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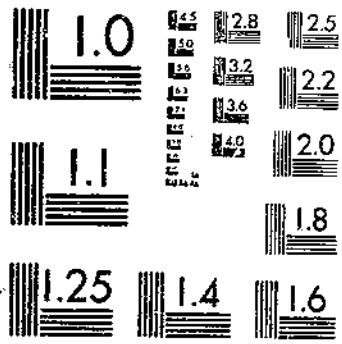

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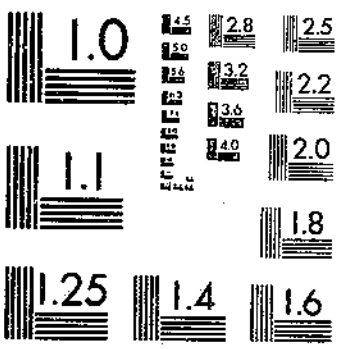

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A Crossbreeding Experiment With Dairy Cattle[1]

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[1] Submitted for publication May 15, 1953, before the agencies of the U. S. Department of Agriculture were reorganized into new groups and given new titles. At the time the authors submitted this report they were in the Division of Breeding, Feeding, and Management, Bureau of Dairy Industry.

INTRODUCTION

In 1939, when the Bureau of Dairy Industry began its crossbreeding experiment at Beltsville, the available published information on crossing breeds of dairy cattle was not too impressive. Very little of the information was based on experimental results.

At that time the use of hybrid corn by farmers was expanding rapidly. Crossbreeding with poultry, swine, and sheep had been studied experimentally and was being accepted in a practical way. These developments had aroused the interest of dairymen in crossbreeding, and many milk-farm operators were speculating on its possibilities. Prior to 1939 there was no ready means of following the practice of crossbreeding in the average farm herd, without the necessity of owning bulls of several breeds. But this obstacle no longer existed after artificial insemination became an established practice in dairy regions.

The crossbreeding investigations at Beltsville were undertaken in order to develop knowledge on the subject which would provide a sound basis for advising the operators of milk-producing farms on what results to expect if they should decide to use crossbreeding as a means of producing better replacements for their milking herds.

Final results on any dairy cattle breeding research project cannot be published until the last animal on the project has died. However, we are reporting here the breeding performance and milk and butterfat production of all individuals used on the project which have had time to complete a normal first-lactation period. This includes the entire foundation cow group, all of the two-breed daughters of these cows, the three-breed animals in the next generation, and some of the progeny of these three-breed individuals. The entire lifetime story on some members of these groups is still developing in herds of cooperating dairymen, and a later publication will deal with their later performance.

This research work was supported mainly by an appropriation from funds made available by the Bankhead-Jones Act of June 29, 1935.

REVIEW OF LITERATURE

Some of the reports reviewed here were published after the crossbreeding experiments at Beltsville had started in 1939. In some of the reports, the small numbers of experimental animals and the sketchy information on the producing ability of the cows and the transmitting ability of the sires tend to make the conclusions of doubtful value.

Much of the experience in crossbreeding has occurred in privately owned herds and in most cases, if results are documented at all, the chroniclers have shown reluctance to define the breeding operation as crossbreeding, but have chosen to refer to it as "grading up." The introduction of a pedigreed sire into a herd of nondescript cattle would undoubtedly result in a high percentage of crossbreeding. Another fault in our use of terminology is that, in identifying daughters of a registered sire, all of those that are not from registered females of the same breed as the sire are reported as grade daughters of the breed of the sire. In a mixed herd of registered females, a sire may have daughters from dams of different breeds which should be identified as crossbreds.

An early grading-up experiment started at the Iowa Agricultural Experiment Station in 1906 and reported by Weaver and associates (*21*) [2] resulted in 14 crossbred daughters sired by registered Guernsey, Holstein, and Jersey bulls and from dams of no recognized breed, which produced 39 percent more milk and 38 percent more butterfat than their dams.

Experiments in crossing dairy and beef breeds appear to have had the primary purpose of using the wide differences between such breeds in milk and butterfat production and various other characters to study the laws of Mendelian heredity, and results that would apply directly to dairymen's problems were only of secondary interest. This is true of the work reported by Cole and Johansson (*4*, *5*, *6*) on crossbreeding between dairy and beef breeds, which was conducted at the Wisconsin Agricultural Experiment Station between 1912 and 1933. The same comment applies to the beef and dairy crossbreeding work started at the Maine Agricultural Experiment Station in 1913, and reported by Gowen (*11*, *12*, *13*).

It is interesting to note that one report by Gowen (*11*) contains a list of 59 literature citations and less than 10 percent of these indicate any direct reference to work on the inheritance of milk and butterfat production. Many more of the references cited deal with heredity of color and horns.

In the later reports by Gowen (*12*, *13*), production records are given for 2 Holstein × Jersey, 2 Guernsey × Holstein, 2 Angus × Jersey, 1 Jersey × Angus, 1 Angus × Holstein, 1 Ayrshire × Angus, and 3 Guernsey × Angus crossbred females. The 8-months' lactation records of these 12 crossbred cows (corrected to the 2-year-old basis) averaged 4,036 pounds of milk; the equivalent records of their dams averaged 3,403 pounds, and the estimated transmitting ability for the sires averaged 3,386 pounds of milk. From these average values it appears that the crossbred cows exceeded the mean of the estimates for their parents by 18.9 percent in yield of milk, and the average of the daughters was higher than the averages of both parents.

The results of experimental crosses between breeds of dairy cattle have a more direct application to dairymen's questions, such as those regarding the risks involved in crossbreeding to change over to another breed, or in raising replacement heifers from good cows of another breed that may be in the herd, or in the possibility of obtaining advantages parallel to those observed in hybrid corn or in crossbred animals in other kinds of livestock.

Robertson (*17*), in a critical review of some of the more important crossbreeding experiments with dairy cattle, expressed a doubt that any such advantages as those obtained with other kinds of livestock had been demonstrated.

One of the most extensive of American crossbreeding experiments with dairy cattle was begun in his own herd in 1911 by T. L. Bowlker, an experienced breeder of fine dairy cattle. He wanted to test the possibility of having characters for high milk yield and butterfat percentage combined in some of the animals in the F_2 crossbred generation. He made reciprocal crosses between Guernsey and Holstein cattle, using purebred sires closely related to some of the most popular animals of the day. After the owner's death, the herd and the experiment were transferred to the Illinois Agricultural Experiment Station.

[2] Italic numbers in parentheses refer to Literature Cited, p. 126.

In his report on data obtained before the herd was transferred to Illinois in 1919, Castle (*3*) lists the production records of 8 Guernsey, 24 Holstein, and 31 F_1 crossbred cows. From these data it appears that the milk records of the crossbred cows exceeded a mean between the Guernsey and Holstein records by 7.6 percent for the first lactation and 15 percent for the second lactation. Castle stated that the higher than intermediate milk production for the F_1 crossbred cows was comparable to "the superior vigor commonly possessed by crossbred organisms."

A complete report on the results with the continuation of this experiment at the Illinois station has not been published, but in the several progress reports Gaines, Yapp, and Campbell (*10*) tentatively concluded that the milk yield of F_1 crossbred cows is slightly higher than an intermediate between the parent breeds, while the butterfat percentage is about at the intermediate, and that both the milk yield and butterfat percentage of F_2 crossbred cows from crossbred parents are also about at the intermediate between the parent breeds.

In a later report of this experiment, Yapp (*22*) gave the average 45-week first-lactation records for 47 F_1 crossbred cows as 7,246 pounds of milk and 313.2 pounds of butterfat; while the average record for 38 F_2 crossbred cows from crossbred parents was 6,883 pounds of milk and 300.8 pounds of butterfat. This decrease of 5 percent in milk yield is less than the 7.6 percent increase of the F_1 crossbreds over an intermediate of the parent breeds that was reported by Castle (*3*). No mention is made of possible environmental changes which could have affected the production results.

The results of the limited number of Jersey and Holstein crosses made at the South Dakota Agricultural Experiment Station have not been reported fully. In some of the last reports on the crossbreeding experiment, Olson (*15*, *16*) referred to 9 F_1, 3 F_2, and 1 F_3 crossbred cows and mentioned that the F_2 crossbred cows were somewhat lower than the F_1 crossbred cows in milk and butterfat yields.

More recently the idea of a different pattern of crossbreeding has received some attention. Rather than proceed by intermatings between individuals of the F_1 generation, some investigators have adopted a breed rotation crossbreeding plan similar to that used at Beltsville.

LaMaster and associates (*14*) recently reported on the work at the South Carolina Agricultural Experiment Station, where a system of breed rotation crossbreeding has been underway for a number of years. Production figures cited show that 12 two-breed cows averaged 426 pounds of butterfat and their purebred dams averaged 362 pounds. Twenty-two three-breed cows averaged 465 pounds of butterfat and their two-breed dams averaged 418 pounds. Thirteen four-breed cows averaged 446 pounds of butterfat and their three-breed dams averaged 414 pounds.

Foreign reports indicate interest in crossbreeding dairy cattle, and one of the early experiments was conducted in the Tranekjaer herd in Denmark beginning in 1906. Crosses were with Red Danish and Jersey cattle. Ellinger (*7*) analyzed the data and made no mention of any F_2 crossbreds, but the F_1 crosses were bred back to Jersey or Red Danish bulls. Producing ability was measured by records made in the first 10 weeks of the first-lactation period. Average milk yields are listed for Red Danes, Jerseys, F_1 crossbreds, ¾ Red Danes,

¾ Jerseys, and ⅞ Jerseys. No mention is made of the quality of the bulls used. Moreover, a 70-day milking test is not long enough to develop all existing differences. Even as reported, the data show that the F_1 crossbreds exceeded the intermediate of the parent breeds in both milk and butterfat yield.

Fandeev (*8*) reported success in increasing milk production and live weight by bringing Kholmogor cattle into the Komi region of northern Russia to cross with the native Pechora breed, which is noted for high butterfat percentages in the milk and adaptability to the environment.

Byckov (*2*) reports that reciprocal crosses of Ayrshires and East Friesians have been made. Production records of the crossbreds by an Ayrshire bull were reported with those of groups of Ayrshire and East Friesian cows. In 300-day-lactation periods the East Friesian cows averaged 296 pounds of butterfat, the Ayrshires 318 pounds, and the crossbreds 347 pounds.

Rostovcev (*18*) reports on the results of mating Gorbatov Red bulls and East Friesian cows. In each of the first three lactations the milk and butterfat yields of the crossbreds were greater than those for either parent breed. The crossbreds also excelled either parent breed in persistency of milk yield. Second-generation crossbreds, produced by mating first-generation crossbreds to East Friesian bulls, had higher milk and butterfat yields in the first lactation than the first-generation crossbreds.

Valerani (*20*) reported on grading up Swiss Brown cattle in Lombardy with Friesian bulls. The average milk yields of the first, second, third, and fourth generations, respectively, were 27.55, 35.27, 41.76, and 53.96 percent higher than the milk yields for the original Swiss Brown cows. When sire indexes are calculated from these data, it appears that either the sires of the first generation were definitely superior to those of the second and third generations, or else the milk yields of the first generation were higher than a mean of the milk yield estimates for their parents. Valerani also observed that an increase of 95 pounds in weight in the first generation was followed by small decreases in subsequent generations.

Schmidt (*19*) reported on the performance of 12 crossbred cows from Schwarzbunte dams and Jersey sires in a German experiment. Average 305-day, first-lactation records were 7,174 pounds of milk (testing 5.05 percent fat) and 362 pounds of butterfat for the crossbred cows, and 7,601 pounds of milk (testing 3.12 percent fat) and 237 pounds of butterfat for the Schwarzbunte dams of the crossbred cows. Corresponding average records for 19 Jersey cows kept in the herd under the same conditions were 5,186 pounds of milk (testing 5.65 percent fat) and 293 pounds of butterfat. From these data it appears that the crossbred cows exceeded a mean of the parent breeds by 12.2 percent in milk, 15.2 percent in butterfat test, and 36.6 percent in butterfat yield. The average butterfat yield of the crossbred cows was higher than that for either parent breed.

Schmidt's data also showed that live weights of the crossbred cows averaged 2.9 percent higher during the first lactation than a mean of the parent breeds. Data on the growth and skeletal measurements on animals in this experiment showed that in general the crossbred animals were a little larger than a mean of the parent breeds.

Buchanan-Smith (*1*), in some observations on the subject of crossbreeding between dairy breeds, expressed dissatisfaction with some

Ayrshire × Jersey, Ayrshire × Guernsey, and Red Poll × Shorthorn crosses that he had made, and a particular dislike for some Ayrshire × Red Poll crosses. However, he reports that Ayrshire × Shorthorn crossbred cows, from beef Shorthorn granddams giving only 2,000 pounds of milk or grandsires with a similar estimate of inheritance, can produce over 11,000 pounds of milk in 305 days.

None of the work reported shows results which would warrant condemnation of crossbreeding with dairy breeds. This appears to be true despite the fact that there is little evidence to indicate that, except for color and conformation, the individuals used to make the crosses were truly representative of the breeds involved. Aside from a few fixed breed characteristics, the germinal makeup of our dairy stock has been extremely heterozygous. Random selection from such stock of material for a crossbreeding experiment would not result in the development of sound information on which to base a fair estimate of the usefulness of crossbreeding, particularly insofar as milk production is concerned.

Part of the disadvantage of random selection can be overcome by more careful selection of foundation females and by the use of production-proved sires. This procedure was incorporated into the plan for the Beltsville crossbreeding experiment, and the first results were published in 1946 as a progress report (*9*). Since then, information on the production records of the crossbreds has been kept up to date by frequently revised reports prepared for distribution to visitors at Beltsville and in answer to mail requests. The same material has been used in talks given before interested groups.

PLAN OF THE EXPERIMENT

The breeds of dairy cattle available for use in the Beltsville crossbreeding experiment were Holstein, Jersey, Red Dane, and Guernsey. Both males and females of the first three breeds were used, but only females of the Guernsey breed were available for the project.

The plan of crossbreeding was to make two-breed crosses (reciprocals where possible) of the available breeds, using progeny-production-proved sires in all matings. The resulting two-breed females were to be mated to a proved sire of the third breed, and all succeeding generations of crossbred females were to be mated to proved sires of the Holstein, Jersey, or Red Dane breeds on a breed-rotation basis. The results reported in this publication indicate that the breeding phase of the experiment was carried out according to the planned procedure.

Throughout the course of the experiment, the measure of producing ability of the crossbred females was the determination of milk and butterfat production during the first normal lactation period. The crossbred cows were milked 3 times a day for a lactation period of 365 days. This was done in order to conform to the standard under which most of the foundation cows had made their production records. The Holstein, Jersey, and Guernsey foundation cows had been recruited for this project from the Bureau of Dairy Industry's various field stations, where they had made production records on 3 milkings a day for 365 days.

The Red Dane foundation cows, however, were already at Beltsville, where they had made their records on 2 milkings a day for 300

days. For comparative purposes in this experiment, these records were adjusted to the 3 × 365-day basis.

The feeding procedures conformed to the established experimental practice of using the feeding standard to determine requirements for maintenance and production and adjusting the feeding accordingly. Feeds used were alfalfa hay, corn silage, and a 15.5-percent-protein grain mixture. The animals were barn fed throughout the year, and were kept in a tie barn.

Milk samples for making butterfat determinations were taken on one day during each 10-day period, and butterfat production was calculated for each 10-day period. Milk was weighed at each milking.

All ordinary precautions were taken to keep the cows healthy.

Discussion of Plans and Early Developments

Attention should be called to the fact that the major plan of this experiment differed from the usual pattern of crossbreeding. Most work of this kind has followed the pattern of making a first cross to produce the two-breed generation and then making intermatings between members of the two-breed generation. The Beltsville project, however, calls for the continuous introduction of new genes through the use of proved sires of the respective breeds, the sires being used on a breed-rotation basis.

In formulating plans for this project, full consideration was given to the limits placed on the scope of the work by available funds, facilities, and animals. With increased funds and a corresponding increase in facilities and animals, it would have been possible to set up the project on a wider base, with final results in similar proportion; but dairy cattle breeding research is costly and moves slowly, and prospects for unlimited support over a long period of years are never bright. This brings up a question as to whether any research should be, or ever is, undertaken short of ideal conditions.

Despite the fact that the funds allotted imposed definite operating limitations on this experiment, a successful attempt has been made to make the work productive of dependable results. It is appalling to consider the important research discoveries which would have failed of achievement if all workers had been obliged to wait until all requirements of perfect experimental design had been met. The planning and execution of this project was done with the benefit of knowledge and experience gained over a period of 20 years in the conduct of dairy cattle breeding research by the Bureau of Dairy Industry at Beltsville and other field stations.

As the work progressed, matings were planned to produce two-breed females in approximately equal numbers in all combinations. Mathematically this is a simple operation, but biologically the objective sought can only be attained by careful planning and at least some cooperation on the part of nature. Margins of safety could not be established when there was so little material with which to work.

A few statistics might be helpful in illustrating the probabilities involved. For instance, how many pregnancies would be required to produce 50 females which could be brought through at least one milk production period?

A total of 89 females were assembled for use on this project as foundation animals. Before becoming part of the project, 57 of the

89 had terminated 167 pregnancies to sires of their own breeds. The results of these pregnancies were 6 dead males and 72 living males, 4 dead females and 83 living females, and 5 abortions. Twenty-nine of the live females did not complete first-lactation records, because they were lost or disposed of; but 19 of these were of the Red Dane breed, of which 5 died as calves, 2 were killed by lightning after calving, 3 were nonbreeders, 3 were sold after aborting, 1 was sold because of mastitis, and 5 were transferred to another station. One in the Jersey group was condemned for TB shortly after calving. There were three sets of mixed twins, consisting respectively of a live male and female, a dead male and female, and a live male and a dead female. The 167 matings produced 54 females useful for study.

Seventy-seven of the 89 foundation females were mated on the cross-breeding project, and completed 179 pregnancies, which resulted in 5 dead males and 97 live males, 3 dead females and 74 live females, of which 4 were freemartins and 6 were abortions. Four pairs of living mixed twins, 1 pair of dead mixed twins, and 1 pair of living male twins were included. Besides the 4 freemartins, 6 others were lost before completing first-calf records, leaving a net of 64 project females which completed records, from 179 terminated pregnancies. The expectation appears to be about 1 useful female for each 3 terminated pregnancies. For the sake of clarity, the above figures are given in tabular form, as follows:

Results of pregnancies		57 cows mated before project	77 cows mated on project
Pregnancies completed	number	167	179
Dead male calves	do	[1] 6	[1] 5
Living male calves	do	[2] 72	[3] 97
Abortions	do	5	6
Dead female calves	do	[2] 4	[1] 3
Living female calves	do	[1] 83	[4] 74
Freemartins	do	1	4
Lost or disposed of	do	28	6
Useful project heifers	do	54	64

[1] Includes 1 twin.
[2] Includes 2 twins.
[3] Includes 6 twins.
[4] Includes 4 twins.

This is offered as an illustration of the difficulties involved in designing for definite achievement and the hazard of random achievement for definite design.

FOUNDATION ANIMALS

The production-proved Holstein, Jersey, and Red Dane sires used in this crossbreeding project were selected on the basis of their demonstrated transmitting ability, the details of which are given on page 97.

The foundation females of the Holstein, Jersey, and Guernsey breeds were assembled from four of the Bureau's field station herds, and the Red Dane foundation females were already available at Beltsville. The Holsteins were brought to Beltsville from Huntley, Mont., and Mandan, N. Dak., the Guernseys from Pontiac, S. C., and the Jerseys from Lewisburg, Tenn.

The decision to use foundation females from the station herds for this project was based on the fact that we had been following a proved-sire breeding program in these herds for a good many years and that the production performance of the cows had been determined under uniform conditions of management, which made it possible to make equitable comparisons.

Furthermore, our knowledge of the breeding and performance of these animals was more complete than it would have been for animals from other sources. In addition, it would have used up most of the funds available during the first 2 years to locate, purchase, and transport suitable females to Beltsville, with very little left for use in feeding and caring for the animals. Also, a disease hazard would have been involved in assembling a herd from various outside sources. Experience has shown that losses following the assembling of herds from outside sources are usually quite serious.

The Huntley Foundation Group

The group of 10 Holstein females obtained from the Huntley field station arrived at Beltsville February 5, 1939. Their birth dates, first production records, and the mature-equivalent values of the records are as follows:

Herd No. and date of birth	Actual production [1]					Mature-equivalent values	
	Milk	Test	Fat	Age		Milk	Fat
	Lbs.	*%*	*Lbs.*	*Yr.*	*Mo.*	*Lbs.*	*Lbs.*
H–330, Jan. 5, 1934	10,726	3.64	391	2	2	14,587	532
H–337, July 6, 1934	11,485	3.77	433	3	6	13,208	498
H–338, July 30, 1934	13,383	3.29	440	2	3	18,067	594
H–340, Oct. 5, 1934	12,334	3.03	374	2	4	16,404	497
H–345, Nov. 17, 1934	12,613	3.50	442	2	3	17,028	597
H–348, Mar. 19, 1935	11,245	3.81	428	2	10	13,944	531
H–349, April 16, 1935	12,839	3.61	463	2	7	16,434	593
H–351, June 3, 1935	11,858	3.58	424	2	3	16,008	572
H–353, June 20, 1935	12,716	4.06	516	2	7	16,276	660
H–357, Aug. 22, 1935	16,892	3.70	625	2	8	21,453	794
Average of 10	12,609	3.60	454	2	7	16,341	587

[1] All records were made on 3 milkings a day for 305 days, under standard conditions of feeding and management.

These 10 heifers were among 30 heifers that made first-calf records at Huntley during 1936, 1937, and 1938. Two of them (H–330 and H–338) were among the 13 that started on test in 1936; 4 of them (H–340, H–345, H–349, and H–351) were among the 8 that started on test in 1937; and the other 4 (H–337, H–348, H–353, and H–357) were among the 9 that started on test in 1938. All records were made on 3 milkings a day for 365 days. The average production of the 10 heifers that were sent to Beltsville, as compared with the average for all heifers tested at Huntley in the same years, is as follows:

Year	Heifers tested (number)	Actual-production average					Mature-equivalent value	
		Milk	Test	Fat	Age		Milk	Fat
		Lbs.	*%*	*Lbs.*	*Yr.*	*Mo.*	*Lbs.*	*Lbs.*
1936	13	12, 484	3. 68	455	2	5	16, 398	598
1937	8	13, 180	3. 47	457	2	5	17, 427	604
1938	9	12, 291	3. 80	465	2	8	15, 673	593
Average for all	30	12, 612	3. 66	459	2	6	16, 455	598
Average for those sent to Beltsville	10	12, 609	3. 60	454	2	7	16, 341	587

When the 10 cows left the Huntley station, 7 of them were pregnant to the services of Holstein bulls. These 7 pregnancies, completed at Beltsville, resulted in 1 mummified calf, 3 male calves, and 3 female calves. One of the female calves died, but the other 2 were considered foundation animals for the project. Their first production records made at Beltsville, on 3 milkings a day for 365 days, are as follows:

Herd No.	Actual production					Mature-equivalent value	
	Milk	Test	Fat	Age		Milk	Fat
	Lbs.	*%*	*Lbs.*	*Yr.*	*Mo.*	*Lbs.*	*Lbs.*
H–420	11, 925	3. 46	413	2	4	15, 860	549
H–423	18, 853	3. 47	654	2	2	25, 640	889
Average	15, 389	3. 47	534	2	3	20, 750	719

The Holstein bull No. 966, which had been selected for use on this project, was known to be heterozygous for color. It was hoped that mating him to cows from Huntley and Mandan might produce a red and white bull calf, since 2 herd sires used at these stations were also heterozygous for color. Five of the 10 cows from Huntley were mated to this bull and terminated 6 pregnancies, which resulted in 3 male and 3 female progeny. None was red and white in color, however. One of the females died early, but the other 2 were added to the Huntley group as foundation animals, along with 1 additional daughter of No. 966 that was bred on the project. These 3 additional females produced as follows:

Herd No.	Actual production					Mature-equivalent value	
	Milk	Test	Fat	Age		Milk	Fat
	Lbs.	*%*	*Lbs.*	*Yr.*	*Mo.*	*Lbs.*	*Lbs.*
HB–19	16, 203	3. 92	635	1	11	23, 008	902
HB–25	14, 715	3. 40	500	1	11	20, 895	710
HB–208	9, 538	3. 88	371	2	1	13, 162	511
Average of 3	13, 485	3. 73	502	2	0	19, 022	708

This makes a total of 15 foundation cows which are included in the group of Huntley origin. Their average production by groups is as follows:

Group	Number	Actual-production average					Mature-equivalent value	
		Milk	Test	Fat	Age		Milk	Fat
		Lbs.	*%*	*Lbs.*	*Yr.*	*Mo.*	*Lbs.*	*Lbs.*
Huntley cows	10	12, 609	3. 60	454	2	7	16, 341	587
In-dam cows	2	15, 389	3. 47	534	2	3	20, 750	719
Bred at Beltsville	3	13, 485	3. 73	502	2	0	19, 022	708
Average of all	15	13, 155	3. 61	477	2	5	17, 465	629

PRODUCTION PERFORMANCE OF THE HOLSTEIN DAUGHTERS OF THE HUNTLEY FOUNDATION GROUP

Before leaving Huntley, the 10 original cows had produced 7 Holstein daughters that made first-calf records at Huntley. The actual production records of the 7 daughters and their dams were as follows:

Herd No.	Daughters tested at Huntley					Herd No.	Dams tested at Huntley				
	Milk	Test	Fat	Age			Milk	Test	Fat	Age	
	Lbs.	*%*	*Lbs.*	*Yr.*	*Mo.*		*Lbs.*	*%*	*Lbs.*	*Yr.*	*Mo.*
H–307	11, 354	4. 03	457	2	3	H–337	11, 485	3. 77	433	3	6
H–308	10, 203	3. 44	354	2	0	H–353	12, 716	4. 06	516	2	7
H–401	13, 576	3. 27	444	2	5	H–338	13, 333	3. 29	440	2	3
H–405	14, 060	3. 47	488	2	1	H–357	16, 802	3. 70	625	2	8
H–409	11, 802	3. 76	444	2	0	H–330	10, 726	3. 64	391	2	2
H–410	17, 166	3. 33	571	2	1	H–340	12, 334	3. 03	374	2	4
H–413	16, 390	3. 33	546	2	0	H–351	11, 858	3. 58	424	2	3
Average of 7: Actual	13, 520	3. 52	472	2	1	Average of 7: Actual	12, 771	3. 58	458	2	6
Mature-equivalent	18, 584	.....	649	.....		Mature-equivalent	16, 572	.....	592	.....	

Two additional Holstein daughters of the Huntley cows were in dam when the group was shipped to Beltsville. These daughters made their first records at Beltsville, as follows:

Herd No.	Daughters tested at Beltsville					Herd No.	Dams tested at Huntley				
	Milk	Test	Fat	Age			Milk	Test	Fat	Age	
	Lbs.	*%*	*Lbs.*	*Yr.*	*Mo.*		*Lbs.*	*%*	*Lbs.*	*Yr.*	*Mo.*
H-420	11, 025	3. 46	413	2	4	H-353	12, 716	4. 06	516	2	7
H-423	18, 853	3. 47	654	2	2	H-357	16, 892	3. 70	625	2	8
Average of 2:						Average of 2:					
Actual	15, 389	3. 47	534	2	3	Actual	14, 804	3. 88	571	2	8
Mature-equivalent	20, 750		719			Mature-equivalent	18, 865		727		

Three other Holstein daughters of the Huntley foundation group resulted from matings made at Beltsville, as was mentioned previously. The production records of these 3 daughters at Beltsville were as follows:

Herd No.	Daughters tested at Beltsville					Herd No.	Dams tested at Huntley				
	Milk	Test	Fat	Age			Milk	Test	Fat	Age	
	Lbs.	*%*	*Lbs.*	*Yr.*	*Mo.*		*Lbs.*	*%*	*Lbs.*	*Yr.*	*Mo.*
HB-19	16, 203	3. 92	635	1	11	H-330	10, 726	3. 64	391	2	2
HB-25	14, 715	3. 40	500	1	11	H-351	11, 858	3. 58	424	2	3
HB-208	9, 538	3. 88	371	2	1	HB-25 [1]	14, 715	3. 40	500	1	11
Average:						Average:					
Actual	13, 485	3. 73	502	2	0	Actual	12, 433	3. 54	438	2	1
Mature-equivalent	19, 022		708			Mature-equivalent	17, 103		605		

[1] Tested at Beltsville.

In all, the 15 foundation females of Huntley origin had a total of 12 Holstein daughters that completed production records. The records are summarized as follows:

Average production of 12 pairs	Daughters					Dams				
	Milk	Test	Fat	Age		Milk	Test	Fat	Age	
	Lbs.	*%*	*Lbs.*	*Yr.*	*Mo.*	*Lbs.*	*%*	*Lbs.*	*Yr.*	*Mo.*
Actual	13, 823	3. 56	490	2	1	13, 025	3. 62	472	2	5
Mature-equivalent	19, 054		675			17, 102		618		

REPRODUCTIVE PERFORMANCE OF THE HUNTLEY FOUNDATION GROUP

The total reproductive performance of the 15 foundation females in the Huntley foundation group breaks down as follows:

The 10 cows that were moved to Beltsville had completed 17 gestation periods at Huntley, which resulted in 5 live male calves, 1 aborted male calf, 2 dead female calves, and 9 live female calves, 7 of which completed production records.

Seven of the 10 cows were pregnant when they were shipped, and these 7 pregnancies resulted in 1 mummified fetus, 3 living male calves, and 3 living female calves, 1 of which died and 2 became project animals.

After arriving at Beltsville, 2 of the original 10 were nonbreeders; the remaining 8, along with the 2 in dam and 3 bred at Beltsville,

make a total of 13 females which were mated on the breeding project at Beltsville. Six of these 13 completed 7 pregnancies to Holstein bulls, which resulted in 3 male calves and 4 female calves, 1 of which died. Nine of the 13 completed 12 pregnancies to Jersey bulls, which resulted in 1 dead and 2 living male calves, 1 dead and 7 living female calves, and also 1 pair of mixed twins. Nine completed 13 pregnancies to Red Dane bulls, which resulted in 8 living male and 4 living female calves, and 1 pair of mixed twins born dead.

In all, they terminated 32 pregnancies with 12 living and 2 dead male calves, 14 living and 2 dead female calves, and 2 sets of mixed twins, 1 pair dead at birth. The net result of 32 pregnancies was 14 living female calves. One interesting observation is that 12 pregnancies to Jersey bulls yielded 7 living female calves, while 13 pregnancies to Red Dane bulls produced only 4 living female calves.

The Mandan Foundation Group

The 13 Holstein females obtained from the Mandan field station arrived at Beltsville January 28, 1939. One cow (M–91) aborted shortly after arriving and was not considered as a foundation cow on the project. The remaining 12 cows are listed below. Their birth dates, first production records, and the mature-equivalent values of the records are as follows:

Herd No. and date of birth	Actual production [1]					Mature-equivalent value	
	Milk	Test	Fat	Age		Milk	Fat
	Lbs.	*%*	*Lbs.*	*Yr.*	*Mo.*	*Lbs.*	*Lbs.*
M–28, Feb. 27, 1932	17, 881	3. 60	644	2	10	22, 172	799
M–35, Aug. 27, 1932	11, 156	3. 69	412	2	4	14, 837	548
M–36, Sept. 3, 1932	16, 585	3. 48	581	2	3	22, 525	784
M–40, Oct. 21, 1932	16, 224	3. 34	542	2	2	22, 065	737
M–52, July 27, 1933	12, 937	3. 55	459	2	5	16, 947	601
M–53, July 31, 1933	14, 352	3. 60	516	2	4	19, 088	686
M–56, Sept. 10, 1933	16, 562	3. 38	560	2	9	20, 868	706
M–57, Sept. 19, 1933	16, 926	3. 37	571	2	3	22, 850	771
M–66, Aug. 16, 1934	12, 132	3. 73	453	2	5	15, 893	593
M–68, Nov. 4, 1934	10, 876	3. 75	408	2	0	15, 226	571
M–71, Jan. 5, 1935	14, 329	3. 60	516	2	2	19, 487	702
M–72, Jan. 6, 1935	12, 884	3. 97	511	2	2	17, 522	695
Average of 12	14, 412	3. 59	514	2	4	19, 123	683

[1] All records were made on 3 milkings a day for 305 days, under standard conditions of feeding and management.

These 12 heifers were among 41 heifers that made first-calf records at Mandan during 1934, 1935, 1936, and 1937. Two of them (M–28 and M–36) were among the 7 that started on test in 1934; 4 of them (M–35, M–40, M–53, and M–57) were among the 16 that started on test in 1935; 3 of them (M–52, M–56, and M–68) were among the 9 that started on test in 1936; and the other 3 (M–66, M–71, and M–72) were among the 9 that started on test in 1937. All records

were made on 3 milkings a day for 365 days. The average production of the 12 heifers that were sent to Beltsville, as compared with the average for all heifers tested at Mandan in the same years, is as follows:

Year	Heifers tested (number)	Actual-production average					Mature-equivalent value	
		Milk	Test	Fat	Age		Milk	Fat
		Lbs.	*%*	*Lbs.*	*Yr.*	*Mo.*	*Lbs.*	*Lbs.*
1934	7	13, 707	3. 54	488	2	3	18, 646	661
1935	16	12, 092	3. 58	431	2	2	16, 464	587
1936	9	12, 184	3. 51	427	2	3	16, 333	574
1937	9	14, 526	3. 50	505	2	2	19, 581	681
Average for all	41	12, 930	3. 54	456	2	3	17, 492	617
Average for those sent to Beltsville	12	14, 412	3. 59	514	2	4	19, 123	683

Three of the 12 cows were pregnant when they left Mandan. These pregnancies terminated in 1 male calf and 2 female calves. One of the females died and the other (M–549) was used as a foundation cow. Her first-calf record at Beltsville was as follows:

Herd No.	Actual production					Mature-equivalent value	
	Milk	Test	Fat	Age		Milk	Fat
	Lbs.	*%*	*Lbs.*	*Yr*	*Mo.*	*Lbs.*	*Lbs.*
M–549	14, 247	3. 32	472	2	2	19, 376	642

As with the Huntley group, some of these cows were mated to the Holstein bull No. 966 with the hopes of getting a red and white bull calf. These matings resulted in 7 pregnancies, which terminated in 1 dead male calf and 4 living male calves (including 1 pair of twins), and 3 living female calves. These 3 females were added to the foundation group. Their first-calf records at Beltsville were as follows:

Herd No.	Actual production					Mature-equivalent value	
	Milk	Test	Fat	Age		Milk	Fat
	Lbs.	*%*	*Lbs.*	*Yr.*	*Mo.*	*Lbs.*	*Lbs.*
MB–2	22, 371	3. 43	768	2	0	31, 319	1, 075
MB–4	10, 889	3. 82	415	2	0	15, 245	581
MB–9	14, 399	4. 01	578	2	0	20, 159	809
Average of 3	15, 886	3. 75	587	2	0	22, 241	822

It should be noted that the unusually high record of MB–2 affects the average unduly in such a small group.

