AN EVALUATION OF LIMOUSIN CATTLE

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An Evaluation of Limousin Cattle[1]

R. R. Frahm[2] and D. R. Belcher[3]

Increasing production costs have made cattle producers keenly interested in determining which breeds and breeding systems will result in maximum profit for a particular production situation. Breed differences represent an important source of genetic variation that can be utilized to genetically improve the efficiency of human food production from livestock.

Dickerson (1969) pointed out that breed differences could be utilized to enhance the efficiency of meat production through (1) grading up to superior breeds, (2) heterosis from systematic crossbreeding and (3) development of new breeds. Consequently, a primary objective of beef cattle genetics research throughout the world is to evaluate breeds and breeding systems for production efficiency under various climatic and management conditions. Dickerson (1969) indicated that evaluation of breeds for production efficiency required

[1]Study conducted by the Oklahoma Agriculture Experiment Station with a research grant from the North American Limousin Foundation.
[2]Professor and Beef Cattle Geneticist, Animal Science Department, Oklahoma State University, Stillwater.
[3]Graduate Research Assistant, Animal Science Department, Oklahoma State University, Stillwater.

Figure 1. Limousin cows and calves in France.

reliable estimates of relative performance for the more promising pure breeds, three-breed crosses from crossbred dams and the F1, F2 and F3 generations of two-breed crosses. Most research facilities are not large enough to provide such a complete set of data on very many breeds. Thus, most studies have involved only some of the necessary crosses, usually two-breed crosses and/or purebreds.

Limousin cattle are relatively new to North American beef production. Consequently, the role and contribution of Limousin to efficient beef production has not been well established. The purpose of this study was to review and summarize research data on a worldwide basis that involved Limousin in comparison with other breeds with regard to traits that are economically important to efficient beef production.

Brief History of Limousin

The Limousin breed is native to the hills and valleys of the old province of Limousin, now the departments of Haute-Vienne and Correze, located in the southcentral part of France. Ancestors of Limousin can be traced to the wild native cattle of Europe, called Aurochs. Rouse (1970) describes Limousin as the second most important beef breed of Continental Europe and indicates they may have the same ancestors as the Austrian and German Yellow cattle. In the 17th and 18th centuries, Limousin were renowned as draft animals and the oxen were slaughtered for meat upon termination of their usefulness. Although many other European breeds were selected for milk production, Limousin have always been selected for draft and meat production.

Figure 2. Limousin heifers in France.

In the early 1800's efforts were intensified to improve the Limousin cattle for meat production. The Limousin herd book was established in 1886 and Limousin have since developed a reputation in France for their hardiness, ease of calving and lean meat yield. The Limousin in France is now selected and managed solely for meat production. Rouse (1970) and French *et. al.* (1966) described Limousin as being large (mature females averaging about 1350 lbs. and bulls 2400 lbs.) but somewhat smaller boned than Charolais.

Limousin were introduced to North America in 1968 with importation of "Castor," renamed "Prince Pompador," from the Pompador Estate in France. Many other purebred Limousin bulls were imported to North America in the years that followed. These early Limousin cattle were very appealing to cattlemen throughout the United States and Canada and many modified their breeding programs to grade up from existing herds to produce American purebreds, 7/8 for females and 15/16 for bulls.

Limousin have shown rapid growth in North America. The 1976 annual report of the North American Limousin Foundation indicated 7,908 members with 139,332 Limousin cattle (ranging from half-bloods to purebreds). Collection and recording of performance data has been aggressively encouraged by the North American Limousin Foundation and in April 1977, 76 percent of the 181,000 Limousin listed in the herd book had some kind of recorded performance data.

Some of the rapid growth of Limousin in North America is probably due to the growing popularity of Limousin cross steers for showring competition. Limousin cross steers have enjoyed considerable success in the past few years and have won many major live animal and carcass shows. For example, in 1976 Limousin crosses were named Grand Champion at 13 state fairs and major regional livestock shows and 90 county fairs.

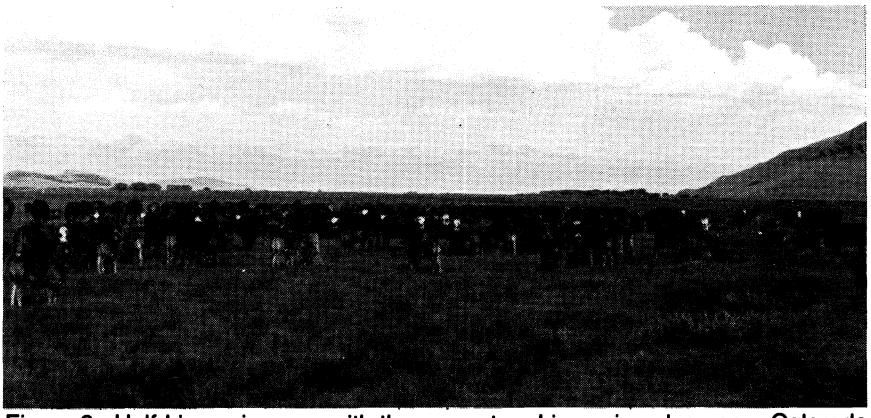

Figure 3. Half Limousin cows with three-quarters Limousin calves on a Colorado ranch.

Materials and Methods

Data Sources

This study was conducted over a two year period beginning in February 1976. Because of their relatively recent importation to North America, there has been insufficient time for very much research to evaluate Limousin on this continent. Consequently, much of the research has been conducted in other countries. In order to gain access to as much information as possible about Limousin cattle the literature was surveyed and interviews were conducted with scientists, Limousin breeders, Limousin breed association officials and beef industry leaders in the United States, Canada, France, Great Britain and Italy.

Since many Limousin breeders recorded performance data on their cattle, data from the North American Limousin Foundation files were analyzed to compare birthweight, weaning weight and yearling weight for different percentages of Limousin breeding. Although these are field records and do not represent a controlled experimental situation, information from these records can be useful in helping to characterize the performance profile of Limousin cattle on this continent.

The most common design employed in research studies involving Limousin was to produce two-breed cross calves by mating bulls of the breeds to be evaluated to cows of some other breed or breeds. Comparing such two-breed crosses provides estimates of one-half of the additive genetic differences among the sire breeds compared for a particular trait assuming a similar

Figure 4. Three-quarters Limousin heifers on an Oklahoma ranch.

level of heterosis among the various crosses.

Because of different breeds involved, differences in management and traits evaluated and differences in definition of some traits, it is difficult to summarize the results of experiments from different countries. The research studies summarized in this report were selected on the basis of being of sufficient size and scope and having enough specific crosses common to other studies to be useful in helping describe the biological characteristics of Limousin relative to other breeds. Most of the data summarized were from two-breed crosses and the few exceptions will be clearly indicated with the data presentation. Brief descriptions of the experiments summarized in this report are presented in Appendix Table 1 along with a list of specific references reporting results from each of these experiments. In some cases, a particular study included more specific crosses than were utilized in this summary. It was decided to include only crosses common to two or more experiments.

Results and Discussion

Breed Association Records

Data on average birthweight, weaning weight and yearling weight for various percentages of Limousin breeding were obtained from the North American Limousin Foundation. These were field records averaged over all breeds involved in the grading up process and represented a wide range of management conditions. Thus, they should be interpreted with some caution.

Figure 5. Three-quarters and seven-eights Limousin heifers on a Colorado ranch.

Nevertheless, the large number of records involved makes them a useful source of information on the impact on performance of using Limousin in a grading up program and provides some indication of the breed's genetic potential for growth.

These field records can be useful in examining the effect of increased percentages of Limousin breeding on performance providing: (1) the other breed composition and management levels are approximately the same for different percentages of Limousin breeding and (2) there was not any selection for increased growth performance as the percentage of Limousin breeding increased, either in terms of the crossbred females selected to produce the next level of Limousin breeding in the grading up program or the particular purebred Limousin bulls used in producing each phase.

Data were obtained on bulls and heifers and both sexes tended to show the same trend in performance as the percentage of Limousin increased. However, only heifer data were analyzed and summarized for this report because: (1) there were considerably more heifer records than bull records and (2) since Limousin in North America is in an expansion phase, any selection effects among different levels of Limousin breeding are expected to be minimal in the case of heifer records, or at least of smaller magnitude than for bull records. This does not negate the possible effects of selection bias that could occur if there was any tendency for the heifers with higher levels of Limousin breeding to have been produced by a more select group of Limousin bulls relative to growth rate than those at lower levels.

Figure 6. Young purebred Limousin bulls on an Oklahoma ranch.

Table 1 presents average birthweights of 90,152 heifer calves with different percentages of Limousin breeding. Average birthweights ranged from 72 to 78 lbs. and were very similar (73.1 lbs) for the 1/2, 3/4 and 7/8 Limousin while the 15/16 and higher levels were about 5 lbs. heavier at birth. The regression of birthweight on level of Limousin breeding indicated that for each 1 percent increase in Limousin breeding above 50 percent there was an increase in birthweight of only .053 pounds.

