue gain rather than milk.
- In the US, crossbreeding Holsteins with Normande, Montbeliarde, Swedish Red, Norwegian Red and Jersey A.I. sires resulted in fewer days open and improved survival compared to pure Holstein herd mates, with little loss of production.
- Crossbred cows can be more profitable than Holstein cows in both low cost and high input production systems.
- US research has indicated that Montbeliarde and Scandinavian Red crossbred cows in particular are more profitable than Holsteins.
- Crossbreeding should be regarded as a mating system that complements genetic improvement within breeds. Heterosis is a bonus that dairy producers can expect in addition to the positive effects of individual genes obtained by using superior A.I. bulls within breed.

■ Introduction

The high milk production potential and high efficiency for milk production of the Holstein cow has led to the dominance of the Holstein breed in many parts of the world. However, selection programs that resulted in these high levels of milk production largely ignored functional traits. The subsequent decline in fertility, health and longevity within the Holstein population has now been thoroughly documented. As a result of this, part of the additional benefits gained with the Holstein breed, through increased milk production efficiency, have been lost through poorer cow health and longevity.

There are a number of approaches by which these problems might be tackled, including the adoption of improved nutritional and management strategies, and genetic approaches. With regard to the latter, three broad strategies are often proposed, namely: 1) improved within-breed selection programs, 2) breed substitution (the introduction of an alternative breed to replace the Holstein breed) and 3) crossbreeding.

■ Crossbreeding

Crossbreeding can be defined as mating of parents of two or more different breeds, strains or species together. While the practice of crossbreeding is widespread within many other livestock enterprises, the adoption of crossbreeding within dairying tends to be more limited. One notable exception to this is the New Zealand dairy sector where a significant proportion of the national dairy herd is crossbred. Nevertheless, interest in crossbreeding has increased in recent years in many countries.

There are a number of reasons why dairy farmers are increasingly considering the adoption of crossbreeding within their herds. These include:

Breed Complementarity

This refers to the introduction of desirable genes from a second breed that may be absent or occur at a low frequency in the recipient breed. Breed complementarity can be used to introduce both production traits and functional traits such as fertility and health into a herd.

Beneficial Effects of Hybrid Vigour

Hybrid vigour describes the additional performance benefits that can be obtained with a crossbred animal over and above the mean of the two parent breeds. For example, if Breed A has a lactation yield potential of 6000 litres, and breed B has a lactation yield potential of 8000 litres, the offspring of the two breeds might be expected to have a lactation yield potential of approximately 7000 litres (Figure 1). However, in the example given the actual production of the crossbred cow is 7350 litres, with the extra 350 litres of milk over and above that expected being due to hybrid vigour. The extent of hybrid vigour varies between traits. For example, for traits such as milk yield and milk composition, hybrid vigour is normally estimated to be between 3–6%, while for traits such as fertility, health and longevity, hybrid vigour may be up to 20%, depending on the degree of genetic differences between the parent breeds.

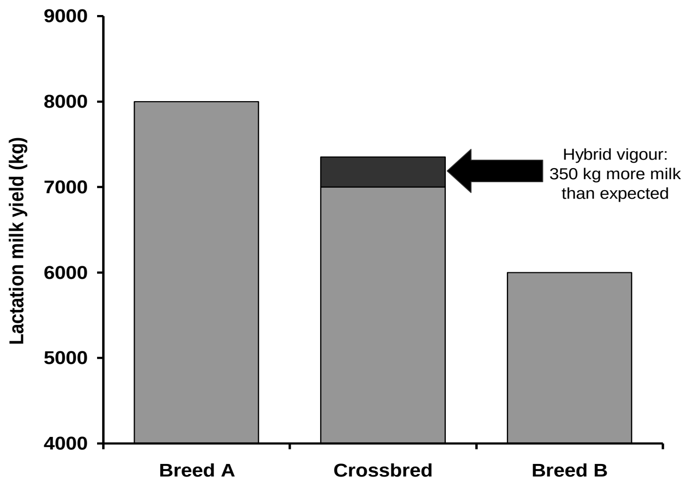

Figure 1: Example of the possible effect of hybrid vigour on milk production when two breeds are crossed

To Reduce Levels of Inbreeding

Inbreeding levels have increased in many dairy cow populations during the last few decades. The negative consequences of inbreeding are inbreeding depression, an increase in undesirable recessive disorders, and a loss in genetic variation. For example, a number of studies have shown an unfavourable association between performance for production traits and non-production traits, with increasing inbreeding depression. Crossing with a second breed is one option by which levels of inbreeding can be rapidly reduced.

