Characteristics of Cressbred Progeny of Holstein Dams Sired by Different Beef Breeds: A Review

Bruce C. Shanks
South Dakota State University

Characteristics of Crossbred Progeny of Holstein Dams Sired by Different Beef Breeds: A Review

Bruce C. Shanks[1]
Department of Animal and Range Sciences

BEEF 2003 – 05

Background

Excellent reviews of cattle breed comparisons or breed-cross comparisons have been previously reported by Franke (1980), Long (1980), and Marshall (1994). However, these reviews do not contain information on the calving ease, performance, carcass characteristics, or beef palatability of crossbred progeny of Holstein dams sired by different beef breeds. In many countries dairy females are commonly mated to beef sires; however, in the United States the use of this practice is somewhat limited. Nevertheless, some United States dairy production schemes utilize beef sires on surplus Holstein heifers and cows. Also, some large commercial dairy operations purchase replacement heifers from outside entities, thus permitting optional breeding schemes for some dairy females in their herds. Finally, in the near future, information on crossbred progeny of Holstein dams sired by different beef breeds could become particularly useful if semen and embryo sexing technology becomes practical, allowing for selective matings to generate dairy replacement heifers, thereby freeing other Holstein females to produce terminal progeny. From a genetic and economic standpoint, the crossing of beef bulls to Holstein females could result in improved utilization of existing genetics and an untapped alternative source of business for beef and dairy producers alike. Therefore, the purpose of this review is to 1) compare the birth, weaning, feedlot, and carcass characteristics of progeny from the matings of Holstein females with different beef sire breeds and 2) suggest possible research needs that warrant further consideration.

Review of Literature

Review of the literature for this paper was conducted across a wide array of journals and publications. All articles found, particular to the subject, were included. Publications were not omitted because of differences in study design, scale, or methodology. Overall, it was discovered that there has been relatively little published research conducted on the birth, weaning, feedlot, or carcass characteristics of progeny produced from the crossings of Holstein dams with different beef sires. Furthermore, most of the available information originated from research trials that were conducted outside of the United States. Information from this review is summarized in the ensuing text and tables.

Table 1 contains mean gestation lengths, dystocia percentages, and birth weights of crossbred progeny of Holstein dams sired by different beef breeds. Menissier et al. (1982) found very little difference among gestation lengths for several different breeds of beef sires, but did find that crossbred progeny of Holstein dams sired by beef bulls would be expected to have longer gestation lengths than purebred Holstein contemporaries. Similarly, data in Table 1 revealed that crossbred progeny of Holstein dams sired by beef bulls would also be expected to have more calving difficulty (dystocia) and somewhat larger birth weights than purebred Holstein contemporaries. Undoubtedly, the relationship of gestation length with calving difficulty and birth weight is reflected in these findings. Research conducted by Brown et al. (1976) suggested that Limousin bulls would minimize calving difficulty and reduce birth weights of crossbred progeny of Holstein cows and beef sires relative to other continental beef breeds studied. In this study, larger dystocia percentages and birth weights were found for Simmental and Maine Anjou sires. Likewise, in two separate studies it was reported that birth weights of progeny sired by Simmental (average bull and heifer birth weights = 103.8 lb) and Limousin (average bull and heifer birth weights = 94.5 lb) bulls were somewhat different and favored Limousin (Forrest, 1980; Forrest, 1981). Menissier et al. (1982) reported that crossing Holstein dams with Hereford sires resulted in the least amount of calving difficulty and the smallest birth weights within the beef sires investigated. South Devon, Limousin, Simmental, and Blonde d'Aquitaine

[1] Ph.D. Graduate Student

crosses experienced mean calving difficulties of less than ten percent, whereas Piedmontese, Charolais, Maine Anjou, and Chianina crosses resulted in calving difficulties of greater than ten percent in the same study. Menissier et al. (1982) found that birth weights were fairly variable across breeds and were not always associated with dystocia.