Average 205-day weaning weights for 105,745 heifer calves with various percentages of Limousin breeding are shown in Table 2. There was a consistent pattern of increasing weaning weight as the percentage of Limousin breeding increased. The 1/2 Limousin calves would be expected to exhibit 100 percent of the possible heterosis for weaning weight, whereas the higher levels of Limousin breeding would be expected to exhibit proportionally less heterosis. Thus, the last column of Table 2 presents average weaning weights that have been reduced by the expected level of heterosis assuming 5 percent heterosis for weaning weight. When heterosis is ignored, the regression of weaning weight on percentage of Limousin breeding indicated that for each 1 percent increase in Limousin breeding above 50 percent there was, on the average, a 1.9 lbs. increase in weaning weight. The regression of average

Table 1. Average Birth Weight For Different Levels Of Limousin Breeding[1]

Percent Limousin (X)	No. Heifer Calves	Average Birthweight, lb. (Y)
50	60,371	74.1
75	26,993	73.0
87	2,465	72.1
100	323	78.0

Regression of Y on X = .053 lb. increase in birthweight per 1% increase in Limousin breeding.

[1]NALF Data, 1977.

Table 2. Average Weaning Weight For Different Levels of Limousin Breeding[1]

Percent Limousin (X)	No. Heifer Calves	Weaning Weight, lb. (Y_1)	Weaning Wt. Adj. for heterosis, lb. (Y_2)	
50	76,663	461	(−5%)	437
75	26,497	500	(−2.5%)	489
87	2,369	525	(−1.25%)	518
100	216	558		558

Regression of Y_1 on X = 1.90 lb. increase in weaning weight per 1% increase in Limousin breeding.

Regression of Y_2 on X = 2.38 increase in weaning weight per 1% increase in Limousin breeding.

[1]NALF Data, 1977.

weaning weights adjusted for heterosis on level of Limousin breeding indicated that each 1 percent increase in Limousin breeding above 50 percent resulted in a 2.38 lbs. increase in weaning weight.

Table 3 presents average yearling weights of 58,664 heifers for different percentages of Limousin breeding. Yearling weight consistently increased as the percentage Limousin breeding increased. As was done for weaning weights, the last column of Table 3 presents average yearling weights reduced by the expected level of heterosis assuming 3 percent heterosis for yearling weight. The regression of yearling weight on percent Limousin breeding indicated that for each 1 percent increase in Limousin breeding above 50 percent, yearling weight increased by 2.71 lbs. and yearling weight adjusted for heterosis increased by 3.11 lbs.

Although these comparisons were not controlled experimental comparisons, they should provide some indication of the effect Limousin would have on these three traits relative to the breeds that have typically been used in the grading up programs in North America. The large number of records should help average out many of the random factors, e.g.; kind of management and breed of dam that can cause differences in these traits. There could possibly be some upward bias in performance at higher levels of Limousin breeding depending upon the extent of selection for increased growth rate among heifer calves and purebred Limousin bulls used in the grading up program. However, it seems likely that such bias, if it existed, would have only inflated the magnitude of the respective regression coefficients to some extent. It seems unlikely that such bias would be large enough to negate the basic conclusion that use of Limousin in a grading up program in North America has resulted in increased growth rate (heavier weaning and yearling weights) without any marked increase in birthweights relative to that of the foundation herd cattle used in the Limousin grading up programs. The ability to increase growth rate without much increase in birthweight is a distinct attribute from the standpoint of calving problems.

Table 3. Average Yearling Weight For Different Levels Of Limousin Breeding[1]

Percent Limousin (X)	No. Heifer Calves	Yearling Weight, lb. (Y_1)	Yearling Wt. Adj. for heterosis, lb. (Y_2)	
50	43,651	664	(−3%)	645
75	14,030	717	(−1.5%)	706
87	896	761	(−.75%)	755
100	87	799		799

Regression of Y_1 on X = 2.71 lb. increase in yearling weight per 1% increase in Limousin breeding.

Regression of Y_2 on X = 3.11 lb. increase in yearling weight per 1% increase in Limousin breeding.

[1]NALF Data, 1977.

Figure 7. Limousin cross calves on an Oklahoma ranch.

Summary of Two-Breed Cross Experiments

General Table Format

The general design for most experiments involving Limousin consisted of producing two-breed cross calves for evaluation by mating bulls of several different breeds to random samples of cows of one or more other breeds. Providing there was a similar level of heterosis exhibited for the crosses being compared for a particular trait, comparing performances from such two-breed crosses does provide an estimate of one-half the additive genetic difference or one-half the differences in breeding value among sire breeds compared within a study for a particular trait.

In data summaries that follow, the various experiments involved are identified as to geographic origin. Most are self explanatory, however, the study conducted at the United States Meat Animal Research Station, Clay Center, Nebraska is designated "USMARC" in the tables. The cow breed or breeds used to produce the crossbred calves in a particular study is indicated

in the footnotes to the data summary tables. The sire breed designation Hereford, Angus in the tables refers to either reciprocal Hereford x Angus crosses or to a Hereford cross. The total number of animals for those specific crosses summarized from a particular study are shown for each trait in order to indicate the relative size of the experiments. A more complete description of each of the experiments is presented in Appendix Table 1.

Data within a study are generally expressed in actual units and as a percentage of the Limousin cross performance. On this basis, the relative performance of Limousin cross cattle is 100 percent. Those crosses that had a larger value for a particular trait than the Limousin cross will have a relative performance greater than 100 percent and those crosses that had a smaller value for a particular trait will have a relative performance less than 100 percent. For some traits, such as postweaning average daily gain, relative performances greater than 100 percent would be considered advantageous, whereas, for other traits, like pounds of feed required per pound of gain, relative performances less than 100 percent would be considered advantageous.

Actual performances were averaged over experiments, however, these averages should be viewed with caution since not all sire breeds were involved in all studies included in the summary. Also there was considerable variation in the number of animals involved in each experiment and the simple average over experiments gives an equal weight to the results from each study. Thus, in some cases it may be beneficial to look more critically at individual experiments for making specific sire breed comparisons and consider size of the experiment as well as the management conditions under which it was conducted. The relative performances, expressed as a percentage of the Limousin cross within each study, were also averaged over experiments and represent a composite evaluation of each sire breed relative to Limousin. Of course, the more experiments represented in the average for a particular sire breed, the more reliable the evaluation of the breed.

Gestation Length, Birthweight and Calving Difficulty

Table 4 compares gestation length of Limousin sired calves with various other breeds in six experiments. Average gestation lengths were similar for Limousin, Chianina and Blonde d'Aquitaine cross calves. Calves from other sire breeds had a two to six day (0.6 to 1.9 percent) shorter gestation period.

In spite of the longer gestation periods, Limousin sired calves were consistently 1 to 11 pounds lighter at birth than calves from most other crossbred groups (Table 5). Averaged over eight studies, calves from most sire breeds were 1 to 12 percent heavier at birth than Limousin cross calves. Hereford, Angus and Jersey cross calves were lighter at birth than Limousin by 8.1 and 17.4 percent, respectively.

Table 4. Gestation Length Of Crossbred Calves (Days)

Sire Breed	USMARC[1] Gestation (%Lim)	N. Zealand[1] Gestation (%Lim)	Canada[2] Gestation (%Lim)	G. Britain[3] Gestation (%Lim)	Denmark[4] Gestation (%Lim)	France[5] Gestation (%Lim)	Average Gestation (%Lim)
Chianina		287 (100)			288.3 (100)		287.5 (100.4)
B. Aquitaine		288 (101)			285.6 (100)		286.8 (100.1)
LIMOUSIN	288 (100)	286 (100)	286 (100)	287.3 (100)	287 (100)	289.5 (100)	287.3 (100)
Charolais	285.9 (99)	284 (99)	285 (100)	284.9 (99)	287 (100)	287 (99)	285.6 (99.4)
Maine-Anjou		284 (99)				284.7 (98)	284.3 (98.8)
Simmental	286.2 (99)	285 (100)	285 (100)	285 (99)	285.2 (99)		285.3 (99.5)
South Devon	285.6 (99)	285 (100)					285.3 (99.5)
Hereford, Angus	282.9 (98)	280 (98)		282 (98)	282.2 (98)		281.7 (98.2)
Jersey	281.8 (98)	281 (98)					281.4 (98.1)
Total No. of Calves	2061	4000	2093	10,218	730	337	

[1]Angus and Hereford cows.
[2]Angus, Hereford and Shorthorn cows.
[3]Field data from Friesian cows.
[4]Red Danish, Black Pied Danish and Jersey cows.
[5]Maine-Anjou, Charolais and Limousin cows.

Table 5. Birthweight of Crossbred Calves (lbs.).

Sire Breed	USMARC[1] B.wt (%Lim)	N. Zealand[1] B.wt (%Lim)	Canada[2] B.wt (%Lim)	G. Britain[3] Freisian B.wt (%Lim)	G. Britain[3] Beef B.wt (%Lim)	Denmark[4] B.wt (%Lim)	France[5] B.wt (%Lim)	Clemson[1] B.wt (%Lim)	Average B.wt (%Lim)
Chianina		79 (116)				94 (111)		72 (109)	82 (112)
Charolais	85 (106)	75 (110)	89 (113)	94 (108)	95 (109)	99 (116)	96 (105)	71 (108)	88 (109.5)
Maine-Anjou		75 (110)					97 (107)	73 (111)	82 (109.2)
Simmental	84 (105)	73 (107)	85 (108)	92 (106)	93 (107)	92 (108)			87 (106.8)
B. Aquitaine		73 (107)				90 (106)			81 (106.7)
South Devon	79 (99)	73 (107)		92 (106)					81 (104)
Friesian		68 (100)						67 (102)	67 (100.8)
LIMOUSIN	80 (100)	68 (100)	79 (100)	87 (100)	87 (100)	85 (100)	91 (100)	66 (100)	80 (100)
Hereford, Angus	74 (93)	64 (94)		77 (89)	75 (86)	80 (94)			74 (91.1)
Jersey	65 (81)	57 (84)							61 (82.6)
Total No. of Calves	2061	4000	2093	4339	9823	730	485	548	

[1]Hereford and Angus cows.
[2]Angus, Hereford and Shorthorn cows.
[3]Field data from Friesian cows in dairy herds and from beef cows, breeds not identified.
[4]Red Danish, Black Pied Danish and Jersey cows.
[5]Charolais, Maine-Anjou and Limousin cows.

