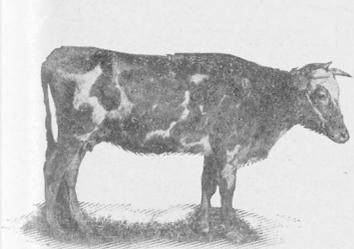
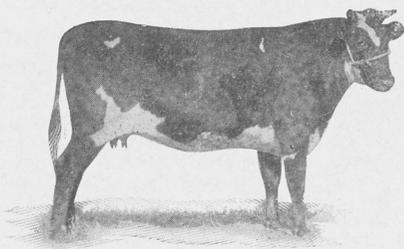


# INFLUENCE OF ENVIRONMENT AND BREEDING IN INCREASING DAIRY PRODUCTION



Scrub Cow No. 8



Grade Cow No. 68 out of No. 8, by  
Holstein sire

The daughter's increase in production over dam was 101% in milk and  
53% in fat

AGRICULTURAL EXPERIMENT STATION  
IOWA STATE COLLEGE OF AGRICULTURE  
AND THE MECHANIC ARTS

Dairy Husbandry Section

Ames, Iowa

# OFFICERS AND STAFF IOWA AGRICULTURAL EXPERIMENT STATION

## STATE BOARD OF EDUCATION

Hon. D. D. Murphy, Elkader  
Hon. Paul E. Stillman, Jefferson  
Hon. Parker K. Holbrook, Onawa  
Hon. Henry M. Eichler, Washington  
Hon. E. P. Schoentgen, Council Bluffs  
Hon. W. C. Stuckslager, Lisbon  
Hon. George T. Baker, Davenport  
Hon. Frank F. Jones, Villisca  
Hon. Charles R. Brenton, Dallas Center

### OFFICERS

Hon. D. D. Murphy, Elkader, President  
Hon. W. R. Boyd, President, Cedar Rapids  
Hon. W. H. Gemmill, Carroll, Secretary  
Hon. Thos. Lambert, Sabula  
Hon. W. H. Gemmill, Carroll

## AGRICULTURAL EXPERIMENT STATION STAFF

Raymond A. Pearson, M. S. A., LL. D., President  
C. F. Curtiss, M. S. A., D. S., Director  
W. H. Stevenson, A. B., B. S. A., Vice-Director

### AGRICULTURAL ENGINEERING

M. F. P. Costelloe, B. S. in C. E., Acting Chief  
C. W. Porter, A. B., B. S., Assistant  
W. G. Kaiser, B. S., Assistant

### AGRONOMY

W. H. Stevenson, A. B., B. S. A., Chief  
H. D. Hughes, B. S., M. S. A., Chief in Farm Crops  
P. E. Brown, B. S., A. M., Ph. D., Chief in Soil Chemistry and Bacteriology  
L. C. Burnett, M. S. A., Chief in Cereal Breeding  
John Buchanan, B. S. A., Superintendent of Co-operative Experiments  
F. S. Wilkins, B. S., Assistant in Farm Crops  
L. W. Forman, B. S. A., M. S., Chief in Field Experiments  
R. S. Potter, A. B., M. S., Ph. D., Assistant Chief in Soil Chemistry  
R. S. Snyder, B. S., Assistant in Soil Chemistry  
F. B. Howe, B. S., Assistant in Soil Survey  
M. E. Olson, B. S., Field Superintendent  
H. W. Johnston, B. S., M. S., Assistant in Soils

### ANIMAL HUSBANDRY

W. H. Pew, B. S. A., Chief  
J. M. Evvard, M. S., Assistant Chief in Animal Husbandry and Chief in Swine Production  
R. Dunn, B. S., Assistant  
G. M. Turpin, B. S., Chief in Poultry Husbandry  
H. H. Kildee, B. S. A., Chief in Dairy Husbandry  
A. C. McCandlish, M. S. A., Assistant in Dairy Husbandry

### BACTERIOLOGY

R. E. Buchanan, M. S., Ph. D., Chief; Associate in Dairy and Soil Bacteriology

### BOTANY

L. H. Pammell, B. Agr., M. S., Ph. D., Chief  
Charlotte M. King, Assistant Chief

### CHEMISTRY

A. W. Dox, B. S. A., A. M., Ph. D., Chief  
W. G. Gaessler, B. S., Assistant Chief  
S. B. Kuzirian, A. B., A. M., Ph. D., Assistant  
G. P. Plaisance, B. S., M. S., Assistant  
A. R. Lamb, B. S., M. S., Assistant  
G. W. Roark, Jr., B. S., Assistant