▪ Crossbreeding Research at AFBI Hillsborough (Northern Ireland), Teagasc Moorepark (Ireland) and University of Minnesota (USA)

Crossbreeding results demonstrating positive implications for animal performance, particularly relating to fertility and health, date back many decades. However, it is the research studies conducted most recently that are arguably most relevant to today's producer given the enormous strides in genetic gain for production potential and the associated decline in fertility and survival that has occurred. This paper presents the key findings from a number of these experiments.

Do Holstein Cows and Crossbred Cows Differ Metabolically? (Experiment 1)

This was one of the first questions addressed within the AFBI research program. The results of the nutrient utilization and energy metabolism measurements that were undertaken to address this issue are presented in Table 1 (Xui et al. 2011*).*

Table 1. Nutrient digestion and metabolizable energy (ME) utilization efficiency of Holstein and Jersey crossbred cows

	Genotype	
	Holstein	Jersey x Holstein
Dry matter digestibility (%)	79.5	79.5
Efficiency of ME use for milk production (%)	58	58

The results of this experiment demonstrated that Jersey crossbred cows and Holstein cows digest their food and utilise the digested nutrients with similar efficiencies.

Research conducted by Teagasc, under pasture-based conditions, have shown production efficiency (higher milk solids output per unit feed intake) differences among dairy breeds. The largest advantage is observed with pure Jersey cows (Prendiville et al., 2009). The higher production efficiency (up to 10% higher than the Holstein-Friesian contemporaries) is attributed to a combination of factors (Beecher et al., 2014): 1) the Jersey's innate higher feed intake capacity, i.e., an ability to consume more feed relative to their body size, facilitated by a larger gastrointestinal capacity, and 2) a higher digestive efficiency, likely due to observed differences in mastication rate during grazing and a slightly different rumen microbial population.

A separate study evaluating Holstein-Friesian, Norwegian Red, Montebeliarde and their crosses with Holstein-Friesian, and Normande and their crosses with Holstein-Friesian, also found differences in milk solids output per unit of intake between the breeds (Buckley et al., 2007). Here, greatest efficiency was observed with the two ‘dairy breeds’ (Holstein-Friesian and Norwegian Red) compared with the more dual purpose Montbeliarde and Normande. Intermediate values were obtained for the two crossbred genotypes. This is not surprising given the strong genetic and phenotypic correlation between milk yield and gross efficiency. The most likely explanation is the dilution of maintenance and increased tissue mobilization at higher milk yields.

Are Crossbred Cows More Efficient Grazers than Pure Bred Cows? (Experiment 2)

Although it is often suggested that crossbred cows, especially Jersey crossbred cows, are more efficient grazers than Holstein cows, there is relatively little scientific information to support this belief.

Table 2. Grass intakes and feeding behaviour of Holstein and Jersey crossbred cows while grazing (Vance et al., 2012)

	Genotype	
	Holstein	Jersey x Holstein
Grass intake (kg DM/day)	17.0	16.3
Grass DM intake/minute (g)	29	26
Grass DM intake/bite (g)	0.47	0.42
Grazing time (minutes/day)	531	582
Grazing bites/minute	62	62
Grazing bites/day	32910	36346
Grazing bouts/day	9.3	7.7
Mean duration of each grazing bout (minutes)	60.0	82.7

Studies at both AFBI and Teagasc Moorepark used ‘bite meters’ to compare the grazing behaviour of Holstein, Jersey (Teagasc only) and Jersey crossbred cows. At AFBI, although the Holstein cows weighed approximately 70 kg more than the crossbred cows, total DM intake did not differ between genotypes (Table 2: Vance et al., 2012). While the smaller crossbred cows consumed less herbage per minute, due to their tendency to have lower intakes per bite, they grazed for longer each day, and as such had significantly more grazing bites/day than the Holstein cows. In addition, although they had fewer grazing bouts/day, the mean duration of each grazing bout was longer. Thus by modifying their grazing behaviour, these smaller crossbred cows were able to achieve similar herbage intakes as the much larger Holstein cows. Very similar findings were reported from the Teagasc study. A point from the Teagasc research was the afore mentioned detail that increased mastication (chewing) during grazing by the Jersey and Jersey×Holstein-Friesian was associated with improved production efficiency.

Performance of Crossbred Cows Within Low Concentrate Input Grazing Systems

The performance of Holstein and Jersey×Holstein crossbred cows was compared over three successive lactations within a modest concentrate (average of 1.1 tonne/cow/lactation) input grazing system at AFBI (Vance et al., 2013).