Limousin cross calves had substantially and consistently less calving difficulty than those sired by other large breeds (Table 6). There was considerable variation in the actual level of calving difficulty reported among studies due to differences in the cow breed and age distribution of cows as well as differences in defining calving difficulty. Averaged over seven studies, calves from most other sire breeds had 16.7 to 100 percent more calving difficulty than the calves sired by Limousin. Only Hereford, Angus and Jersey crosses (the same crossbred groups that had lighter birthweight) had less calving difficulty than Limousin cross calves. The substantially lower incidence of calving problems of Limousin sired calves relative to other large breeds has a distinct economic advantage, particularly to large commercial operations.

Calf Liveability and Preweaning Growth

Total calf mortality from birth to weaning is presented for various crosses from eight studies in Table 7. There was little consistency among experiments as to how calf mortality was reported, and thus for purposes of comparison, total calf mortality prior to weaning was determined from data reported from each experiment. Those breeds that experienced higher levels of calving difficulty tended to experience higher calf losses. There was substantial variation in actual as well as relative preweaning calf mortality among experiments. On the average, calf mortality of many of the larger breed crosses was from 0.6 to 73.2 percent higher than for Limousin cross calves. Compared to Limousin calves, Simmental crosses had 16 to 33 percent more calf death loss in the four largest studies and from 36 to 37 percent less calf mortality in the two smaller studies. Thus, on average, Limousin and Simmental cross calves had similar mortality levels. Compared to Limousin cross calves, Hereford, Angus calves and Jersey cross calves had lower calf mortality by 28.1 and 34.7 percent, respectively.

Average weaning weights for various crosses from seven studies are presented in Table 8. Weaning weights varied considerably among experiments due to large differences in enviromental and management conditions as well as differences in age at weaning. On the average, calves sired by the other large breeds were from 3 to 8 percent heavier at weaning than Limousin crosses, however, Limousin cross calves were 2.6 percent heavier than Hereford, Angus calves and 7.2 percent heavier than Jersey cross calves.

Postweaning Feedlot Performance

Average daily gain postweaning is presented from five studies in Table 9. The length of the feeding period as well as ration and other conditions varied greatly among studies. However, each study was basically a feedlot trial where cattle were managed to make rapid gains. Generally differences among crossbred groups within a study were not large. However, the Hereford, Angus

Table 6. Calving Difficulty of Crossbred Calves.

Sire Breed	USMARC[1] %Calving (%L) diff.	N. Zealand[1] %Calving (%L) diff.	Canada[2] %Calving (%L) diff.	Great Britain[3] Friesian %Calving (%L) diff.	Great Britain[3] Beef %Calving (%L) diff.	Denmark[4] %Calving (%L) diff.	France[5] %Calving (%L) diff.	Average %Calving (%L) diff.
Chianina		15 (250)				6 (150)		10 (200)
Maine-Anjou		14 (233)					31.3 (160)	23 (196.5)
Charolais	34 (142)	18 (300)	21.8 (176)	5.4 (225)	9.0 (122)	9 (225)	25.9 (132)	18 (188.7)
Simmental	29 (121)	11 (183)	15.3 (123)	3.5 (146)	8.9 (120)	6 (150)		12 (140.6)
South Devon	27 (113)	9 (150)						18 (131.3)
B. Aquitaine		11 (183)				2 (50)		6.5 (116.7)
LIMOUSIN	24 (100)	6 (100)	12.4 (100)	2.4 (100)	7.4 (100)	4 (100)	19.6 (100)	10.8 (100)
Hereford, Angus	11 (46)	3.5 (58)		.9 (38)	4.0 (54)	2 (50)		4 (49.1)
Jersey	5 (21)	1 (17)						3 (19)
Total No. of Calves	2061	4000	2093	12,075	8345	730	485	

[1]Hereford and Angus cows.
[2]Angus, Hereford and Shorthorn cows.
[3]Field data from Friesian cows in dairy herds and beef cows, breeds not identified. Calvings from heifers not included.
[4]Red Danish, Black Pied Danish and Jersey cows.
[5]Charolais, Maine-Anjou and Limousin cows.

Table 7. Preweaning Calf Mortality of Crossbred Calves (% of Cows Calving)

Sire Breed	USMARC[1] %Loss (%L)	N. Zealand[1] %Loss (%L)	Canada[2] %Loss (%L)	Great Britain[3] Friesian %Loss (%L)	Great Britain[3] Beef %Loss (%L)	Denmark[4] %Loss (%L)	Clemson[1] %Loss (%L)	France[5] %Loss (%L)	Average %Loss (%L)
Maine-Anjou		9 (129)					30 (263)	11.5 (128)	16.8 (173.2)
Charolais	15.5 (165)	14 (200)	10.2 (76)	5.5 (167)	4.6 (121)	9 (150)	12.8 (112.3)	10.8 (120)	10.3 (158.7)
Chianina		9 (129)				6 (100)	22 (193)		12.3 (140.5)
Friesian		5 (71)					20.8 (182)		12.9 (127)
South Devon	9.5 (101)	7 (100)							8.3 (100.6)
B. Aquitaine		7 (100)				6 (100)			6.5 (100)
LIMOUSIN	9.4 (100)	7 (100)	13.4 (100)	3.3 (100)	3.8 (100)	6 (100)	11.4 (100)	9.0 (100)	7.9 (100)
Simmental	11.1 (118)	9 (129)	8.6 (64)	4.4 (133)	4.4 (116)	2 (33)			6.6 (98.9)
Hereford, Angus	2.8 (30)	5.5 (79)		2.7 (82)	2.0 (52)	7 (117)			4.0 (71.9)
Jersey	6.9 (73)	4 (57)							5.5 (65.3)
Total No. of Calves	1901	4000	785	12,075	8345	730	548	201	

[1]Angus and Hereford cows.
[2]Angus, Hereford and Shorthorn cows.
[3]Field data from Friesian cows in dairy herds and beef cows, breeds not identified.
[4]Red Danish, Black Pied Danish and Jersey cows.
[5]Charolais, Maine-Anjou and Limousin cows.

Table 8. Weaning Weight of Crossbred Calves (lbs)

Sire Breed	USMARC[1] Wn.Wt. (%Lim)	N. Zealand[1] Wn.Wt. (%Lim)	Canada[2] Brandon[2] Wn.Wt. (%Lim)	Canada[2] Guelph[3] Wn.Wt. (%Lim)	G. Britain[4] Wn.Wt. (%Lim)	France[5] Wn.Wt. (%Lim)	Clemson[1] Wn.Wt. (%Lim)	Average Wn.Wt. (%Lim)
Maine-Anjou		387 (105)		522 (115)		475 (103)	457 (108)	460 (107.9)
Simmental	449 (104)	392 (107)	488 (110)	486 (107)	479 (108)			459 (107)
Charolais	455 (105)	394 (107)	460 (103)	519 (115)	494 (111)	471 (102)	434 (102)	461 (106.6)
Chianina		387 (105)					455 (107)	421 (106.4)
Friesian		385 (105)					451 (106)	418 (105.7)
South Devon	427 (99)	378 (103)			479 (108)			428 (103.1)
LIMOUSIN	433 (100)	367 (100)	445 (100)	453 (100)	445 (100)	460 (100)	424 (100)	432 (100)
Hereford, Angus	427 (98)	354 (96)	434 (98)		431 (97)			412 (97.4)
Jersey	403 (93)	339 (92)						371 (92.8)
Total No. of Calves	1901	4000	852	15,841	7429	396	637	

[1]Hereford and Angus cows.
[2]Hereford, Angus and Shorthorn cows.
[3]Field data from several unidentified cow breeds.
[4]Field data from Friesian cows.
[5]Charolais, Maine-Anjou and Limousin cows.

cross and Charolais and Simmental cross calves outgained the Limousin cross calves by 1.6, 6.5 and 8.4 percent, respectively.

Considerable variation existed among experiments as to how feed efficiency was measured as well as inherent variation among experiments due to ration and feeding conditions. Thus, only feed efficiencies relative to the Limousin cross in each experiment are presented for the five studies summarized in Table 10. The relative performances were fairly consistent among experiments and, on the average, Limousin, Charolais and Simmental crosses had similar feed efficiencies, whereas, Hereford, Angus and Maine-Anjou crosses required 3.3 percent less feed per unit of gain. There appears to be a need for additional well designed experiments to evaluate feed efficiency of Limousin cattle relative to other competitive breeds under various management and marketing conditions likely to prevail in North America.