The original 12 from Mandan, the 1 in-dam cow, and the 3 bred at Beltsville make a total of 16 foundation cows in the group of Mandan origin. Their average production by groups is as follows:

Group	Cows (number)	Actual-production average					Mature-equivalent value	
		Milk	Test	Fat	Age		Milk	Fat
		Lbs.	%	*Lbs.*	*Yr.*	*Mo.*	*Lbs.*	*Lbs.*
Mandan cows	12	14, 412	3. 59	514	2	4	19, 123	683
In-dam cow	1	14, 247	3. 32	472	2	2	19, 376	642
Bred at Beltsville	3	15, 886	3. 75	587	2	0	22, 241	822
Average of all	16	14, 678	3. 60	525	2	3	19, 724	706

PRODUCTION PERFORMANCE OF THE HOLSTEIN DAUGHTERS OF THE MANDAN FOUNDATION GROUP

Before leaving Mandan, the 12 original cows had produced 13 Holstein daughters that made first-calf records at Mandan. The actual production records of the 13 daughters and their dams were as follows:

Herd No.	Daughters tested at Mandan					Herd No.	Dams tested at Mandan				
	Milk	Test	Fat	Age			Milk	Test	Fat	Age	
	Lbs.	%	*Lbs.*	*Yr.*	*Mo.*		*Lbs.*	%	*Lbs.*	*Yr.*	*Mo.*
M–91	11, 323	3. 34	378	2	3	M–57	16, 926	3. 37	571	2	3
M–93	15, 393	3. 35	516	2	4	M–53	14, 352	3. 60	516	2	4
M–97	13, 349	2. 94	392	2	0	M–40	16, 224	3. 34	542	2	2
M–508	16, 909	3. 50	591	2	0	M–56	16, 562	3. 38	560	2	0
M–510	11, 468	3. 26	374	2	2	M–68	10, 876	3. 75	408	2	0
M–515	11, 860	3. 64	432	1	11	M–53	14, 352	3. 60	516	2	4
M–516	13, 482	3. 64	491	2	0	M–72	12, 884	3. 97	511	2	2
M–517	12, 155	3. 29	400	2	0	M–71	14, 329	3. 60	516	2	2
M–523	15, 635	3. 06	479	2	8	M–57	16, 926	3. 37	571	2	3
M–530	17, 908	3. 38	607	2	8	M–36	16, 685	3. 48	581	2	3
M–533	13, 105	3. 27	429	2	5	M–66	12, 132	3. 73	453	2	5
M–538	13, 539	3. 43	465	2	4	M–72	12, 884	3. 97	511	2	2
M–543	12, 362	3. 30	408	2	0	M–68	10, 876	3. 75	408	2	0
Average of 13:						Average of 13:					
Actual	13, 734	3. 34	459	2	3	Actual	14, 368	3. 61	513	2	3
Mature-equivalent	18, 583		621			Mature-equivalent	19, 247		690		

The in-dam daughter (M–459) born at Beltsville was tested at Beltsville while her dam (M–36) had been tested at Mandan. The actual production and mature-equivalent values for the daughter and dam were as follows:

Production	Daughter tested at Beltsville					Dam tested at Mandan				
	Milk	Test	Fat	Age		Milk	Test	Fat	Age	
	Lbs.	%	*Lbs.*	*Yr.*	*Mo.*	*Lbs.*	%	*Lbs.*	*Yr.*	*Mo.*
Actual	14, 247	3. 32	472	2	2	16, 685	3. 48	581	2	3
Mature-equivalent	19, 376		642			22, 525		784		

Three additional Holstein daughters from the Mandan cows were born and tested at Beltsville. Their actual production, as compared to that of their dams, was as follows:

Herd No.	Daughters tested at Beltsville					Herd No.	Dams tested at Mandan				
	Milk	Test	Fat	Age			Milk	Test	Fat	Age	
	Lbs.	*%*	*Lbs.*	*Yr.*	*Mo.*		*Lbs.*	*%*	*Lbs.*	*Yr.*	*Mo.*
MB-2	22,371	3.43	768	2	0	M-57	16,926	3.37	571	2	3
MB-4	10,889	3.82	415	2	0	M-40	16,224	3.34	542	2	2
MB-9	14,399	4.01	578	2	0	M-52	12,937	3.55	459	2	5
Average of 3:						Average of 3:					
Actual	15,886	3.75	587	2	0	Actual	15,362	3.42	524	2	3
Mature-equivalent	22,241	.....	822	.....		Mature-equivalent	20,621	.....	703	.....	

When the 4 daughters that were tested at Beltsville are compared with their 4 dams that were tested at Mandan, the resulting averages are as follows:

Average of 4 pairs	Daughters						Dams					
	Milk	Test	Fat	Age			Milk	Test	Fat	Age		
	Lbs.	*%*	*Lbs.*	*Yr.*	*Mo.*		*Lbs.*	*%*	*Lbs.*	*Yr.*	*Mo.*	
Actual production	15,477	3.66	558	2	1		15,693	3.44	538	2	3	
Mature-equivalent	21,525	.....	777	.....			21,097	.....	724	.....		

Ten of the 16 foundation cows in the Mandan group had a total of 17 Holstein daughters that completed production records. The records of the 17 daughters, as compared to those of their dams, were as follows:

Average of 17 pairs	Daughters						Dams					
	Milk	Test	Fat	Age			Milk	Test	Fat	Age		
	Lbs.	*%*	*Lbs.*	*Yr.*	*Mo.*		*Lbs.*	*%*	*Lbs.*	*Yr.*	*Mo.*	
Actual production	14,144	3.41	482	2	2		14,634	3.57	519	2	3	
Mature-equivalent	19,277	.....	658	.....			19,682	.....	698	.....		

One interesting sidelight on experimental work of this kind is the case of cow M–28. She produced 4 male calves at Mandan and 3 male calves at Beltsville.

REPRODUCTIVE PERFORMANCE OF THE MANDAN FOUNDATION GROUP

A summary of the complete reproductive performance of all females in the Mandan foundation group shows that the 12 cows that were moved to Beltsville had completed 38 gestation periods at Mandan, which resulted in 17 live male calves, 3 dead male calves, 15 living female calves, 1 pair of mixed twins, 1 pair of dead female twins, and 1 pair of living male twins. Two of the heifer calves died young.

Three of the 12 cows were pregnant when they left Mandan. These pregnancies terminated with 1 male calf and 2 female calves. One of the females died.

After reaching Beltsville, M–35 was pronounced a nonbreeder and M–36 developed a serious leg infection and had to be destroyed. The other 10 cows were used on the project. Seven of the 10 completed 7 pregnancies to Holstein bulls, which resulted in 1 dead male calf and 4 living male calves (including 1 pair of twins), and 3 female calves, all of which were used as foundation cows on the project. Five of the 10 completed 6 pregnancies to Jersey bulls, which resulted in 2 pairs of mixed twins, 1 live male calf, and 3 live female calves. The freemartins were discarded, 1 of the female calves died, and 2 were used on the project. Six of the 10 completed 10 pregnancies to Red Dane bulls, which resulted in 1 dead male, 7 living male calves, and 2 living female calves, both of which made records. In all, these 10 Mandan cows terminated 23 pregnancies with a net of 7 useful female calves.

The in–dam female and the 3 heifers that were bred at Beltsville terminated 2 pregnancies to Holstein bulls, which resulted in 1 male calf and 1 male abortion; 3 pregnancies to Jersey bulls, which resulted in 3 male calves; and 5 pregnancies to Red Dane bulls, which resulted in 3 male calves and 2 female calves. Both females completed production records.

The 14 females in this group which were bred for project animals terminated 33 pregnancies resulting in 23 male calves, of which 2 were twinned with heifers and 2 were born dead and 1 was a male abortion; and 12 female calves, of which 2 were discarded freemartins and 1 other died, leaving a net of 9 heifers useful on the project.

The Lewisburg Foundation Group

The nine Jersey cows that were obtained from the Lewisburg, Tenn., field station arrived at Beltsville January 31, 1939. All of them had completed first production records at Lewisburg. Their birth dates, first production records, and the mature-equivalent values of the records are as follows:

Herd No. and date of birth	Actual production					Mature-equivalent value	
	Milk	Test	Fat	Age		Milk	Fat
	Lbs.	*%*	*Lbs.*	*Yr.*	*Mo.*	*Lbs.*	*Lbs.*
L–67, Sept. 18, 1931	10, 609	4. 90	520	3	11	11, 670	572
L–77, Jan. 9, 1933	9, 249	4. 92	455	2	4	12, 209	601
L–106, Nov. 5, 1934	6, 199	6. 21	385	2	5	8, 059	501
L–109, Dec. 28, 1934	8, 837	5. 37	474	2	5	11, 488	616
L–111, Jan. 16, 1935	7, 776	5. 90	459	2	8	9, 798	578
L–113, Feb. 4, 1935	6, 887	5. 60	386	2	5	8, 953	502
L–116, Mar. 5, 1935	6, 687	6. 16	412	2	0	9, 362	577
L–119, May 10, 1935	9, 334	5. 15	481	2	8	11, 761	606
L–120, May 19, 1935	9, 136	5. 03	460	2	8	11, 511	580
Average of 9	8, 302	5. 47	448	2	7	10, 535	570

[1] All records were made on 3 milkings daily for 365 days, under standard conditions of feeding and management.

These 9 heifers were among the 34 heifers that made first-calf records at Lewisburg during 1935, 1937, and 1938. Two of them (L–67 and L–77) were among the 3 heifers that started on test in 1935; 5 of them (L–106, L–109, L–111, L–113, and L–116) were among the 21 heifers that had their first calves in 1937; and 2 of them (L–119 and L–120) were among the 10 that calved the first time in 1938. The average production of the 9 heifers that were sent to Beltsville, as compared with the average of all heifers tested at Lewisburg in the same years, was as follows:

Year	Heifers tested (number)	Actual-production average					Mature-equivalent value	
		Milk	Test	Fat	Age		Milk	Fat
		Lbs.	*%*	*Lbs.*	*Yr.*	*Mo.*	*Lbs.*	*Lbs.*
1935	3	8,689	5.03	434	3	2	10,443	522
1937	21	8,447	5.37	449	2	7	10,751	572
1938	10	8,641	5.08	439	2	5	11,206	568
Average for all	34	8,525	5.25	444	2	7	10,857	566
Average for those sent to Beltsville	9	8,302	5.47	448	2	7	10,535	570

Four of the nine cows from Lewisburg were pregnant to the service of Jersey bulls when they reached Beltsville. These 4 pregnancies resulted in 1 male calf and 3 female calves. The 3 females were used as foundation cows, but 1 of them was condemned for TB shortly after she calved and did not complete a production record. The production records of the other two are as follows:

Herd No.	Actual production					Mature-equivalent value	
	Milk	Test	Fat	Age		Milk	Fat
	Lbs.	*%*	*Lbs.*	*Yr.*	*Mo.*	*Lbs.*	*Lbs.*
L–200	7,202	5.32	383	2	1	9,939	529
L–207	8,252	5.49	453	2	1	11,388	625
Average of 2	7,727	5.41	418	2	1	10,664	577

When these 2 in-dam heifers are added to the 9 cows from Lewisburg, the Jersey foundation group consists of 11 cows, whose average production by groups is as follows:

Group	Cows (number)	Actual-production average					Mature-equivalent value	
		Milk	Test	Fat	Age		Milk	Fat
		Lbs.	*%*	*Lbs.*	*Yr.*	*Mo.*	*Lbs.*	*Lbs.*
Lewisburg cows	9	8,302	5.47	448	2	7	10,525	570
In-dam cows	2	7,727	5.41	418	2	1	10,664	577
Average of all	11	8,197	5.46	443	2	6	10,558	572

PRODUCTION PERFORMANCE OF THE JERSEY DAUGHTERS OF THE LEWISBURG FOUNDATION GROUP

Before leaving Lewisburg, 6 of the 9 cows had produced 7 Jersey daughters that made their first-calf records at Lewisburg. The actual production records of the seven Jersey daughters and their dams were as follows:

Herd No.	Daughters tested at Lewisburg					Herd No.	Dams tested at Lewisburg				
	Milk	Test	Fat	Age			Milk	Test	Fat	Age	
	Lbs.	*%*	*Lbs.*	*Yr.*	*Mo.*		*Lbs.*	*%*	*Lbs.*	*Yr.*	*Mo.*
L–150	7,819	5.10	398	2	6	L–67	10,669	4.90	520	3	11
L–155	8,246	5.93	489	3	11	L–106	6,199	6.21	385	2	5
L–164	8,213	5.67	466	2	2	L–111	7,776	5.90	459	2	6
L–172	6,819	5.76	393	2	4	L–119	9,334	5.15	481	2	8
L–185	7,387	5.38	397	2	6	L–106	6,199	6.21	385	2	5
L–190	9,167	4.58	420	2	0	L–109	8,837	5.37	474	2	5
L–191	9,078	4.42	424	3	10	L–77	9,249	4.92	455	2	4
Average of 7:						Average of 7:					
Actual	8,164	5.26	427	2	9	Actual	8,315	5.52	461	2	8
Mature-equivalent	10,224		538			Mature-equivalent	10,435		568		

The two in-dam Jersey heifers made their first-calf records at Beltsville, as follows:

Herd No.	Daughters tested at Beltsville					Herd No.	Dams tested at Lewisburg				
	Milk	Test	Fat	Age			Milk	Test	Fat	Age	
	Lbs.	*%*	*Lbs.*	*Yr.*	*Mo.*		*Lbs.*	*%*	*Lbs.*	*Yr.*	*Mo.*
L–200	7,202	5.32	383	2	1	L–67	10,669	4.90	520	3	11
L–207	8,252	5.49	453	2	1	L–106	6,199	6.21	385	2	5
Average of 2:						Average of 2:					
Actual	7,727	5.41	418	2	1	Actual	8,404	5.56	453	3	2
Mature-equivalent	10,664		577			Mature-equivalent	9,865		537		

The group of 9 Jersey daughters from 6 of the 9 Lewisburg foundation cows averaged slightly less than their dams on an actual-production basis, but on a mature-equivalent basis the dams and daughters were about equal. Their production records were as follows:

Average of 9 pairs	Daughters				Dams			
	Milk	Test	Fat	Age	Milk	Test	Fat	Age
	Lbs.	*%*	*Lbs.*	*Yr. Mo.*	*Lbs.*	*%*	*Lbs.*	*Yr. Mo.*
Actual production	8,020	5.29	425	2 7	8,335	5.53	452	2 9
Mature-equivalent value	10,321		547		10,308		561	

REPRODUCTIVE PERFORMANCE OF THE LEWISBURG FOUNDATION GROUP

The 9 Lewisburg cows had completed 19 gestations at Lewisburg, which resulted in 10 live male calves, 1 dead male calf, 1 abortion, and 7 living female calves.

At Beltsville, all nine Lewisburg cows were bred for project progeny. Eight of them completed 14 pregnancies to Holstein bulls, which resulted in 6 live male calves and 8 live female calves, all of which completed production records. The 9 Lewisburg cows completed 14 pregnancies to Red Dane bulls, which resulted in 10 live male calves, 1 dead female calf, and 3 living female calves, all of which completed production records. The 28 pregnancies resulted in 11 crossbred females useful on the project.

The 3 in-dam Lewisburg Jerseys were all bred at Beltsville, but 1 of them had to be disposed of shortly after she calved. The other 2 completed 3 pregnancies to Holstein sires, the result being 2 live males and 1 live female which completed a production record. The 3 completed 4 pregnancies to Red Dane bulls, the result being 2 live male calves and 2 live female calves, both of which made production records.

Altogether, the 12 cows of Lewisburg origin terminated 35 pregnancies to project bulls. The net result was 14 useful female progeny.

Cow L–111 had daughters by Jersey, Holstein, and Red Dane bulls; and cow L–116 had daughters by Holstein and Red Dane bulls, but none by a Jersey bull.

The Sandhill Foundation Group

The Guernsey group for the crossbreeding project was obtained from the Sandhill field station at Pontiac, S. C. It differed somewhat from the groups obtained from the other stations in that it included a number of younger animals, some of which had started records at Sandhill but did not complete their first normal records until after they freshened at Beltsville. One of the younger animals was from a dam that also made her first record at Beltsville, and she is included with those listed as in dam when the group was shipped.

A total of 15 Guernsey females were moved to Beltsville on April 17, 1939. Three of these failed to breed and did not become a part of the crossbreeding project. Four of the 15 Sandhill cows had completed normal first-calf records at Sandhill; and their birth dates, first production records, and the mature-equivalent values of the records are as follows:

Herd No. and date of birth	Actual production [1]					Mature-equivalent value	
	Milk	Test	Fat	Age		Milk	Fat
	Lbs.	*%*	*Lbs.*	*Yr.*	*Mo.*	*Lbs.*	*Lbs.*
S–31, Aug. 8, 1931	8, 983	5. 29	475	2	9	11, 229	594
S–38, Feb. 21, 1933	8, 056	5. 61	452	2	2	10, 956	615
S–44, Sept. 10, 1933	7, 955	4. 87	387	2	8	10, 023	488
S–75, Mar. 21, 1936	7, 381	5. 18	382	2	5	9, 595	497
Average of 4	8, 094	5. 24	424	2	6	10, 451	549

[1] All records were made on 3 milkings daily for 305 days, under standard conditions of feeding and management.

Seven of the 15 cows from Sandhill made their first normal records at Beltsville. Their birth dates, production records, and the mature-equivalent value of the records are as follows:

Herd No. and date of birth	Actual production [1]					Mature-equivalent value	
	Milk	Test	Fat	Age		Milk	Fat
	Lbs.	*%*	*Lbs.*	*Yr.*	*Mo.*	*Lbs.*	*Lbs.*
S–78, Apr. 9, 1936	11, 031	4. 71	520	4	6	11, 693	551
S–81, May 16, 1936	6, 469	4. 85	314	3	5	7, 569	367
S–89, May 6, 1937	6, 760	5. 89	398	2	4	8, 923	525
S–91, July 14, 1937	8, 736	5. 45	477	2	10	10, 833	591
S–99, Jan. 26, 1938	9, 183	5. 06	465	2	3	12, 305	623
S–104, June 22, 1938	7, 046	5. 09	358	2	5	9, 160	465
S–108, Sept. 25, 1938	8, 169	4. 89	400	2	2	11, 110	544
Average of 7	8, 199	5. 13	419	2	10	10, 228	524

[1] All records were made on 3 milkings daily for 365 days, under standard conditions of feeding and management.

The 4 cows in the older group had their calves during the period from 1934 through 1938, and during that period 34 females completed their first records at Sandhill. The contemporary females of the other 7 tested at Beltsville freshened for their first tests during 1939–40. The average production of the groups tested in these periods was as follows:

Years	Females tested (number)	Actual-production average					Mature-equivalent value	
		Milk	Test	Fat	Age		Milk	Fat
		Lbs.	*%*	*Lbs.*	*Yr.*	*Mo.*	*Lbs.*	*Lbs.*
1934–38	34	8, 419	5. 32	447	2	6	10, 863	576
1939–40	14	8, 649	5. 18	445	2	6	11, 369	584
Average of all	48	8, 486	5. 28	446	2	6	11, 011	578

Five of the cows were pregnant to the service of Guernsey bulls when they left Sandhill. The results of these pregnancies were 1 male calf, 1 abortion, and 3 female calves. One of the females died and the other 2 were retained for foundation cows. These 2, along with 1 previously reported, make up the rest of the foundation group of Guernseys. The production records of these three at Beltsville were as follows:

Herd No.	Actual production					Mature-equivalent value	
	Milk	Test	Fat	Age		Milk	Fat
	Lbs.	*%*	*Lbs.*	*Yr.*	*Mo.*	*Lbs.*	*Lbs.*
S–102	8,052	4.51	363	2	0	11,273	508
S–122	11,630	4.44	516	2	2	15,817	702
S–125	9,186	4.65	427	2	1	12,677	589
Average of 3	9,623	4.53	435	2	1	13,256	600

The consolidated production story on the Guernsey foundation cows is as follows:

Group	Females tested (number)	Actual-production average					Mature-equivalent value	
		Milk	Test	Fat	Age		Milk	Fat
		Lbs.	*%*	*Lbs.*	*Yr.*	*Mo.*	*Lbs.*	*Lbs.*
Tested at Sandhill	4	8,094	5.24	424	2	6	10,451	549
Tested at Beltsville	10	8,626	4.95	424	2	7	11,136	547
All foundation cows	14	8,474	5.03	424	2	7	10,940	547

PRODUCTION PERFORMANCE OF THE GUERNSEY DAUGHTERS OF THE SANDHILL FOUNDATION COWS

The 6 oldest Guernsey foundation cows had produced 4 Guernsey daughters before they were shipped to Beltsville. Two of the daughters were sent to Beltsville before calving age, but the other two completed their first production records at Sandhill, as follows:

Herd No.	Daughters tested at Sandhill					Herd No.	Dams tested at Sandhill				
	Milk	Test	Fat	Age			Milk	Test	Fat	Age	
	Lbs.	*%*	*Lbs.*	*Yr.*	*Mo.*		*Lbs.*	*%*	*Lbs.*	*Yr.*	*Mo.*
S–83	9,514	5.35	509	2	5	S–38	8,056	5.61	452	2	2
S–113	8,892	5.09	453	2	3	S–31	8,983	5.20	475	2	9
Average of 2:						Average of 2:					
Actual	9,203	5.22	481	2	4	Actual	8,520	5.45	464	2	6
Mature-equivalent	12,142		635			Mature-equivalent	11,093		605		

One other Guernsey foundation cow that was tested at Sandhill had a Guernsey daughter that was tested at Beltsville. The production records were as follows:

Herd No.	Daughter tested at Beltsville					Herd No.	Dam tested at Sandhill				
	Milk	Test	Fat	Age			Milk	Test	Fat	Age	
	Lbs.	*%*	*Lbs.*	*Yr.*	*Mo.*		*Lbs.*	*%*	*Lbs.*	*Yr.*	*Mo.*
S–81	6,400	4.85	314	3	6	S–44	7,955	4.87	387	2	8
Mature-equivalent	7,569		367			Mature-equivalent	10,023		488		

In addition, there were three other Guernsey daughters of Sandhill foundation cows. They were the 1 that was sent to Beltsville as a calf, and the 2 in-dam heifers. All three were tested at Beltsville, along with their dams. Their production records are as follows:

Herd No.	Daughters tested at Beltsville					Herd No.	Dams tested at Beltsville				
	Milk	Test	Fat	Age			Milk	Test	Fat	Age	
	Lbs.	*%*	*Lbs.*	*Yr.*	*Mo.*		*Lbs.*	*%*	*Lbs.*	*Yr.*	*Mo.*
S-102	8,052	4.51	363	2	0	S-78	11,031	4.71	520	4	5
S-122	11,030	4.44	516	2	2	S-78	11,031	4.71	520	4	5
S-125	9,186	4.65	427	2	1	S-81	6,469	4.82	314	3	6
Average of 3:						Average of 3:					
Actual	9,623	4.53	435	2	1	Actual	9,510	4.75	451	4	1
Mature-equivalent	13,256		600			Mature-equivalent	10,318		490		

These 3 groups together make a total of 6 Guernsey daughters of the Guernsey foundation cows. The average production of the dams and daughters is as follows:

Average production	Guernsey daughters				Guernsey dams			
	Milk	Test	Fat	Age	Milk	Test	Fat	Age
	Lbs.	*%*	*Lbs.*	*Yr.-Mo.*	*Lbs.*	*%*	*Lbs.*	*Yr.-Mo.*
Actual	8,957	4.82	430	2 5	8,921	5.00	445	3 4
Mature-equivalent	11,937		573		10,527		528	

REPRODUCTIVE PERFORMANCE OF THE SANDHILL FOUNDATION GROUP

Six of the Sandhill foundation cows had completed pregnancies to Guernsey bulls before leaving Sandhill. The result was 10 male calves and 5 female calves. Two of the females made their records at Sandhill, 1 died, and the other 2 made their records at Beltsville and were used as foundation cows.

Five of the six cows were pregnant when they left Sandhill. They calved at Beltsville, producing 1 male calf, 1 abortion, and 3 live female calves. One of the females died and the other two made records and were added to the foundation group.

On the crossbreeding project, the entire group of 14 Guernsey foundation cows completed one or more gestations. Five completed 5 pregnancies to Jersey sires and produced 3 male calves and 2 female calves, 1 of which died. Eleven of the group terminated 17 pregnancies to Holstein sires, which resulted in 1 abortion, 7 male calves, and 9 female calves. Twelve completed 21 pregnancies to Red Dane sires, which resulted in 1 dead male calf, 12 live male calves, and 8 live female calves, 1 of which died.

The net result of 43 pregnancies was 17 crossbred females that completed production records. S-78 had 2 Guernsey daughters, and 1 daughter each by a Holstein bull and a Red Dane bull. Three other foundation cows in this group had crossbred heifers both by Holstein sires and by Red Dane sires.

The Red Dane Foundation Group

The Red Dane cattle were located at Beltsville. In most cases the females selected for the foundation group were cows that had already produced 1 or more Red Dane heifers; but 5 Red Dane heifers that were left after the bulk of the herd had been shipped to Indiana were also included in the foundation group.

In an attempt to bring the number of crossbreds from Red Dane females and Jersey bulls up to a level comparable with that of most of the other groups, these 5 heifers were mated to Jersey sires, but the results of this attempt were 1 abortion, 4 male calves, and 1 female calf from 6 pregnancies.

The management practice in the Red Dane herd at Beltsville was to breed for 1 calf a year, milk the cows twice daily for 300 days, and feed according to milk production. Since the production records of all other female groups were made on 3 milkings daily for 365 days, the Red Dane first normal records were adjusted to that basis by using the factor 1.42. All Red Dane records shown were calculated in this manner in order to compare them with those of their crossbred progeny. However, since only 8 crossbred females from Red Dane dams completed production records, the effect of the adjusted records is small.

A total of 28 Red Dane females were bred for crossbred progeny, but 4 failed to conceive and the 5 heifers mentioned above did not complete records at Beltsville because 4 of them were shipped to Indiana and 1 was slaughtered. These 5 heifers were not represented by progeny.

The 19 Red Dane females which produced Red Dane or crossbred progeny were considered as foundation cows. Their first normal production records, as adjusted to the basis of 3 daily milkings for 365 days, and the mature-equivalent values of the records are as follows:

Herd No. and date of birth	Adjusted-production record					Mature-equivalent value	
	Milk	Test	Fat	Age		Milk	Fat
	Lbs.	*%*	*Lbs.*	*Yr.*	*Mo.*	*Lbs.*	*Lbs.*
D-10, Dec. 22, 1933	10, 549	3. 83	405	2	8	13, 397	514
D-22, Jan. 23, 1936	12, 404	3. 95	490	3	1	14, 885	588
D-24, July 7, 1936	11, 880	4. 03	479	2	5	15, 563	627
D-27, Sept. 10, 1936	13, 136	4. 15	545	2	1	18, 128	752
D-28, Sept. 10, 1936	12, 121	3. 90	473	3	2	14, 424	563
D-30, April 30, 1937	9, 088	4. 26	388	2	3	12, 269	524
D-33, Feb. 27, 1938	13, 988	3. 87	541	3	4	16, 366	633
D-36, June 16, 1938	7, 634	4. 58	349	2	5	10, 001	458
D-40, Nov. 7, 1938	14, 561	3. 56	518	3	4	17, 036	606
D-44, June 12, 1939	12, 899	3. 78	487	2	1	17, 801	672
D-45, Aug. 4, 1939	11, 056	4. 20	464	3	5	12, 825	538
D-47, Dec. 4, 1939	8, 612	4. 53	391	2	1	11, 885	540
D-54, Jan. 9, 1941	12, 549	3. 66	460	2	1	17, 318	635
D-82, July 23, 1941	14, 013	4. 07	571	3	1	16, 816	685
D-66, Feb. 18, 1942	13, 804	4. 10	565	1	11	19, 602	802
D-68, Feb. 25, 1942	12, 002	4. 34	520	3	3	14, 162	614
D-71, April 6, 1942	10, 355	3. 95	409	1	11	14, 704	581
D-72, Aug. 4, 1942	6, 822	4. 51	308	2	9	8, 596	388
D-81, Aug. 14, 1943	12, 610	4. 25	535	3	7	14, 375	610
Average of 19	11, 583	4. 08	468	2	8	14, 745	596

PRODUCTION PERFORMANCE OF THE RED DANE DAUGHTERS OF THE RED DANE FOUNDATION GROUP

Of the 28 Red Dane females used on the project, 4 failed to conceive and 5 were bred only for crossbred progeny before leaving the herd. The remaining 19 Red Dane project foundation cows produced 16 Red Dane heifers that made records at Beltsville. The production records of both the daughters and their dams, as adjusted to a basis of 3 daily milkings for 365 days, are as follows:

Herd No.	Daughters' production					Herd No.	Dams' production				
	Milk	Test	Fat	Age			Milk	Test	Fat	Age	
	Lbs.	*%*	*Lbs.*	*Yr.*	*Mo.*		*Lbs.*	*%*	*Lbs.*	*Yr.*	*Mo.*
D-28	12,121	3.90	473	3	2	D-10	10,549	3.83	405	2	8
D-33	13,988	3.87	541	3	4	D-22	12,404	3.98	490	3	1
D-39	11,004	3.90	432	2	3	D-27	13,136	4.15	545	2	1
D-40	14,561	3.56	518	3	4	D-28	12,121	3.90	473	3	2
D-43	7,985	3.77	301	2	1	D-22	12,404	3.98	490	3	1
D-45	11,056	4.20	464	3	5	D-30	9,088	4.26	388	2	3
D-48	12,580	3.74	470	2	0	D-10	10,549	3.83	405	2	8
D-50	10,960	4.07	446	2	5	D-33	13,988	3.87	541	3	4
D-64	10,786	4.57	493	3	2	D-45	11,056	4.20	464	3	5
D-68	12,002	4.34	520	3	3	D-24	11,880	4.03	479	2	5
D-71	10,355	3.95	409	1	11	D-40	14,561	3.56	518	3	4
D-74	13,305	3.92	523	2	9	D-44	12,899	3.78	487	2	1
D-76	10,215	4.20	429	2	4	D-28	12,121	3.90	473	3	2
D-81	12,610	4.25	535	3	7	D-62	14,013	4.07	571	3	1
D-82	10,751	4.74	510	2	4	D-33	13,988	3.87	541	3	4
D-90	11,206	4.39	496	1	11	D-68	12,002	4.34	520	3	3
Average of 16	11,596	4.09	473	2	8	Average of 16	12,297	3.97	487	3	0
Mature-equivalent	14,700		599			Mature-equivalent	15,172		601		

REPRODUCTIVE PERFORMANCE OF THE RED DANE FOUNDATION GROUP

Disregarding the 4 foundation Red Danes that failed to conceive, the breeding performance of the other 24 shows that 19 completed 59 pregnancies to Red Dane sires which resulted in 22 live male calves, 2 abortions, and 35 living female calves, of which 16 made production records.

Fourteen of the 24 completed 16 pregnancies to Holstein bulls and these resulted in 8 live male calves, 2 abortions, and 6 living female calves, all of which completed production records on the project. Fifteen terminated 20 pregnancies to Jersey bulls with 1 pair of mixed twins, 11 other living male calves, 2 abortions, and 6 living females, 2 of which died. Two others were disposed of before calving, in order to avoid further delay in making a final summary of the results of the crossbreeding project.

In all, the Red Dane foundation cows left a net of 24 females which were of use to the experiment. A preponderance of male calves resulting from the matings for crossbred calves in the Jersey × Red Dane group, left this combination with only two females.

SUMMARY OF THE PRODUCTION AND REPRODUCTION PERFORMANCE OF ALL FOUNDATION GROUPS

This summary brings together the production records of the various foundation groups, and of the subgroups in each foundation group, according to the station of their origin and the station at which they made their records. The average actual production records, by

groups and subgroups, and the mature-equivalent value of the records are as follows:

Foundation groups and subgroups	Cows tested (number)	Actual-production average [1]				Mature-equivalent value	
		Milk	Test	Fat	Age	Milk	Fat
		Lbs.	%	*Lbs.*	*Yr. Mo.*	*Lbs.*	*Lbs.*
Cows tested at home station:							
Huntley Holsteins	10	12, 609	3. 60	454	2 7	16, 341	587
Mandan Holsteins	12	14, 412	3. 59	514	2 4	19, 123	683
Lewisburg Jerseys	9	8, 302	5. 47	448	2 7	10, 535	570
Sandhill Guernseys	4	8, 094	5. 24	424	2 6	10, 451	549
Average of all	35	11, 604	4. 26	470	2 6	15, 129	611
Cows born at home station and tested at Beltsville:							
Sandhill Jerseys	7	8, 199	5. 13	419	2 10	10, 228	524
In-dam heifers from home station tested at Beltsville:							
Huntley Holsteins	2	15, 389	3. 47	534	2 3	20, 750	719
Mandan Holsteins	1	14, 247	3. 32	472	2 2	19, 376	642
Lewisburg Jerseys	2	7, 727	5. 41	418	2 1	10, 664	577
Sandhill Guernseys	3	9, 628	4. 53	435	2 1	13, 256	600
Average of all	8	11, 168	4. 33	460	2 2	15, 121	629
Bred and tested at Beltsville:							
Huntley Holsteins	3	13, 485	3. 73	502	2 0	19, 022	708
Mandan Holsteins	3	15, 886	3. 75	587	2 0	22, 241	822
Beltsville Red Danes	19	11, 583	4. 08	468	2 8	14, 745	596
Average of all	25	12, 330	4. 00	487	2 6	16, 158	637
All cows in foundation groups tested at Beltsville:							
Average of all	40	11, 373	4. 26	469	2 6	14, 913	615

[1] All records on actual 3×365-day basis, except Red Dane records, which have been adjusted from 2×300-day basis to 3×365-day basis.

For ease of comparison, the average production records of the various foundation groups are shown below. Each group includes the foundation cows obtained from the station and also their progeny of the same breed that were used as foundation cows. Their actual average production records and the mature-equivalent value of the records are as follows:

Foundation groups	Cows tested (number)	Actual-production average				Mature-equivalent value	
		Milk	Test	Fat	Age	Milk	Fat
		Lbs.	%	*Lbs.*	*Yr. Mo.*	*Lbs.*	*Lbs.*
Huntley Holsteins	15	13, 155	3. 61	477	2 5	17, 465	629
Mandan Holsteins	16	14, 678	3. 60	525	2 3	19, 724	706
Lewisburg Jerseys	11	8, 197	5. 46	443	2 6	10, 558	572
Sandhill Guernseys	14	8, 474	5. 03	424	2 7	10, 940	547
Beltsville Red Danes	19	11, 583	4. 08	468	2 8	14, 745	596
Average of all	75	11, 481	4. 26	470	2 6	15, 013	613

The difference in the average production of the cows tested at the four field stations and those tested at Beltsville is slight, as shown in the following tabulation:

	Cows tested (number)	Actual-production average				Mature-equivalent value	
		Milk	Test	Fat	Age	Milk	Fat
		Lbs.	*%*	*Lbs.*	*Yr. Mo.*	*Lbs.*	*Lbs.*
Tested at 4 field stations	35	11, 604	4. 26	470	2 6	15, 129	611
Tested at Beltsville	40	11, 373	4. 26	469	2 6	14, 913	615

The 35 cows that were tested at the 4 field stations were brought to Beltsville for use as foundation cows. While they were making their records, other heifers were also on test at the same stations. In the tabulation below, the production of the cows that were brought to Beltsville is compared with that of the heifers that were on test in the same herds during the same years. The Holsteins from the Huntley and Mandan stations are compared with Holsteins in the same station herds; and the Jerseys from Lewisburg and the Guernseys from Sandhill are compared with Jerseys and Guernseys in the same herds. The records of the groups are as follows:

Group	Cows tested (number)	Actual-production average				Mature-equivalent value	
		Milk	Test	Fat	Age	Milk	Fat
		Lbs.	*%*	*Lbs.*	*Yr. Mo.*	*Lbs.*	*Lbs.*
Huntley and Mandan Holsteins sent to Beltsville	22	13, 593	3. 59	487	2 5	17, 859	639
Contemporary Holsteins at Huntley and Mandan	71	12, 789	3. 59	457	2 4	17, 054	609
Lewisburg Jerseys and Sandhill Guernseys sent to Beltsville	13	8, 238	5. 40	441	2 7	10, 509	564
Contemporary Jerseys and Guernseys at Lewisburg and Sandhill	91	8, 526	5. 24	445	2 7	10, 920	569

Statistical analysis showed that there was no significant difference between the animals that were sent to Beltsville and their contemporary groups in either milk yield, fat test, or fat yield—the t values being 0.786, 1.183, and 1.248, respectively.