Mean weaning weights, average daily gains to weaning, and average daily gains in the feedlot of crossbred progeny of Holstein dams sired by different beef breeds are presented in Table 2. Although very inconsistent among studies, information in Table 2 generally indicates that crossbred progeny of Holstein dams sired by beef breeds have only small advantages in growth performance when compared to purebred Holstein contemporaries. In three separate papers, Forrest (1977, 1980, and 1981) reported small advantages for average daily gain in the feedlot for Charolais and Limousin steer and heifer progeny and no differences in feedlot gain for Simmental-sired progeny when compared to purebred Holstein contemporaries. Southgate et al. (1982) and Kempster et al. (1982) reported that continental-sired progeny grew faster in the feedlot than Holstein-sired calves, but calves sired by British bulls were at a slight disadvantage when compared to calves sired by Holstein bulls. Furthermore, in studies conducted in Ireland (Keane et al., 1989) and Hungary (Szűcs et al., 1992), beef bulls (Blonde d'Aquitaine and Limousin) sired progeny with the same average daily gains in the feedlot as progeny sired by Holstein bulls.

In general, if beef sires are going to be bred to Holstein females, calves sired by continental beef breeds, especially Charolais, would be expected to grow faster and weigh more at weaning than progeny sired by British beef breeds. However, inconsistent differences in growth potential between continental- and British-sired calves have been reported. In a large French study, Menissier (1982) found that Charolais progeny had the largest weaning weights, followed by Maine Anjou-sired calves. Other continental beef breeds including Blonde d'Aquitaine, Chianina, Limousin, Piedmontese, and Simmental produced progeny with considerably smaller weaning weights than Charolais-sired calves. Hereford-sired calves were found to be the lightest at weaning in this study. Lalande and Fahmy (1975) concluded that Charolais- and Hereford-sired calves had the highest average daily gains in the feedlot, followed by Limousin-sired calves. Another earlier study, found that progeny sired by Charolais bulls had an advantage in average daily gain to weaning when compared to Hereford-sired calves; however, average daily gains in the feedlot were the same between the two sire breeds (Fahmy and Lalande, 1975). Menissier (1982) found that Charolais progeny had the highest average daily gains in the feedlot (average = 4.94 lbs). Several other breeds were intermediate in comparison, and Limousin- (average = 3.25 lbs) and Hereford-sired (average = 3.22 lbs) progeny were found to have the lowest average daily gains in the feedlot in this study. Charolais and Simmental crossbred calves held an advantage in average daily gain over several breeds in research reported by Southgate et al. (1982) and Kempster et al. (1982).

Table 3 contains mean slaughter weights, carcass weights, and dressing percentages of crossbred progeny of Holstein dams sired by different beef breeds. Calves produced by purebred Holstein matings have the ability to reach similar, or perhaps larger slaughter weights than crossbred progeny of Holstein dams sired by different beef breeds. However, at similar slaughter weights, purebred Holstein contemporaries would be expected to have a smaller carcass weight due to their large disadvantage in dressing percentage. Clearly, one of the greatest advantages of progeny produced from the crossing of Holstein females and beef bulls relative to purebred Holstein matings, is dressing percentage.

Results presented in Table 3 suggests that relative to other beef breeds studied, Piedmontese and Blonde d'Aquitaine beef sires would be expected to consistently produce calves with the highest dressing percentages when mated to Holstein cows. Other continental beef sire breeds, notably Limousin and Charolais, would also be expected to produce progeny that would excel in dressing percentage when bred to Holstein females. Simmental was at a disadvantage for dressing percentage when compared to other continental beef breeds according to research reported by Menissier et al. (1982) and Southgate et al. (1982) and Kempster et al. (1982). However, More O'Ferrall et al. (1989) found no difference in dressing percentage between Simmental- and

Charolais-sired progeny when mated to Holstein cows. Hereford and other British breeds (Angus, Devon, South Devon) had the lowest dressing percentages in the majority of studies summarized in Table 3 (Lalande and Fahmy, 1975; Menissier et al., 1982; Southgate et al., 1982 and Kempster et al., 1982; More O'Ferrall et al., 1989).