Table 9. Postweaning ADG of Crossbred Males (lb/day)

Sire Breed	USMARC[1]	Canada				Average
		Brandon[2]	Ontario[3]	Denmark[4]	G. Britain[5]	
	ADG (%Lim)	ADG (%Lim)	ADG (%Lim)	ADG (%Lim)	ADG (%Lim)	ADG (%Lim)
Simmental	2.75 (116)	2.91 (113)	3.21 (100)	2.77 (106)	2.10 (107)	2.75 (108.4)
Charolais	2.73 (115)	2.75 (107)	3.13 (98)	2.79 (107)		2.85 (106.5)
Hereford, Angus	2.46 (103)		3.28 (103)	2.58 (99)	1.99 (102)	2.58 (101.6)
LIMOUSIN	2.38 (100)	2.58 (100)	3.20 (100)	2.61 (100)	1.96 (100)	2.55 (100)
Total No. of Calves	823	944	129	195	120	

[1]Hereford and Angus cows. ADG adjusted to 217 days on feed.
[2]Hereford, Angus and Shorthorn cows.
[3]Data from several central bull test stations with many undefined cow breeds involved in the crosses.
[4]Red Danish and Black Pied Danish cows.
[5]Friesian cows.

Table 10. Postweaning Feed Efficiency of Crossbred Males Relative to Limousin Crosses, % (Units of Feed Per Unit of Gain)

Sire Breed	USMARC[1]	California[2]	Denmark[3]	Great Britain[4]	France[5]	Average
LIMOUSIN	100	100	100	100	100	100
Simmental	102.2	99.1	96.0	101.6		99.7
Charolais	98.6	100.7	93.9		104.5	99.4
Maine-Anjou		86.6			107	96.8
Hereford, Angus	103.6	97.0	98.6	87.3		96.6
Total No. of Calves	729	50	195	120	110	

[1]Hereford and Angus, MCAL of metabolizable energy per lb. of gain adjusted to 217 days on feed.
[2]Hereford cows.
[3]Red Danish and Black Pied Danish cows.
[4]Friesian cows, F.E. = lbs. of feed per lb. of slaughter weight adjusted to 20% total carcass fat.
[5]Charolais, Maine-Anjou and Limousin cows.

Carcass Traits

Average carcass weights from seven experiments are presented in Table 11. Some studies did not specify whether carcass weights were determined on hot or cold carcasses. Cold carcass weight was used in this summary when both were reported in a study. Carcass weight varied considerably among studies reflecting to some extent differences in the length of the feeding period and carcass size and finish preferences from country to country. Carcasses from other crossbred groups were 1 to 6.5 percent heavier than Limousin cross carçasses with the exception of the Hereford, Angus cross which was 10 percent lighter.

Limousin crosses consistently had a favorable dressing percentage from one experiment to the next (Table 12). Relative to Limousin crosses, the other crossbred groups had, on the average, lower dressing percents by 1.5 to 3 percent. On a within breed basis, dressing percentage is expected to increase as an animal gets fatter. However, in these comparisons among breeds, Limousin cross cattle consistently had higher dressing percentages than the more traditional Hereford, Angus cross cattle which were fatter (Table 14). This suggests than Limousin cross cattle may have proportionally less rumen fill, weight of internal organs and/or hide weight.

A principal objective of producing beef is to provide high quality protein for human consumption. It will likely become increasingly important to utilize breeds and breeding programs that maximize efficiency of lean (and hence protein) production. Unfortunately, carcass composition has not been determined in very many experiments to date and measures of carcass composition differed among experiments. Percent carcass lean was consistently very high for Limousin crosses in the four experiments summarized in Table 13. Limousin and Charolais crosses were very similar in lean composition, whereas, Simmental and Hereford, Angus crosses had lower percent carcass lean by 1.7 and 8 percent, respectively. Conversely, Charolais and Limousin crosses had the least amount of fat (Table 14). On the average, Simmental crosses had 1.3 percent and Hereford, Angus crosses 33.3 percent more fat relative to Limousin crosses.

Only two studies reported an evaluation of tenderness. Table 15 presents the tenderness evaluation of the *longissmus dorsi* by mechanical means (Warner-Bratzler shear force) and subjectively (trained taste panel) for studies conducted in the United States and Denmark. With the mechanical test, higher pounds of shear force indicate less tender or tougher meat, whereas, with the taste panel scores, higher scores indicate more tender meat. Limousin crosses required higher shear force and received slightly lower tenderness scores from the taste panel and were, thus, slightly less tender than the other crosses. However, all of the crosses evaluated were quite satisfactory for tenderness based on their average shear force values and tenderness scores.

Table 11. Carcass Weight at Slaughter (lbs.)

Sire Breed	USMARC[1] Car.Wt. (%Lim)	N. Zealand[1] Car.Wt. (%Lim)	Canada[2] Car.Wt. (%Lim)	G. Britain[3] Car.Wt. (%Lim)	Denmark[4] Car.Wt. (%Lim)	California[5] Car.Wt. (%Lim)	France[6] Car.Wt. (%Lim)	Average Car.Wt. (%Lim)
B. Aquitaine		491 (107)			579 (106)			535 (106.5)
Maine-Anjou		486 (106)				643 (103)	813 (105)	647 (104.6)
Charolais	670 (106)	482 (105)	593 (100)		561 (102)	628 (100)	774 (100)	618 (102.3)
Simmental	652 (103)	482 (105)	578 (97)	536 (93)	552 (101)	703 (112)		590 (102.1)
South Devon	635 (101)	462 (101)						548 (101)
LIMOUSIN	631 (100)	458 (100)	593 (100)	574 (100)	548 (100)	626 (100)	775 (100)	609 (100)
Her., Ang.	616 (98)	426 (93)		396 (69)	519 (95)	600 (96)		509 (90.0)
Total No. of Calves	833	2000	643	120	160	50	110	

[1]Hereford and Angus cows. Data adjusted to 217 days on feed.
[2]Hereford, Angus and Shorthorn cows.
[3]Friesian cows. Data adjusted to 20% carcass fat.
[4]Red Danish and Black Pied Danish cows.
[5]Hereford cows.
[6]Charolais, Maine-Anjou and Limousin cows.

Table 12. Dressing Percentage of Crossbred Males

Sire Breed	USMARC[1] D.P. (%Lim)	N. Zealand[1] D.P. (%Lim)	Canada[2] D.P. (%Lim)	G. Britain[3] D.P. (%Lim)	Denmark[4] D.P. (%Lim)	California[5] D.P. (%Lim)	France[6] D.P. (%Lim)	Average D.P. (%Lim)
LIMOUSIN	64.3 (100)	61 (100)	60.0 (100)	55.0 (100)	56 (100)	62.1 (100)	68.5 (100)	61.0 (100)
Charolais	63.5 (99)	60 (98)	59.4 (99)		54.8 (98)	61.2 (99)	67.5 (99)	61.0 (98.5)
South Devon	64.0 (100)	59 (97)						61.5 (98.1)
Maine-Anjou		60 (98)				60.7 (98)	67.2 (98)	62.6 (98.1)
Simmental	62.8 (98)	59 (97)	58.4 (97)	52.7 (96)	54 (96)	60.9 (98)		58.0 (97)
Hereford, Angus	63.6 (99)	59 (97)		51.2 (93)	54 (96)	61.1 (98)		57.8 (96.7)
Total No. Calves	833	2000	643	120	160	50	110	

[1]Hereford and Angus cows.
[2]Hereford, Angus and Shorthorn cows.
[3]Friesian cows.
[4]Red Danish and Black Pied Danish cows.
[5]Hereford cows.
[6]Charolais, Maine-Anjou and Limousin cows.

Table 13. Lean Composition of Crossbred Carcasses (%L)

Sire Breed	USMARC[1] %Lean (%Lim)	Canada[2] %Lean (%Lim)	Denmark[3] %Lean (%Lim)	G. Britain[4] %Lean (%Lim)	Average %Lean (%Lim)
LIMOUSIN	71.7 (100)	63.8 (100)	70.8 (100)	63.3 (100)	67.4 (100)
Charolais	71.2 (99)	64.5 (101)	70.9 (100)		68.9 (100.2)
Simmental	70.2 (98)	63.1 (99)	70.3 (99)	61.4 (97)	66.1 (98.3)
Her., Ang.	65.5 (91)		66.1 (93)	57.6 (91)	62.8 (92.0)
Total No.	739	643	160	120	

[1]Hereford and Angus cows. Percent retail product adjusted to 217 days on feed.
[2]Hereford, Angus and Shorthorn cows. Percent defatted lean from retail cuts.
[3]Red Danish and Black Pied Danish cows.
[4]Friesian cows. Percent carcass lean adjusted to 948 lbs. slaughter weight.

Table 14. Fat Composition of Crossbred Carcasses (%)

Sire Breed	USMARC[1] Fat% (%Lim)	G. Britain[2] Fat% (%Lim)	Denmark[3] Fat% (%Lim)	Average Fat% (%Lim)
Her., Ang.	22.5 (142)	24.1 (128)	18.1 (127)	21.9 (133.3)
Simmental	16.4 (104)	19.3 (102)	13.6 (96)	16.6 (101.3)
LIMOUSIN	15.8 (100)	18.9 (100)	14.2 (100)	16.4 (100)
Charolais	15.8 (100)		13.1 (92)	14.5 (96.0)
Total No.	739	120	160	

[1]Hereford and Angus cows, adjusted to 217 days on feed.
[2]Friesian cows. Percent carcass fat adjusted to 948 lbs. slaughter weight.
[3]Red Danish and Black Pied Danish cows.