### DAIRYING

M. Mortensen, B. S. A., Chief  
B. W. Hammer, B. S. A., Chief in Dairy Bacteriology

### ENTOMOLOGY

R. L. Webster, A. B., Acting Chief  
C. E. Bartholomew, B.S., M.S., Assistant in Apiculture

### FARM MANAGEMENT

H. B. Munger, B. S., Chief  
O. G. Lloyd, B. S., M. S., Assistant Chief

### HORTICULTURE AND FORESTRY

S. A. Beach, B. S. A., M. S., Chief  
A. T. Erwin, M. S., Chief in Truck Crops  
Laurenz Greene, B. S., M. S. A., Chief in Pomology  
T. J. Maney, B. S., Assistant in Pomology  
G. B. MacDonald, B. S. F., Chief in Forestry

### VETERINARY MEDICINE

C. H. Stange, D. V. M., Chief

### GENERAL OFFICERS

F. W. Beckman, Ph. B., Bulletin Editor  
F. E. Colburn, Photographer

# INFLUENCE OF ENVIRONMENT AND BREEDING IN INCREASING DAIRY PRODUCTION\*

By H. H. Kildee and A. C. McCandlish

Data secured in an investigation which has now been under way for eight years at the Iowa Agricultural Experiment station give direct support to the belief that a good paying dairy herd can be built up from a foundation of common cows thru proper methods of feeding and management and thru the use of a good purebred dairy sire. The results of this work are presented in a preliminary way in this bulletin and will be given in more complete form when the investigation has been carried further.

Investigations of this kind are fundamental to the task of increasing dairy production to meet increasing demands for dairy products because they seek to find ways of getting more milk and butterfat from the overwhelming majority of common cows. There are in the United States, according to government reports, more than 20,000,000 so-called dairy animals whose average production is not half as much as it might be if proper methods of selection, breeding, feeding and management were followed by all dairy farmers. Any information that will help to build up better and more productive dairy herds from these animals is consequently of large value.

The first year's work of any coöperative cow testing association clearly demonstrates that the low average production is due both to poor feeding and inferior cows. However, it is hard to determine the relative importance of improved feeding and management compared with the influence derived from the introduction of "dairy blood" through the use of purebred dairy sires. Then, too, data from the experiment stations showing the influence of these factors are very limited.

With a herd that had been previously poorly fed, Wing<sup>1</sup> found that an abundant ration easily digestible and rather nitrogenous in character and continued thru two years resulted in an average increase of about 50% in total yield of milk and butter fat compared to the production of these cows on the owner's farm the year preceding and the year following the time at the station.

At the Maryland station<sup>2</sup> ten cows of not over average production were kept under good conditions for several years. The

\* This work was started under the direction of Prof. H. G. Van Pelt in 1907 and continued under his direction until his resignation in 1909, then for one year under the direction of Prof. A. Leitch. Since September, 1910, it has been under the direction of the senior author. This is only a preliminary report.

<sup>1</sup> Wing, H. and J. A. Foord. *Record of an Attempt to Increase the Fat in Milk by means of Liberal Feeding.* Bull. Cornell Agr. Exp. Sta. 222. 1904.

<sup>2</sup> Doane, C. F. *The Influence of Feed and Care on the Individuality of Cows.* Bull. Md. Ag. Exp. Sta. 69. 1900.

first year's record was taken as a standard with which to compare succeeding records and it was found that nine out of the ten cows increased in production after the first year. Somewhat similar results in showing the residual and developmental effects of improved feeding were secured at the Cornell station<sup>3</sup> when a herd of sixteen grade and purebred dairy cows which had never before received grain was divided into two lots of eight each. One lot received grain and the other none during the pasturing season. During this season the grain fed lot produced 27% more milk than did the other lot. In the following season six cows of each lot remained and during the pasture season the lot that had received grain during the previous summer produced 16% more milk than did the check lot, both being treated alike the second summer. The increase in production was attributed to the grain fed the previous season and was especially noticeable in the younger animals.

Data showing the influence of the sire on the production of a purebred herd have been obtained at the Missouri station,<sup>4</sup> where during a period of eighteen years, with the system of feeding and management remaining fairly constant, the records of the daughters of six Jersey bulls were compared with the records of their dams. It was found that the average production of the four daughters of the poorest sire for twenty-six lactation periods was 19% less milk and 8% less fat than the average production of their dams for twenty-three lactation periods while the average production of the three daughters of the best bull for fifteen lactation periods was 68% more milk and 61% more fat than the average production of their dams for fourteen lactation periods. This valuable and interesting information clearly demonstrates the variation in the ability of different bulls to transmit dairy qualities, and emphasizes the fact that the selection of a bull to head a purebred herd of dairy cattle is a very important matter.