Table 4 contains mean fat thickness, ribeye area, and marbling scores of crossbred progeny of Holstein dams sired by different beef breeds. In general, crossbred progeny sired by continental or "double muscled" beef sires consistently had much larger ribeye areas than purebred Holstein contemporaries. In fact, in most instances, crossbred progeny sired by continental or "double muscled" beef sires had ribeye areas that were at least 1.55 in^2 larger than those produced by purebred Holstein contemporaries (Forrest, 1977; Forrest, 1980; Forrest, 1981; Southgate et al., 1982 and Kempster et al., 1982; Keane et al.,1989; Szűcs et al., 1992). However, purebred Holstein calves were similar in leanness to crossbred progeny sired by continental or "double muscled" beef sires. Breeds of British origin had larger amounts of external fat, had comparable or smaller ribeye areas, and slightly more marbling than purebred Holstein contemporaries.

Considerable differences existed among beef sire breeds for fat thickness and ribeye area (Table 4). Differences were especially evident between continental and British sires. Lalande and Fahmy (1975) concluded that Hereford-sired progeny had more external fat and smaller ribeye areas than calves sired by either Charolais or Limousin bulls. Fahmy and Lalande (1975) found similar results when comparing Hereford to Charolais, in a separate study. Southgate et al. (1982) and Kempster et al. (1982) reported that Charolais- and Simmental-sired progeny had ribeye areas greater than 9.3 in^2, while Devon, Hereford, Lincoln Red, South Devon, and Sussex sires produced progeny with mean ribeye areas ranging from 7.8 to 8.9 in^2. Angus-sired progeny had a mean ribeye area of 7.4 in^2 in their study. Researchers from Iowa State University (Bertrand et al., 1983) utilized a four-breed diallel design to explore carcass characteristics of progeny from Holstein cows mated to Holstein, Angus, Brown Swiss, and Hereford sires. Brown Swiss bulls sired crossbred calves with the least amount of external fat thickness, the largest ribeye areas, and the least amount of marbling. Conversely, Angus-sired calves had the greatest amount of external fat, the smallest ribeye areas, and the most abundant amount of marbling. Hereford-sired calves from Holstein cows were intermediate in comparison (Bertrand et al., 1983). Based on information in Table 4 it was difficult to detect which sire breed was optimal in terms of producing calves out of Holstein dams with the least amount of external fat thickness. It does seem that Limousin sires would be the most favorable at improving muscling based on research performed by Lalande and Fahmy (1975) and Keane at al. (1989). However, comparisons with "double muscled" beef sires were not evident in the literature.

A small number of researchers (Lalande et al., 1982; Dumont et al., 1987; More O'Ferrall et al., 1989) have compared meat quality traits (tenderness, juiciness, and flavor) of progeny from the matings of Holstein cows with different beef sire breeds (data not shown in tabular form). Lalande et al. (1982) utilized two experiments conducted over two years to study sensory traits of progeny (slaughtered at three different weights) produced by Holstein dams crossed with several different sire breeds (Holstein, Blonde d'Aquitaine, Chianina, Limousin, and Maine Anjou). These researchers found inconsistent differences among sire breeds when slaughtered at different weights. However, they concluded that purebred Holstein contemporaries had slightly superior eating quality at lower slaughter weights when compared with the crosses studied. Dumont et al. (1987) reported that steaks from purebred Holstein heifer carcasses were more tender than steaks from Charolais-sired heifer carcasses; however, taste panel assessment revealed that carcasses from Charolais-sired heifers were more flavorful and juicy. In a study conducted in Ireland, More O'Ferrall et al. (1989) found that Simmental-sired steer calves from Holstein dams had lower average shear force values than purebred Holstein contemporaries or Charolais- and Hereford-cross steer calves. Hereford-cross calves had the highest sensory values for juiciness and flavor. Sensory tenderness scores were similar across breed of sire in this particular study.