Milk Production

Holstein cows produced 625 kg more milk than the Jersey crossbred cows, thus highlighting the potential loss in milk volume associated with crossbreeding (Table 3). The crossbred cows on the other hand produced milk with a significantly higher fat and protein content than the Holstein cows, and when performance was examined on the basis of milk solids production, the yield of fat + protein did not differ between the two genotypes. Although production levels were lower at Teagasc Moorepark, the relative results were very much in line with the findings at AFBI over a similar time frame. At Teagasc Moorepark concentrate feed allocations were lower, generally <0.4 tonne of concentrate/cow/lactation.

Table 3. Effect of dairy cow genotype and management system on full lactation milk production

	Holstein	Jersey x Holstein
Milk yield (kg)	6252	5627
Milk fat (%)	4.20	4.78
Milk protein (%)	3.30	3.59
Milk fat + protein yield (kg)	467	471

Research by Teagasc demonstrates that Norwegian Red×Holstein-Friesian cows are capable of production levels per cow comparable with Holstein-Friesians on grass-based low cost systems.

Body Tissue Reserves

At AFBI Jersey crossbred cows were on average 44 kg lighter than the Holstein cows. However, the changes in live weight throughout the lactation followed a similar pattern with both genotypes (Figure 2), thus suggesting that similar levels of tissue mobilization (early lactation) and tissue gain (late lactation) occurred. At Moorepark, Jersey crossbred cows were also lighter (-57 kg) and had a higher body condition score (+0.22) throughout lactation compared with Holstein-Friesian. Differences in body condition score tended to increase in late lactation. Norwegian Red, Montbeliarde and Normande crossbreds tend to be similar or slightly heavier than Holstein-Friesians. They also tended to maintain higher body condition score throughout lactation.

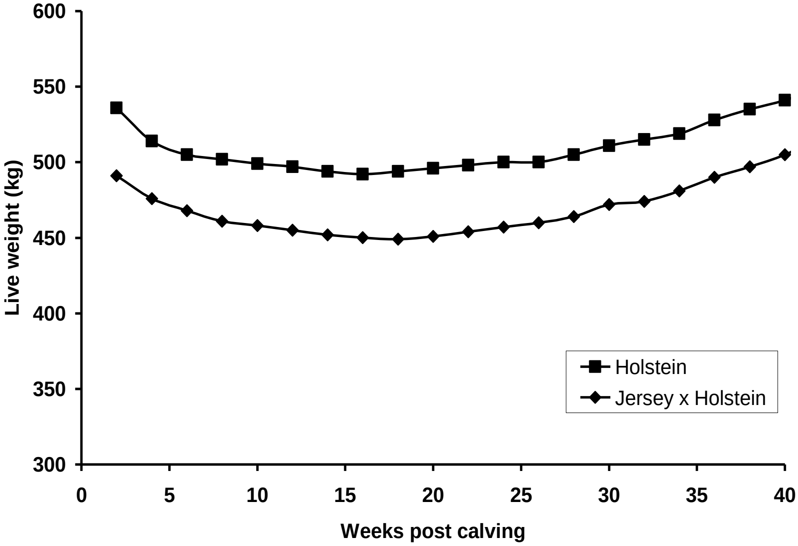

Figure 2: Changes in live weight of Holstein and Jersey x Holstein crossbred cows throughout the first 40 weeks post calving (AFBI)

Fertility and Health Characteristics

At AFBI, Jersey crossbred cows had a higher conception rate to first service, first plus second service, and had a higher conception rate after 12 weeks of breeding, compared with Holstein cows (Table 4). Hybrid vigour is likely to be the main factor contributing to the improved fertility performance with the crossbred cows. For example, hybrid vigour for fertility traits in dairy cattle can be between 5-20%.

Table 4. Effect of dairy cow genotype on fertility performance within low concentrate input systems

	Holstein	Jersey x Holstein
Days to 1st observed heat	50	42
Conception to 1st service (%)	35	58
Conception to 1st and 2nd service (%)	52	81
Pregnancy rate after 12 weeks of breeding (%)	73	89

At Teagasc Moorepark the suitability of Montbeliarde and Normande to seasonal production systems has been questioned, due to minor improvements in reproductive efficiency, primarily due to the late maturing characteristics of those breeds. Norwegian Red and Jersey have been deemed most suitable on the basis of their productivity, reproductive efficiency, superior udder health (Norwegian Red specifically), their moderate size, and early maturing characteristics. While absolute fertility performance values for both Norwegian Red and Jersey crossbreds tended to be higher on the Teagasc studies, the superiority of both crossbreds relative to the Holstein-Friesian was very much in line with the findings at AFBI (Table 4). The research findings at Teagasc, where the performance of purebred Jersey and Norwegian Red cows was also available, would concur with the suggestion from AFBI that much of the superior reproductive performance exhibited by the Jersey crossbreds is not due to additive genetic improvement associated with the Jersey breed, rather, it would seem to be borne primarily out of hybrid vigour. On the other hand, the similar improvement in fertility performance/survival observed with the Norwegian Red crossbreds is due to a combination of additive genetic improvement (breed effect) and the expression of heterosis for the trait.