It is much more difficult, however, to secure data showing the influence of the purebred dairy sire in increasing the production of a scrub or grade herd. In practically all cases where purebred sires are used, improved methods of feeding and managing the herd are initiated at about the same time. And while no one denies the value of this introduction of "dairy blood," definite data showing the value of the purebred sire on the scrub or common herd, independent of improved feeding, have not been available.

Owing to the large investment required, only a small percent of the dairy farmers can have purebred herds. Consequently the greater part of the dairy products of the country come from grade cows. Therefore everything that will increase their pro-

<sup>3</sup> Roberts, I. P. *Sundry Investigations of the Year*. Bull. Cornell Ag. Exp. Sta. 49. 1892.

<sup>4</sup> Eckles, C. H. *Dairy Cattle and Milk Production*. July, 1911.

duction is of great importance. Many farmers with common cattle are desirous of entering the dairy business. Their problem is to decide which method of entry is the better, "buying in," or "growing in." Everyone knows that a good dairy herd can be bought, but many have found that this method is not only expensive, if really good cows are secured, but hazardous, due to the introduction of diseases. Many also buy up a herd before they learn from experience that proper feed and management must be given to the animals. The question of greatest importance and frequently asked is, "Can such a herd be produced from a foundation of common cows where the initial expense is the price of a good purebred dairy sire?" It is important that this question be answered satisfactorily and with assurance of final success and also of a reasonable income from the heifers resulting from the mating with the first purebred sire, before many farmers will attempt to build up efficient and economical dairy herds, using as the foundation the cows they already own.

#### OBJECTS OF THIS INVESTIGATION

In this investigation it is attempted to determine the influence of purebred dairy sires in increasing the production from a foundation of scrub cows as well as the effect of improved feeding and management. In order that other influencing factors might be brought to a minimum, scrub cows from an isolated region of Arkansas were selected for the basis of this work in 1907. The work is still in progress and the data presented in this publication are in the form of a preliminary report, taking all records completed up to the end of 1915. Many of the daughters of the scrub cows are not mature and heifers carrying 75% of the blood of a recognized dairy breed have not as yet gone thru a lactation period.

Stated in detail the objects of this work were agreed upon as follows:

1. To determine the effects of improved feeding and care and whether or not there would be an increase in production in the second and succeeding years due to the residual and continued effects of improved feeding and the development of the digestive and mammary systems.
2. To compare the records of heifers sired by a scrub bull with the records of their dams.
3. To determine the influence of purebred dairy sires on the production of milk and butter fat.
4. To compare scrub with grade calves in rate of growth and digestive powers.

#### ANIMALS USED

In the summer of 1907 Prof. H. G. Van Pelt purchased in an isolated region of Arkansas seven cows, four yearling heifers, two heifer calves and a young bull. These animals were inferior individuals, being rather small, of very limited abdominal, udder

and vein capacity, and very unprepossessing so far as quality and top lines were concerned. So far as could be learned no purebred bulls had ever been used in that section of the state up to the time of purchase. The environment was not such as would stimulate heavy milk production as the cattle received little if any grain or concentrates, being forced to live on the rather scanty supply of grass and hay available.

No attention had been paid to the amount or quality of milk produced or to the length of lactation periods. The principal duty of the cows had been to produce enough milk for family use and to raise their calves.

The cattle reached Ames early in December, 1907, and were in very thin flesh. The accompanying photographs are more expressive than words in giving a true impression of the condition of the cattle at the time of reaching the college farm.

#### PLAN OF INVESTIGATION

The scrub cows and their calves were given the same care, feed, and shelter as the purebred dairy cattle in the herd. This environment has remained fairly constant during the eight years work.

The milk from each cow was weighed each milking and a composite sample taken from which the percent of fat was determined every seventh day. During the past two years the cows have been weighed every Monday morning so that it has been possible to feed what was required for milk production plus body maintenance.

The concentrates in the ration were weighed out each day to each cow producing milk. Amounts of silage and hay were estimated from occasional weighings. These feeds were charged at average prices and the same prices charged for all the years. The cows were credited with the butter fat at an average price of thirty-one cents per pound and skimmed milk at twenty-five cents per hundred. Pasture and soiling crops were charged at \$6.00 per acre in addition to cost of labor, seed, etc., for the latter. The net returns are secured by deducting from the income for butter fat and skimmed milk the cost of all feeds. No charge was made for labor or shelter nor credit given for calves and manure.

Some of the cows were in calf to a scrub bull when they reached the farm and one of them dropped a heifer calf which was later used in the experiment. Purebred sires of the Guernsey, Holstein and Jersey breeds were used on these scrub cows and all heifer calves grown out under the same conditions as the purebred calves on the farm. With the establishment of an Ayrshire herd, an Ayrshire bull is also being used on some of the cows.