Table 15. Tenderness Evaluation of Steaks from the Longissmus Dorsi

Sire Breed	Warner-Bratzler Shear Force USMARC[1] lb. (%Lim)	Denmark[2] lb. (%Lim)	Average lb. (%Lim)	Taste Panel Score[3] USMARC[1] lb. (%Lim)	Denmark[2] lb. (%Lim)	Average lb. (%Lim)
Chianina		10.60 (103.6)	103.6		8.06 (99.3)	99.3
LIMOUSIN	7.56 (100)	10.23 (100)	100	7.00 (100)	8.12 (100)	100
B. Aquitaine		9.88 (96.6)	96.6		7.99 (98.4)	98.4
Simmental	7.63 (100.9)	9.22 (90.1)	95.5	6.91 (98.7)	7.85 (96.7)	97.7
Charolais	6.99 (92.5)	9.77 (95.5)	94.0	7.36 (105.1)	7.93 (97.7)	101.4
Hereford, Angus	7.12 (94.2)	9.19 (89.8)	92.0	7.38 (105.4)	7.36 (90.6)	98.0
Jersey	6.66 (88.1)		88.1	7.51 (107.3)		107.3
South Devon	6.59 (87.2)			7.47 (106.7)		106.7
No. Animals	967	230		423	230	

[1]Hereford and Angus cows.
[2]Red Danish and Black Pied Danish Cattle.
[3]Taste Panel Scores were on a scale of 9 = extremely desirable to 1 = extremely undesirable with 5 = acceptable.

Most other countries use somewhat different criteria for evaluating beef carcasses than those utilized in the United States. Consequently, research results from these countries generally did not report certain traits that are traditionally reported to help evaluate beef carcasses in the United States. Table 16 presents average performance for some of these carcass traits adjusted to 217 days on feed for crossbred groups compared in the USMARC study. Limousin and Charolais cross steers had the largest rib-eye area and the highest conformation scores. Limousin, Charolais and Simmental cross steers had similar amounts of fat cover (averaged .40 inches). Other crossbred groups exceeded this by .06 to .25 inches. Limousin cross steers had the lowest marbling score and consequently the lowest quality grade. It was estimated in this study that on the average Limousin cross steers would require 31 more days on feed than any other crossbred group to attain choice carcass grade.

Reproductive Performance of Crossbred Heifers

Comparative data on the reproductive performance of two-breed cross heifers has been reported from the large studies conducted at USMARC, New Zealand and Canada.

Limousin cross heifers were consistently older at puberty than other crossbred groups for the three studies summarized in Table 17. Compared to Limousin cross heifers, the other crossbred heifers averaged 6 days (1.3 percent) to 65 days (21 percent) younger at puberty. The longer gestation period (Table 4) and the older age at puberty observed for Limousin cross cattle would suggest that Limousin have a slower rate of physiological development. The additional age required to reach puberty would probably not be of major consequence in countries or on ranches where cattle are normally calved first at 30 to 36 months of age. In the USMARC study, 85 to 90 percent of the Limousin cross heifers reached puberty by 450 days of age, thus, most Limousin cross heifers could be bred to calve as two-year-olds, but they may require a higher level of nutrition and management.

Limousin cross heifers were consistently lower in conception rate than other crossbred groups for the three experiments summarized in Table 18. On a relative basis, the other crossbred heifer groups were, on the average, 7 to 31.5 percent higher in conception rate than Limousin cross heifers. This lower conception rate for Limousin cross heifers may be largely due to a slower rate of physiological development as indicated by their older age at puberty (Table 17) and longer gestation periods (Table 4). The limited data available (mostly observations in producer herds) suggest an adequate level of fertility for older Limousin and Limousin cross cows that is not very different from other breeds or crossbred groups.

Table 16. Summary of Certain Carcass Traits from the USMARC Study[1]

Sire Breed	No. Steers	Rib-eye Area		Average fat Thickness		Marbling[2]		Carcass[3] Conformation		Carcass[3] Quality Grade		Estimated Days on Feed to Grade Choice	
		Sq. in.	(%Lim)	inches	(%Lim)	Score	(%Lim)	Score	(%Lim)	Score	(%Lim)	Days	(%Lim)
LIMOUSIN	175	12.79	(100)	.41	(100.0)	9.46	(100)	12.18	(100.0)	8.82	(100.0)	264	(100)
Charolais	177	12.74	(99.6)	.39	(95.1)	10.83	(114.5)	12.25	(100.6)	9.44	(107.0)	228	(86.4)
Simmental	177	12.19	(95.3)	.40	(97.6)	10.44	(110.4)	11.55	(94.8)	9.20	(104.3)	233	(88.3)
South Devon	94	11.63	(90.9)	.49	(119.5)	11.83	(125.1)	11.19	(91.9)	9.87	(111.9)	198	(75.0)
Hereford, Angus	210	11.15	(87.2)	.65	(158.5)	11.86	(125.4)	11.72	(96.2)	9.88	(112.0)	184	(69.7)
Jersey	134	10.62	(83.0)	.46	(112.9)	13.81	(146.0)	9.27	(76.1)	9.91	(112.4)	174	(65.9)

[1]Hereford and Angus cows. Traits except estimated days on feed to grade choice were adjusted to 217 days on feed.
[2]Marbling score equivalents: 13 = modest, 12 = small+, 11 = small, 10 = small– and 9 = slight+.
[3]Carcass conformation and quality grade equivalents: 13 = prime–, 12 = choice+, 11 = choice, 10 = choice–, 9 = good+ and 8 = good.

Cow Characteristics

Although cow productivity is a very important component of efficient beef production, very limited comparative data are available to describe the production characteristics of Limousin purebred and crossbred cows.

Level of milk production is an economically important trait to the cow-calf producer. It is important for cows to produce milk at a level suited to the level of nutrition available and the management objectives of the herd. French studies that compared milk production of purebred cattle indicated that Charolais produced 1.6 and Maine-Anjou 3.4 lb. more milk per day than Limousin cows (Table 19). The USMARC study with two-breed crosses, however, indicated a similar level of milk production for Limousin and Charolais cross cows. Hereford, Angus crosses produced 1.4 lb. and Simmental crosses 5.5 lb. more milk per day than Limousin and Charolais crosses. In addition to the quantity of milk, butterfat and protein composition of the milk are also important in determining the nutritional value of milk for calf growth and development. It was suggested by many people that Limousin milk was

Table 17. Age at Puberty of Crossbred Heifers (Days)

Sire Breed	USMARC[1] Age (%Lim)	N. Zealand[1] Age (%Lim)	Canada[2] Age (%Lim)	Average Age (%Lim)
LIMOUSIN	398 (100)	440 (100)	349 (100)	396 (100)
Charolais	398 (100)	430 (98)	342 (98)	390 (98.7)
Simmental	372 (93)	420 (95)	335 (96)	376 (94.7)
S. Devon	364 (91)	400 (91)		382 (91)
Her., Ang.	371 (93)	385 (88)		378 (90.5)
Jersey	322 (81)	340 (77)		331 (79)
Total No.	819	2000	391	

[1]Hereford and Angus cows.
[2]Hereford, Angus and Shorthorn cows.

Table 18. Conception Rate of Crossbred Heifers (%)

Sire Breed	USMARC[1] %Preg. (%Lim)	N. Zealand[1] %Preg. (%Lim)	Canada[2] %Preg. (%Lim)	Average %Preg. (%Lim)
Jersey	86.4 (105)	90 (158)		88.2 (131.5)
Her., Ang.	93.0 (113)	90 (158)	86.5 (105)	89.8 (125.3)
S. Devon	85.1 (104)	73 (128)		79.0 (116)
Simmental	86.2 (105)	72 (126)	85.0 (103)	81.8 (111.3)
Charolais	80.6 (98)	70 (123)	82.6 (100)	77.7 (107)
LIMOUSIN	82.0 (100)	57 (100)	82.7 (100)	73.9 (100)
Total No.	819	697	1150	

[1]Hereford and Angus cows.
[2]Hereford, Angus and Shorthorn cows.

perhaps higher in butterfat than some of the other beef breeds. Research data were not found to either support or refute this claim.

The French study with purebreds indicated that mature weight of Hereford cows was 24 percent lighter than Limousin cows and Charolais and Maine-Anjou cows were 14 and 8 percent heavier, respectively, than Limousin cows (Table 20).

Individual Experiments

Texas Experiment Comparing 1/2 Limousin, 3/4 Limousin and Hereford x Angus Steers

Feedlot performance and carcass characteristics were evaluated on 72 crossbred steers - 24 each of (a) 3/4 Limousin x 1/4 Angus or Hereford, (b) 1/2 Limousin x 1/2 Angus or Hereford and (c) 1/2 Angus x 1/2 Hereford (Savell, *et. al*; 1976). These cattle were obtained from different sources and, thus, there was some confounding of breed type and source. The 3/4 Limousin crosses were described as older (although birth dates were not known on all cattle) and consequently heavier than the 1/2 Limousin cross steers. A pretest ad-

Table 19. Milk Production of Purebred and Crossbred Cows (lb/day)

Breed or Sire Breed	France[1]				USMARC[2]	
	Bibe, 1976		Vissac, 1974			
	M.P.	(%Lim)	M.P.	(%Lim)	M.P.	(%Lim)
LIMOUSIN	11.7	(100)	10.3	(100)	11.9	(100)
Charolais	13.7	(117)	11.6	(113)	11.9	(100)
Maine-Anjou	15.0	(128)	13.9	(135)		
Simmental					17.6	(147.9)
Hereford			9.9	(97)		
Hereford, Angus					13.3	(111.8)
Total No. Cows	396		130		72	

[1]Purebred cows.
[2]Crossbred cows produced by Angus and Hereford dams.