Analysis of data from seven large dairies in California (Heins et al., 2012; Heins et al., 2012a) where Holstein heifers and cows were mated to Normande, Montbeliarde, Swedish Red and Norwegian Red Breed sires, shows that all of the crossbred groups were superior to the Holsteins for fertility across the first five lactations (Table 5). Furthermore, the crossbred cows had distinct advantages for days open. The difference from the Holsteins ranged from 12 days for the Scandinavian Red×Holstein crossbreds to 20 days for Normande×Holstein crossbreds and 26 days for the Montbeliarde×Holstein crossbreds. Along with the advantages in fertility, crossbred cows in large California dairies had advantages for survival. All crossbred groups had higher percentages of cows that calved a second and third time than Holsteins. Only 0.9% of crossbred cows died prior to first observation for milk recording; however, 3.6% Holsteins died prior to first observation for milk recording. Furthermore, 1.7% of crossbred cows compared to 5.3% of Holstein cows died during the first 305 days of first lactation. More crossbreds remained in these dairies than Holsteins, with only

7.4% of the crossbred cows versus 15.9% of the Holsteins in these dairies being removed (died or culled) by the 305th day of first lactation.

Table 5. Results for Normande×Holstein, Montbeliarde×Holstein, Scandinavian Red×Holstein crossbred cows and Holstein cows

	Holstein	Normande× Holstein	Montbeliarde × Holstein	S Red× Holstein
Trait	(n = 165)	(n = 168)	(n = 369)	(n = 218)
Days to 1st AI	70	66	63	66
Days open	148	128	122	136
SCC (1,000s)	121	119	98	108
305d Milk (kg)	11,417	9,843	10,744	10,627
305d F+P (kg)	762	687	738	733
Survival to 2nd calv (%)	75	88	89	85
Survival to 3rd calv (%)	51	73	75	71
Survival to 4th calv (%)	29	53	55	50
Days of herd life	946	1,263	1,358	1,306
Lifetime profit ($)	4,347	+5,467	6,503	6,272
Profit per day ($)	4.17	3.89	4.39	4.32

A separate experiment, conducted at the University of Minnesota, also confirmed the superior fertility performance of Jersey×Holstein crossbreds, this time in a very high input confinement regime (Table 6). The Jersey×Holstein crossbreds had 35 fewer days open than Holsteins. For survival from first to second calving, Jersey×Holstein crossbreds (80%) and Holsteins (71%) cows did not differ; however, a higher percentage of Jersey×Holstein crossbreds than Holsteins cows tended to calve a third time (64 vs. 49%).

Table 6. Jersey-Holstein crossbreds versus pure Holsteins during their first three lactations in the United States

	Jersey-Holstein	Holstein
First lactation cows (n)	76	73
Milk (kg)	7,905	7,361
Fat plus protein (kg)	526	518
SCS	3.05	2.91
Days open	124	148
Second lactation cows (n)	61	55
Milk (kg)	9,421	8,510
Fat plus protein (kg)	630	605
SCS	3.11	2.87
Days open	121	163
Survival to 3rd calving (%)	80	71
Third lactation cows (n)	50	37
Milk (kg)	9,803	8,530
Fat plus protein (kg)	660	609
SCS	3.79	3.40
Days open	158	200
Survival to 3rd calving (%)	64	49

Research from AFBI indicated that although somatic cell counts (SCC) did not differ between genotypes, the crossbred cows had a significantly lower incidence of mastitis compared to the Holstein cows. However, in this study there was no evidence of genotype having an impact on the number of cows treated for lameness. In the California crossbreeding study, SCC across the five lactations was similar for Normande×Holstein crossbreds and Holsteins, the Montbeliarde×Holstein and Scandinavian Red×Holstein crossbreds were lower for SCC than the Holsteins. This concurs with research from Teagasc.

The Production Performance of Jersey Crossbred Cows Within High Input Systems (Experiment 4)

This study, at AFBI, was designed to compare the performance of crossbred and Holstein cows within a modest-input grazing system and a high-input confinement system. Total concentrate inputs were 0.9 and 3.3 tonne of concentrate/cow, respectively (Vance et al., 2011).

Food Intake

Intakes of Holstein and crossbred cows within the total confinement system did not differ.