Discussion

Crossing Holstein cows with beef breeds could result in increased incidences of dystocia associated with longer gestation lengths and heavier birth weights, indicating that more attention would be necessary during calving to prevent losses. However, if beef sire breeds were mated to Holstein females, resulting progeny could have a slight advantage in growth performance over purebred Holstein counterparts. Dressing percentage would increase substantially if Holstein females were bred to non-British beef sires. Finally, vast improvements in muscling characteristics could also be accomplished by crossing Holstein cows with certain beef breeds, although reducing fat thickness and enhancing meat quality by crossing beef sire breeds with Holstein females could be difficult to achieve. Overall, depending on genetic and management goals, improvements in weaning, feedlot, and carcass characteristics of terminal progeny from dairy herds could be attained by crossing beef sires with Holstein females.

For some traits, there was significant variation in the literature between the different beef sire breeds when mated to Holstein dams. However, no sire breed was recognized as being systematically superior to the others for all traits examined. In order to minimize calving difficulty and reduce birth weights of crossbred progeny of Holstein cows, Hereford and perhaps other British sire breeds would be effective. Limousin bulls, would in general, result in the least amount of calving difficulties and lightest birth weights relative to the other continental breeds reviewed. Progeny from crosses involving Charolais bulls were consistently characterized by more rapid growth to weaning, larger weaning weights, and more desirable gains in the feedlot than other sire breeds. In general, other continental beef breeds sired progeny that were somewhat higher performing than progeny sired by Hereford and other British breeds; however, this was not necessarily always the case. Any of the beef breeds reviewed were capable of producing sufficiently large slaughter and carcass weights, yet Piedmontese-, Blonde d'Aquitaine-, Limousin-, and Charolais-sired progeny from Holstein females were unparalleled in dressing percentage. There was some indication that Simmental would be at a disadvantage for dressing percent when compared to other continental beef breeds. For other carcass characteristics, including fat thickness and ribeye area, sizeable differences were evident between continental and British sire breeds. It was not apparent which continental sire produced the leanest calves when bred to Holstein females; however, Limousin-sired calves excelled in muscling characteristics. South Devon sires produced progeny with the largest ribeye areas relative to other British sire breeds reviewed. None of the studies reporting carcass traits included Holstein-sired calves and calves sired by "double muscled" bulls. These breeds could potentially contribute to even larger effects on cutability traits. Angus-sired progeny from Holstein dams had the highest degree of intramuscular fat in the one study that included data on marbling score. Due to limited information, distinctions between the different beef sire breeds for meat quality traits (tenderness, juiciness, and flavor) were not evident in the literature. In general, sire breed comparisons presented in this review do not differ greatly from studies using non-Holstein dams, except possibly for comparisons to purebred Holsteins, in which heterosis becomes a factor.

In spite of the large numbers of Holstein females present in the United States and other countries there are gaps in our knowledge concerning the birth, weaning, feedlot, and carcass characteristics of crossbred progeny of Holstein dams sired by different beef breeds. Moreover, given the larger utilization of beef sires on Holstein dams in foreign nations, the bulk of the available information is from research conducted in overseas countries. Therefore, genetic differences in the breeds, systems of production, and slaughter ages and weights were particular to the countries involved and, although of some value, the research trials do not provide results that may be readily applied to United States dairy production conditions. Potentially, the commercial crossing of dairy females with beef sires could become more common in the United States because of continued purchase of replacement heifers from outside entities, improved and increased use of semen and embryo sexing technology, or for other reasons. If so, more information will have to become available to characterize the relative advantages and disadvantages of the different beef sire breeds when mated to Holstein females.

Conclusion

This review indicates that, in general, crossing beef sires with Holstein females could result in improved weaning, feedlot, and carcass characteristics of terminal progeny from dairy herds. However, crossing Holstein cows with beef breeds could result in increased incidences of dystocia. For some traits, there was significant variation in the literature between the different beef sire breeds when mated to Holstein dams. However, no sire breed was recognized as being systematically superior to the others for all traits examined. Finally, this review indicates that if the practice of producing crossbred Holstein progeny becomes more common in the United States, more information will have to be available to characterize the relative advantages and disadvantages of the different beef sire breeds when mated to Holstein females.