A total of 89 females were designated as foundation cows on the crossbreeding project. Fourteen of these either failed to breed or died before completing a production record. The remaining 75 all conceived at least once for project calves, and all completed production records.

Fifty-seven foundation cows were pregnant one or more times to bulls of their own respective breed, and as a group they terminated 167 such pregnancies. The reproductive performance of the 57 cows,

the female progeny lost from the project, and the net result as measured by the number of female progeny that lived to complete production records is as follows:

	Huntley Holsteins	Mandan Holsteins	Lewisburg Jerseys	Sandhill Guernseys	Beltsville Red Danes	Total
Foundation cows---number--	10	12	9	7	19	57
Pregnancies to bulls of same breed----------number--	24	41	23	20	59	167
Reproduction performance:						
Abortions-----number--	1	-------	1	1	2	5
Dead male calves-do----	1	[1] 4	1	-------	-------	[1] 6
Live male calves--do----	8	[2] 20	11	11	22	[3] 72
Dead female calves-do----	2	[2] 2	-------	-------	-------	[2] 4
Live female calves-do----	12	[1] 18	10	8	35	[1] 83
Female progeny lost from the project:						
Died as calves--number--	3	3	-------	2	5	13
Freemartins-----do----	-------	1	-------	-------	-------	1
Nonbreeders-----do----	-------	-------	-------	-------	3	3
Killed by lightning number--	-------	-------	-------	-------	2	2
Killed after aborting number--	-------	-------	-------	-------	3	3
Killed by mastitis-do----	-------	-------	-------	-------	1	1
Sent to Indiana---do----	-------	-------	-------	-------	5	5
Total losses----do----	3	4	-------	2	19	28
Females that completed production records--number--	9	14	10	6	16	55

[1] Includes 1 twin.
[2] Includes 2 twins.

One of the Jersey females had a male calf and was later condemned for TB. The remaining 54, plus the 6 Holsteins bred from the foundation females at Beltsville (3 each in the Huntley and Mandan groups), make up a total of 60 daughters from foundation cows that were of the same breed as their respective dams. The average production records of the 60 daughters and their dams are shown by station groups, as follows:

Station and breed	Cows tested (number)	Actual-production average of daughters				Actual-production average of dams			
		Milk	Test	Fat	Age	Milk	Test	Fat	Age
		Lbs.	*%*	*Lbs.*	*Yr. Mo.*	*Lbs.*	*%*	*Lbs.*	*Yr. Mo.*
Huntley Holsteins	12	13,823	3.56	490	2 1	13,025	3.62	472	2 5
Mandan Holsteins	17	14,144	3.41	482	2 2	14,634	3.57	519	2 3
Lewisburg Jerseys	9	8,020	5.29	425	2 7	8,335	5.53	452	2 9
Sandhill Guernseys	6	8,957	4.28	430	2 5	8,921	5.00	445	3 4
Beltsville Red Danes	16	11,506	4.09	473	2 8	12,297	3.97	487	3 0
Average of all:									
Actual	60	11,993	4.04	467	2 5	12,173	4.12	483	2 8
Mature-equivalent	60	15,035	-------	620	-------	15,042	-------	618	-------

Thirty-two daughters produced more milk than their dams, 23 had a higher butterfat test, and 28 produced more butterfat than their dams.

To complete the story on the reproductive performance of the foundation cows, the results achieved when these cows were used on the crossbreeding project and mated to produce project animals are presented in tabular form below. Seventy-seven foundation females completed 179 pregnancies for project offspring. The results of these pregnancies, listed by station groups, were as follows:

	Huntley Holsteins	Mandan Holsteins	Lewisburg Jerseys	Sandhill Guernseys	Beltsville Red Danes	Total
Foundation cows—number	13	14	12	14	24	77
Pregnancies terminated—number	32	33	35	43	36	179
Reproduction performance:						
Abortions—number	-------	1	-------	1	4	6
Dead male calves—do	[1] 2	2	-------	1	-------	[1] 5
Live male calves—do	[1] 14	[2] 21	20	22	[1] 20	[3] 97
Dead female calves—number	[1] 2	-------	1	-------	-------	[1] 3
Live female calves—do	[1] 16	[4] 12	14	19	[1] 13	[2] 74
Female progeny lost from the project:						
Died as calves—number	1	1	-------	2	2	6
Freemartins—do	1	2	-------	-------	1	4
Total losses—do	2	3	-------	2	3	10
Females left for project use—number	14	9	14	17	10	64
Straight Holsteins used as foundation cows—number	3	3	-------	-------	-------	6
Disposed of in order to complete report on this generation—number	1	-------	-------	-------	2	3
Crossbred heifers that made production records—number	9	6	14	17	8	55

[1] Includes 1 twin. [2] Includes 4 twins. [3] Includes 6 twins. [4] Includes 2 twins.

The preponderance of male calves (102 males to 77 females) is excessive; but in the results of pregnancies to bulls of the same breed as the cows, the ratio was 78 males to 87 females. When the 2 sets of results are combined, the ratio of 180 males to 164 females is about normal.

Photographs of Foundation Cows

In the following pages are pictures of some of the foundation cows of the different breeds. Each picture is marked with the cow's herd number, so that reference may be made to her record as given in the text. (See figs. 1 to 4, inclusive.)

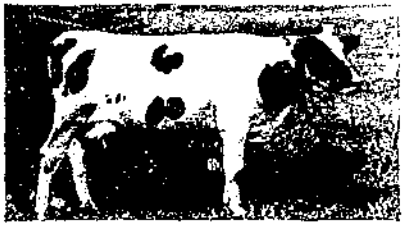
HOLSTEIN FOUNDATION COWS

H–330. 6 YEARS, 0 MONTH.

H–340. 6 YEARS, 1 MONTH.

H–345. 6 YEARS, 4 MONTHS.

H–349. 4 YEARS, 9 MONTHS.



H–420. 2 YEARS, 5 MONTHS.

H–423. 3 YEARS, 7 MONTHS.

M–56. 8 YEARS, 0 MONTH.

M–57. 6 YEARS, 4 MONTHS.

M–68. 5 YEARS, 5 MONTHS.

M–549. 2 YEARS, 3 MONTHS.

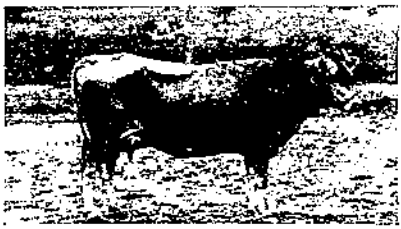
FIGURE 1.—Holstein foundation cows in the Huntley and Mandan groups.

JERSEY FOUNDATION COWS

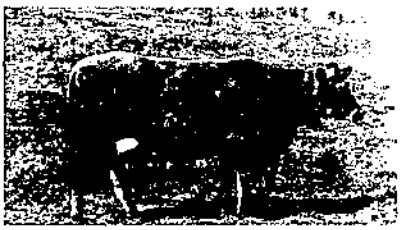
L–77. 7 YEARS, 1 MONTH.

L–106. 5 YEARS, 2 MONTHS.

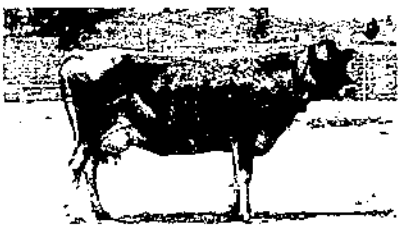
L–109. 5 YEARS, 1 MONTH.



L–111. 4 YEARS, 10 MONTHS.

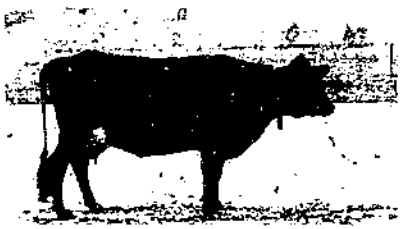


L–113. 6 YEARS, 2 MONTHS.



L–116. 5 YEARS, 2 MONTHS.

L–119. 5 YEARS, 1 MONTH.



L–120. 4 YEARS, 8 MONTHS.

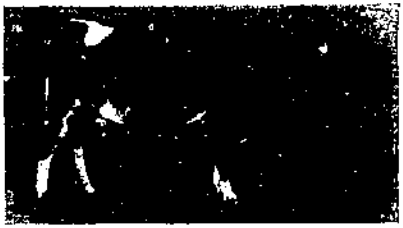
L–200. 2 YEARS, 1 MONTH.

L–207. 2 YEARS, 2 MONTHS.

FIGURE 2.—Jersey foundation cows in the Lewisburg group.

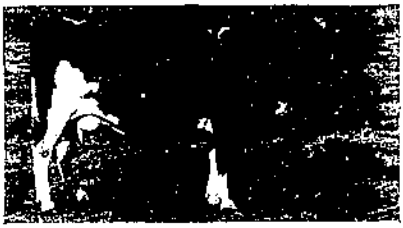
GUERNSEY FOUNDATION COWS

S–38. 7 YEARS, 3 MONTHS.



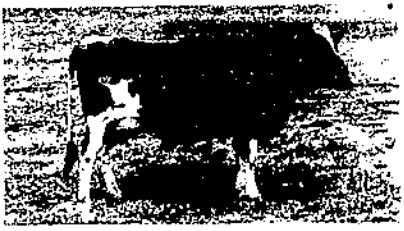
S–44. 7 YEARS, 2 MONTHS.

S–78. 3 YEARS, 6 MONTHS.



S–81. 4 YEARS, 8 MONTHS.

S–89. 2 YEARS, 5 MONTHS.



S–99. 4 YEARS, 11 MONTHS.

S–104. 3 YEARS, 10 MONTHS.

S–108. 3 YEARS, 7 MONTHS.

S–122. 2 YEARS, 2 MONTHS.

S–125. 2 YEARS, 2 MONTHS.

FIGURE 3.—Guernsey foundation cows in the Sandhill group.

RED DANE FOUNDATION COWS

D–22. 2 YEARS, 10 MONTHS.

D–33. 2 YEARS, 3 MONTHS.

D–40. 4 YEARS, 8 MONTHS.

D–54. 2 YEARS, 2 MONTHS.

D–62. 2 YEARS, 1 MONTH.

D–71. 3 YEARS, 1 MONTH.

D–72. 2 YEARS, 10 MONTHS.

FIGURE 4. Red Dane foundation cows from the Beltsville herd.

257084 -54 —3

TWO-BREED CROSSES

All production records of crossbred females and their foundation dams, except the few Red Dane dams, were made on 3 milkings daily for 365-day lactations. The records of the Red Dane foundation dams have been adjusted to that basis by the use of the factor 1.42.

Butterfat test determinations on the crossbred cows were made by taking milk samples from the 3 individual milkings on 1 day in each 10-day period and testing them for butterfat content. This test was applied to the 10-day period during which the samples were taken.

Since it was evident that facilities available would not permit of the retention of all animals for lifetime production determinations in the Beltsville herd, the dam-and-daughter comparisons were made on a basis of first normal production records, and the average mature-equivalent values were calculated for each subgroup. Because some of the dams were tested at their home stations before coming to Beltsville, and others made their first records at Beltsville, the groups are divided on this basis.

Crossbred Progeny of Foundation Holstein Cows in the Huntley Group

Seven of the original 10 Huntley cows, the 2 in-dam daughters, and the 3 Beltsville-bred Holsteins in the Huntley group were mated for crossbred calves. These 12 cows completed 25 pregnancies, of which 13 were to Red Dane bulls and 12 to Jersey bulls. The 13 pregnancies to Red Dane bulls resulted in 9 male calves (1 dead twin) and 5 female calves (1 dead twin), a net of 4 females. The 12 pregnancies to Jersey bulls resulted in 4 male calves (1 dead and 1 twin) and 9 females (1 dead and 1 twin), a net of 7 females. The difference in sex ratio is notable, even though the numbers are small. One of the crossbred heifers sired by a Red Dane bull was disposed of in order to avoid further delay in making a final analysis of this generation.

The first group shown are the crossbred daughters by Jersey sires and from Huntley Holstein dams. The actual production records of the Jersey × Holstein daughters tested at Beltsville, and the comparable records of their dams tested at Huntley and at Beltsville, are as follows:

Herd No.	Jersey × Holstein daughters tested at Beltsville					Herd No.	Huntley Holstein dams tested at Huntley				
	Milk	Test	Fat	Age			Milk	Test	Fat	Age	
	Lbs.	*%*	*Lbs.*	*Yr.*	*Mo.*		*Lbs.*	*%*	*Lbs.*	*Yr.*	*Mo.*
X–1 [1]	9,784	4.85	475	2	0	H–330	10,726	3.64	391	2	2
X–17 [2]	13,337	3.85	531	2	3	H–340	12,334	3.03	374	2	4
X–41 [1]	12,453	4.63	576	2	5	H–345	12,013	3.50	442	2	3
X–42 [1]	10,490	4.90	514	2	4	H–330	10,726	3.64	391	2	2
Average of 4:						Average of 4:					
Actual	11,641	4.56	525	2	3	Actual	11,600	3.45	400	2	3
Mature-equivalent	15,661		706			Mature-equivalent	15,652		540		
							Huntley Holstein dams tested at Beltsville				
X–32 [3]	13,728	3.94	540	1	11	H–420	11,925	3.40	413	2	4
X–35 [1]	10,508	5.21	550	2	1	H–423	18,853	3.47	654	2	2
X–276 [4]	14,825	4.25	631	2	0	HB–208	9,538	3.88	371	2	1
Average of 3:						Average of 3:					
Actual	13,020	4.48	574	2	3	Actual	13,439	3.60	479	2	2
Mature-equivalent	17,509		771			Mature-equivalent	18,221		650		
	All Jersey × Holstein daughters						All Huntley Holstein dams				
Average of 7:						Average of 7:					
Actual	12,232	4.52	546	2	3	Actual	12,388	3.52	434	2	3
Mature-equivalent	16,452		734			Mature-equivalent	16,753		587		

[1] Nos. X–1, X–35, X–41, and X–42 were by Jersey sire No. 1114.
[2] No. X–17 was by Jersey sire No. 1102.
[3] No. X–32 was by Jersey sire No. 1565.
[4] No. X–276 was by Jersey sire No. 1186.

Two of the three Red Dane × Holstein daughters from Huntley Holstein cows were from dams tested at Huntley, and the other was from a dam that made her record at Beltsville. The actual production records of the three dam-and-daughter pairs are as follows:

Herd No.	Red Dane × Holstein daughters tested at Beltsville					Herd No.	Huntley Holstein dams tested at Huntley				
	Milk	Test	Fat	Age			Milk	Test	Fat	Age	
	Lbs.	*%*	*Lbs.*	*Yr.*	*Mo.*		*Lbs.*	*%*	*Lbs.*	*Yr.*	*Mo.*
X–22 [1]	16,040	3.60	611	2	2	H–315	12,613	3.50	442	2	3
X–23 [1]	14,036	3.77	552	2	6	H–319	12,839	3.61	463	2	7
Average of 2:						Average of 2:					
Actual	15,703	3.69	582	2	1	Actual	12,726	3.56	453	2	5
Mature-equivalent	21,771		802			Mature-equivalent	16,731		595		
							Huntley Holstein dam tested at Beltsville				
X–56 [1]	10,100	4.08	657	2	0	H–423	18,853	3.47	654	2	2
Mature-equivalent	22,540		920			Mature-equivalent	25,610		889		
	All Red Dane × Holstein daughters						All Huntley Holstein dams				
Average of 3:						Average of 3:					
Actual	15,805	3.82	607	2	1	Actual	14,708	3.53	520	2	4
Mature-equivalent	22,027		841			Mature-equivalent	19,701		693		

[1] Nos. X–22, X–23, and X–56 were by Red Dane sire D–501.

The 10 crossbred daughters of the Huntley foundation cows are grouped below according to the station at which the daughters and dams made their production records. The average production of the 10 dam-and-daughter pairs was as follows:

	Jersey × Holstein and Red Dane × Holstein daughters tested at Beltsville				Huntley Holstein foundation dams tested at Huntley			
	Milk	Test	Fat	Age	Milk	Test	Fat	Age
Average of 6:	*Lbs.*	*%*	*Lbs.*	*Yr. Mo.*	*Lbs.*	*%*	*Lbs.*	*Yr. Mo.*
Actual	13,025	4.27	544	2 2	11,975	3.49	417	2 4
Mature-equivalent	17,697		738		16,011		558	
					Huntley Holstein group dams tested at Beltsville			
Average of 4:								
Actual	13,709	4.38	595	2 2	14,792	3.57	523	2 2
Mature-equivalent	18,767		809		20,076		710	
	All Jersey × Holstein and Red Dane × Holstein daughters from Huntley group dams							
Average of 10:								
Actual	13,331	4.31	564	2 2	13,102	3.52	460	2 3
Mature-equivalent	18,125		766		17,637		610	

Five daughters produced more milk than their dams, 10 had a higher butterfat test, and 9 produced more butterfat than their dams.

The Huntley Holstein foundation group had 12 Holstein daughters and 10 crossbred daughters, which produced as follows:

Group	Cows tested (number)	Actual-production average				Mature-equivalent value	
		Milk	Test	Fat	Age	Milk	Fat
		Lbs.	*%*	*Lbs.*	*Yr. Mo.*	*Lbs.*	*Lbs.*
Holstein daughters	12	13,823	3.56	490	2 1	19,054	675
Crossbred daughters	10	13,331	4.31	564	2 2	18,125	766

Crossbred Progeny of the Foundation Holstein Cows in the Mandan Group

Ten of the original 12 Mandan cows, the 1 in-dam heifer, and the 3 Beltsville-bred Holsteins in the Mandan group were mated for crossbred calves. These 14 cows terminated 24 pregnancies, of which 15 were to Red Dane bulls and 9 to Jersey bulls. The 15 pregnancies to Red Dane bulls resulted in 11 male calves (1 dead) and 4 females, all of which have completed production records. The 9 pregnancies to Jersey bulls resulted in 6 male calves (2 twins) and 5 females (2 twins). One of the 5 died, and as 2 were freemartins, only 2 were left to complete production records.

The sex ratio of the Red Dane × Holstein crosses at Mandan was 11 males to 4 females, whereas the sex ratio of the Red Dane × Hol-

stein crosses at Huntley was 9 males to 5 females. Combining the Mandan and Huntley groups shows that 28 pregnancies of Holstein females to Red Dane bulls resulted in 20 male calves and 9 female calves, including 1 pair of dead mixed twins.

The total of 21 pregnancies of Holstein cows to Jersey bulls (9 at Mandan and 13 at Huntley) resulted in 10 male calves and 14 female calves, including 3 pairs of twins and 1 dead calf.

The actual production records of the Jersey × Holstein daughters from Mandan cows and their Holstein dams are as follows:

Herd No.	Jersey × Holstein daughters tested at Beltsville					Herd No.	Mandan Holstein dams tested at Mandan				
	Milk	Test	Fat	Age			Milk	Test	Fat	Age	
	Lbs.	*%*	*Lbs.*	*Yr.*	*Mo.*		*Lbs.*	*%*	*Lbs.*	*Yr.*	*Mo.*
X–3 [1]	13,005	4.71	615	1	11	M–71	14,329	3.60	516	2	2
X–47 [1]	12,189	5.13	625	1	8	M–57	16,926	3.37	571	2	3
Average of 2:						Average of 2:					
Actual	12,627	4.92	620	1	10	Actual	15,628	3.49	544	2	3
Mature-equivalent	18,296	...	899	...	...	Mature-equivalent	21,169	...	737	...	...

[1] Nos. X–3 and X–47 were by the Jersey bull No. 1114.

The actual production records of the Red Dane × Holstein daughters from Mandan cows and their Holstein dams are as follows:

Herd No.	Red Dane × Holstein daughters tested at Beltsville					Herd No.	Mandan Holstein dams tested at Mandan				
	Milk	Test	Fat	Age			Milk	Test	Fat	Age	
	Lbs.	*%*	*Lbs.*	*Yr.*	*Mo.*		*Lbs.*	*%*	*Lbs.*	*Yr.*	*Mo.*
X–14	13,643	4.05	552	2	2	M–56	16,592	3.38	560	2	9
X–46	11,103	4.05	449	1	11	M–68	10,876	3.75	408	2	0
Average of 2:						Average of 2:					
Actual	12,373	4.05	501	2	1	Actual	13,719	3.57	484	2	5
Mature-equivalent	17,169	...	695	...	...	Mature-equivalent	18,047	...	639	...	...
							Mandan Holstein dams tested at Beltsville				
X–58	13,956	4.27	596	2	4	M–549	14,247	3.32	472	2	2
X–63	17,303	3.83	665	2	4	MB–2	22,371	3.43	768	2	9
Average of 2:						Average of 2:					
Actual	15,076	4.05	631	2	4	Actual	18,309	3.38	620	2	1
Mature-equivalent	20,857	...	839	...	...	Mature-equivalent	25,347	...	858	...	...
	All Red Dane × Holstein daughters [1]						All Mandan Holstein dams				
Average of 4:						Average of 4:					
Actual	14,024	4.05	595	2	2	Actual	16,014	3.47	552	2	3
Mature-equivalent	19,004	...	767	...	...	Mature-equivalent	21,697	...	749	...	...

[1] All of the crossbred daughters were by Red Dane bull D–501.

The unusually high production of MB–2 in this group of dams has an undue influence in this small group.

The actual average production records of all crossbred progeny of the Mandan Holstein group of foundation dams have been brought together, by groups, as follows:

	Jersey × Holstein and Red Dane × Holstein daughters tested at Beltsville				Mandan Holstein foundation dams tested at Mandan			
	Milk	Test	Fat	Age	Milk	Test	Fat	Age
Average of 4:	*Lbs.*	*%*	*Lbs.*	*Yr. Mo.*	*Lbs.*	*%*	*Lbs.*	*Yr. Mo.*
Actual	12,500	4.49	558	1 11	14,673	3.53	514	2 4
Mature-equivalent	17,728		797		19,508		688	
	Red Dane × Holstein daughters tested at Beltsville				Mandan Holstein group dams tested at Beltsville			
Average of 2:								
Actual	15,675	4.05	631	2 4	18,309	3.38	620	2 1
Mature-equivalent	20,857		839		25,347		858	
	All Jersey × Holstein and Red Dane × Holstein daughters				All Mandan Holstein dams			
Average of 6:								
Actual	13,558	4.34	584	2 1	15,885	3.48	549	2 3
Mature-equivalent	18,768		810		21,521		745	

One daughter produced more milk than her dam, 6 daughters had a higher butterfat test, and 4 produced more butterfat than their dams.

The Mandan Holstein foundation group had 17 Holstein daughters and 6 crossbred daughters which produced as follows:

Group	Cows tested (number)	Actual-production average				Mature-equivalent value	
		Milk	Test	Fat	Age	Milk	Fat
		Lbs.	*%*	*Lbs.*	*Yr. Mo.*	*Lbs.*	*Lbs.*
Holstein daughters	17	14,144	3.41	482	2 2	19,277	658
Crossbred daughters	6	13,558	4.34	584	2 1	18,768	810

MANDAN AND HUNTLEY CROSSBREDS COMBINED

The crossbred progeny of the Huntley and Mandan groups are combined to show the results of the Jersey × Holstein and Red Dane × Holstein crosses. A total of 49 pregnancies resulted in 16 females with completed production records. The actual production records of all Jersey × Holstein crosses, compared to the records of their dams, were as follows:

Herd No.	Jersey × Holstein daughters					Herd No.	Holstein dams				
	Milk	Test	Fat	Age			Milk	Test	Fat	Age	
	Lbs.	*%*	*Lbs.*	*Yr.*	*Mo.*		*Lbs.*	*%*	*Lbs.*	*Yr.*	*Mo.*
X–1 [1,2]	9,784	4.85	475	2	9	H–339	10,726	3.64	391	2	2
X–3 [1]	13,065	4.71	615	1	11	M–71	14,320	3.60	516	2	2
X–17 [3]	13,837	3.85	533	2	3	H–340	12,334	3.03	374	2	4
X–32 [4]	13,728	3.44	546	1	11	H–129	11,925	3.46	413	2	4
X–35 [1,2]	10,508	5.24	550	2	2	H–123	18,853	3.47	654	2	2
X–41 [1]	12,453	4.63	576	2	5	M–345	12,613	3.50	442	2	3
X–42 [1]	10,490	4.99	514	2	4	H–330	10,726	3.64	391	2	2
X–47 [1]	12,189	5.13	625	1	8	M–57	16,926	3.37	571	2	3
X–276 [5]	14,825	4.25	631	2	9	H B–208	9,538	3.88	371	2	1
Average of 9	12,320	4.61	562	2	2	Average of 9	13,103	3.51	458	2	3
Difference	−788	+1.10	+104			Difference					
Mature-equivalent average	16,862		770			Mature-equivalent average	17,734		620		

[1] Nos. X–1, X–3, X–35, X–41, X–42, and X–47 were by sire No. 1114.
[2] Nos. X–1 and X–35 had mastitis while on test.
[3] No. X–17 was by sire No. 1102.
[4] No. X–32 was by sire No. 1505.
[5] No. X–276 was by sire No. 1186.

Three daughters produced more milk than their dams, 9 had a higher butterfat test, and 8 produced more butterfat than their dams.

The actual production records of all Red Dane × Holstein crosses, compared to the records of their dams, were as follows:

Herd No.[1]	Red Dane × Holstein daughters					Herd No.	Holstein dams				
	Milk	Test	Fat	Age			Milk	Test	Fat	Age	
	Lbs.	*%*	*Lbs.*	*Yr.*	*Mo.*		*Lbs.*	*%*	*Lbs.*	*Yr.*	*Mo.*
X–14	13,643	4.05	552	2	2	M–56	16,562	3.38	560	2	9
X–22	16,949	3.60	611	2	2	H–345	12,613	3.50	442	2	3
X–23	14,636	3.77	552	2	0	H–349	12,239	3.61	453	2	7
X–46 [2]	11,103	4.05	449	1	11	M–68	10,876	3.75	408	2	0
X–56	16,109	4.08	657	2	0	H–123	18,853	3.47	654	2	2
X–58	13,956	4.27	596	2	4	M–349	14,247	3.32	472	2	2
X–63	17,393	3.83	665	2	4	M B–2	22,371	3.43	768	2	0
Average of 7	14,826	3.95	583	2	1	Average of 7	15,480	3.49	538	2	3
Difference	−654	+.46	+45			Difference					
Mature-equivalent average	20,299		799			Mature-equivalent average	20,842		725		

[1] All crossbred daughters were by sire No. D–501.
[2] No. X–46 had mastitis during her test.

Four daughters produced more milk, 7 had a higher butterfat test, and 5 produced more butterfat than their dams.

Crossbred Progeny of the Foundation Jersey Cows in the Lewisburg Group

The 9 original Lewisburg Jersey cows and the 3 in-dam heifers completed a total of 35 pregnancies when they were mated for crossbred calves. Seventeen pregnancies to Holstein bulls resulted in 8 male calves and 9 female calves; all of the latter have completed production records. The 18 pregnancies to Red Dane sires produced 12 male calves and 6 female calves; 1 of the latter was dead at birth, but the other 5 have completed production records. Again the matings to Red Dane bulls resulted in many more male calves than female calves.

The actual production records of the Holstein × Jersey daughters from Lewisburg Jersey cows, as compared to the records of their dams, are as follows:

Herd No.	Holstein × Jersey daughters tested at Beltsville					Herd No.	Lewisburg Jersey dams tested at Lewisburg				
	Milk	Test	Fat	Age			Milk	Test	Fat	Age	
	Lbs.	%	Lbs.	Yr.	Mo.		Lbs.	%	Lbs.	Yr.	Mo.
X–5	13,032	4.62	602	2	4	L–77	9,249	4.92	455	2	4
X–11	12,584	4.82	606	2	4	L–119	9,334	5.15	481	2	8
X–20	12,393	5.13	636	1	11	L–109	8,837	5.37	474	2	5
X–30	11,567	5.60	664	2	0	L–116	6,687	6.16	412	2	0
X–38	11,929	5.06	607	2	1	L–111	7,770	5.90	459	2	8
X–40	13,690	4.74	649	2	8	L–106	6,199	6.21	385	2	5
X–76	12,997	4.91	638	2	4	L–120	9,136	5.03	460	2	8
X–84	13,554	4.57	619	1	11	L–119	9,334	5.15	481	2	8
Average of 8:						Average of 8:					
Actual	12,680	4.94	624	2	2	Actual	8,310	5.49	451	2	6
Mature-equivalent	17,167		846			Mature-equivalent	10,731		583		
	Holstein × Jersey daughter tested at Beltsville						Lewisburg Jersey dam tested at Beltsville				
X–51	13,800	4.44	613	2	5	L–200	7,202	5.32	383	2	1
Mature-equivalent	17,940		797			Mature-equivalent	9,039		529		
	All Holstein × Jersey daughters [1]						All Jersey dams				
Average of 9:						Average of 9:					
Actual	12,804	4.88	623	2	3	Actual	8,425	5.47	443	2	5
Difference	+4,690	−.59	+181			Difference					
Mature-equivalent	17,252		840			Mature-equivalent	10,054		577		

[1] None of the Holstein × Jersey daughters had as high a butterfat test as their Lewisburg Jersey dams, but all 9 exceeded their dams in milk and butterfat production. All 9 daughters were by the Holstein sire No. 966.

The actual production records of the Red Dane × Jersey daughters from Lewisburg Jersey cows, as compared with the records of their dams, are as follows:

Herd No.	Red Dane × Jersey daughters tested at Beltsville					Herd No.	Lewisburg Jersey dams tested at Lewisburg				
	Milk	Test	Fat	Age			Milk	Test	Fat	Age	
	Lbs.	*%*	*Lbs.*	*Yr.*	*Mo.*		*Lbs.*	*%*	*Lbs.*	*Yr.*	*Mo.*
X-7	12,228	4.80	586	2	7	L-113	6,887	5.60	386	2	5
X-10	12,561	5.03	631	1	11	L-116	6,687	6.16	412	2	0
X-18	13,315	5.06	674	2	2	L-111	7,776	5.90	459	2	8
Average of 3:						Average of 3:					
Actual	12,701	4.96	630	2	3	Actual	7,117	5.89	419	2	4
Mature-equivalent	17,158		852			Mature-equivalent	9,371		552		
							Jersey dams in Lewisburg group tested at Beltsville				
X-29	12,691	4.55	579	1	11	L-200	7,202	5.32	383	2	1
X-70	11,579	4.47	518	1	11	L-207	8,252	5.49	453	2	1
Average of 2:						Average of 2:					
Actual	12,135	4.52	549	1	11	Actual	7,727	5.41	418	2	1
Mature-equivalent	17,232		779			Mature-equivalent	10,004		577		
	All Red Dane × Jersey daughters [1]						All Jersey dams				
Average of 5:						Average of 5:					
Actual	12,475	4.78	598	2	1	Actual	7,361	5.69	419	2	3
Difference	+5,114	−.91	+179			Difference					
Mature-equivalent	17,188		823			Mature-equivalent	9,888		502		

[1] All 5 daughters produced more milk and butterfat than their dams, but none had as high a butterfat test as her dam. All daughters were sired by the Red Dane bull No. D-501.

The average production of all Holstein × Jersey and Red Dane × Jersey daughters from Lewisburg foundation Jerseys was as follows:

	Crossbred daughters tested at Beltsville					Jersey dams tested at Lewisburg				
	Milk	Test	Fat	Age		Milk	Test	Fat	Age	
	Lbs.	*%*	*Lbs.*	*Yr.*	*Mo.*	*Lbs.*	*%*	*Lbs.*	*Yr.*	*Mo.*
Average of 11:										
Actual	12,685	4.94	626	2	2	7,991	5.60	442	2	5
Mature-equivalent	17,164		848			10,369		575		
						Jersey dams tested at Beltsville				
Average of 3:										
Actual	12,390	4.82	570	2	1	7,552	5.38	406	2	1
Mature-equivalent	17,468		785			10,422		561		
	All crossbred daughters					All Lewisburg Jersey dams				
Average of 14:										
Actual	12,686	4.84	614	2	2	7,897	5.55	435	2	4
Mature-equivalent	17,229		834			10,381		572		

The Lewisburg foundation group of Jerseys had 9 Jersey daughters and 14 crossbred daughters which produced as follows:

Group	Cows tested (number)	Actual-production average				Mature-equivalent value	
		Milk	Test	Fat	Age	Milk	Fat
		Lbs.	*%*	*Lbs.*	*Yr. Mo.*	*Lbs.*	*Lbs.*
Jersey daughters	9	8,020	5.29	425	2 7	10,321	547
Crossbred daughters	14	12,686	4.84	614	2 2	17,229	834

Crossbred Progeny of the Foundation Guernsey Cows in the Sandhill Group

A total of 14 Guernseys in the Sandhill group contributed female crossbred progeny. Five cows completed 5 pregnancies to Jersey sires, which resulted in 3 male calves and 2 female calves; 1 of the females died shortly after calving. Eleven cows completed 17 pregnancies to Holstein sires, which resulted in 1 abortion, 7 male calves, and 9 female calves. Twelve cows completed 21 pregnancies to Red Dane bulls, which resulted in 13 male calves (1 dead), and 8 female calves, 1 of which died before reaching calving age. Again the pregnancies to Red Dane bulls produced more male calves than female calves.

Comparisons of the crossbred daughters from Sandhill foundation cows with the Guernsey dams are given below by subgroups.

The actual production records of the one Jersey × Guernsey crossbred and her dam are as follows:

Herd No.	Jersey × Guernsey daughter tested at Beltsville				Herd No.	Guernsey dam tested at Beltsville			
	Milk	Test	Fat	Age		Milk	Test	Fat	Age
	Lbs.	*%*	*Lbs.*	*Yr. Mo.*		*Lbs.*	*%*	*Lbs.*	*Yr. Mo.*
X–13 [1]	10,053	5.27	562	2 2	S–102	8,052	4.51	363	2 0
Mature-equivalent	14,488		764		Mature-equivalent	11,273		508	

[1] X–13 was by the Jersey sire No. 1665.