Milk Production

The crossbred cows produced 280 kg (modest input grazing system) and 2037 kg (total confinement system) less milk than the Holstein cows. When the higher fat and protein content of the milk of the Jersey crossbred cows is taken into account, fat + protein yield was similar with the two breeds on the modest input system, in agreement with the findings of Experiment 3 (Figure 3). However, within the total confinement system Holstein cows had a fat + protein yield approximately 100 kg higher than the crossbred cows, demonstrating that the Holstein cows had better genetic potential to continue to respond to higher concentrate feed levels than the crossbred cows.

Data from the California dairies showed that all three types of crossbred cows had reduced 305-day fat plus protein production compared to their Holstein herd mates across lactations, but the magnitude of the difference from Holstein cows was small from a practical perspective for the Montbeliarde×Holstein and Scandinavian Red×Holstein cows. The Montbeliarde×Holstein and Scandinavian Red×Holstein crossbreds were only 3% and 4% lower, respectively, than Holstein cows; however, Normande×Holstein crossbreds were 10% lower than Holstein cows for fat plus protein production.

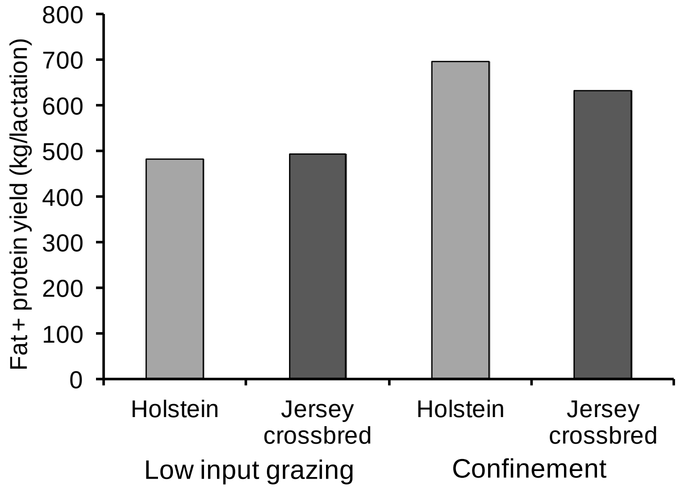

Figure 3: Fat + protein yield of Holstein and Jersey crossbred cows when managed on a low input grazing system and a high input confinement system

Body Tissue Reserves

This difference in performance can be explained in part by changes in body condition score (Figure 4).

Within the low-input grazing system the condition scores of both genotypes followed a similar pattern. However, on the high-input system the Jersey crossbred cows began to gain body condition from approximately week-20 of lactation onwards, so that by week-35 of lactation the mean condition score of this group was almost 3.0, compared to a score of approximately 2.5 with the Holstein cows. Thus, crossbred cows offered a high concentrate feed level began to partition a significant proportion of food consumed to body tissue reserves, commencing mid lactation, and were at risk of becoming over-fat in late lactation. This difference in nutrient partitioning between genotypes within the total confinement system provides an explanation as to why the crossbred cows did not respond to the additional concentrate offered to the same extent as the Holstein cows - part of the extra nutrients offered simply were partitioned towards body tissue reserves.

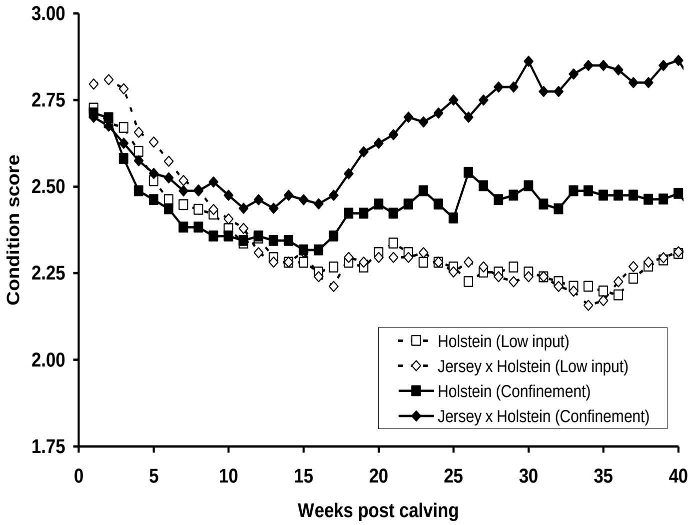

Figure 4: Changes in condition score of Holstein cows and Jersey x Holstein crossbred cows during the first 40 weeks of lactation within a low input grazing system and a total confinement system (AFBI)

Hoof Health

Within this study crossbred cows had a lower incidence of hoof health problems than the Holstein cows. It has long been suggested that the black hooves of Jersey crossbred cows make them less susceptible to hoof problems, with previous research having demonstrated that Jersey cows have harder hooves than Holstein cows. This did appear to be true.