Literature Cited

Bertrand, J. K., R. L. Willham, and P. J. Berger. 1983. Beef, dairy, and beef X dairy carcass characteristics. J. Anim. Sci. 57:1440-1448.

Brown, C. J., L. B. Daniels, and C. Flynn. 1976. Crosses between Holstein cows and certain exotic beef sires. Arkansas Farm Research. 25(6):7.

Davies, M. H., H. F. Grundy, and R. Hardy. 1999. An evaluation of Piedmontese x Holstein-Freiesian cattle for beef production. Irish J. of Agric. Res. 38:201-208.

Dumont, R., J. H. Teissier, J. Bonnemaire, and M. Roux. 1987. Early calving heifers versus maiden heifers for beef production from dairy herds. II. Physicochemical and sensorial characteristics of meat. Lives. Prod. Sci. 16:21-35.

Fahmy, M. H. and G. Lalande. 1975. Growth rate, feed conversion ratio and carcass traits of Charolais X Holstein-Friesian and Hereford X Holstein-Friesian steers slaughtered at three different weights. Anim. Prod. 20:11-18.

Forrest, R. J. 1977. A comparison of birth, growth, and carcass characteristics between purebred Holstein-Friesian steers and Charolais X Holstein (F_1) crossbreds. Can J. Anim. Sci. 57:713-718.

Forrest, R. J. 1980. A comparison of growth and carcass characteristics between Holstein-Friesian steers and Simmental X Holstein (F_1) crossbreds. Can J. Anim. Sci. 60:591-598.

Forrest, R. J. 1981. A comparison of the growth, feed efficiency and carcass characteristics between purebred Holstein-Friesian steers and Limousin X Holstein (F_1) steers and heifers. Can J. Anim. Sci. 61:515-521.

Franke, D. E. 1980. Breed and heterosis effects of American Zebu cattle. J. Anim. Sci. 50:1206-1214.

Keane, M. G., G. J. More O'Ferrall, and J. Connolly. 1989. Growth and carcass composition of Friesian, Limousin X Friesian, and Blonde d'Aquitaine X Friesian steers. Anim. Prod. 48:353-365.

Kempster, A. J., G. L. Cook, and J. R. Southgate. 1982. A comparison of the progeny of British Friesian dams and different sire breeds in 16- and 24-month beef production systems. Anim. Prod. 34:167-178.

Lalande, G., E. Larmond, and M. H. Fahmy. 1975. A note on performance traits of crossbred beef X dairy steers finished on fast- and slow-gaining feeding regimes. Anim. Prod. 21:81-84.

Lalande, G., E. Larmond, and M. H. Fahmy. 1982. Meat quality evaluation at three slaughter weights of steers from the Holstein-Friesian breed and its crosses with Maine-Anjou, Limousin, Chianina, and Blonde d'Aquitaine. Can. J. Anim. Sci. 62:363-369.

Long, C. R. 1980. Crossbreeding for beef production: Experimental results. J. Anim. Sci. 51:1197-1223.

Marshall, D. M. 1994. Breed differences and genetic parameters for body composition traits in beef cattle. J. Anim. Sci. 72:2745-2755.

Menissier, F., J. Sapa, J. L. Foulley, J. Frebling, and B. Bonaiti. 1982. Comparison of different sire breeds crossed with Friesian cows: Preliminary results. Curr. Top. in Vet. Med. and Anim. Sci. 21:95-136.

More O'Ferrall, G. J., R. L. Joseph, P. V. Tarrant, and P. McGloughlin. 1989. Phenotypic and genetic parameters of carcass and meat-quality traits in cattle. Lives. Prod. Sci. 21:35-47.