The actual production records of the Holstein × Guernsey daughters and their dams are as follows:

Herd No.	Holstein × Guernsey daughters tested at Beltsville					Herd No.	Guernsey dams tested at Sandhill				
	Milk	Test	Fat	Age			Milk	Test	Fat	Age	
	Lbs.	*%*	*Lbs.*	*Yr.*	*Mo.*		*Lbs.*	*%*	*Lbs.*	*Yr.*	*Mo.*
X–26	11,717	4.84	567	2	0	S–31	8,983	5.29	475	2	9
X–33	11,363	5.53	629	2	0	S–38	8,056	5.61	452	2	2
X–43	11,990	4.12	494	2	4	S–44	7,955	4.87	387	2	8
Average of 3:											
Actual	11,690	4.83	563	2	1	Average of 3: Actual	8,331	5.26	438	2	6
Mature-equivalent	16,046		743			Mature-equivalent	10,736		566		
							Guernsey dams in the Sandhill group tested at Beltsville				
X–16	14,577	4.68	683	2	5	S–78	11,031	4.71	520	4	6
X–28	14,052	4.63	651	2	3	S–99	9,183	5.06	465	2	3
X–44	15,284	4.10	627	1	11	S–89	6,760	5.89	398	2	4
X–45	11,341	4.95	561	2	9	S–404	7,046	5.09	358	2	5
X–50	12,697	4.97	631	2	9	S–408	8,169	4.89	400	2	2
X–214	12,147	4.53	550	2	0	S–125	9,186	4.65	427	2	1
Average of 6: [1]											
Actual	13,350	4.04	617	2	4	Average of 6: Actual	8,563	5.05	428	2	8
Mature-equivalent	17,756		818			Mature-equivalent	10,978		550		
	All Holstein × Guernsey crossbreds [2]						All Guernsey dams				
Average of 9:											
Actual	12,796	4.71	599	2	3	Average of 9: Actual	8,435	5.12	431	2	7
Difference	+4,341	−.41	+168			Difference					
Mature-equivalent value	17,186		805			Mature-equivalent value	10,897		555		

[1] One Holstein × Guernsey crossbred in this group had a higher butterfat test than her Guernsey dam, but all 6 produced more milk and butterfat than their respective dams.
[2] All 9 Holstein × Guernsey crossbreds were sired by Holstein bull No. 966.

The actual production records of the Red Dane × Guernsey crossbreds and their dams are as follows:

Herd No.	Red Dane × Guernsey daughters tested at Beltsville [1]					Herd No.	Sandhill Guernsey dams tested at Beltsville				
	Milk	Test	Fat	Age			Milk	Test	Fat	Age	
	Lbs.	*%*	*Lbs.*	*Yr.*	*Mo.*		*Lbs.*	*%*	*Lbs.*	*Yr.*	*Mo.*
X–21	14,614	4.12	602	2	1	S–81	6,469	4.85	314	3	5
X–52	14,011	4.30	603	2	2	S–99	9,183	5.06	465	2	3
X–53	14,055	4.79	674	1	11	S–78	11,031	4.71	520	4	6
X–61	12,463	4.35	542	1	11	S–125	9,186	4.65	427	2	1
X–73	12,756	4.25	542	2	0	S–122	11,630	4.44	516	2	2
X–74	11,747	4.62	542	2	4	S–404	7,046	5.09	358	2	5
X–206	12,324	4.59	566	2	2	S–89	6,760	5.89	398	2	4
Average of 7:											
Actual	13,143	4.43	582	2	1	Average of 7: Actual	8,758	4.95	428	2	9
Difference	+4,385	−.52	+154			Difference					
Mature-equivalent	18,140		803			Mature-equivalent	11,163		546		

[1] One daughter had a higher butterfat test than her dam, and all 7 daughters produced more milk and butterfat than their dams. X–206 was sired by the Red Dane bull D–508 and all others by D–501.

The average production records of all crossbred daughters from Sandhill Guernsey cows are summarized below, as follows:

	Daughters tested at Beltsville				Dams tested at Sandhill			
	Milk	Test	Fat	Age	Milk	Test	Fat	Age
Average of 3:	*Lbs.*	*%*	*Lbs.*	*Yr. Mo.*	*Lbs.*	*%*	*Lbs.*	*Yr. Mo.*
Actual	11, 690	4. 83	563	2 1	8, 331	5. 26	438	2 6
Mature-equivalent	16, 046		743		10, 736		566	
					Dams tested at Beltsville			
Average of 14:								
Actual	13, 054	4. 58	595	2 2	8, 624	4. 96	424	2 8
Mature-equivalent	17, 719		807		11, 092		545	
	All crossbred daughters				All Guernsey dams			
Average of 17:								
Actual	12, 813	4. 63	590	2 2	8, 572	5. 02	426	2 7
Mature-equivalent	17, 424		801		11, 029		548	

The Sandhill Guernsey foundation group had 6 Guernsey daughters and 17 crossbred daughters, which produced as follows:

Group	Cows tested (number)	Actual-production average				Mature-equivalent value	
		Milk	Test	Fat	Age	Milk	Fat
		Lbs.	*%*	*Lbs.*	*Yr. Mo.*	*Lbs.*	*Lbs.*
Guernsey daughters	6	8, 957	4. 82	430	2 5	11, 937	573
Crossbred daughters	17	12, 813	4. 63	590	2 2	17, 424	801

Crossbred Progeny of the Foundation Red Dane Cows in the Beltsville Herd

No particular group of cows in the Red Dane herd was set aside for the crossbreeding work, but the plan was to mate females in that herd which had produced heifers of their own breed. There were some exceptions to this practice, most of which came in the later years of the experiment when an effort was made to build up the Jersey × Red Dane group of females by mating 5 Red Dane heifers to a Jersey bull. Previously, this particular cross had produced only 3 females, 2 of which had completed production records and 1 was still under calving age. It was hoped that by mating the 5 Red Dane heifers to a Jersey bull, the number of females in this cross could be brought more in line with the other crossbred combinations.

This piece of planning produced 1 abortion, 4 male calves, and 1 female calf. This calf and the other heifer were disposed of in order to make a complete analysis of this phase of the project at this time. All told, 28 Red Dane cows were bred for crossbred calves; 4 of them failed to conceive and the other 24 completed 36 pregnancies. Twenty

of these were to Jersey bulls and resulted in 2 abortions, 12 male calves (1 twin), and 7 female calves (1 freemartin). Two completed records on the project, 2 died before reaching calving age, and the other 2 were disposed of. There were 16 pregnancies to Holstein bulls and they resulted in 2 abortions, 8 male calves, and 6 female calves. All of the latter have completed production records.

Comparisons of crossbred daughters of Red Dane foundation cows with their Red Dane dams are given below by subgroups.

The actual production records of the Holstein × Red Dane crossbreds and the adjusted records of their Red Dane dams are as follows:

Herd No.	Holstein × Red Dane daughters tested at Beltsville[1]					Herd No.	Red Dane dams tested at Beltsville				
	Milk	Test	Fat	Age			Milk	Test	Fat	Age	
	Lbs.	*%*	*Lbs.*	*Yr.*	*Mo.*		*Lbs.*	*%*	*Lbs.*	*Yr.*	*Mo.*
X-15	12,730	4.04	514	2	3	D-22	12,401	3.95	490	3	1
X-85	13,744	3.81	524	2	1	D-33	13,988	3.87	541	3	4
X-87	13,283	3.97	528	1	11	D-40	14,561	3.56	518	3	4
X-95	14,321	3.83	548	1	11	D-71	10,358	3.95	409	1	11
X-98	13,352	4.23	564	2	0	D-72	6,822	4.51	308	2	9
X-99	16,602	3.72	618	2	0	D-51	12,549	3.66	460	2	1
Average of 6:						Average of 6:					
Actual	14,005	3.93	540	2	1	Actual	11,778	3.92	454	2	9
Difference	+2,227	+.01	+95			Difference					
Mature-equivalent	19,629		765			Mature-equivalent	14,818	3.92	572		

[1] All 6 daughters were sired by Holstein bull No. 966. Four of the daughters produced more milk than their dams, 4 had a higher butterfat test than their dams, and 5 produced more butterfat than their dams.

The actual production records of the Jersey × Red Dane crossbreds and the adjusted records of their Red Dane dams are as follows:

Herd No.	Jersey × Red Dane daughters tested at Beltsville[1]					Herd No.	Red Dane dams tested at Beltsville				
	Milk	Test	Fat	Age			Milk	Test	Fat	Age	
	Lbs.	*%*	*Lbs.*	*Yr.*	*Mo.*		*Lbs.*	*%*	*Lbs.*	*Yr.*	*Mo.*
X-67	11,816	5.34	631	2	10	D-22	12,401	3.95	490	3	1
X-86	11,213	4.81	539	1	11	D-42	14,013	4.07	571	3	1
Average of 2:						Average of 2:					
Actual	11,515	5.08	585	2	5	Actual	13,209	4.01	531	3	1
Difference	−1,169	+1.07	+54			Difference					
Mature-equivalent	15,287		774			Mature-equivalent	15,851		637		

[1] Both daughters were sired by Jersey sire No. 1114. Both daughters tested higher than their dams, 1 made more butterfat, but neither produced as much milk as her dam.

The average production records of all crossbred daughters from Red Dane dams are as follows:

	Crossbred daughters tested at Beltsville				Red Dane dams tested at Beltsville			
	Milk	Test	Fat	Age	Milk	Test	Fat	Age
Average of 8:	*Lbs.*	*%*	*Lbs.*	*Yr. Mo.*	*Lbs.*	*%*	*Lbs.*	*Yr. Mo.*
Actual	13,383	4.22	558	2 2	12,138	3.94	473	2 10
Mature-equivalent	18,544		767		15,076		588	

The Red Dane foundation group had 16 Red Dane daughters and 8 crossbred daughters, which produced as follows:

Group	Cows tested (number)	Average production				Mature-equivalent value	
		Milk	Test	Fat	Age	Milk	Fat
		Lbs.	*%*	*Lbs.*	*Yr. Mo.*	*Lbs.*	*Lbs.*
Red Dane daughters [1]	16	11, 596	4. 09	473	2 8	14, 700	599
Crossbred daughters [2]	8	13, 383	4. 22	558	2 2	18, 544	767

[1] Records of Red Dane daughters as adjusted to 3 × 365-day basis.
[2] Records of crossbred daughters are actual production on 3 × 365-day basis.

Average Production of All Two-Breed Groups Compared With That of the Dams

In all, 77 cows completed 179 pregnancies when bred to project sires, and produced 64 heifers and 6 of these were straight Holsteins which were used as foundation cows. Three others left Beltsville before completing records, and that leaves 55 two-breed females which are available for study. The groups of various two-breed combinations with their average milk and butterfat production are brought together in the following table:

Two-breed combinations	Cows (number)	Actual-production average				Mature-equivalent value	
		Milk	Test	Fat	Age	Milk	Fat
		Lbs.	*%*	*Lbs.*	*Yr. Mo.*	*Lbs.*	*Lbs.*
Jersey × Guernsey	1	10, 653	5. 27	562	2 3	14, 483	764
Jersey × Holstein	9	12, 320	4. 61	562	2 2	16, 862	770
Holstein × Jersey	9	12, 804	4. 88	623	2 3	17, 253	840
Holstein × Guernsey	9	12, 796	4. 71	599	2 3	17, 186	805
Holstein × Red Dane	6	14, 005	3. 93	549	2 1	19, 629	765
Red Dane × Holstein	7	14, 826	3. 95	583	2 2	20, 299	799
Red Dane × Jersey	5	12, 475	4. 78	598	2 1	17, 188	823
Red Dane × Guernsey	7	13, 143	4. 43	582	2 1	18, 149	803
Jersey × Red Dane	2	11, 515	5. 08	585	2 5	15, 287	774
All crossbreds [1]	55	13, 039	4. 53	586	2 2	17, 811	799
All dams	55	10, 540	4. 55	455	2 6	13, 799	594
Difference		+2,499	−. 02	+131			

[1] 41 crossbred daughters produced more milk than their dams, 25 had a higher butterfat test, and 30 produced more butterfat.

The 55 two-breed crosses are shown below in different groupings based on the location of their dams when their production records were made.

Group 1 consists of 24 two-breed crosses from dams that made their records at Huntley, Mandan, Lewisburg, or Sandhill. Their actual production records are as follows:

Group 1	Crossbred daughters tested at Beltsville				Dams tested at home station			
	Milk	Test	Fat	Age	Milk	Test	Fat	Age
Average of 24:	*Lbs.*	*%*	*Lbs.*	*Yr. Mo.*	*Lbs.*	*%*	*Lbs.*	*Yr. Mo.*
Actual	12, 615	4. 64	586	2 2	10, 143	4. 68	447	2 5
Mature-equivalent	17, 252		803		13, 365		588	

Group 2 is made up of 23 two-breed crosses from dams in the four field station groups that made their production records at Beltsville. Their actual production records are as follows:

Group 2	Crossbred daughters tested at Beltsville				Dams tested at Beltsville			
	Milk	Test	Fat	Age	Milk	Test	Fat	Age
Average of 23:	*Lb.*	*%*	*Lb.*	*Yr. Mo.*	*Lb.*	*%*	*Lb.*	*Yr. Mo.*
Actual	13, 362	4. 49	595	2 2	10, 399	4. 64	459	2 5
Mature-equivalent	18, 141		807		13, 806		603	

Group 3 contains the 8 two-breed daughters from Red Dane dams that made their records at Beltsville. The actual production records of the daughters and the adjusted records of the dams are as follows:

Group 3	Crossbred daughters tested at Beltsville				Red Dane dams tested at Beltsville			
	Milk	Test	Fat	Age	Milk	Test	Fat	Age
Average of 8:	*Lbs.*	*%*	*Lbs.*	*Yr. Mo.*	*Lbs.*	*%*	*Lbs.*	*Yr. Mo.*
Actual	13, 383	4. 22	558	2 2	12, 138	3. 94	473	2 10
Mature-equivalent	18, 544		767		15, 076		588	

By combining groups 2 and 3 we find that the dams of 31 of the 55 two-breed crosses made their production records at Beltsville, and the averages of the 31 dams and daughters are as follows:

Groups 2 and 3	Crossbred daughters tested at Beltsville				Dams tested at Beltsville			
	Milk	Test	Fat	Age	Milk	Test	Fat	Age
Average of 31:	*Lbs.*	*%*	*Lbs.*	*Yr. Mo.*	*Lbs.*	*%*	*Lbs.*	*Yr. Mo.*
Actual	13, 368	4. 42	586	2 2	10, 848	4. 46	460	2 6
Mature-equivalent	18, 245		797		14, 134		599	

The most interesting thing about these different groups is the uniformity of the production levels.

The production performance of the straightbred and crossbred female progeny of the foundation cows is summarized in the following averages:

Group	Cows tested (number)	Actual-production average				Mature-equivalent value	
		Milk	Test	Fat	Age	Milk	Fat
		Lbs.	%	Lbs.	Yr. Mo.	Lbs.	Lbs.
Straightbred daughters	60	11, 963	4. 04	467	2 5	15, 935	620
Crossbred daughters	55	13, 039	4. 53	586	2 2	17, 811	799

Direct comparisons of crossbred daughters and straightbred daughters from the same dam can be made by pairing the available progeny that have completed production records. Twenty of the foundation dams had 1 or more daughters in each group, and 37 pairs are available for comparison.

The average production performance of the foundation dams and their straightbred daughters and crossbred daughters was as follows:

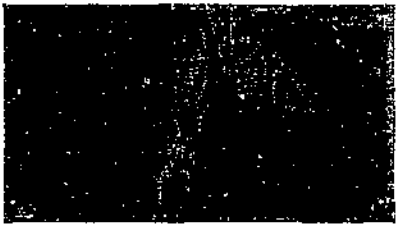
Group	Pairs (number)	Actual-production average				Mature-equivalent value	
		Milk	Test	Fat	Age	Milk	Fat
		Lbs.	Percent	Lbs.	Yr. Mo.	Lbs.	Lbs.
Foundation dams	37	11, 117	4. 43	469	2 10	13, 994	588
Straightbred daughters	37	11, 070	4. 34	461	2 4	14, 785	613
Crossbred daughters	37	12, 588	4. 64	583	2 3	17, 216	796
Difference between crossbred and straightbred daughters		+1, 518	+. 30	+122	.....	+2, 431	+183

Twenty-four of the crossbred daughters produced more milk than their straightbred sibs, 24 had a higher butterfat test, and 31 produced more butterfat.

Photographs of the Two-Breed Crosses

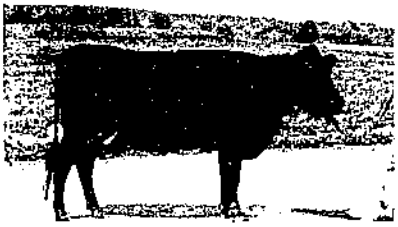
In the following pages are pictures of the two-breed crosses, shown by breed-combination groups. Each picture is marked with the cow's herd number, so that reference may be made to her production record as given in the text. (See figs. 5 to 11, inclusive.)

JERSEY × HOLSTEIN CROSSBREDS



X–1. 2 YEARS, 0 MONTH.

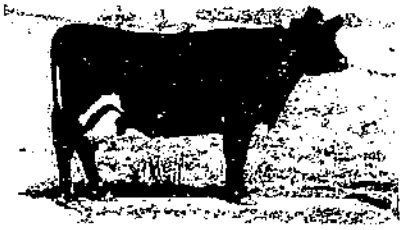
X–3. 2 YEARS, 5 MONTHS.



X–17. 3 YEARS, 6 MONTHS.

X–32. 2 YEARS, 0 MONTH.

X–35. 2 YEARS, 1 MONTH.



X–41. 4 YEARS, 10 MONTHS.

X–42. 3 YEARS, 3 MONTHS.

X–47. 5 YEARS, 3 MONTHS.

X–276. 2 YEARS, 10 MONTHS.

FIGURE 5.—Jersey × Holstein crossbreds.

257884°—54——4

HOLSTEIN × JERSEY CROSSBREDS

X–5. 3 YEARS, 7 MONTHS.

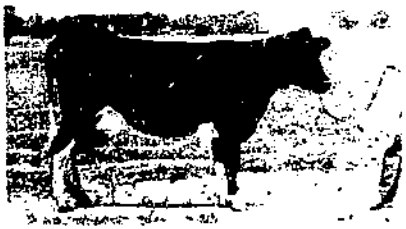
X–11. 2 YEARS, 5 MONTHS.

X–20. 3 YEARS, 3 MONTHS.

X–30. 3 YEARS, 7 MONTHS.

X–38. 2 YEARS 0 MONTH.

X–40. 2 YEARS, 9 MONTHS.



X–51. 2 YEARS, 7 MONTHS.

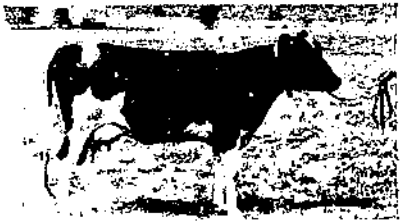
X–76. 2 YEARS, 6 MONTHS.

X–84. 2 YEARS, 1 MONTH.

FIGURE 6.—Holstein × Jersey crossbreds.

HOLSTEIN × GUERNSEY CROSSBREDS

X–16. 2 YEARS, 6 MONTHS.



X–26. 2 YEARS, 1 MONTH.

X–28. 3 YEARS, 8 MONTHS.

X–33. 3 YEARS, 9 MONTHS.

X–43. 2 YEARS, 6 MONTHS.

X–44. 5 YEARS, 6 MONTHS.

X–45. 4 YEARS, 0 MONTH.

X–59. 2 YEARS, 0 MONTH.

X–214. 2 YEARS, 0 MONTH.

FIGURE 7. Holstein × Guernsey crossbreds.

HOLSTEIN × RED DANE CROSSBREDS

X–15. 2 YEARS, 4 MONTHS.

X–85. 2 YEARS, 3 MONTHS.

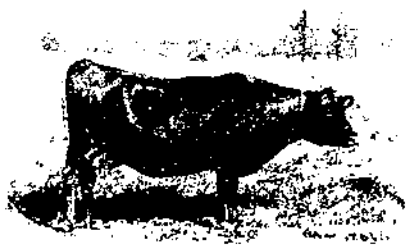
X–87. 2 YEARS, 0 MONTH.

X–95. 2 YEARS, 4 MONTHS.

X–98. 2 YEARS, 2 MONTHS.

X–99. 2 YEARS, 2 MONTHS.

JERSEY × RED DANE CROSSBREDS



X–67. 2 YEARS, 11 MONTHS.

X–86. 2 YEARS, 0 MONTH.

FIGURE 8.—Holstein × Red Dane crossbreds and Jersey × Red Dane crossbreds.

RED DANE × HOLSTEIN CROSSBREDS

X–14. 2 YEARS, 3 MONTHS.

X–22. 3 YEARS, 3 MONTHS.

X–23. 3 YEARS, 3 MONTHS.

X–46. 1 YEAR, 11 MONTHS.

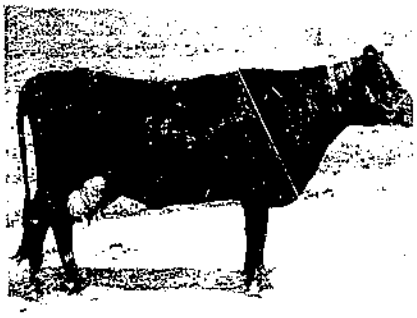
X–56. 2 YEARS, 2 MONTHS.

X–58. 3 YEARS, 11 MONTHS.

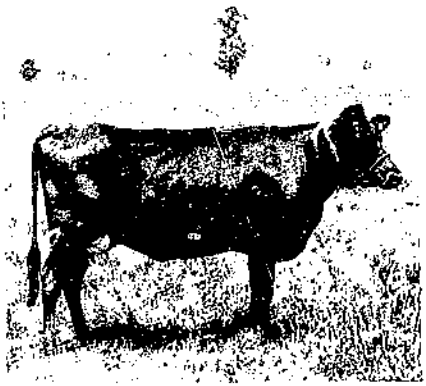
X–63. 2 YEARS, 5 MONTHS.

FIGURE 9.—Red Dane × Holstein crossbreds.

RED DANE × JERSEY CROSSBREDS

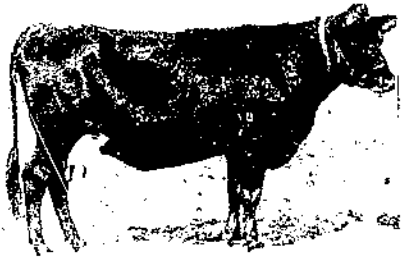


X–7. 4 YEARS, 1 MONTH.



X–10. 2 YEARS, 0 MONTH.

X–18. 2 YEARS, 3 MONTHS.

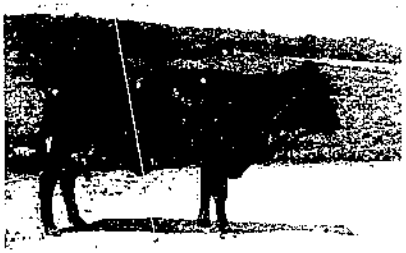


X–29. 3 YEARS, 3 MONTHS.

X–70. 3 YEARS, 2 MONTHS.

FIGURE 10.—Red Dane × Jersey cross heifers.

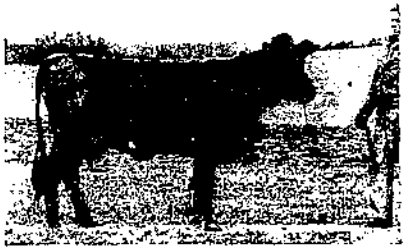
RED DANE × GUERNSEY CROSSBREDS



X–21. 3 YEARS, 3 MONTHS.

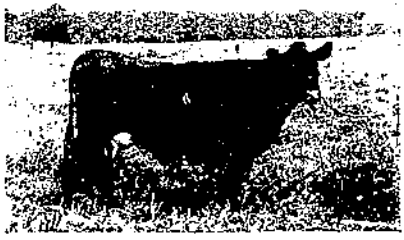
X–52. 2 YEARS, 4 MONTHS.

X–53. 1 YEAR, 11 MONTHS.



X–61. 3 YEARS, 5 MONTHS.

X–73. 3 YEARS, 8 MONTHS.



X–74. 2 YEARS, 5 MONTHS.

X–206. 2 YEARS, 2 MONTHS.

FIGURE 11.—Red Dane × Guernsey crossbreds.

Breeding Results in Making Various Two-Breed Combinations

The difficulties encountered in keeping all crossbred combinations in balance, so far as numbers are concerned, are more easily understood when a study is made of results following the use of sires of different breeds. For this reason the breeding performance of bulls of different breeds is presented here. The results obtained with Red Dane sires are as follows:

	Matings of Red Dane sires to—			
	Holstein cows	Jersey cows	Guernsey cows	Cows of all 3 breeds
Pregnancies terminated	28	18	21	67
Dead male calves	[1] 2		1	[1] 3
Live male calves	18	12	12	42
Dead female calves	[1] 1	1		[1] 2
Live female calves	8	5	8	21
Died			1	1
Loaned	1			1
Net project females	7	5	7	19

[1] Includes 1 twin.

The ratio of 2 male calves to 1 female calf made the groups sired by Red Dane bulls smaller than would have been true if the normal sex ratio had prevailed.

The results obtained with Holstein bulls are as follows:

	Matings of Holstein bulls to—			
	Jersey cows	Guernsey cows	Red Dane cows	Cows of all 3 breeds
Pregnancies terminated	17	17	16	50
Abortions		1	2	3
Live male calves	8	7	8	23
Live female calves	9	9	6	24
None lost				
Net project females	9	9	6	24

With fewer pregnancies terminated, these results are much more favorable than from matings to Red Dane sires.

The results obtained with Jersey sires are as follows:

	Matings of Jersey sires to—			
	Holstein cows	Guernsey cows	Red Dane cows	Cows of all 3 breeds
Pregnancies terminated	21	5	20	46
Abortions			2	2
Dead male calves	1			1
Live male calves	[1] 9	3	[2] 12	[3] 24
Dead female calves	1			1
Live female calves	[1] 13	2	[2] 7	[3] 22
Freemartins	3		1	4
Died	1	1	2	4
Loaned			2	2
Net project females	9	1	2	12

[1] Includes 3 twins.
[2] Includes 1 twin.
[3] Includes 4 twins.

Freemartins, early deaths, and late arrivals considerably reduced the number of females which were useful on the project.

THREE-BREED CROSSES

The plan of this experiment calls for mating the two-breed females to proved sires of a third breed. Some overlapping of generations is bound to occur on a project of this kind, but the results are reported by generations regardless of the time the individual appeared in the herd. Because it was necessary to transfer most of the crossbred animals to herds of cooperators after they had completed their first normal records, usually only the first two matings were made according to the project plan. This placed a limitation on the total number of progeny available in the later generations.

Every effort was made to breed each animal to the proved sire called for in the outline, but in some instances the older sires did not settle cows promptly or were not available at the time for mating. Such situations were met in most cases by mating the cows to young crossbred bulls; and, in order to present the entire reproductive story and yet maintain clarity, the reproductive performance tabulations are divided into two groups: (1) The regular matings that were made according to the project plan, and (2) the irregular matings that were made to meet emergencies. After the cooperative work in the field is completed it will be possible to write the complete story of the breeding records of these animals.

There was only 1 Jersey × Guernsey female in the two-breed group, and she was not continued as part of the experiment after completing her production record. The other 54 females in the 8 two-breed groups were mated to regular project sires and reproduced as follows:

Two-breed groups	Number of females	Pregnancies terminated	Abortions	Male calves		Female calves	
				Live	Dead	Live	Dead
Jersey × Holstein	9	19	1	9	1	7	1
Holstein × Jersey	9	34	2	18		[1] 14	[1] 1
Holstein × Guernsey	9	27	2	10		[2] 13	[1] 3
Red Dane × Guernsey	7	17		10		7	
Red Dane × Jersey	5	18	1	5		11	1
Red Dane × Holstein	7	14		7		7	
Holstein × Red Dane	6	15		6	[2] 2	8	
Jersey × Red Dane	2	5	1	2		2	
Total	54	149	7	67	[2] 3	[2] 60	[2] 6

[1] Includes 1 twin.
[2] Includes 2 twins.

Of the 69 living female calves, 3 died, 1 was condemned for TB, 3 were disposed of after aborting or calving or because of disease, and 3 others were loaned to cooperators in order to make a complete generation analysis at this time. One of the remaining 59 is now on test but all the others have completed production records.

An additional 21 pregnancies were terminated by these 54 females when they were mated irregularly. These resulted in 11 male calves and 11 female calves (including a pair of mixed twins) and 1 in each group was born dead. The 10 living female calves included 1 freemartin, 2 by unknown sires, and 1 nonbreeder—all of which were disposed of—and 6 others that have completed production records.

Progeny of the Jersey × Holstein Crossbred Females

Only 4 of this group of 9 females contributed female offspring sired by Red Dane bulls. A total of 19 pregnancies to such bulls were completed by the group and they resulted in 1 abortion, 10 male calves, and 8 female calves. One of the females was dead at birth. Six of the others have completed production records, and the last one was loaned.

The production records of the daughters are shown opposite those of their dams, and a mature-equivalent value is given for each group, as follows:

Herd No.	Daughters (RD × J × H)[1]					Herd No.	Dams (Jersey × Holstein)				
	Milk	Test	Fat	Age			Milk	Test	Fat	Age	
	Lbs.	*%*	*Lbs.*	*Yr.*	*Mo.*		*Lbs.*	*%*	*Lbs.*	*Yr.*	*Mo.*
X-39	13,992	4.35	609	1	11	X-3	13,065	4.71	615	1	11
X-54	16,500	4.16	686	1	11	X-17	13,837	3.85	533	2	3
X-68	12,522	5.21	653	2	3	X-35	10,508	5.24	550	2	1
X-79	9,687	5.31	514	2	6	X-17	13,837	3.85	533	2	3
X-235	12,317	4.67	575	2	0	X-17	12,189	5.13	625	1	8
X-274	14,121	4.08	577	2	0	X-17	12,189	5.13	625	1	8
Average of 6: Actual	13,190	4.63	602	2	1	Average of 6: Actual	12,604	4.65	580	2	0
Mature-equivalent	18,285		833			Mature-equivalent	17,749		820		

[1] X-39, X-54, X-68, and X-79 were sired by D-501; X-235 was sired by D-507; and X-274 was sired by D-540.

Progeny of the Holstein × Jersey Crossbred Females

Six of the 9 females in this group produced heifer calves sired by Red Dane bulls, and the group as a whole terminated 34 pregnancies to Red Dane bulls. These resulted in 2 abortions, 18 male calves, and 15 female calves, including a pair of female twins of which 1 member was born dead. One of the 14 living female calves died, and the other 13 have completed production records. There is evidence of differing sire effects in some of the Red Dane progeny groups; therefore the daughters of this group are shown in 2 subgroups, each sired by 2 different bulls. The production records of the group sired by D-501 and D-540 are as follows:

Herd No.	Daughters (RD × H × J)[1]					Herd No.	Dams (Holstein × Jersey)				
	Milk	Test	Fat	Age			Milk	Test	Fat	Age	
	Lbs.	*%*	*Lbs.*	*Yr.*	*Mo.*		*Lbs.*	*%*	*Lbs.*	*Yr.*	*Mo.*
X-65	12,896	4.67	602	1	11	X-5	13,032	4.62	602	2	4
X-71	13,006	4.70	611	2	0	X-38	11,929	5.09	607	2	1
X-75	11,491	5.34	613	1	11	X-20	12,383	5.13	636	1	11
X-96	16,775	3.74	627	2	0	X-51	13,800	4.41	613	2	5
X-97	13,821	4.60	635	2	1	X-20	12,383	5.13	636	1	11
X-265	16,439	4.24	697	2	7	X-38	11,929	5.09	607	2	1
X-298	16,348	3.82	625	2	3	X-38	11,929	5.09	607	2	1
Average of 7: Actual	14,397	4.44	630	2	1	Average of 7: Actual	12,484	4.94	615	2	1
Mature-equivalent	19,740		866			Mature-equivalent	17,009		845		

[1] X-65, X-71, and X-75 were sired by D-501; and X-96, X-97, X-265, and X-298 were sired by D-540.

The production records of the group sired by D–507 and D–508 are as follows:

Herd No.	Daughters (RD × H × J) [1]					Herd No.	Dams (Holstein × Jersey)				
	Milk	Test	Fat	Age			Milk	Test	Fat	Age	
	Lbs.	*%*	*Lbs.*	*Yr.*	*Mo.*		*Lbs.*	*%*	*Lbs.*	*Yr.*	*Mo.*
X–207	12,857	4.19	540	2	1	X–5	13,032	4.62	602	2	4
X–213	13,236	4.50	596	2	1	X–30	11,867	5.06	604	2	0
X–225	12,051	4.19	505	2	3	X–61	13,800	4.44	613	2	5
X–227	14,259	4.02	574	2	1	X–20	12,383	5.13	636	1	11
X–246	8,469	4.31	365	2	6	X–40	13,090	4.74	649	2	8
X–257	11,999	4.11	493	2	5	X–51	13,800	4.44	613	2	5
Average of 6:						Average of 6:					
Actual	12,150	4.22	512	2	3	Actual	13,095	4.83	630	2	4
Mature-equivalent	16,382		688			Mature-equivalent	17,423		840		

[1] X–246 was sired by D–507 and the other 5 by D–508.

This group of 6 sired by D–507 and D–508 furnish a contrast to the previous group of 7 sired by D–501 and D–540. No reasonable explanation can be offered except that there is undoubtedly a wide difference in the genetic ability of these two pairs of sires. The average production of the 13 crossbred daughters by the 4 Red Dane sires was as follows:

	All daughters (RD × H × J) by 4 Red Dane sires				Dams (Holstein × Jersey)			
	Milk	Test	Fat	Age	Milk	Test	Fat	Age
Average of 13:	*Lbs.*	*%*	*Lbs.*	*Yr. Mo.*	*Lbs.*	*%*	*Lbs.*	*Yr. Mo.*
Actual	13,360	4.34	576	2 2	12,766	4.89	622	2
Mature-equivalent	18,167		784		17,249		842	

Progeny of the Holstein × Guernsey Crossbred Females

Seven of the 9 Holstein × Guernsey females had project females sired by Red Dane bulls which completed production records. The group terminated 27 pregnancies to Red Dane sires and these resulted in 2 abortions, 10 male calves, and 16 female calves, including 1 pair of female twins and 3 dead female calves. Ten of the 13 living females have completed production records, 1 died as a calf, 1 was disposed of because of severe mastitis, and the other has been loaned to a cooperator. The same 4 Red Dane bulls were used to produce this group of daughters of the Holstein × Guernsey females, and they are shown in 2 subgroups as were the daughters of the Holstein × Jersey

females. The production records of the group sired by D–501 and D–540 are as follows:

Herd No.	Daughters (RD × H × G) [1]					Herd No.	Dams (Holstein × Guernsey)				
	Milk	Test	Fat	Age			Milk	Test	Fat	Age	
	Lbs.	*%*	*Lbs.*	*Yr.*	*Mo.*		*Lbs.*	*%*	*Lbs.*	*Yr.*	*Mo.*
X–55	15,284	4.47	684	2	1	X–16	14,577	4.68	683	2	5
X–60	15,036	3.98	598	1	11	X–26	11,717	4.84	567	2	0
X–66	10,029	4.45	714	2	3	X–25	14,052	4.62	651	2	3
X–93	10,282	4.79	493	2	6	X–15	11,341	4.95	561	2	9
X–201	18,419	3.58	659	2	2	X–H	15,284	4.16	627	1	11
Average of 5:						Average of 5:					
Actual	15,008	4.25	630	2	2	Actual	13,394	4.64	618	2	3
Mature-equivalent	20,424		855			Mature-equivalent	18,013		820		

[1] X–55, X–60, and X–66 were sired by D–501; and X–01 and X–201 were sired by D–540.