On-Farm Comparison of Holstein and Crossbred Cows

The performance of Holstein and Jersey crossbred cows was examined in a study conducted on 11 Northern Ireland dairy farms, with this study involving approximately 190 cows of each breed (Ferris et al., 2012). While space prevents the full results of this study being presented here, in general, the results of this study were in close agreement with the outcomes of Experiments 3 and 4, described above.

This study allowed the survival of each of the two breeds to be examined. Crossbred cows had a higher survivability than Holstein cows, with 48% of Jersey crossbred cows surviving until the end of the fourth lactation, compared to 39% of Holstein cows. When extrapolated, the data indicates that on average Holstein cows survived for 3.6 lactations while crossbred cows survived for 4.8 lactations.

The results of this study were used to compare the financial performance of the two breeds (Table 7). Milk yield and milk composition were adjusted to take account of the different herd structures arising due to differences in survival between breeds, with milk price adjusted for compositional bonuses. The analysis has been undertaken using Canadian dollars, based on a milk price of $0.45 per litre. Differences between breeds in replacement rates, still birth rates, calves sold, and cull cows sold have been included within the calculations. The values of Holstein calves sold were assumed as $174 (bull) and $261 (heifer), while the value of Jersey crossbred calves sold were assumed as $87 (bull) and $261 (heifer). Holstein cull cows were assumed to have a value of $1044, while crossbred cull cows were assumed to have a value of $818. The value of replacement heifers was assumed to be the same for both breeds ($2262). Feed costs were based on annual food intakes obtained from previous AFBI studies (involving similar levels of performance), with feed costs assumed to be the same for both breeds ($1075/cow/year). Vet/medicine and semen costs were assumed to be 20% lower with the crossbred cows due to their improved health and fertility ($212/cow/year vs $252/cow/year).

The overall outcome of the economic analysis was that Jersey crossbred cows had a gross margin and net profit which was $68/cow/year higher than for the Holstein-Friesian cows. Total overhead costs were assumed as $853/cow/year.

Table 7. Comparison of the economic performance of Holstein-Friesian and Jersey crossbred cows (cow/year basis)

	Holstein-Friesian	Jersey crossbred
Milk sold (litres/cow/year)	6372	5973
Fat (%)	4.17	4.74
Protein (%)	3.39	35.9
Outputs ($/cow/year)		
Milk sold	3007	3026
Calves sold	157	124
Cull cows sold	287	167
Less replacement charge	623	463
Total outputs	2828	2854
Variable costs ($/cow/year)	1328	1286
Gross margin ($/cow/year)	1500	1568
Overhead costs ($/cow/year)	853	853
Net profit ($/cow/year)	647	715

Economic analysis using the biological data generated from the crossbreeding studies at Teagasc Moorepark has highlighted a substantial profit benefit per lactation with the Jersey×Holstein-Friesian and Norwegian Red×Holstein-Friesian cows (Table 8). The difference in performance (Canadian Dollars), equated to over $27,000 and $19,500, respectively, annually on a 40 ha farm. Base milk price was taken as $0.40/l. This implies over $270 and $195 more profit per cow per year, respectively. This economic analysis was very detailed, taking into account differences in production characteristics, body weight differences, replacement rates/survival, cull cow and male calf values etc. The improved profitability is primarily attributable to improvements in milk revenue and the large differences in reproductive efficiency/longevity observed with the crossbred herds. The economic performance of the Norwegian Red×Holstein-Friesian is for the most part what is expected if the Holstein-Friesian cows had similar fertility performance/replacement rates to the Jersey×Holstein-Friesian cows. So the benefits from the Jersey×Holstein-Friesian is more than that accounted for by improvements in fertility. Independent research undertaken by the Irish Cattle Breeding Federation has indicated a potential benefit from cross-breeding of some $150/lactation in the first cross over that explained by the Economic Breeding Index. This means that heterosis adds in excess of $150 per lactation in the form of added performance in the first cross.

In the California dairies research study (Table 5), profit was defined to include revenues and expenses for milk, fat, protein, and other solids production; SCC; reproduction; feed intake; calf value; salvage value; dead cow disposal; fixed cost; and interest cost. For profitability, Normande×Holstein cows had

26% greater lifetime profit per cow, but 6.7% less profit per day, than Holstein cows. On the other hand, Montbeliarde×Holstein and Scandinavian Red×Holstein cows had 50% to 44%, respectively, more lifetime profit per cow and 5.3% to 3.6%, respectively, more profit per day than Holstein cows. The advantages for profit per day of the Montbeliarde×Holstein and Scandinavian Red×Holstein crossbreds over Holsteins may seem modest. However, the daily profit margin must be multiplied by 365 days to estimate annual difference in profit, and the estimates of profit per day ignore potential differences in breed groups for health costs. The additional profit per day on an annual basis was $80 for Montbeliarde×Holstein and $55 for Scandinavian Red×Holstein cows compared to Holstein cows; which, for a 250-cow herd, would result in an additional annual profit of $20,000 for Montbeliarde×Holstein cows and $13,750 for Scandinavian Red×Holstein cows compared to Holstein cows.