Roux, M., J. H. Teissier, J. Bonnemaire, and R. Dumont. 1987. Early calving heifers versus maiden heifers for beef production from dairy herds. I. The effects of genotype (Friesian and Charolais X Friesian) and two feeding levels in the rearing period on growth and carcass quality. Lives. Prod. Sci. 16:1-19.

Southgate, J. R. G. L. Cook, and A. J. Kempster. 1982. A comparison of the progeny of British Friesian dams and different sire breeds in 16- and 24-month beef production systems. Anim. Prod. 34:155-166.

Szűcs, E., A. Csiba, I. Ács, and K. Ugry. 1992. Effect of commercial crossing of Holstein-Friesian cows with Limousin sires on slaughter value traits including beef quality. World Rev. of Anim. Prod. 27:64-74.

Table 1. Breed of sire differences for gestation length, dystocia, and birth weight (Holstein dams)

Breed of sire	n	Sex	Gestation length, d	Dystocia, %	Birth weight, lb	Comments	Source
Holstein	19	B	-	0.0	94.0	Arkansas	Brown et al., 1976
Holstein	33	H	-	3.0	93.2		
Limousin	18	B	-	17.0	100.2		
Limousin	8	H	-	13.0	87.2		
Maine Anjou	17	B	-	24.0	114.1		
Maine Anjou	9	H	-	22.0	96.2		
Simmental	15	B	-	19.0	107.1		
Simmental	11	H	-	9.0	97.1		
Holstein	42	B	-	-	99.3	Canada	Forrest, 1980
Simmental	27	H	-	-	98.9		
Simmental	37	B	-	-	108.6		
Holstein	39	B	-	-	95.8	Canada	Forrest, 1981
Limousin	50	H	-	-	90.3		
Limousin	42	B	-	-	98.5		
Holstein	69	B	284	1.5	85.9	France	Menissier et al., 1982
Blonde d'Aquitaine	168	B	291	8.8	92.5		
Charolais	152	B	289	13.1	101.1		
Chianina	86	B	291	15.7	98.2		
Hereford	165	B	287	4.3	89.4		
Limousin	162	B	292	5.2	93.8		
Maine-Anjou	75	B	287	13.6	97.6		
Piedmontese	67	B	291	12.4	95.4		
Simmental	72	B	291	7.7	98.2		
South Devon	76	B	288	6.5	93.6		

Table 2. Breed of sire differences for weaning weight, average daily gain to weaning, and average daily gain in the feedlot (Holstein dams)

Breed of sire	n	Sex	Weaning weight, lb	Average daily gain to weaning, lb	Average daily gain in the feedlot, lb	Comments	Source
Charolais	28	S	-	-	2.2	Canada	Lalande and Fahmy, 1975
Hereford	26	S	-	-	2.2	Fast-gaining feedlot diet only	
Limousin	29	S	-	-	1.9		
Charolais	30	S	-	2.0	2.8	Canada	Fahmy and Lalande, 1975
Hereford	30	S	-	1.8	2.8		
Holstein	12	S	-	-	2.6	Canada	Forrest, 1977
Charolais	6	H	-	-	2.4	Avg. of 3 growth rate intervals	
Charolais	12	S	-	-	2.9		
Holstein	42	S	-	-	2.8	Canada	Forrest, 1980
Simmental	27	H	-	-	2.3	Avg. of 3 growth rate intervals	
Simmental	37	S	-	-	2.9		
Holstein	39	S	-	-	2.7	Canada	Forrest, 1981
Limousin	50	H	-	-	2.2	Avg. of 3 growth rate intervals	
Limousin	42	S	-	-	2.8		
Holstein	15	B	543.0	-	2.4	France	Menissier et al., 1982
Blonde d'Aquitaine	31	B	529.8	-	3.8		
Charolais	33	B	585.0	-	4.9		
Chianina	18	B	551.9	-	4.5		
Hereford	34	B	507.7	-	3.2		
Limousin	31	B	518.8	-	3.2		
Maine-Anjou	18	B	574.0	-	4.4		
Piedmontese	17	B	518.8	-	3.8		
Simmental	17	B	556.3	-	4.1		
South Devon	16	B	551.9	-	4.2		