The other 5 tested daughters of the Holstein × Guernsey females were sired by D–507 and D–508, and their production records are as follows:

Herd No.	Daughters (RD × H × G) [1]					Herd No.	Dams (Holstein × Guernsey)				
	Milk	Test	Fat	Age			Milk	Test	Fat	Age	
	Lbs.	*%*	*Lbs.*	*Yr.*	*Mo.*		*Lbs.*	*%*	*Lbs.*	*Yr.*	*Mo.*
X–211	11,295	4.70	531	2	8	X–16	14,577	4.68	683	2	5
X–221	13,064	4.43	579	2	5	X–15	11,341	4.95	561	2	9
X–223	9,131	5.25	479	2	5	X–33	11,363	5.53	629	2	0
X–245	14,125	4.35	615	2	4	X–16	14,577	4.68	683	2	5
X–253	14,206	4.33	616	2	1	X–43	11,909	4.12	491	2	4
Average of 5:						Average of 5:					
Actual	12,364	4.61	564	2	5	Actual	12,770	4.79	610	2	5
Mature-equivalent	16,265		741			Mature-equivalent	16,762		802		

[1] X–211, X–221, and X–223 were sired by D–508; and X–245 and X–253 were sired by D–507.

The 2 daughters of D–507 averaged better than their dams, but the group of 5 is definitely different than the group of daughters sired by D–501 and D–540.

When the 2 groups are combined, the average production of the 10 Red Dane × Holstein × Guernsey crosses and that of their dams is as follows:

	Daughters (RD × H × G) by 4 Red Dane bulls				Dams (Holstein × Guernsey)			
	Milk	Test	Fat	Age	Milk	Test	Fat	Age
Average of 10:	*Lbs.*	*%*	*Lbs.*	*Yr. Mo.*	*Lbs.*	*%*	*Lbs.*	*Yr. Mo.*
Actual	13,686	4.43	597	2 3	13,082	4.72	614	2 5
Mature-equivalent	18,346		798		17,387		816	

Progeny of the Jersey × Red Dane Crossbred Females

The 2 Jersey × Red Dane females were mated 5 times to Holstein bulls and the 5 pregnancies resulted in 1 abortion, 2 male calves, and 2 female calves. Both of the females were daughters of the same cow. Their production performance and that of their dam was as follows:

Herd No.	Daughters (H × J × RD) [1]					Herd No.	Dam (Jersey × Red Dane)				
	Milk	Test	Fat	Age			Milk	Test	Fat	Age	
	Lbs.	*%*	*Lbs.*	*Yr.*	*Mo.*		*Lbs.*	*%*	*Lbs.*	*Yr.*	*Mo.*
X-231	14,320	4.22	604	2	0	X-86	11,213	4.81	539	1	11
X-281	13,087	4.02	527	2	4	X-86	11,213	4.81	539	1	11
Average of 2:						Average of 2:					
Actual	13,701	4.12	566	2	2	Actual	11,213	4.81	539	1	11
Mature-equivalent	18,727		773			Mature-equivalent	15,092		766		

[1] X-231 and X-281 were sired by the Holstein bull Governor.

Progeny of the Red Dane × Guernsey Crossbred Females

Six of the 7 Red Dane × Guernsey females had 7 heifer calves sired by 3 Holstein sires. The group of 7 completed a total of 17 pregnancies to Holstein bulls resulting in 10 male calves and 7 female calves. One of the latter was loaned to a cooperator. The production performance of the remaining 6 daughters and their dams was as follows:

Herd No.	Daughters (H × RD × G) [1]					Herd No.	Dams (Red Dane × Guernsey)				
	Milk	Test	Fat	Age			Milk	Test	Fat	Age	
	Lbs.	*%*	*Lbs.*	*Yr.*	*Mo.*		*Lbs.*	*%*	*Lbs.*	*Yr.*	*Mo.*
X-78	10,469	4.60	491	2	5	X-21	14,614	4.12	602	2	1
X-216	12,621	5.27	665	2	0	X-53	14,055	4.79	674	1	11
X-218	14,542	3.92	570	2	0	X-73	12,756	4.25	542	2	0
X-224	13,202	4.15	548	2	0	X 52	14,044	4.30	603	2	2
X-275	12,413	4.11	510	2	0	X-206	12,524	4.59	566	2	2
X-401	13,805	4.27	589	2	2	X-61	12,463	4.35	542	1	11
Average of 6:						Average of 6:					
Actual	12,842	4.40	562	2	1	Actual	13,376	4.40	588	2	1
Mature-equivalent	17,712		775			Mature-equivalent	18,590		818		

[1] X-78, X-216, and X-218 were sired by No. 956; X-224 and X-275 were sired by Governor; and X-401 was sired by No. 1763.

Progeny of the Red Dane × Jersey Crossbred Females

Each of the 5 Red Dane × Jersey females had 1 or more daughters sired by Holstein bulls. The 5 completed 18 pregnancies when bred to Holstein bulls and the results were 1 abortion, 5 male calves, and 12 female calves, 1 of which was born dead. Of the 11 live females, 1 died, 9 have completed production records, and the last one (X–421) is now on test. Production records of the 9 daughters and their dams are as follows:

Herd No.	Daughters (H × RD × J)[1]					Herd No.	Dams (Red Dane × Jersey)				
	Milk	Test	Fat	Age			Milk	Test	Fat	Age	
	Lbs.	*%*	*Lbs.*	*Yr.*	*Mo.*		*Lbs.*	*%*	*Lbs.*	*Yr.*	*Mo.*
X–50	16,186	3.97	643	1	11	X–7	12,228	4.80	586	2	7
X–57[2]	16,098	5.47	825	3	8	X–18	13,315	5.06	674	2	2
X–62	16,862	3.92	661	2	0	X–29	12,691	4.56	579	1	11
X–82	15,903	4.72	751	2	6	X–10	12,501	5.03	631	1	11
X–90	11,392	4.92	556	2	0	X–18	13,315	5.06	674	2	2
X–203	15,578	4.68	636	2	0	X–10	12,561	5.03	631	1	11
X–209	12,479	4.12	514	1	11	X–29	12,691	4.56	579	1	11
X–210	12,732	3.95	504	1	11	X–18	13,315	5.06	674	2	2
X–212	13,396	4.48	600	1	11	X–70	11,579	4.47	518	1	11
Average of 9:						Average of 9:					
Actual	14,393	4.40	632	2	2	Actual	12,695	4.85	616	2	1
Mature-equivalent	19,697		855			Mature-equivalent	17,557		852		

[1] All 9 daughters were sired by Holstein bull No. 966.
[2] X–57 had 2 short-time abortions before calving normally.

Progeny of the Red Dane × Holstein Crossbred Females

The 7 Red Dane × Holstein females each had 1 daughter sired by a Jersey bull. They completed 14 pregnancies when bred to Jersey sires, which resulted in 7 male calves and 7 female calves. One of these females died of ketosis after calving. The other 6 have completed production records, as follows:

Herd No.	Daughters (J × RD × H)[1]					Herd No.	Dams (Red Dane × Holstein)				
	Milk	Test	Fat	Age			Milk	Test	Fat	Age	
	Lbs.	*%*	*Lbs.*	*Yr.*	*Mo.*		*Lbs.*	*%*	*Lbs.*	*Yr.*	*Mo.*
X–48	12,658	5.07	643	2	0	X–14	13,543	4.05	552	2	2
X–81	11,226	4.92	553	1	11	X–21	14,636	3.77	552	2	0
X–83	11,103	5.04	560	2	0	X–22	16,940	3.00	611	2	2
X–204	9,044	4.97	494	2	5	X–40	11,103	4.05	449	1	11
X–248	14,178	4.48	635	1	11	X–58	13,956	4.27	596	2	4
X–252	10,312	4.17	430	2	5	X–63	17,393	3.83	665	2	4
Average of 6:						Average of 6:					
Actual	11,572	4.78	552	2	1	Actual	14,013	3.93	571	2	2
Mature-equivalent	16,081		763			Mature-equivalent	19,026		778		

[1] X–48, X–81, X–83, and X–204 were sired by Jersey bull No. 1114; and X–248 and X–252 were sired by Jersey bull No. 1186.

Because X–252 was troubled during her first-lactation period by an abscessed leg, sore feet, and generally poor health, she was started on test after calving a second time. Her production during the first 4 months was about 50 percent higher than during the same period of the first lactation, but she then contracted a severe case of mastitis and was sold for beef because of the damage to her udder.

Progeny of the Holstein × Red Dane Crossbred Females

Five of the 6 Holstein × Red Dane females had heifer calves sired by Jersey bulls. The 6 completed 15 pregnancies to Jersey sires and these resulted in 8 male calves, including a pair of dead twins, and 8 female calves. Six of the 8 have completed production records, 1 was slaughtered as a TB reactor, and the other was disposed of after an early abortion. The 6 daughters and their dams produced as follows:

Herd No.	Daughters (J × H × RD) [1]					Herd No.	Dams (Holstein × Red Dane)				
	Milk	Test	Fat	Age			Milk	Test	Fat	Age	
	Lbs.	*%*	*Lbs.*	*Yr.*	*Mo.*		*Lbs.*	*%*	*Lbs.*	*Yr.*	*Mo.*
X–77	12,128	4.27	517	2	0	X–15	12,730	4.04	514	2	3
X–232	14,381	4.19	603	2	1	X–87	13,283	3.97	528	1	11
X–259	18,144	4.14	751	2	1	X–99	16,602	3.72	618	2	0
X–277	12,592	4.62	582	2	8	X–87	13,283	3.97	528	1	11
X–291	12,937	3.93	509	2	0	X–95	14,321	3.83	549	2	0
X–406	11,629	4.83	562	1	11	X–98	13,352	4.23	564	2	0
Average of 6:						Average of 6:					
Actual	13,230	4.33	587	2	2	Actual	13,929	3.96	550	2	0
Mature-equivalent	18,747		807			Mature-equivalent	19,741		770		

[1] X–77 was sired by Jersey No. 1114; X–232, X–259, X–277, and X–291 were sired by Jersey No. 1186; and X–406 was sired by Jersey No. 1593.

Photographs of the Three-Breed Crosses

In the following pages are pictures of the three-breed crosses, grouped according to the breed combinations. Each picture is marked with the cow's Herd No., so that reference may be made to her production record as given in the text. (See figs. 12 to 19, inclusive.)

3-BREED CROSSES (RED DANE × JERSEY × HOLSTEIN)

X–39. 3 YEARS, 4 MONTHS.

X–54. 3 YEARS, 6 MONTHS.

X–68. 3 YEARS, 10 MONTHS.

X–79. 3 YEARS, 9 MONTHS.

X–235. 2 YEARS, 0 MONTH.

X–274. 2 YEARS, 1 MONTH.

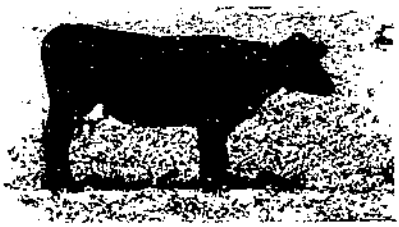
FIGURE 12.—Three-breed crosses (Red Dane × Jersey × Holstein).

3-BREED CROSSES (RED DANE × HOLSTEIN × JERSEY)

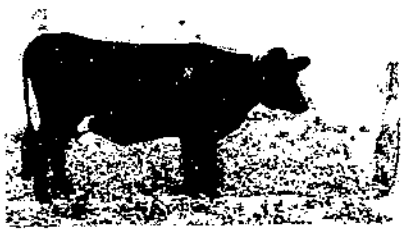
X–65. 3 YEARS, 3 MONTHS.

X–71. 2 YEARS, 2 MONTHS.

X–75. 2 YEARS, 1 MONTH.



X–96. 2 YEARS, 4 MONTHS.



X–97. 2 YEARS, 3 MONTHS.

X–207. 2 YEARS, 2 MONTHS.

X–213. 2 YEARS, 2 MONTHS.

X–225. 2 YEARS, 3 MONTHS.

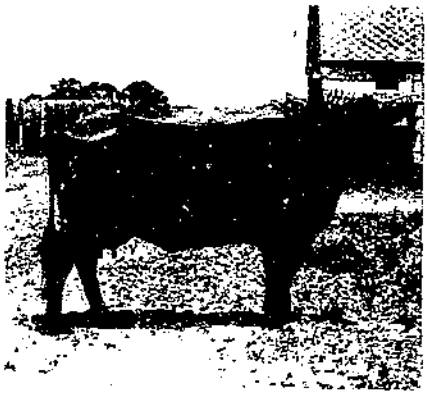
X–227. 3 YEARS, 6 MONTHS.

X–246. 2 YEARS, 6 MONTHS.

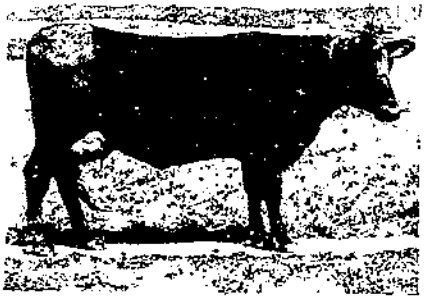
FIGURE 13.—Three-breed crosses (Red Dane × Holstein × Jersey).

3-BREED CROSSES (RED DANE × HOLSTEIN × JERSEY)

X–257. 3 YEARS, 8 MONTHS.

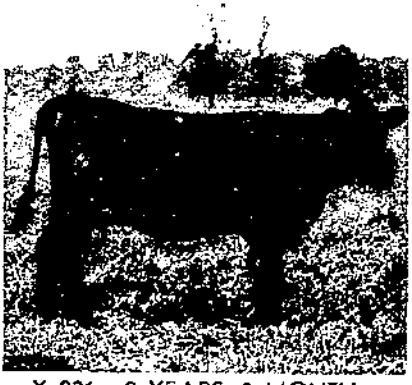


X–265. 2 YEARS,. ONTHS9M

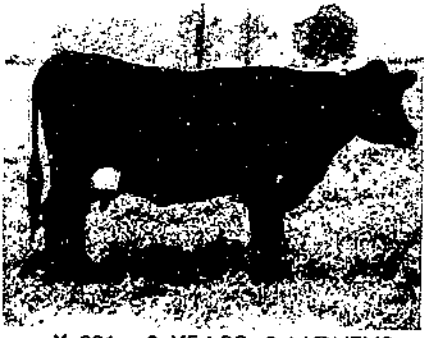


X–298. 2 YEARS, 3 MONTHS.

3-BREED CROSSES (HOLSTEIN × JERSEY × RED DANE)



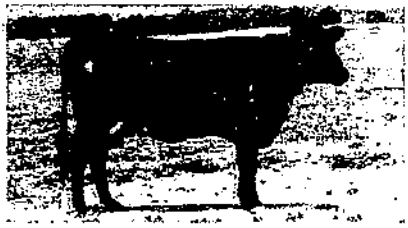
X–231. 2 YEARS, 0 MONTH.



X–281. 2 YEARS, 5 MONTHS.

FIGURE 14.—Three-breed crosses (Red Dane × Holstein × Jersey) and three-breed crosses (Holstein × Jersey × Red Dane).

3-BREED CROSSES (RED DANE × HOLSTEIN × GUERNSEY)



X-55. 2 YEARS, 2 MONTHS.

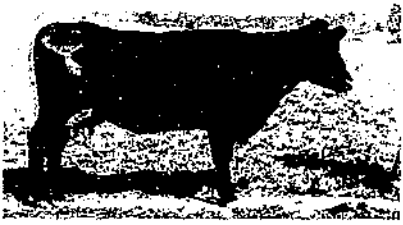
X-60. 2 YEARS, 0 MONTH.

X-66. 2 YEARS, 6 MONTHS.

X-93. 2 YEARS, 6 MONTHS.

X-201. 2 YEARS, 1 MONTH.

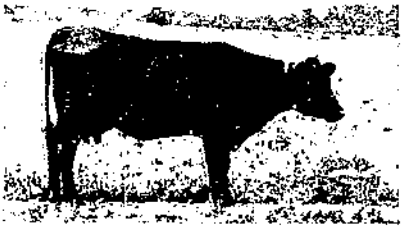
X-211. 2 YEARS, 9 MONTHS.



X-221. 3 YEARS, 9 MONTHS.

X-223. 2 YEARS, 6 MONTHS.

X-245. 2 YEARS, 4 MONTHS.

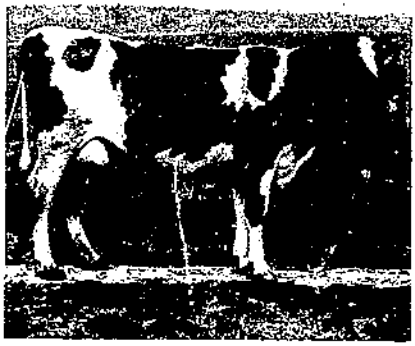


X-253. 2 YEARS, 3 MONTHS.

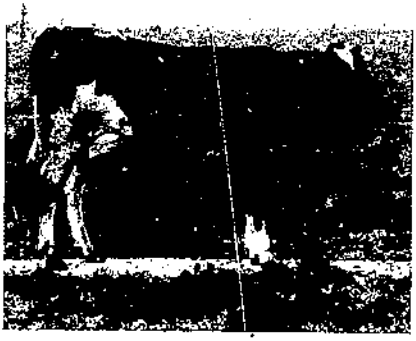
FIGURE 15.—Three-breed crosses (Red Dane × Holstein × Guernsey).

3-BREED CROSSES (HOLSTEIN × RED DANE × GUERNSEY)

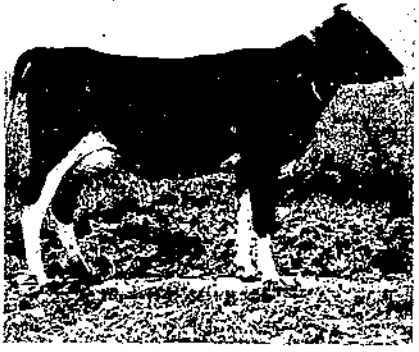
X–78. 3 YEARS, 9 MONTHS.



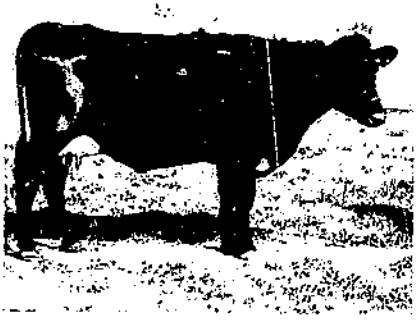
X–216. 2 YEARS, 1 MONTH.



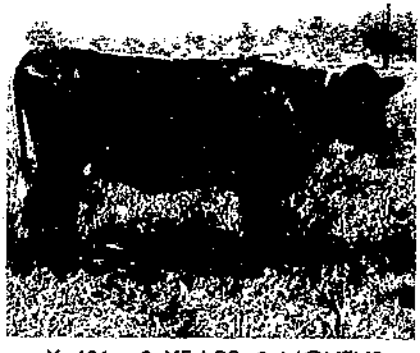
X–218. 2 YEARS, 1 MONTH.



X–224. 2 YEARS, 1 MONTH.



X–275. 2 YEARS, 1 MONTH.

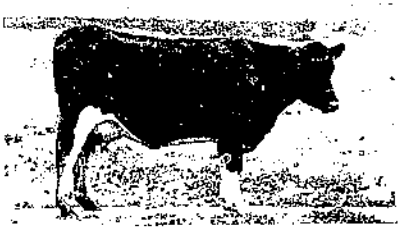


X–401. 2 YEARS, 3 MONTHS.

FIGURE 16.—Three breed crosses (Holstein × Red Dane × Guernsey).

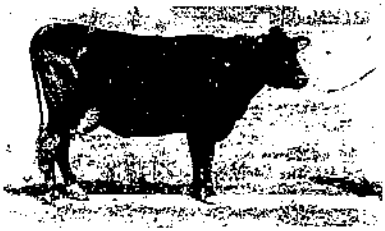
3-BREED CROSSES (HOLSTEIN × RED DANE × JERSEY)

X–50. 4 YEARS, 0 MONTH.



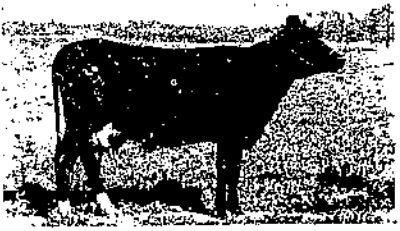
X–57. 3 YEARS, 9 MONTHS.

X–62. 2 YEARS, 2 MONTHS.

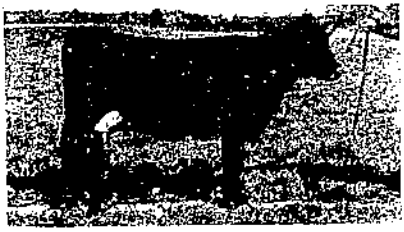


X–82. 2 YEARS, 8 MONTHS.

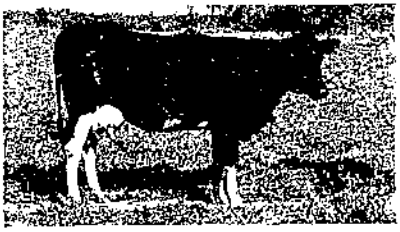
X–90. 2 YEARS, 1 MONTH.



X–203. 2 YEARS, 2 MONTHS.



X–209. 2 YEARS, 0 MONTH.



X–210. 2 YEARS, 0 MONTH.

X–212. 2 YEARS, 1 MONTH.

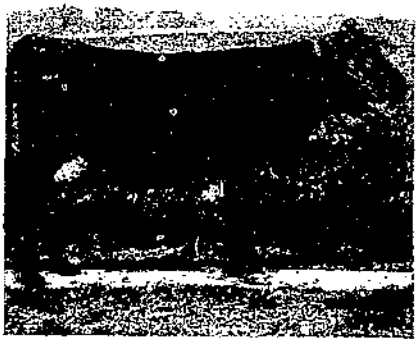
FIGURE 17.—Three-breed crosses (Holstein × Red Dane × Jersey).

3-BREED CROSSES (JERSEY × RED DANE × HOLSTEIN)

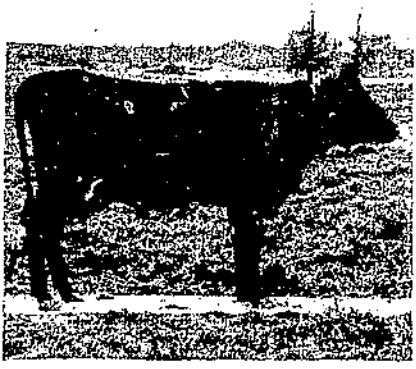
X–48. 2 YEARS, 0 MONTH.

X–81. 3 YEARS, 3 MONTHS.

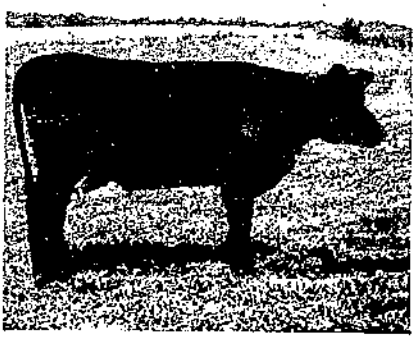
X–83. 2 YEARS, 1 MONTH.



X–204. 2 YEARS, 6 MONTHS.



X–248. 2 YEARS, 0 MONTH.



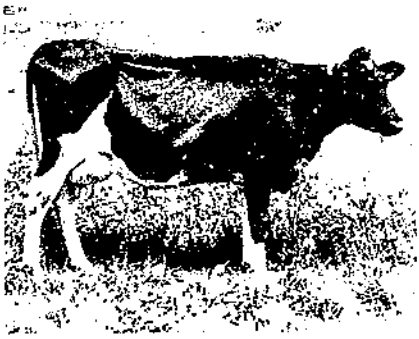
X–252. 2 YEARS, 6 MONTHS.

FIGURE 18.—Three-breed crosses (Jersey × Red Dane × Holstein).

3-BREED CROSSES (JERSEY × HOLSTEIN × RED DANE)

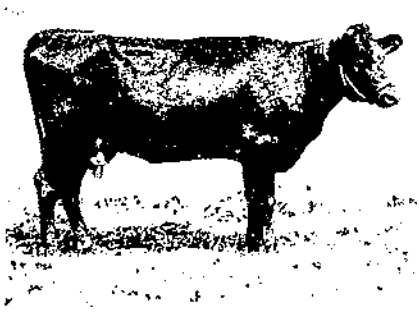
X–77. 3 YEARS, 8 MONTHS.

X–232. 2 YEARS, 2 MONTHS.

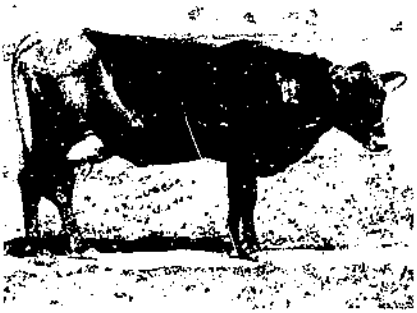


X–259. 2 YEARS, 1 MONTH.

X–277. 2 YEARS, 9 MONTHS.



X–291. 2 YEARS, 1 MONTH.



X–406. 2 YEARS, 0 MONTH.

FIGURE 19.—Three-breed crosses (Jersey × Holstein × Red Dane).

Average Production of the Three-Breed Groups and Their Two-Breed Dams

The 58 three-breed daughters by project sires and out of two-breed dams are shown below by groups, according to the breed combination of the group. Thirty-two of the 58 daughters produced more milk than their respective dams, 30 produced more butterfat, and 22 had a higher fat test. The average production of each of the 8 groups, based on actual first records of both the daughters and the dams, was as follows:

Breed combination	Pairs	Three-breed daughters by project sires					Breed combination	Two-breed dams				
	Number	Milk	Test	Fat	Age			Milk	Test	Fat	Age	
		Lbs.	*%*	*Lbs.*	*Yr.*	*Mo.*		*Lbs.*	*%*	*Lbs.*	*Yr.*	*Mo.*
RD × J × H	6	13,190	4.63	602	2	1	J × H	12,604	4.65	580	2	0
RD × H × J	13	13,350	4.34	576	2	2	H × J	12,766	4.89	622	2	2
RD × H × G	10	13,686	4.43	597	2	3	H × G	13,082	4.72	614	2	5
H × J × RD	2	13,704	4.12	566	2	2	J × RD	11,213	4.81	539	1	11
H × RD × G	6	12,842	4.40	562	2	1	RD × G	13,376	4.40	588	2	1
H × RD × J	9	14,393	4.40	632	2	2	RD × J	12,695	4.85	616	2	1
J × RD × H	6	11,572	4.78	552	2	1	RD × H	14,613	3.83	571	2	2
J × H × RD	6	13,236	4.33	587	2	2	H × RD	13,929	3.96	550	2	0
Average of all 58:							Average of all 58:					
Actual		13,361	4.44	588	2	2	Actual	13,114	4.58	596	2	2
Mature-equivalent		18,240		801			Mature-equivalent	16,000		818		

There were 6 daughters of these two-breed females that resulted from matings to nonproject sires. These 6 were continued in the herd until they had completed production records and, since they are progeny of the cows on the project, their production performance is made part of the record, as follows:

Herd No.	Daughters by nonproject sires[1]					Herd No.	Two-breed dams				
	Milk	Test	Fat	Age			Milk	Test	Fat	Age	
	Lbs.	*%*	*Lbs.*	*Yr.*	*Mo.*		*Lbs.*	*%*	*Lbs.*	*Yr.*	*Mo.*
X-49	14,082	4.68	658	2	0	X-11(H × J)	12,584	4.82	606	2	4
X-92	15,484	4.15	642	2	1	X-30(H × J)	11,867	5.00	664	2	0
X-279	11,770	4.70	553	2	0	X-214(H × G)	12,147	4.53	550	2	0
X-241	12,079	4.80	623	2	4	X-29(RD × J)	12,691	4.56	579	1	11
X-242	11,059	4.77	527	2	7	X-18(RD × J)	13,315	5.06	674	2	2
X-234	11,275	4.78	539	2	5	X-15(H × RD)	12,730	4.04	514	2	3
Average of 6:						Average of 6:					
Actual	12,775	4.65	590	2	3	Actual	12,556	4.77	598	2	1
Mature-equivalent	17,233		786			Mature-equivalent	17,258		822		

[1] X-49 and X-92 were sired by X-120, a Red Dane × Holstein bull; X-279 was sired by Jersey No. 1186 and X-241, X-242, and X-234 were sired by X-101, a Red Dane × Holstein × Guernsey bull.

Adding the 6 daughters of the nonproject sires to the 58 daughters of the project sires makes a total of 64 daughters from the two-breed dams. Their average production, and that of their dams, was as follows:

	All daughters of two-breed dams				Two-breed dams			
	Milk	Test	Fat	Age	Milk	Test	Fat	Age
Average of 64:	*Lbs.*	*%*	*Lbs.*	*Yr. Mo.*	*Lbs.*	*%*	*Lbs.*	*Yr. Mo.*
Actual	13, 306	4. 46	588	2 2	13, 061	4. 60	596	2 2
Mature-equivalent	18, 145	------	800	------	17, 930	------	818	------

The differences are not significant, but it should be stated that due to difficulties with supervisory help there was some decline in the quality of management during the period when many of the three-breed records were made.

Production Performance of Three-Breed Crosses, Grouped According to Their Sires

Production performance of the three-breed daughters of two-breed dams has been shown in groupings according to the breed makeup of the dams. Additional information on the results of crossbreeding is revealed when these three-breed crosses are assembled in get-of-sire groups. The figures shown are the average production results by groups according to breed combination and then an average for all daughters of each of the bulls used.

The average production of the daughters of 4 Red Dane sires, and that of their two-breed dams, was as follows:

Number of daughters	Daughters of Red Dane sire D-501				Breed combination	Dams			
	Milk	Test	Fat	Age		Milk	Test	Fat	Age
	Lbs.	*%*	*Lbs.*	*Yr. Mo.*		*Lbs.*	*%*	*Lbs.*	*Yr. Mo.*
4	13,175	4.76	616	2 2	J × H	12,812	4.41	558	2 2
3	12,464	4.90	609	1 11	H × J	12,448	4.95	615	2 1
3	15,450	4.30	665	2 1	H × G	13,440	4.72	634	2 3
Average of 10:					Average of 10:				
Actual	13,644	4.66	628	2 1	Actual	12,894	4.66	598	2 2
Mature-equivalent	18,946		872		Mature-equivalent	17,585		816	
	Daughters of Red Dane sire D-510								
1	14,121	4.08	577	2 0	J × H	12,189	5.13	625	1 8
4	15,846	4.10	646	2 3	H × J	12,510	4.94	616	2 2
2	14,346	4.19	576	2 4	H × G	13,313	4.53	594	2 4
Average of 7:					Average of 7:				
Actual	15,171	4.12	616	2 3	Actual	12,694	4.85	611	2 1
Mature-equivalent	20,473		830		Mature-equivalent	17,481		842	
	Daughters of Red Dane sire D-507								
1	12,317	4.67	575	2 0	J × H	12,189	5.13	625	1 8
1	8,469	4.31	365	2 6	H × J	13,690	4.74	649	2 8
2	14,166	4.34	616	2 3	H × G	13,284	4.40	589	2 5
Average of 4:					Average of 4:				
Actual	12,279	4.42	543	2 3	Actual	13,112	4.67	613	2 3
Mature-equivalent	16,625		735		Mature-equivalent	17,517		821	
	Daughters of Red Dane sire D-508								
5	12,886	4.20	542	2 2	H × J	12,976	4.85	626	2 3
3	11,163	4.70	530	2 6	H × J	12,427	5.05	624	2 5
Average of 8:					Average of 8:				
Actual	12,240	4.42	537	2 4	Actual	12,770	4.92	625	2 3
Mature-equivalent	16,259		713		Mature-equivalent	17,041		837	

	Daughters of 4 Red Dane sires [1]				Dams			
	Milk	Test	Fat	Age	Milk	Test	Fat	Age
	Lbs.	*%*	*Lbs.*	*Yr. Mo.*	*Lbs.*	*%*	*Lbs.*	*Yr. Mo.*
Average of 29:								
Actual	13,437	4.43	588	2 2	12,843	4.78	611	2 2
Mature-equivalent	18,253		799		17,400		829	

[1] 18 of the 29 daughters produced more milk than their respective dams, 13 produced more fat, and 6 had higher test.

The average production of the daughters of 3 Holstein sires, and that of their two-breed dams, was as follows:

Number of daughters	Daughters of Holstein sire No. 966				Breed combination	Dams			
	Milk	Test	Fat	Age		Milk	Test	Fat	Age
	Lbs.	%	*Lbs.*	*Yr. Mo.*		*Lbs.*	%	*Lbs.*	*Yr. Mo.*
3	12,544	4.63	575	2 2	RD × G	13,808	4.39	606	2 0
9	14,393	4.40	632	2 2	RD × J	12,695	4.85	616	2 1
Average of 12:					Average of 12:				
Actual	13,931	4.46	618	2 2	Actual	12,973	4.73	614	2 1
Mature-equivalent	19,008		839		Mature-equivalent	18,000		851	
	Daughters of Holstein sire Governor								
2	13,704	4.12	566	2 2	J × RD	11,213	4.81	539	1 11
2	12,808	4.13	529	2 0	RD × G	13,184	4.45	585	2 2
Average of 4:					Average of 4:				
Actual	13,256	4.13		2 1	Actual	12,199	4.63	562	2 1
Mature-equivalent	18,328		547		Mature-equivalent	16,927		781	
	Daughter of Holstein sire No. 1763								
1	13,805	4.27	589	2 2	RD × G	12,463	4.35	542	1 11
Mature-equivalent	18,774		801		Mature-equivalent	17,697		770	

	Daughters of 3 Holstein sires [1]				Dams			
	Milk	Test	Fat	Age	Milk	Test	Fat	Age
Average of 17:	*Lbs.*	%	*Lbs.*	*Yr. Mo.*	*Lbs.*	%	*Lbs.*	*Yr. Mo.*
Actual	13,764	4.37	600	2 2	12,761	4.69	597	2 1
Mature-equivalent	18,835		817		17,729		830	

[1] 11 of the 17 daughters produced more milk than their respective dams; 9 produced more butterfat, and 4 had a higher test.