Table 8: Physical and financial components of Holstein-Friesian (HF), Jersey (J), Jersey×Holstein-Friesian (JX), Norwegian Red (NR) and Norwegian Red×Holstein-Friesian (NRX) cows on a 40 ha farm

	Breed group				
	HF	J	JX	NR	NRX
Annual milk yield (kg)	543,916	480,087	510,032	542,073	555,302
Milk Sales (kg)	532,713	466,845	498,773	530,599	544,135
Milk protein (kg)	18,607	18,837	19,397	18,562	19,034
Milk fat (kg)	21,943	24,875	23,817	21,843	22,030
Milk protein (%)	3.49	4.03	3.88	3.49	3.49
Milk Fat (%)	4.12	5.32	4.77	4.05	4.05
No. of cows	96.3	113.8	96.7	98.6	95.9
Land area (Ha)	40	40	40	40	40
Stocking rate (LU/Ha)	2.28	2.70	2.34	2.38	3.32
Milk price (c/l)	30.68	38.12	35.47	30.52	30.52
Labour cost ($)	41,640	49,217	42,695	43,508	42,345
Concentrate costs ($)	8,930	10,556	9,663	9,846	9,584
Livestock sales ($)	43,013	34,044	32,511	39,146	39,602
Replacement costs ($)	58,356	68,973	40,403	41,171	40,073
Total costs ($)	224,778	250,634	206,679	209,562	205,902
Milk price 40c/l					
Milk returns ($)	238,013	259,224	257,685	235,839	241,835
Profit/kg milk solids ($)	1.38	0.98	1.94	1.64	1.85
Profit/Ha ($)	1,407	1,067	2,088	1,635	1,889
Profit Farm ($)	56,249	42,635	83,517	65,423	75,534

Issues To Be Considered Before Adopting Crossbreeding

The findings of the AFBI studies, together with an increasing body of international evidence, has clearly demonstrated the potential advantages of crossbred cows in terms of improved health, fertility and longevity. So is the ‘crossbreeding route’ one that all farmers should be actively considering? On many farms where appropriate sire selection programs have been in place in the past, crossbreeding may offer a lesser benefit in terms of an overall improvement in economic performance, while on other farms crossbreeding is likely to have a very real role. The following are some of the key issues that need to be considered before embarking on a crossbreeding program:

a) Crossbreeding will not solve problems associated with poor management or poor nutrition. It has been suggested that a ‘bad’ ‘pure-bred’ farmer will be an even poorer ‘crossbred’ farmer. Farmers must clearly identify why they are considering crossbreeding (i.e. what is the issue they are trying to address), and then identify if crossbreeding is likely to provide part of the solution, or if management changes will be equally effective.

b) With careful sire selection crossbreeding can represent genetic improvement through a combination of both additive and non-additive genetic improvement. Additive genetic improvement takes place when the top AI sires (for the most economically important traits) are used within that breed. The non-additive component is via heterosis or hybrid vigour. Selection indexes that have a major emphasis on functional traits now exist for the Holstein breed within many countries. Through careful sire selection, bulls that can help to overcome current herd weaknesses can be chosen. Nevertheless, on many herds it will take quite a few generations to reverse some longstanding problems and for many crossbreeding does offer a more immediate solution.

c) Performance of the first crosses will please even the most critical. As outlined, first crosses tend to tick all the boxes: display full hybrid vigour, productive and fertile. They also tend to be uniform in appearance (colour, size, etc.). For traits displaying a lot of hybrid vigour, e.g., fertility and longevity, subsequent generation performance may decline, depending to varying extents on the additive genetic contribution of the follow on sires selected. Hybrid vigour should be recognized as a ‘bonus’ rather than long term genetic gain. Adopting crossbreeding solely to gain the benefits of hybrid vigour is unlikely to be justified, although undoubtedly levels of hybrid vigour for some functional traits can be high. It is critical to remember that hybrid vigour is not fully passed on to the next generation. The extent to which hybrid vigour is expressed in later generations is dependent on the strategy taken after the first cross. A common question among dairy farmers considering crossbreeding is "where to after the first cross?" Several schemes are available for creating replacement animals via crossbreeding. The three most common are as follows:

- Two-way crossbreeding. This entails mating the F_1 cow to a high genetic merit sire of one of the parent breeds used initially. In the short term hybrid vigour will be reduced but over time settles down at 66.6%.
- Three way crossing. Uses high genetic merit sires of a third breed. When the F_1 cow is mated to a sire of a third breed hybrid vigour is maintained at 100%. However, with the reintroduction of sires from the same three breeds again in subsequent generations, for example Holstein-Friesian, hybrid vigour averages out at 85.7%.
- Synthetic crossing. This involves the use of high genetic merit crossbred bulls. In the long term a new (synthetic) breed is produced. Hybrid vigour in this strategy is reduced to 50% initially and is reduced gradually with time.

d) While crossbreeding may be advocated as a means of overcoming inbreeding depression, levels of inbreeding within many Holstein populations are still relatively low. It has been suggested that inbreeding really only becomes problematic when levels are >6.25%. With careful sire selection, high levels of inbreeding can be avoided.

e) It is suggested that crossbreeding can complicate management, especially in relation to housing and milking facilities. Depending on the breeds used, crossbreeding can result in smaller cows (e.g. Jersey), and cows with a more diverse range of sizes. While the former may be advantageous within a grazing system, smaller and mixed sized cows can pose problems in the milking parlour and in cubicle houses. Such problems, however, are relatively easily overcome.

f) The impact of crossbreeding on the value of cull cows, male calves and surplus breeding stock needs to be considered. The impact may vary depending on the breed chosen. For example, the use of the Montbeliarde breed within a crossbreeding program may well increase the value of cull cows and male calves, while the reverse is likely to be true when the Jersey is used. In addition, the impact of crossbreeding on the long term value of the herd needs to be considered. This issue has been factored in to the economic analyses presented. In reality this aspect of the enterprise should represent a minor contribution to overall profit and so is often over emphasized by those opposed to crossbreeding.

g) The choice of the second (and possibly third) breed for use within a crossbreeding program is critical. A number of issues need to be considered. Firstly, the breed should be suitable for the milk production system in which its offspring will function (i.e. low input grazing vs high input confinement). In most cases, a breed should be chosen to minimize any loss in milk production, while at the same time maximizing the gain to be made in other traits. Evidence from AFBI studies would suggest that Jersey crossbreds are not particularly suited to high input systems, while evidence from the U.S. would suggest that Scandinavian crosses are. In addition, any breed being considered for use within a crossbreeding program should have an associated breed improvement progeny testing program, with a significant focus on traits of greatest economic importance. To facilitate this, breeds being considered should have a sufficiently large population size to allow ongoing genetic improvements to be made. When choosing a breed the first step is to identify the key goals of the crossbreeding program, and to identify a breed that will allow these goals to be achieved.

h) The choice of sire within a breed is perhaps even more critical than the choice of breed itself. Additive genetic improvement, i.e., the superiority of the sire team within breed cannot be ignored. The perception is still widespread that a bull of a different breed purchased from a 'neighbour down the road' will be suitable for crossbreeding, just because it is of a 'different breed'. This will only do a great disservice to the concept of crossbreeding. Sires used within crossbreeding programs should be top sires for the desirable traits from within the breed selected.

i) Using a breed that is genetically 'distanced' from the parent breed will also impact on the level of heterosis to be gained. For example, while some have advocated the use of Red Holsteins as a 'breed' for 'crossbreeding', the benefits of these in terms of heterosis will be small, although they may provide scope for 'out crossing' within many Holstein populations.

j) Jersey-Holstein crossbreds tended to be good cows in all systems; however, better sorts of crossbreds probably exist for confinement dairying in the Northern Hemisphere, in particular where payment is milk volume based rather than milk solids based. Jersey-Holstein crossbreds are probably most suited to lower input systems that incorporate loose housing or pastures for grazing. Jersey-Holstein crossbreds were much more likely to survive to 3rd and 4th lactation than their pure Holstein herd mates – the not-so-good news is, in later lactations, the Jersey-Holstein crossbreds tended to become extremely deep in the udder, become high in SCC, and leave the herds quickly at that stage of life. Crossbreeding systems in confinement dairies will most likely benefit from using three (suitable) breeds. Preliminary results in California and the University of Minnesota indicate no loss in production by adding a third breed into a crossbreeding system.

Conclusions

Crossbreeding is not for everyone, and crossbreeding will not overcome problems of poor management. Nevertheless, a well-planned and well-managed crossbreeding program can result in robust cows with fewer calving difficulties, fewer health problems, higher levels of fertility, and ultimately improved longevity. While crossbreeding may have a detrimental impact on some economic aspects such as the value of male calves and cull cows, the positive financial impact associated with improvements in functional traits has the potential to improve overall economic performance of the dairy business.

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