Table 2. Continued

Breed of sire	n	Sex	Weaning weight, lb	Average daily gain to weaning, lb	Average daily gain in the feedlot, lb	Comments	Source
Holstein	93	S	-	1.9	1.8	Canada	Southgate et al., 1982
Angus	46	S	-	1.7	1.7	Avg. of 2 production systems	and Kempster et al.,
Charolais	62	S	-	2.1	2.1		1982
Devon	118	S	-	1.9	1.9		
Hereford	90	S	-	1.8	2.0		
Lincoln Red	18	S	-	1.8	2.0		
Simmental	65	S	-	2.0	2.3		
South Devon	47	S	-	1.9	2.0		
Sussex	40	S	-	1.9	2.0		
Holstein	40	S	-	1.7	2.4	Ireland	Keane et al., 1989
Blonde d'Aquitaine	40	S	-	1.6	2.4		
Limousin	40	S	-	1.4	2.5		
Holstein	8	B	-	-	2.3	Hungary	Szűcs et al., 1992
Limousin	8	B	-	-	2.3	Avg. daily gain per day of life	
Charolais	15	H	474.6	-	1.9	United Kingdom	Davies et al., 1999
Charolais	18	S	463.6	-	2.4		
Piedmontese	15	H	465.8	-	1.8		
Piedmontese	18	S	468.0	-	2.2		

Table 3. Breed of sire differences for slaughter weight, carcass weight, and dressing percentage (Holstein dams)

Breed of sire	n	Sex	Slaughter weight, lb	Carcass weight, lb	Dressing percentage	Comments	Source
Charolais	28	S	-	-	56.1	Canada	Lalande and Fahmy,
Hereford	26	S	-	-	55.8	Avg. of 2 feedlot regimes	1975
Limousin	29	S	-	-	56.4		
Charolais	30	S	-	-	56.2	Canada	Fahmy and Lalande,
Hereford	30	S	-	-	56.1	Avg. of 3 slaughter weights	1975
Holstein	12	S	1044.2	591.6	56.7	Canada	Forrest, 1977
Charolais	6	H	1041.9	593.8	57.2		
Charolais	12	S	1037.5	611.5	58.8		
Holstein	42	S	1048.6	589.4	56.3	Canada	Forrest, 1980
Simmental	27	H	1046.4	600.4	57.5		
Simmental	37	S	1044.2	600.4	57.3		
Holstein	39	S	1110.4	578.4	55.7	Canada	Forrest, 1981
Limousin	50	H	1110.4	618.1	59.4		
Limousin	42	S	1108.2	624.7	58.6		
Holstein	14	B	1086.1	587.2	53.9		
Blonde d'Aquitaine	31	B	1094.9	633.6	57.8	France	Menissier et al., 1982
Charolais	33	B	1185.4	664.5	56.8	Cold carcass weight	
Chianina	18	B	1130.2	649.0	56.2		
Hereford	34	B	1057.4	582.8	55.9		
Limousin	31	B	1077.3	613.7	56.7		
Maine-Anjou	18	B	1156.7	649.0	56.1		
Piedmontese	17	B	1101.5	642.4	58.7		
Simmental	16	B	1150.1	633.6	55.2		
South Devon	16	B	1139.1	629.1	55.4		