The average production of the daughters of 3 Jersey sires, and that of their two-breed dams, was as follows:

Number of daughters	Daughters of the Jersey sire No. 1114				Breed combination	Dams			
	Milk	Test	Fat	Age		Milk	Test	Fat	Age
	Lbs.	*%*	*Lbs.*	*Yr. Mo.*		*Lbs.*	*%*	*Lbs.*	*Yr. Mo.*
4	11,235	5.00	562	2 1	RD × H	14,083	3.87	541	2 1
1	12,128	4.27	517	2 0	H × RD	12,730	4.04	514	2 3
Average of 5:					Average of 5:				
Actual	11,414	4.85	553	2 1	Actual	13,812	3.90	536	2 1
Mature-equivalent	15,845		768		Mature-equivalent	19,009		737	
	Daughters of Jersey sire No. 1186								
2	12,245	4.33	533	2 2	RD × H	15,675	4.05	631	2 4
4	14,514	4.22	611	2 3	H × RD	14,372	3.87	556	2 0
Average of 6:					Average of 6:				
Actual	13,757	4.26	585	2 2	Actual	14,896	3.93	581	2 1
Mature-equivalent	18,771		797		Mature-equivalent	20,710		802	
	Daughter of Jersey sire No. 1593								
1	11,629	4.83	562	1 11	H × RD	13,352	4.23	564	2 0
Mature-equivalent	16,514		797		Mature-equivalent	18,693		790	

	Daughters of 3 Jersey sires [1]				Dams			
	Milk	Test	Fat	Age	Milk	Test	Fat	Age
Average of 12:	*Lbs.*	*%*	*Lbs.*	*Yr. Mo.*	*Lbs.*	*%*	*Lbs.*	*Yr. Mo.*
Actual	12,603	4.55	570	2 1	14,271	3.94	560	2 1
Mature-equivalent	17,231		785		19,833		774	

[1] 3 of the 12 daughters produced more milk than their respective dams, 8 daughters produced more butterfat, and 12 daughters tested higher.

Some discussion of the results with these individual sires is called for, as the results are somewhat warped in a few cases. The performance of the 3 Holstein sires is fairly consistent in that all daughter groups averaged higher than their dams in milk, and on the basis of actual records the 17 daughters produced about 1,000 pounds more milk than their dams and held about even on butterfat production. The mature-equivalent figures show about 1,100 pounds more milk for the daughters and 13 pounds less fat on the average. The dams to which the Holstein sires were mated produced less milk and 11 pounds more fat than the average of the entire two-breed group.

The 3 Jersey sires, as expected, sired daughters which produced less milk and somewhat more butterfat than their dams. On an actual basis the daughters averaged about 1,600 pounds less milk, raised the fat percentage about 0.6 percent, and averaged 10 pounds more butterfat than their two-breed dams. The same picture holds when studied on a mature-equivalent basis. The two-breed dams from which these daughters came averaged higher in milk and lower in butterfat than the entire two-breed group.

Two of the four Red Dane bulls made a very good showing when mated to two-breed females of different combinations. D–501 raised the milk and butterfat materially, both on an actual and on a mature-equivalent basis, and the butterfat test remained the same. D–540 (an inbred son of D–501) had daughters which showed an increase of almost 2,500 pounds in milk and a slight increase in butterfat on an actual-record basis, and a 3,000-pound increase in milk but a slight decline in fat production on a mature-equivalent basis. There was a marked drop in butterfat test by his daughters.

D–507 had only 4 daughters, and 1 of these made the lowest record of any crossbred in either generation. This daughter (X–246) was out of a high-producing dam. In this small group this 1 low record has an undue effect on the average; the other 3 daughters show an average increase of more than 600 pounds of milk and 1 pound of butterfat over their dams.

D–508 was definitely a poor transmitter. While 4 of his 8 daughters produced more milk than their dams, only 1 of the 8 produced more butterfat. His daughters averaged almost 90 pounds less butterfat than their dams on an actual basis, and 124 pounds less on a mature-equivalent basis. The effect of this bull's daughters on the entire three-breed group of crossbreds is best shown by comparing the average production of all 58 animals in the group with the average of the 50 that remain when the daughters of D–508 are omitted. The average production of the 58 three-breed daughters, and that of their two-breed dams, was as follows:

	58 three-breed daughters				58 two-breed dams			
	Milk	Test	Fat	Age	Milk	Test	Fat	Age
Average of 58:	*Lbs.*	*%*	*Lbs.*	*Yr. Mo.*	*Lbs.*	*%*	*Lbs.*	*Yr. Mo.*
Actual	13, 361	4. 44	588	2 2	13, 114	4. 58	596	2 2
Mature-equivalent	18, 240	.....	801	..	18, 000	.....	818	..

The average production of 50 three-breed daughters (omitting the 8 sired by D–508), and that of their two-breed dams, was as follows:

	50 three-breed daughters				50 two-breed dams			
	Milk	Test	Fat	Age	Milk	Test	Fat	Age
Average of 50:	*Lbs.*	*%*	*Lbs.*	*Yr. Mo.*	*Lbs.*	*%*	*Lbs.*	*Yr. Mo*
Actual	13, 540	4. 44	598	2 2	13, 168	4. 52	592	2 1
Mature-equivalent	18, 556	.....	816	.....	18, 153	.....	815	.....

Without the daughters of D–508, the three-breed group shows increases in both milk and butterfat over their dams, on both the actual and mature-equivalent bases.

REPRODUCTIVE PERFORMANCE OF THE THREE-BREED CROSSES

Although all cows in this group have not yet moved into herds of cooperators, the reproductive story on this phase of the project is almost complete, and is summarized below in tabular form. The pregnancies listed in the table are those which resulted when the cows were mated according to the project plan. This plan called for mating the three-breed females to proved sires to start a second round of three breeds. However, in the case of those animals descended from foundation cows of the Guernsey breed, this particular mating was to a proved Jersey bull, and the result can be classed as a four-breed. Others would be designated as in the second cycle, first breed.

Breed combination of female	Breed of sire used	Pregnancies terminated	Abortions	Male calves		Female calves	
				Live	Dead	Live	Dead
RD × J × H	Holstein	13		[1] 6		[1] 8	
RD × H × J	Jersey	31		[1] 15	1	[1] 16	
RD × H × G	do	23	1	14		[2] 9	
H × RD × G	do	12	1	5		6	
H × RD × J	do	21	4	5		12	
J × RD × H	Holstein	8	1	5		2	
J × H × RD	Red Dane	9		6		3	
H × J × RD	do	4		2	1	1	
Total		121	7	[2] 58	2	[3] 57	

[1] Includes 1 twin.
[2] Includes 2 twins.
[3] Includes 4 twins.

Of the 57 live heifer calves, 2 were freemartins, 2 were loaned because their dam died before completing a production record, 4 died as calves, and 7 others were lost before completing a production record. Twenty-three of the 42 remaining have completed production records, the others being on test or under calving age.

In addition to the above, this group terminated 18 pregnancies when bred to nonproject sires. These resulted in 5 male calves and 13 female calves, 1 of which was born dead. Four died as calves, 1 was discarded because of a damaged udder, and 6 of the others have completed production records.

PROGENY OF THE THREE-BREED CROSSES

Progeny of Red Dane × Jersey × Holstein Females

Six RD × J × H females completed 16 pregnancies when bred to Holstein sires, resulting in 6 male calves and 8 female calves, including 1 pair of mixed twins. Of the 8 females, 1 was a freemartin, 5 have completed production records, and the other 2 are now on test. Matings to nonproject bulls produced 3 females, 1 of which died and the other 2 have completed records.

The production performance of the daughters of RD × J × H females and their dams was as follows:

Herd No.	Daughters (H × RD) × J × H)[1]					Herd No.	Dams (RD × J × H)				
	Milk	Test	Fat	Age			Milk	Test	Fat	Age	
	Lbs.	*%*	*Lbs.*	*Yr.*	*Mo.*		*Lbs.*	*%*	*Lbs.*	*Yr.*	*Mo.*
X-69	14,712	4.32	635	2	1	X-39	13,982	4.35	609	1	11
X-94	14,418	4.34	627	1	11	X-39	15,992	4.35	696	1	11
X-262	14,697	4.58	673	2	2	X-54	16,500	4.16	686	1	11
X-272	12,717	4.26	541	2	0	X-68	12,522	5.21	653	2	3
X-293	12,793	4.23	541	2	1	X-54	16,500	4.16	686	1	11
Average of 5:						Average of 5:					
Actual	13,867	4.35	603	2	1	Actual	14,701	4.45	649	2	0
Mature-equivalent	19,243		837			Mature-equivalent	20,700		907		

[1] X-69 and X-94 were by Holstein sire No. 966; X-262 and X-272 were by Holstein sire Governor; and X-293 was by Holstein sire No. 1763.

Three daughters produced more milk than their respective dams, 2 produced more butterfat, and 2 had a higher butterfat test.

It should be noted that the average production of this group of three-breed dams is considerably higher than that of the three-breed group as a whole.

Progeny of Red Dane × Holstein × Jersey Females

Thirteen females in this group have terminated 31 pregnancies from matings to Jersey sires. These resulted in 16 male calves and 16 female calves. One male calf was born dead, and there was 1 pair of mixed twins. The 16 female calves included 1 freemartin; 2 died as calves, 2 were disposed of because of mastitis and calving difficulties, 2 are now on test, 3 are under calving age, and 6 have completed production records. No females resulted from matings to nonproject bulls.

The production performance of the daughters of RD × H × J females and their dams was as follows:

Herd No.	Daughters (J × RD × H × J)[1]					Herd No.	Dams (RD × H × J)				
	Milk	Test	Fat	Age			Milk	Test	Fat	Age	
	Lbs.	*%*	*Lbs.*	*Yr.*	*Mo.*		*Lbs.*	*%*	*Lbs.*	*Yr.*	*Mo.*
X-240	11,661	4.40	513	2	6	X-65	12,896	4.67	602	1	11
X-251	16,455	3.98	655	2	2	X-96	16,775	3.74	627	2	0
X-256	13,245	4.30	596	2	7	X-71	13,006	4.70	611	2	0
X-258	10,745	4.92	528	2	3	X-97	13,821	4.60	635	2	1
X-270	12,975	4.65	604	2	0	X-65	12,896	4.67	602	1	11
X-407	11,530	6.18	713	2	4	X-97	13,821	4.60	635	2	1
Average of 6:						Average of 6:					
Actual	12,760	4.77	602	2	4	Actual	13,869	4.50	615	2	0
Mature-equivalent	16,985		806			Mature-equivalent	19,410		866		

[1] X-407 was by Jersey sire No. 1593; all others were by Jersey sire No. 1186.

Two daughters produced more milk than their respective dams, 3 produced more butterfat, and 3 tested higher.

Progeny of Red Dane × Holstein × Guernsey Females

Eleven females in this group were bred to Jersey sires and terminated 23 pregnancies, which resulted in 1 abortion, 14 male calves, and 9 female calves, including a pair of twins. The dam of the twins was lost due to mastitis, and they were placed on loan. Two of the remaining 7 have completed production records, 3 are on test, and 2 are under calving age. Four pregnancies to nonproject bulls resulted in 3 female calves, 2 of which have completed production records.

The production performance of the daughters of the RD × H × G females and their dams was as follows:

Herd No.	Daughters (J × RD × H × G)[1]					Herd No.	Dams (RD × H × G)				
	Milk	Test	Fat	Age			Milk	Test	Fat	Age	
	Lbs.	*%*	*Lbs.*	*Yr.*	*Mo.*		*Lbs.*	*%*	*Lbs.*	*Yr.*	*Mo.*
X-261	15,401	4.38	705	2	4	X-66	16,029	4.45	714	2	3
X-263	19,930	4.36	870	2	1	X-93	16,282	4.70	493	2	6
Average of 2:						Average of 2:					
Actual	13,166	4.47	591	2	3	Actual	13,156	4.62	604	2	6
Mature-equivalent	17,706		794			Mature-equivalent	17,320		794		

[1] Both daughters were by the Jersey bull No. 1186.

Progeny of Holstein × Jersey × Red Dane Females

The 2 females in this group terminated 4 pregnancies when bred to Red Dane bulls. They produced 3 male calves and 1 female calf. One of the males was dead at birth, and the female calf is under breeding age.

Progeny of Holstein × Red Dane × Guernsey Females

This group of 6 females completed 12 pregnancies resulting from matings to Jersey sires. There was 1 abortion, 5 male calves, and 6 female calves. One female died as a calf, 2 were discarded because of lump jaw and mastitis, 2 have completed production records, and the other is on test. None were bred to nonproject sires.

The production performance of the daughters of H × RD × G females and their dams was as follows:

Herd No.	Daughters (J × H × RD × G)[1]					Herd No.	Dams (H × RD × G)				
	Milk	Test	Fat	Age			Milk	Test	Fat	Age	
	Lbs.	*%*	*Lbs.*	*Yr.*	*Mo.*		*Lbs.*	*%*	*Lbs.*	*Yr.*	*Mo.*
X-237	12,442	4.58	569	2	0	X-78	10,460	4.69	491	2	5
X-414	12,911	4.97	643	2	1	X-218	14,5[illegible]	3.92	570	2	0
Average of 2:						Average of 2:					
Actual	12,677	4.78	606	2	1	Actual	12,506	4.31	531	2	3
Mature-equivalent	17,648		842			Mature-equivalent	16,985		718		

[1] X-237 was by the Jersey sire No. 1186, and X-414 was by the Jersey sire No. 1593.

Progeny of Holstein × Red Dane × Jersey Females

As a result of matings to Jersey sires, 10 females in this group have terminated 21 pregnancies with 4 abortions, 5 male calves, and 12 female calves. Three of the heifers were lost, 2 are on test, and the other 7 have completed production records. There is also 1 female resulting from a mating to a nonproject bull which has completed a production record.

The production performance of the daughters of the H×RD×J females and their dams was as follows:

Herd No.	Daughters (J × H × RD × J)[1]					Herd No.	Dams (H × RD × J)				
	Milk	Test	Fat	Age			Milk	Test	Fat	Age	
	Lbs.	*%*	*Lbs.*	*Yr.*	*Mo.*		*Lbs.*	*%*	*Lbs.*	*Yr.*	*Mo.*
X-243	12,210	5.06	618	2	4	X-82	15,903	4.72	751	2	6
X-264	13,681	4.51	617	2	2	X-50	16,186	3.97	643	1	11
X-267	16,076	4.20	684	2	3	X-203	15,578	4.08	636	2	0
X-269	11,558	4.76	550	2	8	X-210	12,732	3.95	504	1	11
X-278	10,913	4.86	531	2	6	X-212	13,396	4.48	600	1	11
X-280	13,676	4.52	619	2	6	X-90	11,392	4.92	556	2	0
X-294	14,059	4.13	580	2	0	X-82	15,903	4.72	751	2	6
Average of 7:						Average of 7:					
Actual	13,166	4.59	600	2	4	Actual	14,420	4.41	634	2	1
Mature-equivalent	17,424		793			Mature-equivalent	19,770		807		

[1] All daughters were by the Jersey sire No. 1186.

Two daughters produced more milk than their respective dams, 3 produced more butterfat, and 5 tested higher.

This group of dams averaged considerably higher than the three-breed females as a whole. The failure of the 2 daughters of X–82 to approach her record of 751 pounds of butterfat accounts for all of the difference between the daughter and dam groups.

Progeny of Jersey × Red Dane × Holstein Females

This group of 6 females terminated 8 pregnancies resulting from matings to Holstein sires. They had 1 abortion, 5 male calves, and 2 female calves, 1 of which died young. They also conceived 4 times to nonproject bulls and had 2 male calves and 2 female calves. One of the latter freshened with only 3 functional quarters.

The production performance of a daughter of a J × RD × H female and her dam was as follows:

Herd No.	Daughter (H × J × RD × H)				Herd No.	Dam (J × RD × H)			
	Milk	Test	Fat	Age		Milk	Test	Fat	Age
	Lbs.	*%*	*Lbs.*	*Yr. Mo.*		*Lbs.*	*%*	*Lbs.*	*Yr. Mo.*
X–88	13,206	4.47	590	2 3	X–48	12,668	5.07	643	2 0
Mature-equivalent	17,529	.....	786	.....	Mature-equivalent	17,735	.....	900	.....

Progeny of Jersey × Holstein × Red Dane Females

The first females in this group produced only male calves, and the 6 altogether terminated 9 pregnancies to Red Dane sires which resulted in 6 male calves and 3 female calves, all of which are under calving age. There were also 3 pregnancies to nonproject bulls, which resulted in 1 male calf and 2 female calves. One of the females died and the other is under calving age.

Average Production of the Progeny of the Three-Breed Females

For convenience, the progeny of the three-breed females are shown below by groups according to their breed combination. The average production of the various groups, and that of their three-breed dams, was as follows:

Breed combination	Daughters[1]					Three-breed dams			
	Number	Milk	Test	Fat	Age	Milk	Test	Fat	Age
		Lbs.	*%*	*Lbs.*	*Yr. Mo.*	*Lbs*	*%*	*Lbs.*	*Yr. Mo.*
H × RD × J × H	5	13,867	4.35	603	2 1	14,701	4.46	649	2 0
J × RD × H × J	6	12,769	4.77	602	2 4	13,860	4.50	615	2 0
J × RD × H × G	2	13,166	4.47	591	2 3	13,156	4.62	604	2 5
J × H × RD × G	2	12,877	4.78	606	2 1	12,506	4.31	531	2 3
J × H × RD × J	7	13,160	4.50	600	2 4	14,429	4.41	634	2 1
H × J × RD × H	1	13,206	4.47	590	2 3	12,668	5.07	643	2 0
Average of all 23:									
Actual	.....	13,174	4.58	600	2 3	13,987	4.48	621	2 1
Mature-equivalent	.....	17,704	.....	800	.....	19,336	.....	859	.....

[1] 10 of the 23 daughters produced more milk than their respective dams, 10 produced more butterfat, and 12 tested higher.

Two facts need to be considered in assessing the comparative performance of the 23 daughters and dams in this group. All but 6 daughters are by Jersey sires, which may account in part for the difference in milk production. Also, this group of 23 three-breed

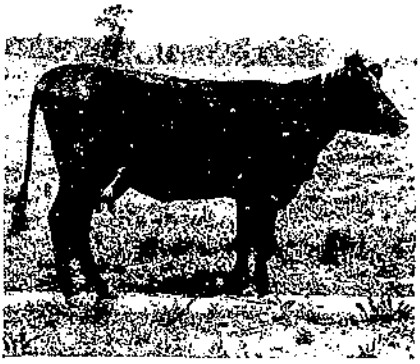
dams averaged 873 pounds more milk and 25 pounds more butterfat than the average of all 58 of the three-breed females. These figures may change somewhat when more daughters of Holstein sires and those of Red Dane sires have completed records.

There is a high degree of uniformity in the average production of the progeny of the three-breed groups regardless of the order of breed rotation.

Photographs of Progeny of Three-Breed Crosses

In the following pages are pictures of the progeny of the three-breed crosses. Each picture is marked with the cow's herd number, so that reference may be made to her production records as given in the text. (See figs. 20 to 23, inclusive.)

PROGENY OF 3-BREED CROSSES (H × RD × J × H)



X–69. 2 YEARS, 3 MONTHS.

X–94. 1 YEAR, 11 MONTHS.

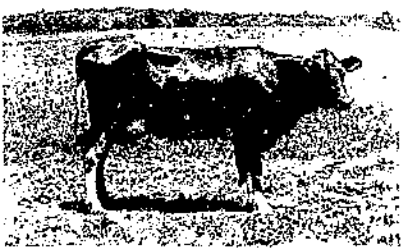
X–262. 2 YEARS, 2 MONTHS.

X–272. 2 YEARS, 0 MONTH.

X–293. 2 YEARS, 2 MONTHS.

FIGURE 20.—Progeny of three-breed crosses (Holstein × Red Dane × Jersey × Holstein).

PROGENY OF 3-BREED CROSSES (J × H × RD × J)



X–243. 2 YEARS, 5 MONTHS.

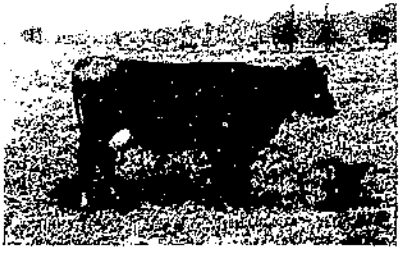
X–264. 2 YEARS, 3 MONTHS.

X–267. 2 YEARS, 3 MONTHS.

X–269. 2 YEARS, 9 MONTHS.

X–278. 2 YEARS, 7 MONTHS.

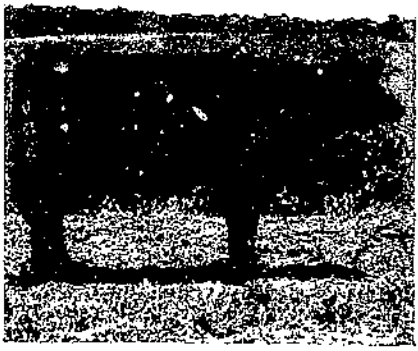
X–280. 2 YEARS, 6 MONTHS.



X–294. 2 YEARS, 1 MONTH.

FIGURE 21.—Progeny of three-breed crosses (Jersey × Holstein × Red Dane × Jersey).

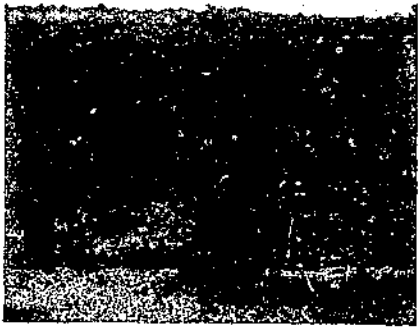
PROGENY OF 3-BREED CROSSES (J × RD × H × J)



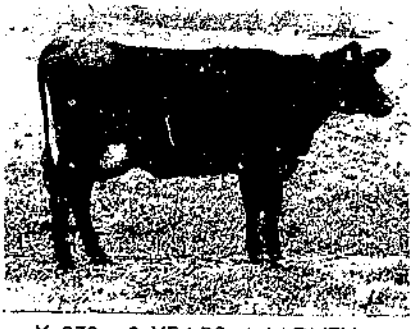
X–240. 2 YEARS, 6 MONTHS.

X–254. 2 YEARS, 2 MONTHS.

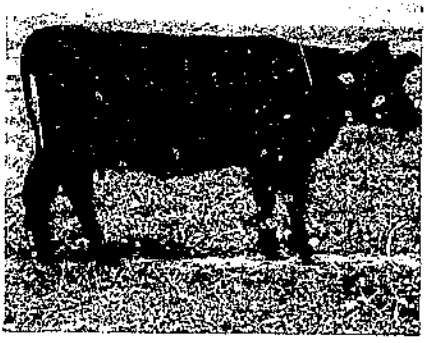
X–256. 2 YEARS, 7 MONTHS.



X–258. 2 YEARS, 3 MONTHS.



X–270. 2 YEARS, 1 MONTH.



X–407. 2 YEARS, 5 MONTHS.

FIGURE 22.—Progeny of three-breed crosses (Jersey × Red Dane × Holstein × Jersey).

PROGENY OF 3-BREED CROSSES

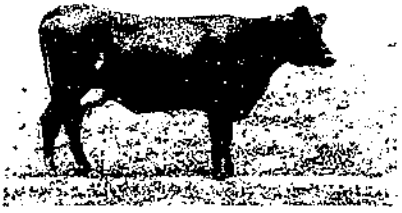
(J × RD × H × G)

X–261. 2 YEARS, 5 MONTHS.

X–263. 2 YEARS, 1 MONTH.

(J × H × RD × G)

X–237. 2 YEARS, 0 MONTH.



X–414. 2 YEARS, 3 MONTHS.

(H × J × RD × H)

X–88. 2 YEARS, 4 MONTHS.

FIGURE 23.—Progeny of three-breed crosses (Jersey × Red Dane × Holstein × Guernsey) and (Jersey × Holstein × Red Dane × Guernsey) and (Holstein × Jersey × Red Dane × Holstein).

PROGENY OF THE THREE-BREED FEMALES AND NONPROJECT BULLS

To complete the story of the production performance of the three-breed groups and their progeny, the 6 daughters that were sired by 2 nonproject bulls are listed below along with the herd number and breed combination of their three-breed dams. The production of the daughters and that of their dams was as follows:

Herd No.	Daughters by nonproject bulls				Dam's Herd No. and breed combination	Three-breed dams			
	Milk	Test	Fat	Age		Milk	Test	Fat	Age
	Lbs.	%	*Lbs.*	*Yr. Mo.*		*Lbs.*	%	*Lbs.*	*Yr. Mo.*
X-220 [1]	12,985	4.73	614	1 11	X-68 (RD × J × H).	12,522	5.21	653	2 3
X-238 [2]	12,356	5.03	622	2 11	X-79 (RD × J × H).	9,687	5.31	514	3 6
X-215 [1]	13,421	4.36	586	1 11	X-66 (RD × H × G).	16,029	4.45	714	2 3
X-229 [2]	15,115	4.10	619	2 0	X-60 (RD × H × G).	15,036	3.98	598	1 11
X-239 [2]	13,927	4.17	581	1 11	X-90 (H × RD × J).	11,302	4.92	556	2 0
X-222 [1]	11,073	4.60	550	2 0	X-81 (J × RD × H).	11,225	4.92	553	1 11
Average of 6: [3]					Average of 6: [3]				
Actual	13,296	4.50	595	2 1	Actual	12,634	4.80	598	2 2
Mature-equivalent	18,400	------	822	------	Mature-equivalent	17,332	------	819	------

[1] Sired by X-179, a Red Dane × Jersey × Holstein bull.
[2] Sired by X-191, a Red Dane × Holstein × Guernsey bull.
[3] 5 of the 6 daughters produced more milk than their respective dams, 3 produced more butterfat, and 1 had a higher test.

When these 6 daughters are added to the 23 that were bred according to the project plan, the get of the three-breed dams as summarized to date produced as follows:

	29 daughters				29 dams			
	Milk	Test	Fat	Age	Milk	Test	Fat	Age
Average of 29:	*Lbs.*	%	*Lbs.*	*Yr. Mo.*	*Lbs.*	%	*Lbs.*	*Yr. Mo.*
Actual	13,200	4.57	599	2 2	13,707	4.54	616	2 1
Mature-equivalent	17,895	------	804	------	18,922	------	850	------

The small number of individuals which have completed production records in subsequent generations represent only a fraction of the final total, and for this reason the analysis of these later generations will be deferred until more complete information becomes available.

A generation-by-generation summary of the foregoing material follows:

Generation	Females (number)	Actual-production average					Mature-equivalent value		
		Milk	Test	Fat	Age		Milk	Test	Fat
		Lbs.	%	*Lbs.*	*Yr.*	*Mo.*	*Lbs.*	%	*Lbs.*
Foundation	55	10,540	4.55	455	2	6	13,790	4.55	594
2-breed crosses	55	13,630	4.53	586	2	2	17,811	4.53	799
3 breed crosses (regular)	58	13,361	4.44	588	2	2	18,240	4.44	801
3-breed crosses (irregular)	6	12,775	4.65	590	2	3	17,233	4.65	786
All 3-breed crosses	64	13,306	4.46	588	2	2	18,145	4.46	800
Progeny of 3 breeds (regular)	23	13,174	4.58	600	2	3	17,764	4.58	800
Progeny of 3 breeds (irregular)	6	13,296	4.50	595	2	1	18,400	4.50	822
All progeny of 3 breeds	29	13,200	4.57	590	2	2	17,895	4.57	804

There are 23 daughters of the 3-breed females that follow the project pattern, and since 15 of these are by the Jersey sire No. 1186, and the remaining 8 are by 1 Jersey sire and 3 Holstein sires, no study of sire influence is made here; but the data will be included when the individual sires are discussed.

SISTER GROUPS

There are several full-sister groups in this study, and also a number of maternal half-sister groups. Production information about the latter may be of some assistance in assaying the breeding worth of the different bulls used on the project, and these groups are brought together here for the benefit of students of breeding. The production records are given here on a mature-equivalent basis, which is best for making comparisons of this kind.

In the two-breed group, only 2 sets of full sisters appeared. One set was from a Holstein foundation cow, and the other was from a foundation Jersey cow. Their mature-equivalent records are as follows:

Full-sister groups	Mature-equivalent records		
	Milk	Test	Fat
	Lbs.	%	*Lbs.*
Dam (Holstein): H–330	14,587	3.64	532
Daughters by Jersey sire No. 1114:			
X–1	13,698	4.85	665
X–42	13,952	4.90	684
Dam (Jersey): L–119	11,761	5.15	606
Daughters by Holstein sire No. 966:			
X–11	16,611	4.82	800
X–84	19,247	4.57	879

Maternal half-sister groups were more numerous than full-sister groups, and these are grouped here to show the comparative performance of the sires. The mature-equivalent records are as follows:

Maternal half-sister groups	Mature-equivalent records		
	Milk	Test	Fat
	Lbs.	*%*	*Lbs.*
Dam (Holstein): H–423	25, 640	3. 47	889
Daughter X–35 by Jersey sire No. 1114	14, 501	5. 24	759
Daughter X–56 by Red Dane sire D–501	22, 540	4. 08	920
Dam (Holstein): H–345	17, 028	3. 50	597
Daughter X–41 by Jersey sire No. 1114	16, 313	4. 63	755
Daughter X–22 by Red Dane sire D–501	23, 051	3. 60	831
Dam (Red Dane): D–22	14, 885	3. 95	588
Daughter X–15 by Holstein sire No. 966	17, 186	4. 00	694
Daughter X–67 by Jersey sire No. 1114	14, 652	5. 34	782
Dam (Guernsey): S–89	8, 923	5. 89	525
Daughter X–44 by Holstein sire No. 966	21, 703	4. 10	890
Daughter X–206 by Red Dane sire D–508	16, 760	4. 59	770

Four Guernsey cows and 3 Jersey cows each had 2 daughters that were maternal half sisters and sired by the same 2 bulls. One of each pair of half sisters was by Holstein sire No. 966, and the other was by Red Dane sire D–501. These 2 groups offer an interesting comparison of these 2 sires. The mature-equivalent records of the dams and daughters are as follows:

Maternal half sisters by 2 sires	Mature-equivalent records		
	Milk	Test	Fat
Guernsey dams:	*Lbs.*	*%*	*Lbs.*
Dam S–99	12, 305	5. 06	623
Daughter X–28 by Holstein sire No. 966	18, 830	4. 63	872
Daughter X–52 by Red Dane sire D–501	19, 100	4. 30	820
Dam S–78	11, 693	4. 71	551
Daughter X–16 by Holstein sire No. 966	18, 950	4. 68	888
Daughter X–53 by Red Dane sire D–501	19, 958	4. 79	956
Dam S–125	12, 677	4. 65	589
Daughter X–214 by Holstein sire No. 966	17, 005	4. 53	770
Daughter X–61 by Red Dane sire D–501	17, 697	4. 35	770
Dam S–104	9, 160	5. 09	465
Daughter X–45 by Holstein sire No. 966	14, 176	4. 95	701
Daughter X–74 by Red Dane sire D–501	15, 506	4. 62	716
Jersey dams:			
Dam L–116	9, 362	6. 16	577
Daughter X–30 by Holstein sire No. 966	16, 614	5. 60	930
Daughter X–10 by Red Dane sire D–501	17, 837	5. 03	896
Dam L–111	9, 798	5. 90	578
Daughter X–38 by Holstein sire No. 966	16, 462	5. 09	838
Daughter X–18 by Red Dane sire D–501	18, 108	5. 06	917
Dam L–200	9, 939	5. 32	529
Daughter X–51 by Holstein sire No. 966	17, 940	4. 44	797
Daughter X–29 by Red Dane sire D–501	18, 021	4. 56	822
Average of 7:			
Dams	10, 705	5. 27	559
Daughters by Holstein sire No. 966	17, 140	4. 85	828
Daughters by Red Dane sire D–501	18, 032	4. 67	842

All daughters of D–501 produced more milk than the daughters of No. 966, but 6 of the 7 daughters of No. 966 tested higher than those of D–501. In 1 pair the butterfat production was the same, but 4 of the 6 other daughters of D–501 produced more butterfat than their half sisters sired by No. 966.

More full-sister groups were developed in the three-breed crosses because the pattern of breeding was then established, and if a sire continued in service for a reasonable period he had an opportunity to sire such groups. One cow (X–18) in the two-breed group had 3 daughters that were full sisters, as shown below. The mature-equivalent records of the full-sister groups produced by two-breed dams were as follows:

Full-sister groups from 2-breed dams	Mature-equivalent records		
	Milk	Test	Fat
	Lbs.	*%*	*Lbs.*
Red Dane × Jersey dams:			
Dam X–18	18, 108	5. 06	917
Daughter X–57 by Holstein sire No. 966	17, 061	5. 47	932
Daughter X–90 by Holstein sire No. 966	15, 822	4. 92	778
Daughter X–210 by Holstein sire No. 966	18, 080	3. 95	715
Dam X–10	17, 837	5. 03	896
Daughter X–82 by Holstein sire No. 966	20, 356	4. 72	961
Daughter X–203 by Holstein sire No. 966	21, 809	4. 08	891
Jersey × Red Dane dam:			
Dam X–86	15, 922	4. 81	766
Daughter X–231 by Holstein sire Governor	20, 048	4. 22	846
Daughter X–281 by Holstein sire Governor	17, 405	4. 02	700
Holstein × Red Dane dam:			
Dam X–87	19, 637	3. 97	750
Daughter X–232 by Jersey sire No. 1186	19, 845	4. 19	832
Daughter X–277 by Jersey sire No. 1186	15, 991	4. 62	739
Jersey × Holstein dam:			
Dam X–17	18, 680	3. 85	720
Daughter X–54 by Red Dane sire D–501	23, 430	4. 16	975
Daughter X–79 by Red Dane sire D–501	12, 496	5. 31	663
Holstein × Jersey dams:			
Dam X–38	16, 462	5. 09	838
Daughter X–265 by Red Dane sire D–540	20, 878	4. 24	885
Daughter X–298 by Red Dane sire D–540	21, 906	3. 82	838
Dam X–51	17, 940	4. 44	797
Daughter X–225 by Red Dane sire D–508	15, 666	4. 19	656
Daughter X–257 by Red Dane sire D–508	15, 592	4. 11	641

Some pairs are quite similar in production and others show wide variation. The most widely divergent pair are the daughters of X–17, and this may be due in part to a severe foot injury to X–79 about the time she calved.