Table 20. Purebred Mature Cow Weight (lb)[1]

Breed	France	
	Cow Wt.	(%Lim)
Charolais	1529	(114)
Maine-Anjou	1459	(108)
LIMOUSIN	1346	(100)
Hereford	1025	(76)
Total No. Cows	143	

[1]Weight at 5 years of age

justment period of six weeks and a removal procedure for extra steers were employed to minimize differences due to origin. However, to some extent differences in origin and age are reflected in the results. Cattle were fed an 80 percent concentrate ration consisting of grain, silage, cottonseed meal, salt and calcium. One-half of the cattle were slaughtered after 177 days in the feedlot and the balance after 212 days. Detailed evaluation was conducted on one-half the carcass in each group. Specific linear contrasts (comparisons) were made for 3/4 Limousin *vs.* 1/2 Limousin and 1/2 Limousin *vs.* Angus x Hereford in the analysis.

Feedlot performance data are presented in Table 21. Average daily gains and feed conversion were similar for the two Limousin cross groups. The 1/2 Limousin steers outgained the Angus x Hereford steers by .25 lb/day on the 177 day test and by .59 lb/day on the 212 day test and required .62 and .76 fewer pounds of feed per pound of gain for the two respective feeding periods. These comparisons between 1/2 Limousin and Hereford x Angus are contrary to most of the comparisons in Tables 9 and 10. The design of the studies summarized in Tables 9 and 10 provides a better genetic comparison because both the Limousin crosses and Hereford, Angus crosses were produced by cows sampled from the same cow herd, were raised in contemporary groups and entered the feeding period at similar ages. The authors of the Texas report caution readers about the possibility of some bias in comparisons between breed groups due to differences in origin and possible differences in age.

Carcass characteristics are presented in Table 22. The 3/4 Limousin steers had significantly larger rib-eye areas, less fat thickness and higher yield grades (1.1 *vs.* 1.7) than the 1/2 Limousin, while 1/2 Limousin steers had less fat thickness, larger rib-eye area and higher yield grades (1.7 *vs.* 3.01) than the Angus x Hereford. U.S.D.A. quality grades were 1.35 quality scores higher (over 1/3 of a quality grade) for 1/2 Limousin compared to 3/4 Limousin, while the Angus x Hereford steers exceeded the 1/2 Limousin by .95 of a quality score (nearly 1/3 of a quality grade). The 3/4 Limousin cross steers had less fat trim and more total edible portion and percentage of primal cuts than Hereford x Angus steers. Differences in tenderness as mechanically measured by a Warner-Bratzler shear were not significant. The overall satisfaction score from a taste panel evaluation was slightly lower for the Limousin groups than the Hereford x Angus steers fed 177 days, while the 3/4 Limousin had a slightly lower score than 1/2 Limousin and Hereford x Angus steers fed 212 days. Mean values for taste panel scores indicated all breed and slaughter groups were acceptable in eating quality.

Partial economic efficiency was calculated for each breed and slaughter group in Table 23 at various price differentials for carcass quality and yield grades. These were considering comparisons in "partial economic efficiency" because the only factors considered were feed requirements during the feeding phase and carcass characteristics which were most highly related to value.

Table 21. Feedlot Performance of 3/4 Limousin, 1/2 Limousin and Angus X Hereford Steers[1]

Trait	Slaughter Group 1 (177 days in feedlot)					Slaughter Group 2 (212 days in feedlot)				
	Breed Groups			Linear Contrasts[2]					Linear Contrasts[2]	
	3/4Lim	1/2Lim	Ang-Her	3/4L vs. 1/2Lim	1/2L vs. Ang-Her	3/4Lim	1/2Lim	Ang-Her	3/4L vs. 1/2Lim	1/2L vs. Ang-Her
No. steers	12	12	12			12	12	12		
Initial weight, lbs.	576	516	587	*	*	575	520	587	*	*
Final weight, lbs.	1134	1051	1077	*	ns	1197	1167	1109	ns	ns
ADG, lb/day	3.15	3.02	2.77	ns	*	2.93	3.05	2.46	ns	*
Lbs dry matter/ lb. gain	7.06	6.85	7.47	ns	*	7.34	7.13	7.89	ns	*

[1]The other breed composition of Limousin cross steers was either Angus or Hereford.
[2]* = Differences between means is statistically significant (P<.05), ns = difference between means is nonsignificant (P<.05).

Table 22. Carcass Traits of 3/4 Limousin, 1/2 Limousin and Angus X Hereford Steers[1]

Trait	Slaughter Group 1 (177 days in feedlot)					Slaughter Group 2 (212 days in feedlot)				
	Breed Groups			Linear Contrasts[2]					Linear Contrasts[2]	
	3/4Lim	1/2Lim	Ang-Her	3/4L vs. 1/2Lim	1/2L vs. Ang-Her	3/4Lim	1/2Lim	Ang-Her	3/4L vs. 1/2Lim	1/2L vs. Ang-Her
Chilled carcass wt., lbs.	681	623	638	*	ns	722	685	669	ns	ns
Dressing percent	62.9	62.1	62.0	ns	ns	63.2	61.5	63.3	*	*
Fat thickness, in.	.23	.29	.54	ns	*	0.18	0.29	0.44	*	*
Rib-eye area, sq. in.	16.1	14.1	12.4	*	*	14.8	12.7	11.6	*	*
USDA Yield Grade[3]	0.9	1.6	3.0	*	*	1.3	1.8	3.0	*	*
USDA Quality Grade[3]	9.5	10.9	12.1	*	*	10.3	11.6	12.3	*	ns
Fat trim %	6.8	8.0	12.3	ns	*	7.1	8.7	11.7	*	*
Bone %	14.2	14.5	13.4	ns	*	14.1	14.6	13.5	ns	*
Total edible portions %[4]	77.0	75.0	72.2	*	*	77.5	75.1	73.4	*	*
Boneless prime cuts %[5]	59.9	57.2	54.6	*	*	58.8	56.8	54.8	*	*
Warner-Bratzler Shear, lbs.	9.4	8.1	7.2	ns	ns	7.8	7.7	11.2	ns	ns
Taste panel overall satisfaction score[6]	5.8	6.1	6.8	ns	*	5.6	6.4	6.4	*	ns

[1]The other breed composition of Limousin cross steers was either Angus or Hereford.
[2]* = differences between means is statistically significant (P<.05), ns = difference between means is non-significant (P<.01)
[3]Quality grade equivalent, 12 = choice−, 11 = Good+, 10 = Good, 9 = Good−
[4]Boneless lean plus acceptable fat from each wholesale cut.
[5]Boneless, closely trimmed retail cuts from round, rump, loin, rib and chuck.
[6]Taste panel overall eating satisfaction score: 8 = like extremely, 1 = dislike extremely.

Table 23. Return Per Steer Above Feeding Costs at Different Market Conditions Relative to Quality Grade and Yield Grade, $[1]

Price Differential per cwt. Carcass ($)							
Yield Grade	Carcass Quality Grade	Slaughter Group (177 days in feedlot)			Slaughter Group (212 days in feedlot)		
		3/4Lim	1/2Lim	Ang-Her	3/4Lim	1/2Lim	Ang-Her
0	3	285.48	266.46	280.90	285.91	257.87	285.17
	5	278.72	264.51	282.09	282.33	256.82	291.04
2	3	307.96	290.31	289.16	211.26	280.72	292.72
	5	300.21	288.37	290.34	308.90	279.66	298.56
5	3	341.68	326.08	301.55	352.39	316.49	304.06
	5	334.95	324.19	302.72	348.29	313.91	309.87

[1]Return per steer is partial economic efficiency based only on the feeding and slaughter phases of beef production. Individual carcass value and feeding costs were used to compute return per steer.

Prefeeding costs such as those involving the cow herds utilized to produce these steers and other feedlot costs such as labor and overhead costs were not included. Comparisons of partial economic efficiency in Table 23 indicated that no breed group was favored under all price situations. Limousin cross cattle tended to become more economically advantageous as the price differential for higher carcass yield increased.

Economic Efficiency of Terminal Cross Sires

Many traits are important to efficient beef production and it is important to characterize available breeds with regard to each of these traits. It is also important to compare the total production efficiency of various breeding systems and how it is influenced by particular breeds. Smith (1976) evaluated economic efficiency for a terminal cross production system as influenced by the various sire breeds involved in the USMARC study. In this study, all production costs (both fixed and variable) associated with maintaining the cow herd and the feedlot costs for the progeny were determined and this amount was subtracted from the total value of the retail product actually produced by each crossbred group to determine profit per cow. In this analysis consideration was given to calving difficulty, calf liveability, growth rate, feed efficiency, carcass composition and quality grade. In the two figures that summarize data from this study, Hereford, Angus straightbreds are the average of Hereford and Angus purebred performance, whereas, Hereford, Angus crosses are reciprocal Hereford x Angus crosses. All others are the average of the respective sire breeds crossed with Hereford and Angus cows.