Table 3. Continued

Breed of sire	n	Sex	Slaughter weight, lb	Carcass weight, lb	Dressing percentage	Comments	Source
Holstein	93	S	1081.7	532.0	49.2	Canada	Southgate et al., 1982
Angus	46	S	911.7	441.5	48.4	Avg. of 2 production systems	and Kempster et al.,
Charolais	62	S	1242.8	638.0	51.3		1982
Devon	118	S	975.7	472.4	48.4		
Hereford	90	S	989.0	485.7	49.1		
Lincoln Red	18	S	1024.3	498.9	48.7		
Simmental	65	S	1167.8	585.0	50.1		
South Devon	47	S	1117.0	558.5	50.0		
Holstein	32	S	1134.7	657.8	-	Iowa	Bertrand et al., 1983
Angus	32	S	1117.0	668.9	-		
Brown Swiss	27	S	1181.0	693.2	-		
Hereford	29	S	1108.2	662.3	-		
Holstein	78	H	1055.2	543.0	52.5	France	Roux et al., 1987
Charolais	80	H	1141.3	624.7	53.9		
Holstein	40	S	1441.5	790.3	54.8	Ireland	Keane et al., 1989
Blonde d'Aquitaine	40	S	1476.8	849.9	57.5		
Limousin	40	S	1410.6	812.4	57.6		
Holstein	218	S	1320.1	721.9	54.7	Ireland	More O'Ferrall et al.,
Charolais	21	S	1404.0	783.7	55.9		1989
Hereford	35	S	1317.9	735.1	55.7		
Simmental	14	S	1326.7	743.9	56.0		
Holstein	8	B	1106.0	635.8	57.4	Hungary	Szűcs et al., 1992
Limousin	8	B	1117.0	664.5	59.4		
Charolais	15	H	962.5	536.4	55.7	United Kingdom	Davies et al., 1999
Charolais	18	S	1024.3	582.8	56.9	Cold carcass weight	
Piedmontese	15	H	986.8	571.7	57.9		
Piedmontese	18	S	1039.7	604.9	58.2		

Table 4. Breed of sire differences for fat thickness, ribeye area, and marbling score (Holstein dams)

Breed of sire	n	Sex	Fat thickness, in	Ribeye area, in^2	Marbling Score	Comments	Source
Charolais	28	S	0.1	10.5	-	Canada	Lalande and Fahmy,
Hereford	26	S	0.3	9.6	-	Slow-gaining feedlot regime only	1975
Limousin	29	S	0.1	11.3	-		
Charolais	30	S	0.2	11.2	-	Canada	Fahmy and Lalande,
Hereford	30	S	0.3	10.1	-	Avg. of 3 slaughter weights	1975
Holstein	12	S	0.5	10.7	-	Canada	Forrest, 1977
Charolais	6	H	0.5	11.9	-		
Charolais	12	S	0.4	12.2	-		
Holstein	42	S	0.4	10.4	-	Canada	Forrest, 1980
Simmental	27	H	0.6	11.5	-		
Simmental	37	S	0.4	11.6	-		
Holstein	39	S	0.4	9.3	-	Canada	Forrest, 1981
Limousin	50	H	0.7	12.1	-		
Limousin	42	S	0.5	11.9	-		
Holstein	93	S	-	8.4	-	Canada	Southgate et al., 1982
Angus	46	S	-	7.4	-	Avg. of 2 production systems	and Kempster et al., 1982
Charolais	62	S	-	10.3	-		
Devon	118	S	-	7.8	-		
Hereford	90	S	-	7.9	-		
Lincoln Red	18	S	-	7.8	-		
Simmental	65	S	-	9.5	-		
South Devon	47	S	-	8.9	-		
Sussex	40	S	-	8.3	-		

Table 4. Continued

Breed of sire	n	Sex	Fat thickness, in	Ribeye area, in^2	Marbling Score[a]	Comments	Source
Holstein	32	S	0.2	12.2	13.9	Iowa	Bertrand et al., 1983
Angus	32	S	0.5	11.5	15.2		
Brown Swiss	27	S	0.2	12.6	12.1		
Hereford	29	S	0.4	11.6	14.1		
Holstein	40	S	-	12.2	-	Ireland	Keane et al., 1989
Blonde d'Aquitaine	40	S	-	14.4	-		
Limousin	40	S	-	14.6	-		
Holstein	8	B	-	13.6	-	Hungary	Szűcs et al., 1992
Limousin	8	B	-	15.7	-		

[a]12 = slight +, 13 = small -, 14 = small, 15 = small +, and 16 = modest