Maternal half sisters were produced quite frequently by the two-breed dams, particularly by Holstein × Jersey dams, as a number of these were used in the Beltsville nutrition herd and were bred according to the project plan while there. These half-sister groups also bring out the differences in the breeding worth of the Red Dane sires D–501, D–540, and D–508. The mature-equivalent records of the dams and daughters are as follows:

Maternal half sisters from 2-breed dams	Mature-equivalent records		
	Milk	Test	Fat
	Lbs.	*%*	*Lbs.*
Holstein × Jersey dams:			
Dam X–5	17, 202	4. 62	795
Daughter X–65 by Red Dane sire D–501	18, 312	4. 67	855
Daughter X–207 by Red Dane sire D–508	17, 784	4. 19	746
Dam X–51	17, 940	4. 44	797
Daughter X–96 by Red Dane sire D–540	23, 485	3. 74	878
Daughter X–225 by Red Dane sire D–508	15, 666	4. 19	656
Daughter X–257 by Red Dane sire D–508	15, 592	4. 11	641
Dam X–38	16, 462	5. 09	838
Daughter X–265 by Red Dane sire D–540	20, 878	4. 24	885
Daughter X–298 by Red Dane sire D–540	21, 906	3. 82	838
Daughter X–71 by Red Dane sire D–501	18, 208	4. 70	856
Dam X–20	17, 584	5. 13	903
Daughter X–97 by Red Dane sire D–540	19, 072	4. 60	877
Daughter X–75 by Red Dane sire D–501	16, 318	5. 34	871
Jersey × Holstein dams:			
Dam X–47	18, 040	5. 13	925
Daughter X–274 by Red Dane sire D–540	19, 769	4. 08	807
Daughter X–235 by Red Dane sire D–507	17, 243	4. 67	805
Dam X–45	14, 176	4. 95	701
Daughter X–93 by Red Dane sire D–540	13, 161	4. 79	631
Daughter X–221 by Red Dane sire D–508	16, 988	4. 43	753
Dam X–16	18, 950	4. 68	888
Daughter X–55 by Red Dane sire D–501	21, 092	4. 47	944
Daughter X–211 by Red Dane sire D–508	14, 231	4. 70	669
Daughter X–245 by Red Dane sire D–507	18, 645	4. 35	811

This last group of three maternal half sisters produced according to the transmitting ability of their sires. With a single exception, half sisters sired by D–501 or D–540 always outproduced those sired by D–508.

PRODUCTION OF BELTSVILLE CROSSBRED COWS IN COOPERATING DAIRY HERDS

In the early days of the project, space at Beltsville permitted testing some of the cows in lactation periods subsequent to the first, and they were then milked twice daily for a lactation period of 305 days. However, only a very few cows had been carried on this program when our facilities would no longer afford barn room to carry cows in the herd after the first lactations were completed. A program was then developed for placing the crossbred cows in herds of cooperating dairymen, in order to make further determinations as to their worth under ordinary farm conditions.

This type of cooperation has been conducted in six herds, and the herds will be designated by number in the order in which cooperation was begun. Herd No. 1 is the Beltsville herd, where a number of cows were used for experimental feeding work and were milked twice daily for 305 days. Herd No. 2 was owned and operated by Paul Strickler at Waterford, Va. Herd No. 3 is owned and operated by Frank P. Parish, Taneytown, Md. Herd No. 4 is owned and operated by Paul Martin of Damascus, Md. Herd No. 5 is owned and operated by Meade Brothers at Richmond, Va., and Herd No. 6 is owned and

operated by Charles W. Collier, Darlington, Md. The owners of these herds are all members of local dairy-herd-improvement associations, and milk and butterfat production records are reported on a monthly basis. The usual disturbances due to mastitis, dry pasture, and scarce labor conditions occur in these herds, and the management in most cases is about average for herds handled under dairy farm conditions.

Comparative Production of Two-Breed Crosses

The two-breed crosses have completed a total of 130 lactation periods in the cooperating herds, and the results have been set up in tabular form below. The average production of each group when on test at Beltsville in the first-lactation period on 3 milkings daily for 365 days, and their later performance under dairy farm conditions when milked twice daily for not more than 305 days, was as follows:

Comparative production of 2-breed crosses

Number of cows	First lactation at Beltsville (3X365 days)					Herd	Second lactation (2X305 days)					
	Milk	Test	Fat	Age			Milk	Test	Fat	Age		Days
	Lbs.	*%*	*Lbs.*	*Yr.*	*Mo.*		*Lbs.*	*%*	*Lbs.*	*Yr.*	*Mo.*	
18	13,164	4.65	607	2	1	No. 1	9,487	4.59	433	3	5	301
4	13,310	4.62	613	2	4	No. 2	9,854	4.58	452	3	6	302
17	13,585	4.38	590	2	3	No. 3	11,310	4.14	464	3	8	304
Average of 39	13,363	4.53	609	2	2		10,319	4.39	449	3	7	302
							Third lactation (2X305 days)					
14	13,287	4.61	607	2	1	No. 1	10,800	4.42	472	4	5	298
9	13,197	4.88	639	2	2	No. 2	9,570	4.85	461	4	6	296
14	13,503	4.32	570	2	2	No. 3	11,336	4.14	464	4	8	302
Average of 34	13,373	4.54	601	2	2		10,894	4.38	467	4	7	300
							Fourth lactation (2X305 days)					
8	13,090	4.61	604	2	1	No. 1	10,422	4.50	465	5	7	300
8	13,346	4.73	628	2	1	No. 2	9,657	4.63	450	5	6	297
14	14,227	4.23	596	2	3	No. 3	11,952	4.04	478	5	9	301
Average of 30	13,601	4.47	609	2	2		10,032	4.33	467	5	8	300
							Fifth lactation (2X305 days)					
4	12,428	4.97	618	2	0	No. 1	9,586	4.84	463	6	6	297
3	13,251	4.99	661	2	0	No. 2	9,328	4.94	462	6	4	301
6	14,172	4.33	615	2	3	No. 3	12,150	3.98	485	6	10	305
Average of 13	13,561	4.68	627	2	1		10,710	4.47	473	6	8	300
							Sixth lactation (2X305 days)					
Average of 8	13,602	4.77	637	2	2		11,558	4.54	518	7	10	295
							Seventh lactation (2X305 days)					
Average of 6	13,215	4.89	636	2	1		11,630	4.48	512	8	7	305
							All lactations (2X305 days)					
Average of 130 records							10,763	4.40	467	5	1	301

The number of records for the sixth and seventh lactation periods in the individual herds was small, so only an average is shown.

A number of these two-breed cows are still in production, but with 130 lactations completed the average figure affords a good estimate of the ability of these animals to produce under farm conditions.

In Herd No. 2 a practice of breeding the cows soon after calving was followed and some of the lactation periods were quite a bit shorter than the standard 305 days.

Comparative Production of Three-Breed Crosses

The average production of the three-breed crosses in their first-lactation periods at Beltsville, when milked 3 times a day for 365 days, and their average production in subsequent-lactation periods in cooperating herds, when milked 2 times a day for not more than 305 days, was as follows:

Comparative production of 3-breed crosses

Number of cows	First lactation at Beltsville (3×365 days)					Herd	Second lactation (2×305 days)					
	Milk	Test	Fat	Age			Milk	Test	Fat	Age		Days
	Lb.	*%*	*Lb.*	*Yr.*	*Mo.*		*Lb.*	*%*	*Lb.*	*Yr.*	*Mo.*	
5	14,022	4.23	628	1	11	No. 1	11,856	4.03	460	3	4	295
2	14,684	4.58	671	2	1	No. 2	10,218	4.54	463	3	5	302
21	13,943	4.54	625	2	2	No. 3	11,709	4.37	510	3	7	302
18	13,651	4.47	605	2	2	No. 4	10,802	4.09	441	3	5	302
3	14,817	4.50	664	2	2	No. 5	9,827	4.45	436	3	4	305
6	13,834	4.26	589	2	2	No. 6	12,462	4.34	530	3	5	272
Average of 55	13,817	4.46	619	2	1		11,351	4.25	480	3	6	298
							Third lactation (2×305 days)					
4	15,429	4.12	634	1	11	No. 1	12,164	4.05	491	4	5	305
1	15,284	4.47	684	2	1	No. 2	9,402	4.66	438	4	0	298
20	14,030	4.51	628	2	2	No. 3	11,263	4.34	489	4	8	300
8	13,016	4.47	589	2	1	No. 4	10,785	4.17	460	4	0	305
5	10,781	4.34	480	2	4	No. 5	10,414	4.28	443	4	9	286
Average of 38	13,579	4.45	599	2	2		11,006	4.27	476	4	8	301
							Fourth lactation (2×305 days)					
3	15,907	4.04	642	1	11	No. 1	11,666	4.16	485	5	10	305
1	13,992	4.35	609	1	11	No. 2	10,191	4.10	418	5	2	270
10	14,053	4.70	649	2	3	No. 3	11,821	4.33	503	5	11	295
2	11,545	4.98	575	2	4	No. 4	10,168	4.45	453	6	0	305
Average of 16	14,083	4.59	637	2	2		11,483	4.30	488	5	10	296
							Fifth lactation (2×305 days)					
Average of 5	13,770	4.50	611	2	1		11,172	4.29	479	6	10	297
							Sixth lactation (2×305 days)					
1 record	13,992	4.35	609	1	11		10,487	4.21	444	7	11	256
							All lactations (2×305 days)					
Average of 115 records							11,270	4.27	480	4	4	298

The three-breed cows averaged higher than the two-breed cows in all lactation periods, except the sixth, where the numbers are small. In the overall averages of well above 100 records in each group, the three-breed cows produced about 600 pounds more milk and 13 pounds more butterfat than the two-breed cows, and the average calving age of the three-breed cows was 4 years 4 months as compared to 5 years 1 month for the two-breed cows.

The general conditions fluctuated within the individual herds and there were differences between herds due to labor turnover and poor pasture, as well as in the incidence of mastitis. One herd suffered a setback due to an outbreak of Brucellosis and two others slumped in production when supervision of the herds was relaxed for reasons beyond the owners' control.

No particular selection was followed in placing cows with cooperators, except that animals with unsound udders or breeding troubles were not moved into these herds. The production and reproduction performance of the animals was quite satisfactory to the herd owners, all of whom had had considerable experience in dairying before the cooperation was started.

Regularity of breeding is well indicated by the average age of calving in each succeeding lactation period.

SIRES USED ON THE CROSSBREEDING PROJECT

Holstein Sires

Sire No. 966 was the only Holstein sire in service during the period the first-generation crossbreds were produced, but his period of service extended into some of the subsequent generations. This sire was bred at Beltsville but proved in the herd of the Northeastern Penitentiary at Lewisburg, Pa., where the standard procedure was to milk 3 times a day for a 305-day lactation period.

The proof on which sire No. 966 was selected for use on the crossbreeding project was based on the production records of 31 dam-and-daughter pairs in the Lewisburg herd, the highest mature-equivalent record of each of the dams and daughters being used in developing the proof. The average production of the dams and daughters, on a mature-equivalent, 3×305-day basis, is as follows:

	Average production (M. E. 3×305)		
	Milk	Test	Fat
Pairs:	*Lb.*	*%*	*Lbs.*
31 Holstein daughters	18,416	3.51	645
31 Holstein dams	17,772	3.46	619
Difference	+644	+.05	+26
Number of daughters better than their dams	17	14	16

A more recent study of the Lewisburg herd produced the following proof on Holstein sire No. 966. In this proof all available records for each of the dams and daughters were averaged on a mature-equivalent, 3 × 305-day basis, and are as follows:

	Number of records	Average production (M. E. 3×305)		
		Milk	Test	Fat
Pairs:		*Lbs.*	*%*	*Lbs.*
33 Holstein daughters	97	16,887	3.5	590
33 Holstein dams	144	16,068	3.4	549
Difference		+819	+.1	+41
Number of daughters better than their dams		20	22	21

As stated previously, sire No. 966 was bred to some of the Huntley and Mandan foundation females. The 6 Holstein daughters resulting from these matings were tested and their records produce still another proof on this sire. This proof is based on the first-lactation records

made on 3 milkings daily for 365 days in the Beltsville herd, and is as follows:

	Actual-production average (3×365)					Mature-equivalent value	
	Milk	Test	Fat	Age		Milk	Fat
Pairs:	*Lbs.*	*%*	*Lbs.*	*Yr.*	*Mo.*	*Lbs.*	*Lbs.*
6 Holstein daughters	14, 686	3. 74	545	2	0	20, 631	765
6 Holstein dams	13, 898	3. 48	481	2	2	18, 892	654
Difference	+788	+. 26	+64			+1, 739	+111
Number of daughters better than their dams	4	5	4			4	4

On the crossbreeding project, No. 966 sired 24 two-breed daughters from Jersey, Guernsey, and Red Dane foundation dams. The production performance of the two-breed crossbred daughters and their dams is shown below by groups and also in summarized form. The actual-production average (3×365 days) was as follows:

	Actual-production average (3×365)					Mature-equivalent value	
	Milk	Test	Fat	Age		Milk	Fat
Pairs:	*Lbs.*	*%*	*Lbs.*	*Yr.*	*Mo.*	*Lbs.*	*Lbs.*
9 Holstein × Jersey daughters	12, 504	4. 88	623	2	3	17, 253	840
9 Jersey dams	8, 195	5. 47	443	2	5	10, 654	577
Difference	+4, 309	−. 58	+180			+6, 599	+263
Number of daughters better than their dams	9	0	9			9	9
Pairs:							
9 Holstein × Guernsey daughters	12, 796	4. 71	599	2	3	17, 186	805
9 Guernsey dams	8, 485	5. 12	431	2	6	10, 897	555
Difference	+4, 311	−. 41	+168			+6, 289	+250
Number of daughters better than their dams	9	1	9			9	9
Pairs:							
6 Holstein × Red Dane daughters	14, 005	3. 93	549	2	1	19, 629	765
6 Red Dane dams	11, 778	3. 92	454	2	9	14, 818	572
Difference	+2, 227	+. 01	+95			+4, 811	+193
Number of daughters better than their dams	4	4	5			6	6
Average of all pairs:							
24 two-breed daughters	13, 102	4. 58	596	2	2	17, 822	808
24 dams	9, 200	4. 95	442	2	7	11, 786	567
Difference	+3, 902	−. 37	+154			+6, 036	+241
Number of daughters better than their dams	22	5	23			24	24

Because of his long period of service on the crossbreeding project, No. 966 also sired 12 three-breed daughters from two-breed dams and

3 daughters from three-breed dams. The actual-production average of the daughters and dams, is as follows:

	Actual-production average (3×365)					Mature-equivalent value	
	Milk	Test	Fat	Age		Milk	Fat
Pairs:	*Lbs.*	*%*	*Lbs.*	*Yr.*	*Mo.*	*Lbs.*	*Lbs.*
12 three-breed daughters	13,931	4.46	618	2	2	19,008	839
12 two-breed dams	12,973	4.73	614	2	1	18,000	851
Difference	+958	−.27	+4			+1,008	−12
Number of daughters better than their dams	7	4	7			6	6
Pairs:							
3 daughters of three-breed dams	14,112	4.38	617	2	1	19,535	854
3 three-breed dams	13,551	4.59	620	2	0	19,158	877
Difference	+561	−.21	−3			+377	−23
Number of daughters better than their dams	3	0	2			3	2

The production records of the crossbred daughters of No. 966, beyond the first generation, are summarized as follows:

	Actual-production average (3×365)					Mature-equivalent value	
	Milk	Test	Fat	Age		Milk	Fat
Pairs:							
15 second- and third-generation crossbred daughters	*Lbs.* 13,964	*%* 4.44	*Lbs.* 618	*Yr.* 2	*Mo.* 2	*Lbs.* 19,114	*Lbs.* 842
15 two- and three-breed crossbred dams	13,089	4.70	615	2	0	18,231	856
Difference	+875	−.26	+3			+883	−14
Number of daughters better than their dams	10	4	9			9	8

Various provings indicate that Holstein sire No. 966 was a good transmitter. When he was used on the crossbreeding project, his daughters in each successive generation showed a somewhat higher average than those in the preceding generation.

The Holstein sire Governor was one of the proved bulls used at Beltsville, and he sired only a limited number of daughters on the crossbreeding experiment. His DHIA proof in the 1950 proved-sire list, on a mature-equivalent 2 milkings daily, 305-day basis, is as follows:

	Average production (M. E. 2×305)		
	Milk	Test	Fat
Pairs:	*Lbs.*	*%*	*Lbs.*
32 Holstein daughters	12,062	3.7	451
32 Holstein dams	11,402	3.8	429
Difference	+660	−.1	+22
Number of daughters better than their dams	20	17	18

He sired 4 daughters from two-breed dams and 2 daughters from three-breed dams which have completed production records. These 6 daughters proved him as follows:

	Actual-production average (3×365)				Mature-equivalent value	
	Milk	Test	Fat	Age	Milk	Fat
Pairs:	*Lbs.*	*%*	*Lbs.*	*Yr. Mo.*	*Lbs.*	*Lbs.*
6 crossbred daughters	13,406	4.22	567	2 1	18,517	784
6 crossbred dams	12,969	4.65	598	2 1	18,006	813
Difference	+437	—.43	—31		+511	—29
Number of daughters better than their dams	4	1	1		4	1

Holstein sire No. 1763 followed Governor. He was bred at Beltsville and proved in a dairyman's herd in Pennsylvania. His DHIA proof reported in the 1950 proved-sire list is as follows:

	Average production (M. E. 2×305)		
	Milk	Test	Fat
Pairs:	*Lbs.*	*%*	*Lbs.*
15 Holstein daughters	13,603	3.9	534
15 Holstein dams	14,115	3.8	531
Difference	—512	+.1	+3
Number of daughters better than their dams	7	8	11

Red Dane Sires

The Red Dane sire D–501 came from Denmark with the foundation herd, and he was proved in the Red Dane herd at Beltsville. These cattle were all milked twice daily for 300-day lactation periods, and the proof on D–501 shown below is based on the mature-equivalent values of such records. All records of both the daughters and the dams were averaged, which is according to regular DHIA proving procedure. The proof is as follows:

	Number of records	Average production (M. E. 2×300)		
		Milk	Test	Fat
Pairs:		*Lbs.*	*%*	*Lbs.*
15 Red Dane daughters	45	10,306	4.12	424
15 Red Dane dams	57	9,243	4.14	379
Difference		+1,063	—.02	+45
Number of daughters better than their dams		11	5	11

All of the crossbreeding work was done on a basis of 3 milkings daily for 365 days, and if the standard factor of 1.42 that is used for converting records from 2×305 days to 3×365 days were applied to the above records, the Red Dane daughters of D–501 would average 14,634 pounds of milk and 602 pounds of butterfat, and their dams would average 13,125 pounds of milk and 538 pounds of butterfat.

On the crossbreeding project, D–501 was bred to members of 3 groups of foundation cows, and the results are shown here separately in order to assess his value for crossbreeding. The average production of the daughters and dams was as follows:

	Actual-production average (3×365)					Mature-equivalent value	
	Milk	Test	Fat	Age		Milk	Fat
Pairs:							
7 daughters from Holstein dams	*Lbs.* 14,826	% 3.95	*Lbs.* 583	*Yr.* 2	*Mo.* 1	*Lbs.* 20,299	*Lbs.* 799
7 Holstein dams	15,489	3.49	538	2	3	20,842	725
Difference	−654	+.46	+45			−543	+74
Number of daughters better than their dams	3	7	5			3	6
Pairs:							
5 daughters from Jersey dams	12,475	4.78	598	2	1	17,188	823
5 Jersey dams	7,361	5.69	419	2	3	9,888	562
Difference	+5,114	−.91	+179			+7,300	+261
Number of daughters better than their dams	5	0	5			5	5
Pairs:							
6 daughters from Guernsey dams	13,280	4.41	584	2	1	18,381	809
6 Guernsey dams	9,091	4.80	433	2	10	11,537	550
Difference	+4,189	−.39	+151			+6,844	+259
Number of daughters better than their dams	6	1	6			6	6
Average of all pairs:							
18 two-breed daughters	13,657	4.33	588	2	1	18,796	809
18 dams	11,095	4.54	470	2	5	14,697	621
Difference	+2,562	−.21	+118			+4,099	+188

D–501 was also mated to some of the 2-breed crossbreds, and sired 10 daughters in the 3-breed generation. They proved him as follows:

	Actual-production average (3×365)					Mature-equivalent value	
	Milk	Test	Fat	Age		Milk	Fat
Pairs:							
10 three-breed daughters	*Lbs.* 13,644	% 4.66	*Lbs.* 628	*Yr.* 2	*Mo.* 1	*Lbs.* 18,946	*Lbs.* 872
10 two-breed dams	12,894	4.66	598	2	2	17,585	816
Difference	+750	0	+30			+1,361	+56
Number of daughters better than their dams	7	4	7			8	7

The breeding performance of D–501 speaks for itself, and the averages of his daughter groups advanced with each generation.

The Red Dane bull D–540 was an inbred son of D–501. He was used first in the Beltsville herd for matings to inbred daughters of D–501, but later on was accepted as a herd sire. Only a limited proof was developed with his Red Dane daughters because the early ones were inbred and quite a few of the later ones were transferred to Indiana for use on a breeding project. No comparable records on the latter are available, so the proof at Beltsville is offered on daughters milked twice daily for 300 days, using averages of all available records corrected to a mature-equivalent basis. Four of the 7 daughters were inbred. The production records of the 7 dam-and-daughter pairs are as follows:

	Number of records	Average production (M. E. 2×300)		
		Milk	Test	Fat
Pairs:		*Lbs.*	%	*Lbs.*
7 Red Dane daughters	13	10,358	3.88	400
7 Red Dane dams	21	9,182	4.02	356
Difference		+1,176	−.14	+44
Number of daughters better than their dams		5	3	6

When these averages are converted to a basis of 3 milkings daily for 365 days, by using the factor 1.42, the daughters average 14,708 pounds of milk and 568 pounds of butterfat while their dams average 13,038 pounds of milk and 506 pounds of butterfat.

From matings to two-breed dams D–540 sired 7 three-breed daughters. They proved him as follows:

	Actual-production average (3×365)					Mature-equivalent value	
	Milk	Test	Fat	Age		Milk	Fat
Pairs:							
7 three-breed daughters	*Lbs.* 15,171	% 4.12	*Lbs.* 616	*Yr.* 2	*Mo.* 3	*Lbs.* 20,473	*Lbs.* 830
7 two-breed dams	12,694	4.85	611	2	1	17,481	842
Difference	+2,477	−.73	+5			+2,992	−12
Number of daughters better than their dams	6	0	4			6	4

Red Dane bull D–507 was bred at Beltsville and sent to a group of cooperating herds in Michigan for proving. The level of production in these herds was low, and the proof as reported in a DHIA proved-sire list is as follows:

	Average production (M. E. 2×305)		
	Milk	Test	Fat
Pairs:	*Lbs.*	%	*Lbs.*
75 daughters	7,501	4.0	303
75 dams	7,134	4.1	295
Difference	+367	−.1	+8

There was a wide range in the level of production of the daughters, and those in better managed herds performed fairly well.

D–507 had no great part in the crossbreeding project, since he sired only 4 daughters in the three-breed group. One of these was an extremely low producer, making only 365 pounds of butterfat, which reduced the average of the group of 4 daughters to 543 pounds. The other 3 daughters averaged 602 pounds of butterfat in their first lactation periods, which is about the average for all cows in this three-generation group.

Red Dane sire D–508 was handled similarly to D–507, and his proof in the Michigan herds was reported in the DHIA proved-sire list as follows:

	Average production (M. E. 2×305)		
	Milk	Test	Fat
Pairs:	*Lbs.*	*%*	*Lbs.*
25 daughters	8,490	3.8	327
25 dams	8,312	3.7	304
Difference	+178	+.1	+23

Most of his daughters were in low level herds, and because of his breeding he was accepted for use on the project. His performance has already been discussed and needs no further comment after the figures on the performance of his three-breed daughters have been shown, as follows:

	Actual-production average (3×365)					Mature-equivalent value	
	Milk	Test	Fat	Age		Milk	Fat
Pairs:							
8 three-breed daughters	*Lbs.* 12,240	*%* 4.42	*Lbs.* 537	*Yr.* 2	*Mo.* 4	*Lbs.* 16,259	*Lbs.* 712
8 two-breed dams	12,770	4.92	625	2	3	17,041	837
Difference	−530	−.50	−88			−782	−124
Number of daughters better than their dams	3	1	1			4	1

Even though the level of production of the dams is above that of the entire group of two-breed crosses, this is the only sire that had daughters which failed to produce at something approximating the level of their dams in this generation. This tends to show that good transmitting sires are necessary in order to hold a high level of milk and butterfat production.

Jersey Sires

The Jersey sire No. 1102 was a Beltsville-bred bull that had been proved in Virginia, and he sired one crossbred daughter from a Holstein dam. Jersey sire No. 1565 was an unproved inbred son of No. 1186, and he sired only two crossbred daughters. Because of their small contribution no discussion of their merit is warranted.

Sire No. 1114 was bred at Beltsville and proved in Virginia before being used on the project. His DHIA proof was reported as follows:

	Average production (M. E. 2×305)		
	Milk	Test	Fat
Pairs:	*Lbs.*	*%*	*Lbs.*
7 Jersey daughters	8,053	5.89	460
7 Jersey dams	7,732	5.44	416
Difference	+321	+.45	+44

Sire No. 1114 was also used in the Jersey herd at Beltsville, and for comparative purposes his proof is based on the first-lactation records of his Jersey daughters and their dams, as made on 3 milkings daily for 365 days. Their average actual production records were as follows:

	Actual-production average (3×365)				Mature-equivalent value	
	Milk	Test	Fat	Age	Milk	Fat
Pairs:	*Lbs.*	*%*	*Lbs.*	*Yr. Mo.*	*Lbs.*	*Lbs.*
10 Jersey daughters	8,935	5.99	532	2 5	11,870	707
10 Jersey dams	9,926	5.14	510	2 2	13,472	692
Difference	−991	+.85	+22		−1,602	+15
Number of daughters better than their dams	3	10	6		3	5

On the crossbreeding experiment, he sired 6 daughters from Holstein dams and 2 from Red Dane dams. These 8 two-breed daughters and their dams averaged as follows:

	Actual-production average (3×365)				Mature-equivalent value	
	Milk	Test	Fat	Age	Milk	Fat
Pairs:	*Lbs.*	*%*	*Lbs.*	*Yr. Mo.*	*Lbs.*	*Lbs.*
8 two-breed daughters	11,440	4.95	566	2 2	15,704	776
8 Holstein and Red Dane dams	13,824	3.66	503	2 5	18,235	662
Difference	−2,384	+1.29	+63		−2,531	+114
Number of daughters better than their dams	0	8	6		0	7

He had a limited number of three-breed daughters, of which 4 were from Red Dane × Holstein dams and 1 was from a Holstein × Red Dane dam. These daughters and their dams produced as follows:

	Actual-production average (3×365)				Mature-equivalent value	
	Milk	Test	Fat	Age	Milk	Fat
Pairs:						
5 three-breed daughters	*Lbs.* 11,414	% 4.85	*Lbs.* 553	*Yr. Mo.* 2 1	*Lbs.* 15,845	*Lbs.* 768
5 two-breed dams	13,812	3.90	536	2 1	19,009	737
Difference	−2,398	+.95	+17		−3,164	+31
Number of daughters better than their dams	0	5	4		0	4

The Jersey sire No. 1186 was bred at Beltsville, and was in service there during his entire lifetime. The Beltsville proof shown is based on first-calf records of his Jersey daughters and their dams, made on 3 milkings daily for 365 days, as follows:

	Actual-production average (3×365)				Mature-equivalent value	
	Milk	Test	Fat	Age	Milk	Fat
Pairs:	*Lbs.*	%	*Lbs.*	*Yr. Mo.*	*Lbs.*	*Lbs.*
20 Jersey daughters	11,037	5.09	562	2 4	14,940	755
20 Jersey dams	10,604	5.28	556	2 5	14,092	739
Difference	+463	−.18	+6		+848	+16
Number of daughters better than their dams	11	10	10		12	10

He sired only 1 two-breed daughter, which was from a Holstein dam. When bred to two-breed cows he produced 6 three-breed daughters, and he also sired 15 daughters that were from three-breed dams. These records of these 22 crossbred daughters were used to develop the following proof on No. 1186:

	Actual-production average (3×365)				Mature-equivalent value	
	Milk	Test	Fat	Age	Milk	Fat
Pairs:	*Lbs.*	%	*Lbs.*	*Yr. Mo.*	*Lbs.*	*Lbs.*
22 crossbred daughters	13,334	4.45	590	2 3	17,846	789
22 dams	13,889	4.30	594	2 1	19,159	815
Difference	−555	+.15	−4		−1,313	−26
Number of daughters better than their dams	10	15	11		7	9

The last Jersey sire which had daughters on the crossbreeding project is No. 1593. He was bred at Beltsville and proved in a cooperator's herd in Virginia. His DHIA proof was reported as follows:

	Average production (M. E. 2×305)		
	Milk	Test	Fat
Pairs:	*Lbs.*	*%*	*Lbs.*
8 Jersey daughters	7,837	5.7	445
8 Jersey dams	8,024	4.9	395
Difference	−187	+.8	+50
Number of daughters better than their dams	5	7	6

He has 2 daughters from two-breed females and 1 from a three-breed female which have completed records. Their average production and that of their dams was as follows:

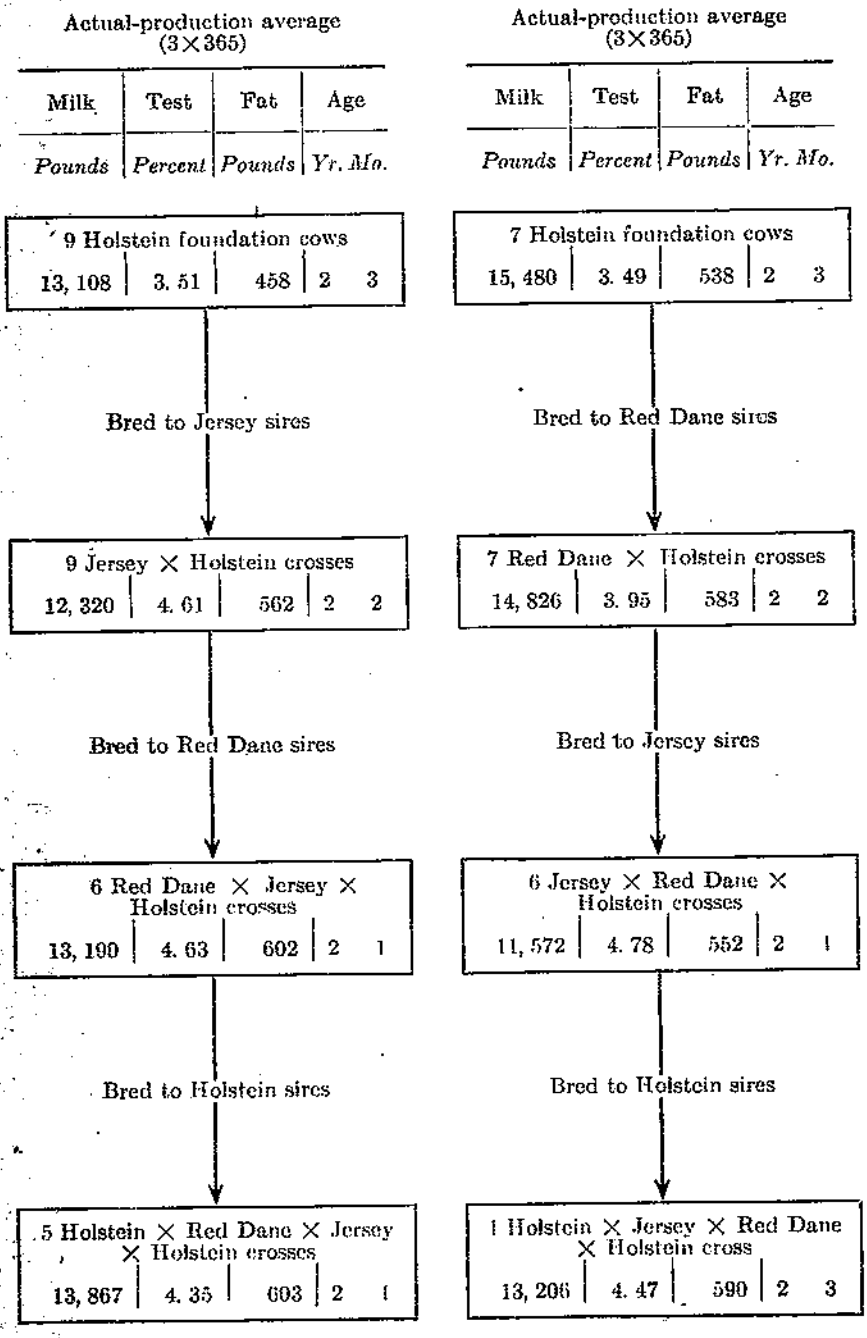
	Actual-production average (3×365)					Mature-equivalent value	
	Milk	Test	Fat	Age		Milk	Fat
Pairs:	*Lbs.*	*%*	*Lbs.*	*Yr.*	*Mo.*	*Lbs.*	*Lbs.*
3 crossbred daughters	12,033	5.33	639	2	1	16,531	875
3 crossbred dams	13,905	4.25	590	2	0	19,375	822
Difference	−1,872	+1.08	+49			−2,844	+53

There will be a number of this bull's daughters reported later when their production records are completed.

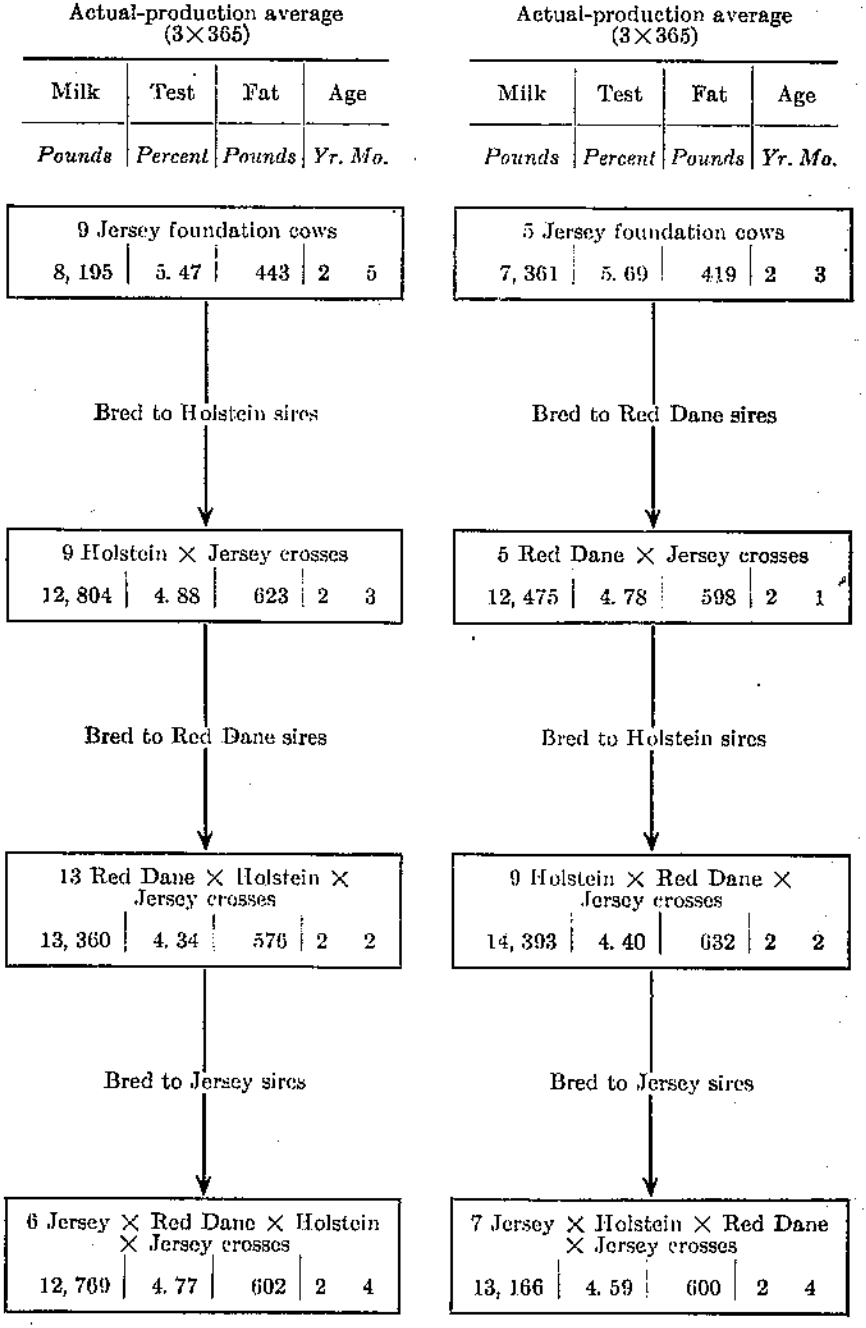
ORDER OF SIRE-BREED ROTATION

Some interest has been expressed in the importance of the order in which the different breeds of sires were used in this method of crossbreeding. For that reason, diagrams have been prepared to show the results when sires were used in different orders of rotation after the first cross.