Figure 8 shows the profit per cow when the progeny were fed to attain a constant slaughter grade of choice for all groups. Since Hereford x Angus is a popular cross, the profitability per cow of each group has been expressed as a percentage of the Hereford x Angus reciprocal crosses. The 15 percent higher

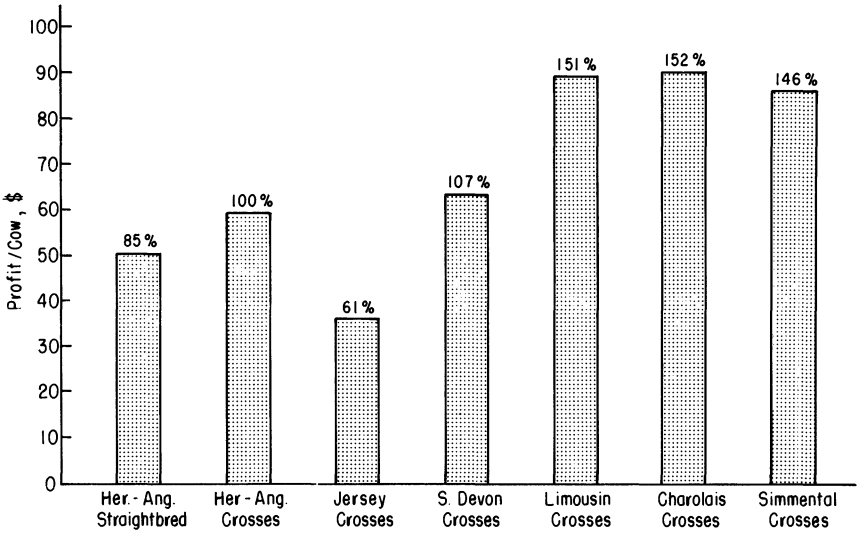

Figure 8. Profit per cow based on progeny performance to a constant slaughter grade of low-choice at $1.15 per pound of choice-grade retail product.

profitability of the Hereford x Angus cross over Hereford and Angus straightbred production represents the economic advantage due to heterosis. These data clearly demonstrate a marked advantage in profit per cow of 46 to 52% from using large, muscular breeds like Limousin, Charolais and Simmental as terminal cross sires on Hereford and Angus cows.

Under current marketing and grading conditions, calves sired by Limousin, Charolais and Simmental bulls would require a longer feeding period to attain a choice carcass grade. Figure 9 presents comparisons in profit per cow based on a fixed feeding period of 217 days. On this basis, a higher percentage of the Limousin, Charolais and Simmental cross steers would fail to reach the desired choice grade, and thus would result in some reduction in economic value when good grade carcasses sell for less than choice grade carcasses. When choice grade retail product was valued at $1.15 per pound and good grade retail product at $1.07 per pound, Limousin cross steers showed a 38 percent advantage over Hereford x Angus crosses in profit per cow and were closely followed by Charolais and Simmental crosses at 27 and 26 percent, respectively.

These comparisons clearly show that producers have an opportunity to significantly increase profit per cow in terms of the actual retail product value produced in a terminal cross production system utilizing sire breeds of large mature size, high growth rate, good feed efficiency and lean composition.

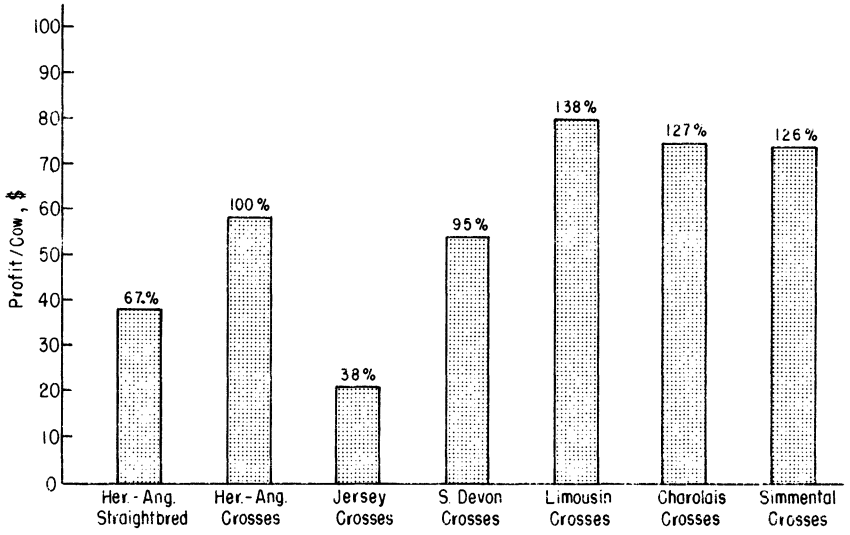

Figure 9. Profit per cow based on progeny performance for a postweaning feeding period of 217 days and $1.15 per pound for choice-grade $1.07 per pound for good-grade retail product.

Summary and Conclusions

Sufficient research results are not available to accurately and completely evaluate the biological characteristics of Limousin cattle for their effect on the efficiency of producing beef. However, the data summarized in this report are sufficient to help characterize the relative strengths and weaknesses of Limousin cattle with regard to many traits of economic importance.

An overall evaluation of Limousin cross cattle relative to other crossbred groups is presented in Table 24 on a scale of ++ for superior performance to −− for inferior performance. Such an evaluation is difficult, particularly for some traits, and should only be considered as an overall guide of Limousin cross performance relative to the other crossbred groups with which they were compared. More critical comparisons can be made with specific crosses by looking at the appropriate table summarizing results for a particular trait. In some cases, looking at specific experiments may be more useful for making comparisons for a particular purpose than using the average relative performance over experiments. The range in performances of other crosses relative to Limousin crosses are also presented in Table 24, both for within experiment comparisons and for relative performances averaged over experiments. For some traits, like growth rate, positive relative performances indicate more

Table 24. Overall Evaluation of Limousin Cross Cattle for Various Traits

Trait	Evaluation[1]	Range in other crossbred groups performance relative to Limousin crosses (%)	
		Within study	Averaged over studies
Gestation length	−	−2 to 1	−1.9 to 0.4
Birthweight	+	−19 to 16	−17.4 to 12
Calving difficulty	+	−83 to 200	−81 to 100
Preweaning calf mortality	0	−70 to 163	−34.7 to 73.2
Weaning weight	0	−8 to 15	−7.2 to 7.9
Postweaning ADG	−	−2 to 16	1.6 to 8.4
Postweaning feed efficiency	0	−13.4 to 4.5	−3.4 to −0.3
Carcass weight	0	−31 to 12	−10 to 6.5
Dressing percent	++	−7 to 0	−3.3 to −1.5
Percent carcass lean	++	−9 to 1	−8 to 0.2
Percent carcass fat	++	−8 to 42	−4 to 33.3
Tenderness, Warner-Bratzler[2]	−	−12.8 to 3.6	−11.9 to 3.6
Tenderness, Taste Panel[2]	−	−9.4 to 7.3	−2.3 to 7.3
Age at Puberty	−	−23 to 0	−21 to −1.3
Heifer conception rate	−−	−2 to 58	7 to 31.5
Milk production	−	−3 to 47.9	- - - -
Mature cow weight	0	−24 to 14	- - - -
Rib-eye area	++	−17 to −.04	- - - -
Average Fat Thickness	+	−4.9 to 58.5	- - - -
Marbling	−−	10.4 to 46	- - - -
Carcass conformation	+	−23.9 to 0.6	- - - -
Carcass quality grade	−−	4.3 to 12.4	- - - -
Feedlot days to choice grade	−−	−44.1 to −13.6	- - - -

[1]++ = suberior performance, + = slightly superior performance, 0 = average or intermediate performance, − = slightly inferior performance and −− = inferior performance.
[2]Positive relative performance values indicate less tenderness for Warner-Bratzler shear values and more tenderness for taste panel scores.

favorable performance, whereas, for other traits, like preweaning calf mortality, it would indicate less favorable performance.

Compared to most other breeds Limousin cross cattle had higher dressing percents, larger rib-eye, higher percent carcass lean and lower percent carcass fat. In addition, Limousin sired calves had significantly lighter birth weights and less calving difficulty than other large breeds.

Limousin cross cattle had an adequate and competitive level of performance with regard to carcass weight, calf survival, feed efficiency and mature cow size. Limousin performance for these traits was similar to that of other breeds. Feed efficiency is a very important trait but the limited data available and the diversity in how it was measured make it particularly difficult to evaluate this trait for Limousin cattle. Additional well designed studies to evaluate the efficiency of growth in Limousin cattle under management and marketing conditions likely to prevail in the beef industry would be justified. It would be interesting, for example, to compare breeds relative to their effi-

ciency of producing lean. Limousin cross cattle appeared to have growth rates similar to the traditional Hereford x Angus crosses, however, relative to other large breeds the growth rate of Limousin in cross cattle was slower. Limousin cross cattle were consistently less tender, however still quite acceptable with regard to tenderness and overall consumer acceptability.

Limousin cross calves had longer gestation periods, and heifers reached puberty at an older age and conceived at a lower rate when managed to produce their first calf at two years of age. These factors perhaps indicate Limousin cattle are somewhat slower in rate of physiological development. Limited data suggested that Limousin had slightly lower milk production than Hereford x Angus cows. This can be either an advantage or a disadvantage depending upon the production circumstances. Mostly though, it is simply a biological characteristic to consider in selecting complementary breeds for use in a systematic crossbreeding program.

It would appear that maximum efficiency of beef production will occur by involving complementary breeds in well planned, systematic crossbreeding systems. The systems that seem most likely to be employed extensively are static three-breed terminal crosses and two or three breed rotational crosses. Breeds that will be major contributors to future beef production will be those that are uniquely superior for one or more traits economically important to efficient beef production and that will complement other breeds in crossbreeding systems.

In general, Limousin appear reasonably well adapted to a wide range of climatic and management conditions. Performance levels of Limousin cattle were sufficiently competitive for economically important traits to insure an increasing contribution to efficient beef production. The biological characteristics of Limousin appear to be such that under many management conditions Limousin would be a viable choice as either a terminal sire breed or as one of the breeds in a rotational crossbreeding program.

A breed must capitalize on its strengths and improve its weaknesses in order to enhance its influence on beef production on a long term basis. The high lean composition and low fat composition of Limousin cross carcasses and the lighter birthweights which result in significantly less calving difficulty relative to the other large breeds compared in this study are distinctly competitive attributes. However, Limousin cross cattle had a slower growth rate than the other large breeds. A recommended selection program to enhance the value of Limousin cattle for efficient beef production would be to utilize selection procedures that will increase growth rate while at the same time minimizing any correlated increase in birthweight and mature size. Since most cattle in North America are managed to calve first at two years of age, some selection should probably also be exercised against slow physiological development.

Appendix Table 1. Description of Experiments Summarized in this Study

Location	Description	References
California	An experiment conducted at the University of California, Davis involving calves produced from Hereford cows and Simmental, Limousin, Maine-Anjou, Lincoln Red, Brown Swiss, Charolais, Angus and Hereford bulls. Ten steer calves of each crossbred group were obtained for evaluation of feedlot performance. The steers received a 30 mg implant of DES and all groups were on feed 132 days before slaughtering started and were slaughtered at a commercial plant when an anticipated low choice grade had been attained.	1
Canada, Brandon	A project conducted by the Canadian Department of Agriculture at Brandon, Manitoba to evaluate performance of calves from Charolais, Simmental and Limousin bulls when mated to Hereford, Angus and Shorthorn cows. Calves were produced in 18 contract herds, primarily under range conditions, resulting in over 5000 matings over a 4 year period. At weaning all calves were taken to the Canadian Research Stations where steers were fed under feedlot conditions for evaluation of growth traits and slaughtered for carcass evaluation. Heifers were kept for further evaluation of maternal traits.	3, 19, 20, 39, 40
Canada, Guelph	A study conducted by the Department of Animal and Poultry Science, University of Guelph. Sire Summary lists from various organizations were utilized to obtain the data with the greatest number of records coming from the Canadian Department of Agriculture, Canadian Record of Performance data for 1971-72 calves and the Alberta commercial herd data for 1971-72. A total of 15,841 records were used to evaluate Charolais, Simmental and Limousin sired calves. Data were adjusted for breed of dam, age of dam and sex of calf.	44
Canada, Ontario	Field data summarized by the Canadian Department of Agriculture on the performance of bulls at central test stations in Ontario. This summary data included performance records on 932 bulls consisting of purebred Angus, Charolais, Hereford, Santa Gertrudis and Shorthorn bulls and crossbred Charolais, Hereford, Limousin and Simmental bulls from cows of various breeds.	2, 4
Clemson	A study conducted by Clemson University at Experiment Stations in South Carolina involving Angus, Polled Hereford, Charolais, Holstein, Maine-Anjou, Limousin and Chianina bulls mated to Angus and Hereford cows over an 8 year period producing approximately 991 calves. Records were collected on calving and preweaning traits and many of the calves were used in subsequent grazing and feeding trials.	45, 50
Denmark	A study conducted by the National Institute of Animal Science and the Danish Meat Research Institute. Hereford, Limousin, Blonde d' Aquitaine, Charolais, Romagnola, Chianina, Simmental and Danish Red and White bulls were mated to Red Danish, Black Pied Danish and Jersey cows and resulted in 1006 single calvings over a 3 year period. Calves were pro-	5, 6, 7, 32, 33

Appendix Table 1. (cont.)

Location	Description	References
	duced numerous private dairy herds throughout the area and calving performance was recorded by the farmer on questionnaires. At 2-4 weeks of age the calves were transported to the experiment station and fed whole or skim milk until seven months of age and thereafter self fed concentrates plus up to 2.2 lbs. of hay per day.	
France	A study conducted at the Center of Applied Quantitative Genetics Research. Purebred and reciprocal crossbred calves were produced by mating Maine-Anjou, Charolais and Limousin bulls to Maine-Anjou, Charolais and Limousin cows. A sample of Hereford cows bred to Hereford bulls was used as a control. A total of 476 calves were produced over a 4 year period. Females were raised in drylot and managed to calve first at two years of age.	9, 10, 36, 37, 51
Great Britain	A study developed by the Limousin and Simmental Tests Steering Committee to evaluate imported breeds of cattle under British conditions. Limousin, Simmental, Charolais and Hereford bulls were mated AI to Friesian cows at private dairy herds over a 2 year period and farmers recorded calving performance on questionnaires, approximately 12,075 records were obtained. Thirty steers of each breed type except Charolais were taken to experiment stations for growth and carcass evaluation. A similar survey conducted with beef cows involved mating Limousin, Simmental, Angus, Charolais, Devon, Hereford, Lincoln Red and South Devon bulls to various breeds of beef cows and approximately 5,704 records for birthweight and 13,528 records for weaning weight were analyzed.	13, 14, 15, 16, 17, 34
New Zealand	A study conducted by the Ministry of Agriculture and Fisheries at the Ruakara Animal Research Station, Hamilton, New Zealand. Angus, Hereford, Friesian, Jersey, Maine-Anjou, Charolais, Blonde d'Aquitaine, Simmental, Limousin, South Devon and Chianina bulls were mated AI to over 2,200 Hereford and Angus cows in 3 experimental beef herds over a 3 year period with approximately 4,000 total calvings under range type conditions. Chianina bulls were used for 1 year only.	8, 11, 12
Texas	A study conducted by Texas A&M University and the Texas Agricultural Experiment Station at research stations at Spur and College Station. The study involved 72 crossbred steers; 24 each of 3/4 Limousin x 1/4 Angus or Hereford, 1/2 Limousin x 1/2 Angus or Hereford and 1/2 Angus x 1/2 Hereford that were compared for feedlot and carcass characteristics.	42
USMARC	A study conducted by the U.S. Department of Agriculture at the U.S. Meat Animal Research Center, Clay Center, Nebraska. Bulls from Hereford, Polled Hereford, Angus, Jersey, South Devon, Charolais, Simmental and Limousin breeds were mated to Hereford and Angus cows over a 3 year period and	27, 28, 29, 30, 38, 46, 47, 48

Appendix Table 1. (cont.)

Location	Description	References
	resulted in approximately 2,368 calves produced under improved pasture conditions. At weaning all steer calves were placed in feedlot for growth trait measurements and subsequent carcass evaluation. Steers were slaughtered on one of three slaughter dates after approximately 184, 218 and 251 days on feed (varied some each year). Carcass traits were reported and adjusted to three end points (1) constant age on feed and 217 days in feedlot, (2) constant carcass weight of 634 lbs. and (3) constant carcass quality grade of choice. All heifers were kept for further evaluation on reproductive performance.	

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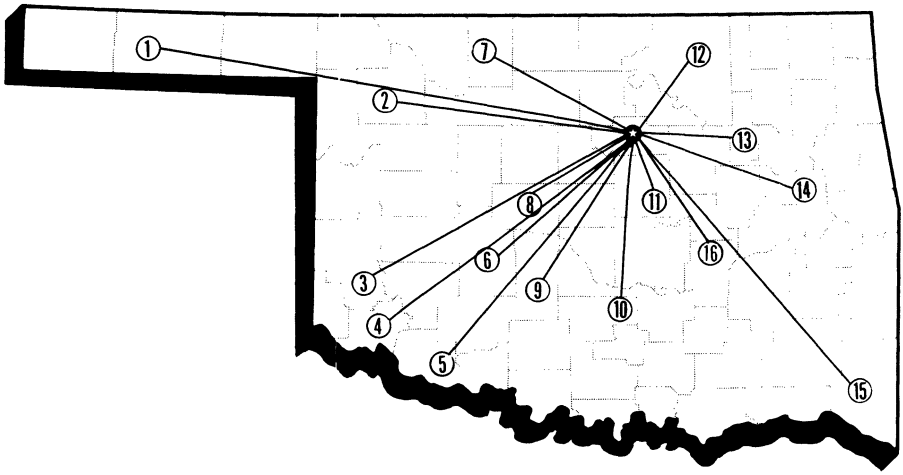

Main Station — *Stillwater, Perkins and Lake Carl Blackwell*

1. Panhandle Research Station — *Goodwell*
2. Southern Great Plains Field Station — *Woodward*
3. Sandyland Research Station — *Mangum*
4. Irrigation Research Station — *Altus*
5. Southwest Agronomy Research Station — *Tipton*
6. Caddo Research Station — *Ft. Cobb*
7. North Central Research Station — *Lahoma*
8. Southwestern Livestock and Forage Research Station — *El Reno*
9. South Central Research Station — *Chickasha*
10. Agronomy Research Station — *Stratford*
11. Pecan Research Station — *Sparks*
12. Veterinary Research Station — *Pawhuska*
13. Vegetable Research Station — *Bixby*
14. Eastern Research Station — *Haskell*
15. Kiamichi Field Station — *Idabel*
16. Sarkeys Research and Demonstration Project — *Lamar*

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