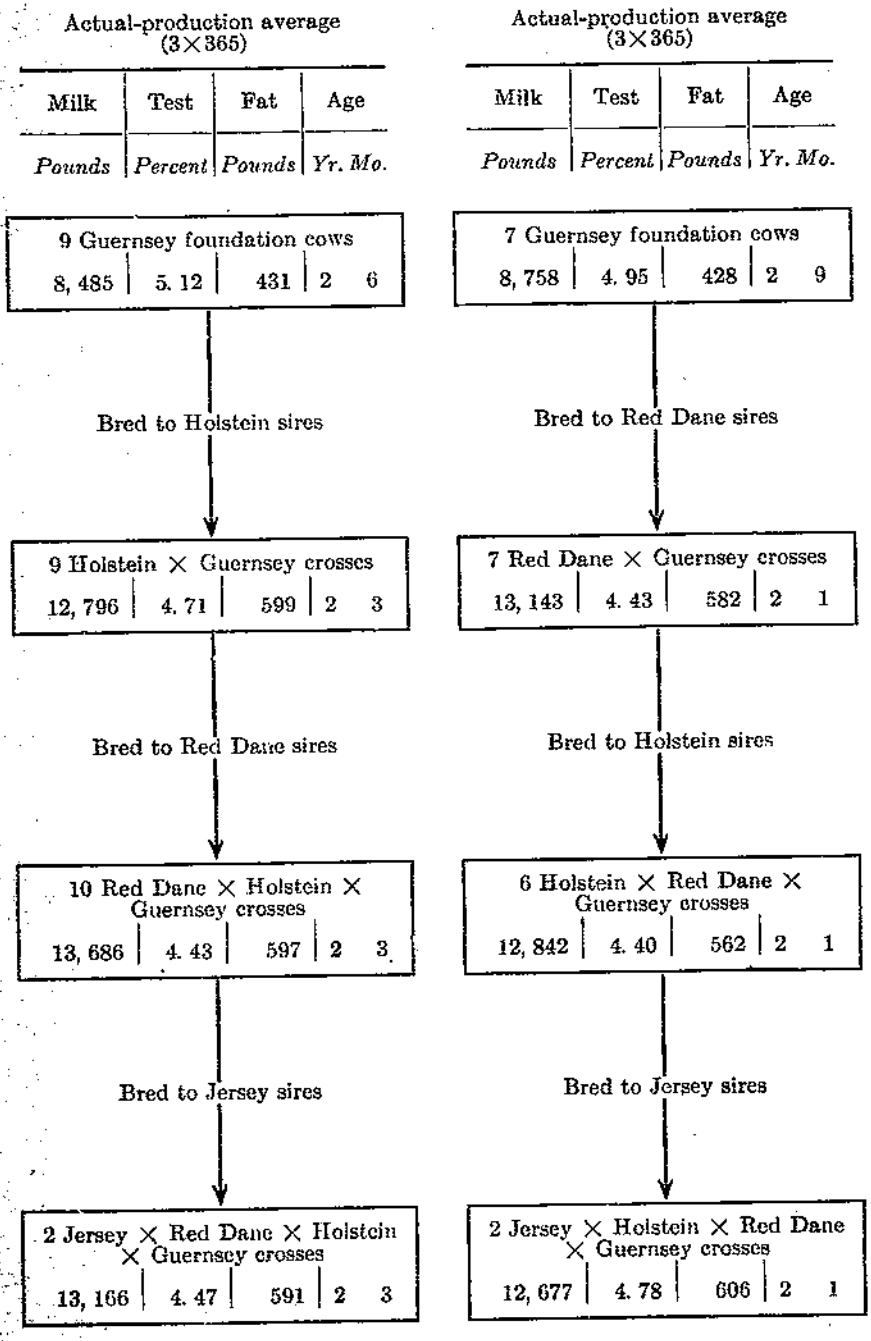
The following diagram shows the production performance of 2 groups of Holstein foundation cows, and that of the crossbred generations when sires were used in 2 different orders of rotation:



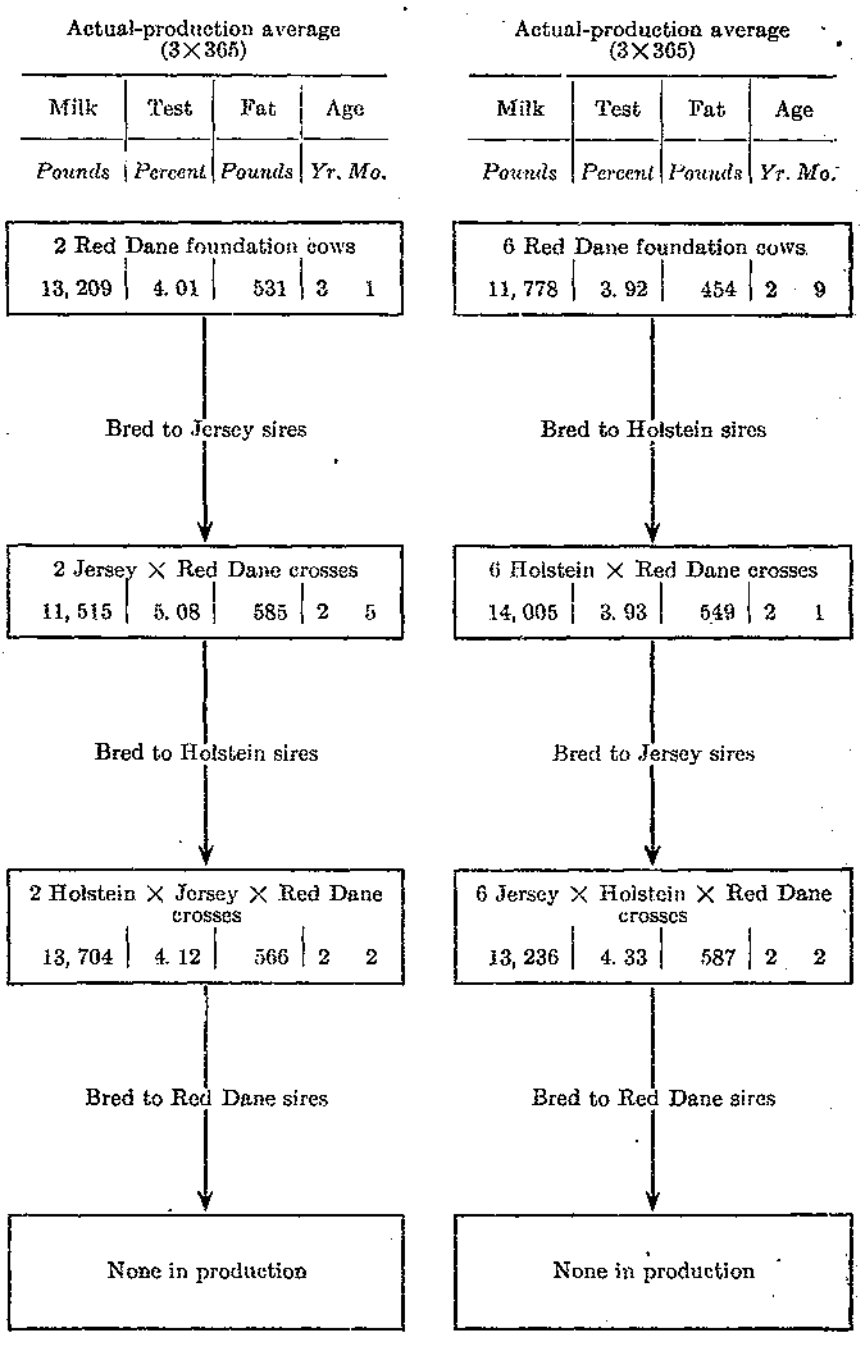
The following diagram shows the production performance of 2 groups of Jersey foundation cows, and that of the crossbred generations when the sires were used in 2 different orders of rotation:



The following diagram shows the production performance of 2 groups of Guernsey foundation cows, and that of the crossbred generations when the sires were used in 2 different orders of rotation:



The following diagram shows the production performance of 2 groups of Red Dane foundation cows, and that of the crossbred generations when the sires used were in 2 different orders of rotation:



Indications are that the order of breeds in a cycle is not particularly important, as the influence of the individual sires used seems stronger than any particular breed combination. There are no serious declines in the second and third generations of crossing. In the case of the Red Dane × Holstein × Jersey group of 13, the drop in butterfat can be accounted for by the daughters of D–508. Without these daughters the level of production would have been much higher, as already indicated in preceding discussions of this group.

PERSISTENCY OF PRODUCTION BY THE CROSSBREDS

Persistency of milk and butterfat production in dairy cattle is recognized as a valuable attribute. The ability to maintain a relatively high level of production throughout the lactation period is one of the qualities possessed by all good dairy cows, and this ability contributes a great deal toward the income from operating a milk-producing herd.

Early summaries of the production records of the crossbred cows at Beltsville gave indications that these animals were quite persistent, particularly in the production of butterfat.

Instead of following the customary practice of reporting yields of milk and butterfat on a monthly basis, we have assembled and totaled the production data for 30-day periods. Each cow's milk was sampled during each 10-day period and tested for butterfat. This procedure greatly reduced the effects of variations in butterfat tests.

In this study of persistency, in which the yields of milk and butterfat by 30-day periods were used, the last 5 days of the standard lactation were not included. What is presented here are yields for twelve 30-day periods, the first period beginning the fourth day after calving. Figures shown for milk and butterfat production in the twelve 30-day periods are averages for all cows in the various groups. (See table 1.)

TABLE 1.—*Average yields of milk and butterfat by 30-day periods for foundation cows, 2-breed crosses, and 3-breed crosses*

30-day period	Average milk yield			Average butterfat yield		
	Foundation cows	2-breed crosses	3-breed crosses	Foundation cows	2-breed crosses	3-breed crosses
	Pounds	*Pounds*	*Pounds*	*Pounds*	*Pounds*	*Pounds*
1st	979	1, 155	1, 172	40. 6	48. 5	51. 5
2d	1, 077	1, 289	1, 292	44. 3	52. 1	53. 1
3d	1, 020	1, 242	1, 257	42. 2	52. 2	51. 8
4th	959	1, 193	1, 194	40. 9	50. 9	50. 4
5th	908	1, 152	1, 138	39. 8	50. 2	49. 4
6th	859	1, 101	1, 091	37. 6	49. 3	48. 9
7th	815	1, 057	1, 074	36. 7	48. 3	47. 8
8th	787	1, 020	1, 048	35. 2	46. 8	47. 0
9th	739	1, 008	1, 010	34. 0	46. 4	46. 4
10th	718	976	968	32. 7	45. 5	44. 9
11th	683	936	923	31. 6	44. 3	43. 6
12th	598	840	851	29. 1	41. 1	41. 3

There is no generally accepted procedure for assigning a numerical value to persistency, but several methods have been suggested and used in studies of this kind.

If the yield in the 12th period is divided by the yield in the 2d or peak period, a percentage figure is arrived at, which may have some value for comparing groups. By this method it is revealed that the foundation cows produced about 55 percent as much in the 12th as in the 2d period; whereas the figure for the 2 crossbred groups is 65 percent.

A more detailed procedure, which has had some use, is to calculate the percentage which the yield of each period is of that of the preceding period, ignoring the first period. The percentages are then averaged. By this method the foundation cows had a figure of 94.3 percent, and the two crossbred groups, 95.9 percent for milk yield. For butterfat yield, the figure for the foundation group was 95.9 percent, the figure for the 2-breed crossbred group was 97.7 percent, and the figure for the 3-breed crossbred group was 97.5 percent. Since these figures are averages for 10 declines, even these small differences are significant.

In our breeding studies at Beltsville we have developed a measure of persistency which is based on the hypothesis that, if there were perfect persistency, 8.33 percent of a 360-day milk or butterfat yield would be produced in each of the twelve 30-day periods. The sum of the differences between 8.33 percent and the percentages of the total milk yield actually produced in each of the 30-day periods is taken as the measure of departure from perfect persistency. By this method, low values indicate good persistency and high values indicate poor persistency.

Applying this method to the individual-cow records, and using averages for the groups, the figures are as follows:

Group:	*Milk*	*Butterfat*
Foundation cows	14.39	10.22
Two-breed crossbreds	9.17	5.44
Three-breed crossbreds	9.75	5.95

These figures confirm the results obtained by applying other methods, and there is definite indication that both groups of crossbred animals were more persistent in both milk and butterfat yields than the foundation animals. This can be seen when the average production figures are charted as in figures 24 and 25.

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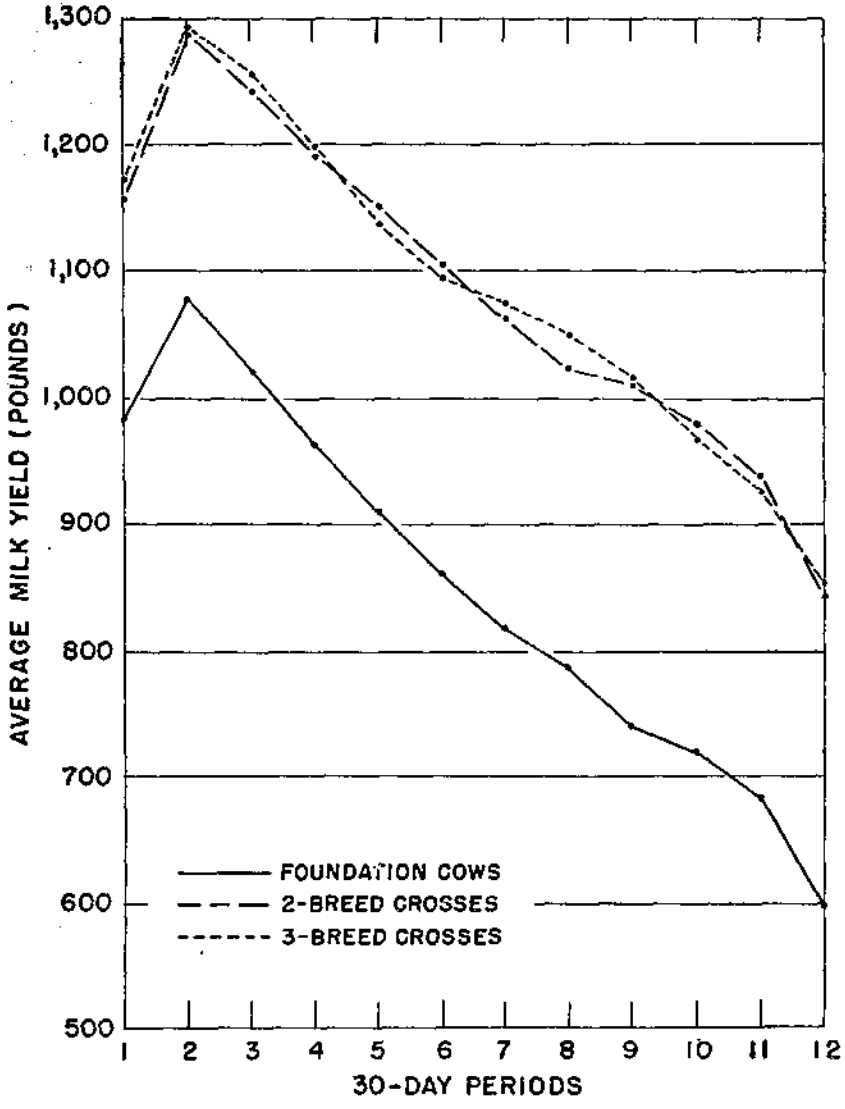

FIGURE 24.—Average milk production of the foundation cows, two-breed crosses, and three-breed crosses in each of the twelve 30-day periods.

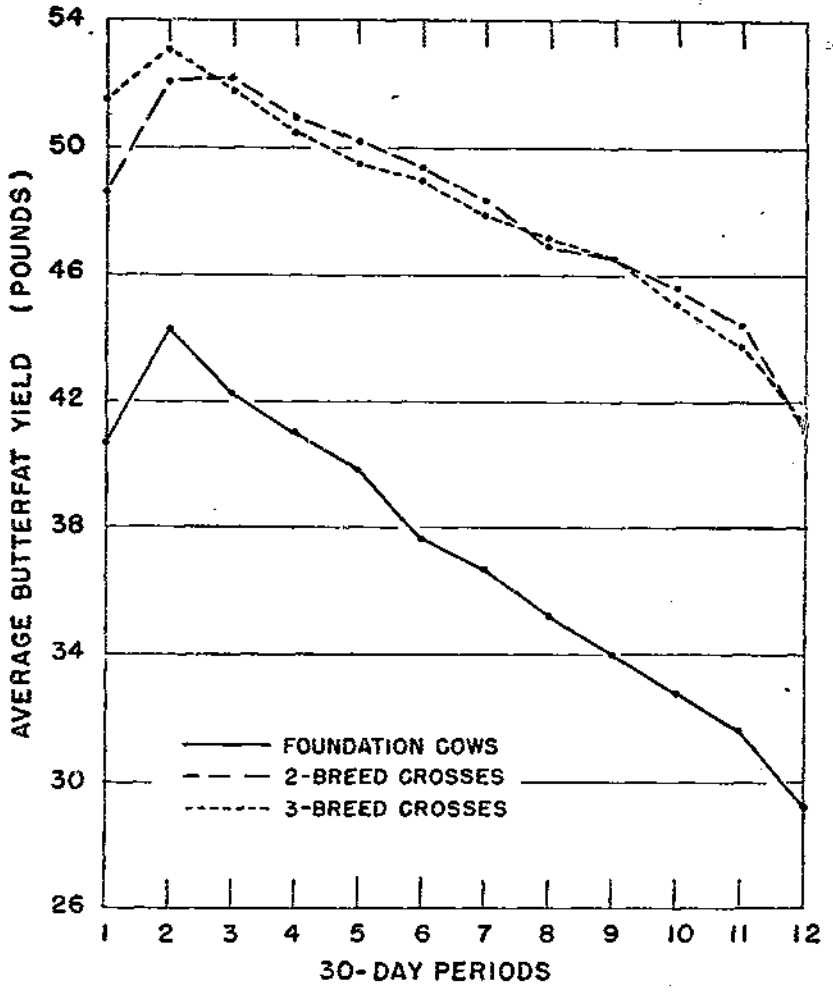

FIGURE 25.—Average butterfat production of the foundation cows, two-breed crosses, and three-breed crosses in each of the twelve 30-day periods.

BODY WEIGHTS OF THE CROSSBRED FEMALES

A complete analysis of data on body weights and measurements will be reported in another publication, but the averages of periodic body weights are presented here to afford some indication of relative size of the various breed combinations.

Table 2 gives the weights of the two-breed crosses. In each case, a standard weight for a combination of the two breeds is shown, which is the intermediate average weight of animals of both breeds at the ages shown. Where reciprocal crosses were made, the results are shown for each group and then for the two groups combined. The first symbol indicates the breed of the sire and the second the breed of the dam.

The weight figures on all two-breed combinations, where there is marked difference in size between the parent breeds, show a pronounced tendency for the progeny to more nearly approach the average weight of the larger parent, regardless of whether it is the male or female parent. This tendency is not quite so clear in the case of the Holstein and Red Dane combinations when compared to the standard weight for these crosses, but when compared to their own dams, the progeny of Red Dane cows tend to vary from their dams more than the daughters of the Holstein cows.

The average weights of the two-breed crosses at various ages were as follows:

	H × J	H × G	H × RD	RD × H	RD × J	RD × G	J × H	J × RD
	Lbs.	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*
At birth	75	82	87	100	72	86	76	71
180 days	358	335	365	372	333	345	339	340
365 days	633	619	666	665	604	617	602	595
18 months	825	838	807	856	780	789	797	779
Freshening	1,090	1,128	1,077	1,161	1,009	1,065	1,040	992
Average weight during first 10 months of lactation	1,048	1,070	1,071	1,121	988	1,002	1,009	973

Average weights of the three-breed groups have also been compared to a standard established for animals of the different combinations and to a standard for their own dams. The data for the three-breed crosses are shown in table 3.

TABLE 2.—*Average weights of two-breed crossbred groups, and variations from the standard weight*

HOLSTEIN × JERSEY (9 animals) AND JERSEY × HOLSTEIN (9 animals)

Ages when weighed	Average weights				Variations from the standard			Variations from own dams	
	H × J group	J × H group	Both groups	Standard for each group	H × J group	J × H group	Both groups	H × J group	J × H group
	Pounds	*Pounds*	*Pounds*	*Pounds*	*Pounds*	*Pounds*	*Pounds*	*Pounds*	*Pounds*
At birth	75	76	76	76	−1	0	0	+22	−9
180 days	358	339	349	336	+22	+3	+13	+119	−23
365 days	633	602	617	609	+24	−7	+8	+211	−47
18 months	825	797	811	784	+41	+13	+27	+261	−39
Precalving	1,090	1,040	1,065	1,029	+61	+11	+36		
Average for first 10 months of lactation	1,048	1,009	1,029	1,022	+26	−13	+7	+224	−86

HOLSTEIN × RED DANE GROUP (6 animals) AND RED DANE × HOLSTEIN GROUP (7 animals)

	H × RD group	RD × H group	Both groups	Standard for each group	H × RD group	RD × H group	Both groups	H × RD group	RD × H group
At birth	87	100	94	87	0	+13	+7	+5	+3
180 days	365	372	368	370	−5	+2	−2	+18	−23
365 days	666	665	665	656	+10	+9	+9	+72	−25
18 months	807	886	850	862	−55	+24	−12	+15	−17
Precalving	1,077	1,161	1,122	1,134	−57	+27	−12		
Average for first 10 months of lactation	1,071	1,121	1,098	1,095	−24	+26	+3	+74	−26

TABLE 2.—*Average weights of two-breed crossbred groups, and variations from the standard weight*—Continued

JERSEY × RED DANE GROUP (3 animals) AND RED DANE × JERSEY GROUP (5 animals)

Ages when weighed	Average weights				Variations from the standard			Variations from own dams	
	J × RD group	RD × J group	Both groups	Standard for each group	J × RD group	RD × J group	Both groups	J × RD group	RD × J group
	Pounds	*Pounds*	*Pounds*	*Pounds*	*Pounds*	*Pounds*	*Pounds*	*Pounds*	*Pounds*
At birth	71	72	72	68	+3	+4	+4	−11	+22
180 days	340	333	336	311	+29	+22	+25	−12	+92
365 days	595	604	601	561	+34	+43	+40	−40	+180
18 months	779	789	785	737	+42	+52	+48	−27	+221
Precalving	992	1,009	1,002	970	+22	+39	+32	----------	----------
Average for first 10 months of lactation	973	988	983	950	+23	+38	+33	−37	+188

HOLSTEIN × GUERNSEY GROUP (9 animals)

	H × G group			Standard for the group	H × G group			H × G group	
At birth	82	----------	----------	81	+1	----------	----------	+16	----------
180 days	335	----------	----------	333	+2	----------	----------	+73	----------
365 days	619	----------	----------	591	+28	----------	----------	+143	----------
18 months	838	----------	----------	772	+66	----------	----------	+206	----------
Precalving	1,128	----------	----------	1,054	+74	----------	----------	----------	----------
Average for first 10 months of lactation	1,070	----------	----------	1,041	+29	----------	----------	+183	----------

RED DANE × GUERNSEY GROUP (7 animals)

	RD × G group			Standard for the group	RD × G group			RD × G group	
At birth	86			73	+13			+17	
180 days	345			308	+37			+100	
365 days	617			543	+74			+162	
18 months	789			724	+65			+142	
Precalving	1,065			973	+92				
Average for first 10 months of lactation	1,002			947	+55			+115	

TABLE 3.—*Average weights of the three-breed groups, and variations from the standards established*

RD × H × J GROUP (13 animals) AND RD × J × H GROUP (6 animals)

Ages when weighed	Average weights				Variations from the standard			Variations from own dams	
	RD × H × J group	RD × J × H group	Both groups	Standard for each group	RD × H × J group	RD × J × H group	Both groups	RD × H × J group	RD × J × H group
	Pounds	*Pounds*	*Pounds*	*Pounds*	*Pounds*	*Pounds*	*Pounds*	*Pounds*	*Pounds*
At birth	82	76	80	77	+5	−1	+3	+10	+3
180 days	355	358	356	341	+14	+17	+15	+5	+24
365 days	631	622	628	609	+22	+13	+19	+12	+26
18 months	813	825	817	800	+13	+25	+17	−15	+31
Precalving	1, 106	1, 070	1, 094	1, 058	+48	+12	+26		
Average for first 10 months of lactation	1, 072	1, 017	1, 055	1, 028	+44	−11	+27	+30	+73

J × RD × H GROUP (6 animals) AND J × H × RD GROUP (6 animals)

	J × RD × H group	J × H × RD group	Both groups	Standard for each group	J × RD × H group	J × H × RD group	Both groups	J × RD × H group	J × H × RD group
At birth	71	79	75	72	−1	+7	+3	−28	−12
180 days	307	321	314	324	−17	−3	−10	−68	−49
365 days	554	604	579	585	−31	+19	−6	−115	−70
18 months	713	756	735	761	−48	−5	−26	−173	−50
Precalving	950	1, 017	983	989	−39	+28	−6		
Average for first 10 months of lactation	952	988	970	975	−23	+13	−5	−177	−76

H × RD × J GROUP (9 animals) AND H × J × RD GROUP (2 animals)[1]

	H × RD × J group	H × J × RD group	Both groups	Standard for each group	H × RD × J group	H × J × RD group	Both groups	H × RD × J group	H × J × RD group
At birth	76	71	75	81	−5	−10	−6	+5	+6
180 days	357	324	351	353	+4	−29	−2	+24	−24
365 days	638	584	628	632	+6	−48	−4	+30	−46
18 months	829	798	823	823	+6	−25	0	+31	+16
Precalving	1,112	1,073	1,104	1,088	+24	−15	+16	----------	----------
Average for first 10 months of lactation	1,058	1,054	1,058	1,065	−7	−11	−7	+60	+80

RD × H × G GROUP (11 animals)

	RD × H × G group			Standard for the group	RD × H × G group			RD × H × G group	
At birth	87	----------	----------	80	+7	----------	----------	+3	----------
180 days	360	----------	----------	339	+21	----------	----------	+18	----------
365 days	624	----------	----------	599	+25	----------	----------	−13	----------
18 months	838	----------	----------	793	+45	----------	----------	−20	----------
Precalving	1,149	----------	----------	1,075	+74	----------	----------	----------	----------
Average for first 10 months of lactation	1,106	----------	----------	1,043	+63	----------	----------	+1	----------

[1] Since there were only 2 animals in the H × J × RD group, these figures are not very dependable when compared to those for larger groups.

TABLE 3.—*Average weights of the three-breed groups, and variations from the standards established*—Continued

H × RD × G GROUP (5 animals)

Ages when weighed	Average weights				Variations from the standard			Variations from own dams	
	H × RD × G group			Standard for the group	H × RD × G group			H × RD × G group	
	Pounds	*Pounds*	*Pounds*	*Pounds*	*Pounds*	*Pounds*	*Pounds*	*Pounds*	*Pounds*
At birth	87			84	+3			+1	
180 days	365			351	+14			+15	
365 days	641			623	+18			+16	
18 months	864			817	+47			+61	
Precalving	1, 124			1, 083	+41				
Average for first 10 months of lactation	1, 077			1, 057	+20			+79	

The weight figures on the three-breed combinations are not so striking as those of the first cross. The Holstein and Red Dane sires usually sired three-breed daughters which were larger than their two-breed dams, and the Jersey bulls tended to decrease the size of the daughters from two-breed dams. However, with the exception of progeny of Jersey sires, there is somewhat marked similarity in the weights of the three-breed crosses at most ages, and to illustrate this point the average weights are listed by breed combinations, as follows:

	H × J × RD	H × J × RD	H × RD × G	RD × H × J
	Lbs.	*Lbs.*	*Lbs.*	*Lbs.*
At birth	76	71	87	82
180 days	357	324	365	355
365 days	638	584	641	631
18 months	829	708	864	813
Precalving	1,112	1,073	1,121	1,106
Average for first 10 months of lactation	1,058	1,054	1,077	1,072
	RD × J × H	RD × H × G	J × RD × H	J × H × RD
	Lbs.	*Lbs.*	*Lbs.*	*Lbs.*
At birth	76	87	71	79
180 days	358	360	307	321
365 days	622	624	554	604
18 months	825	838	713	756
Precalving	1,070	1,149	950	1,017
Average for first 10 months of lactation	1,017	1,106	952	988

Considering these weight figures in broad terms it might be said that body weights in the crossbreds follow the general pattern of individual breed averages. On a basis of body weights, the four breeds concerned would rank Holstein, Red Dane, Guernsey, and Jersey. Using the averages shown at six age periods, and disregarding the fact that the numbers in the various combinations are different, a fair estimate of the ranking of various breed combinations would be as follows:

	Two-breed crosses	Three-breed crosses
First	RD × H	H × RD × G
Second	H × RD	RD × H × G
Third	H × G	H × RD × J
Fourth	H × J	RD × H × J
Fifth	RD × G	RD × J × H
Sixth	J × H	H × J × RD
Seventh	RD × J	J × H × RD
Eighth	J × RD	J × RD × H

DISCUSSION

The results of this crossbreeding project have been presented in sufficient detail in the preceding pages so that very little discussion is called for here. Every effort was made to maintain operating conditions according to the planned procedure, so that no additional explanation would be needed to assist the reader in interpreting the results. Despite every effort to have comparable numbers of animals in all groups, this aim was not always achieved. The reasons are given in discussing the group performance.

Reproductive performance of the animals on this project was satisfactory when compared to other experimental groups where all breeding data are available for study. The use of old sires may have had some adverse effect.

No extensive statistical analysis of the individual groups was undertaken because the numbers were too small to justify such work.

It is acknowledged that any breeding research with dairy cattle could be improved by enlarging its scope through increased numbers, but it is necessary to consider that the facilities and funds required for this type of experimental work are so great that nothing would ever be accomplished if research workers waited for ideal conditions before undertaking their studies. Such philosophy has never existed in the field of research, which is indeed fortunate, since so many fundamental discoveries have resulted from work which was undertaken despite severe handicaps.

SUMMARY AND CONCLUSIONS

The crossbreeding experiment at Beltsville was started in 1939, with foundation groups of females of the Holstein, Guernsey, Jersey, and Red Dane breeds. First-generation crossbreds were produced by mating the foundation cows to proved sires of the Holstein, Jersey, and Red Dane breeds. Guernsey sires were not available, so there are no reciprocal groups to compare with the Holstein × Guernsey and Red Dane × Guernsey groups.

The pattern of the project called for a rotation of breeds, using proved sires to produce each generation. Very few inter-hybrid matings were made.

The transmitting performance of the sires used is fully discussed. Only one of the proved sires used on this project failed to live up to the promise of his previous proof.

Production performance of the crossbred females was determined during the first normal lactation period, and all cows were milked 3 times daily for 365 days. Feeding and management was the same for all groups and all were barn fed during the test lactation periods. Our facilities were not extensive enough to retain all animals in the herd during their entire productive lives. However, through cooperation with dairy farm operators, we obtained information about the subsequent production and reproduction performance of the crossbreds that afforded an estimate of their value in commercial milk-producing herds.

Production records of all project animals in this report are actual first-lactation records, with mature-equivalent values indicated in most cases.

Using only the records of the females that were produced by following the breeding pattern of rotation of breeds, the experiment has yielded the following results by generations:

Generation	Cows (number)	Actual-production average					Mature-equivalent value	
		Milk	Test	Fat	Age		Milk	Fat
		Lbs.	*%*	*Lbs.*	*Yr.*	*Mo.*	*Lbs.*	*Lbs.*
Foundation	55	10, 540	4. 55	455	2	6	13, 799	594
Two-breed crosses	55	13, 039	4. 53	586	2	2	17, 811	799
Three-breed crosses	58	13, 361	4. 44	588	2	2	18, 240	801
Progeny of three-breeds	23	13, 174	4. 58	600	2	3	17, 764	800

The standard deviation and the coefficient of variation have been calculated for the first three groups (which have been completed) with the following results:

Generation	Milk production		Fat test		Butterfat production	
	Standard deviation	Coefficient of variation	Standard deviation	Coefficient of variation	Standard deviation	Coefficient of variation
Foundation	4, 859	35. 4	0. 906	19. 7	114. 3	19. 2
Two-breed crosses	2, 294	12. 9	. 496	10. 9	75. 3	9. 4
Three-breed crosses	3, 193	17. 5	. 449	10. 1	112. 4	14. 0

Because the foundation group is composed of animals of four different breeds, the high standard deviation for milk production is to be expected; but for the within-breeds, the average standard deviation is 3,299 and the average coefficient of variation is 24.0. There is a marked decline in variation in the first generation, but some increase in the next generation.

These results indicate that, when production-proved sires are used for crossbreeding in a 3- or 4-breed rotation, a big increase in milk and butterfat production can be expected in the first cross, and slight increases in subsequent crosses.

Crossbred cows produced by this system of breeding were placed in herds of cooperating dairymen where they proved to be satisfactory dairy cows. The two-breed group completed 130 lactation periods on twice-a-day milking, with an average production of 10,763 pounds of milk and 467 pounds of butterfat in 301 days. The three-breed group under the same conditions completed 115 lactation periods, with an average of 11,270 pounds of milk and 480 pounds of butterfat in 298

days. These are averages of actual records, most of which were made when the cows were less than 5 years old.

Studies of persistency of milk production show that the crossbreds have a high degree of persistency, which accounts in part for their high level of production.

The pattern of body weights seems to be in accordance with what would be expected in various combinations of the four breeds used on this experiment.

The order of breed rotation does not appear to be too important, except as it might affect the size of the animals in the new generation. The data indicate rather that the transmitting quality of the sires used is the key to continued improvement.

The results of this experimental breeding lead to the general recommendation that for dairymen who are using artificial breeding, and have no special interest in a particluar breed but are primarily concerned with increasing the efficiency of their cows and establishing a high level of milk and butterfat production, the best practice to follow is to breed each cow to the best sire available.

The notion has existed that females resulting from crossing two breeds might be acceptable dairy animals but that no offspring from such animals should be raised for replacements in the dairy herd. There is sufficient evidence presented here to indicate that female progeny of crossbred cows, when sired by production-proved bulls, will develop into very satisfactory dairy animals.

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