Some of the scrub cows dropped bull calves every year as long as they were in the herd, thus the number of heifers for use

in this work has been limited. The bull calves were killed or vealed. The only ones saved were by the scrub bull brought with the cows and used one year. These calves were used in a feeding test reported in the latter part of this bulletin. Heifers by purebred sires were bred to other purebred sires of the same breed and the heifer calves resulting from this union were also kept for dairy purposes. A few of these heifers carrying 75% of the blood of recognized dairy breeds have just freshened but their records are not available for this preliminary report of the work.

### RESULTS

Unfortunately, records of production and feed consumed prior to the time the cows were brought to the college farm are not available. Consequently it is impossible to compare the records of the cows under their original environment and those obtained under conditions such as a fairly well managed herd would have.

However, a comparison of successive lactation periods, after coming to the farm, is of interest and in the following tables the cows are divided into two classes: The two cows that came to the farm at four years of age in table I and those advanced in age in table II.

#### SUCCESSIVE LACTATION PERIODS OF SCRUB COWS

In table I are shown the milk and fat records of cows nos. 6 and 31 for seven successive lactation periods. As these cows were about four years of age at the time of the first lactation period at the college farm, a part of the increase in production should be attributed to their normal development. However, the greater part of the increase is considered due to the development of digestive and milk secreting systems due to superior feeding and milking, and the residual effects of better feeding, as the cows had all been but scantily fed and poorly cared for

TABLE I—AVERAGE YEARLY RECORDS OF THE COWS NOS. 6 AND 31, THAT CAME TO THE COLLEGE FARM AT 4 YEARS OF AGE

No. of Lactation Period	MILK		FAT		Net returns over feed cost	Cost of feed per pound of fat
	Lbs.	Increase or decrease from first lactation %	Lbs.	Increase or decrease from first lactation %		
1	3084.6		149.24		\$13.93	26c
2	3984.4	29	178.97	19	32.15	18c
3	4618.1	50	217.79	46	31.68	21c
4	4907.7	59	229.91	54	37.48	19c
5	4224.0	37	197.59	32	31.80	19c
6	1991.3	-35	84.76	-50	1.97	34c
7	2862.5	-8	133.70	-10	18.95	21c



Fig. 1. Scrub cow no. 6, showing condition at arrival. First year's record at station, 4 years of age, 2,742.1 lbs. of milk, 131.04 lbs. of fat.

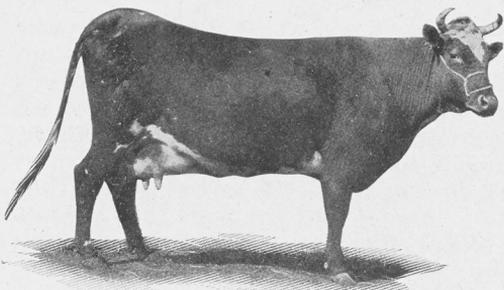


Fig. 2. Scrub cow no. 6, three years later. Record, 5556.7 lbs. of milk, 244.79 lbs. of fat. Increase over first record, 2814.6 lbs. milk and 113.75 lbs. fat.

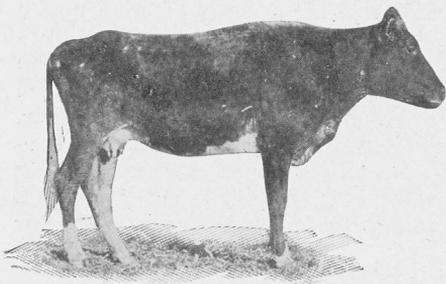


Fig. 3. Scrub cow no. 9, an aged cow, showing condition at time of arrival at station.

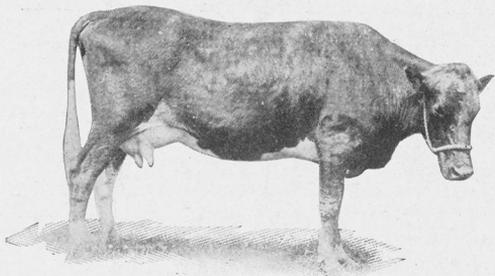


Fig. 4. Scrub cow no. 9, one year later. Record for year, 3647.6 lbs. milk and 180.7 lbs. fat.

before coming to the farm. It will be noticed that the cows increased rapidly and steadily up to the fourth lactation period, at the station when they produced 59% more milk and 54% more fat than during the first period. This is a much greater increase over the four-year-old performance than was ever secured from animals raised on the college farm and is five times as great as the breed associations' handicap (by which the four-year old is required to produce 90% as much as required of a mature cow five years old or over). The decrease for the following periods is not regular, due to the fact that cow no. 31 produced much more during the seventh than during the sixth period, but the decline is what one would expect from advancing age.

In the net returns column it will be noticed that the greatest returns were secured in the fourth period after coming to the farm when the average for the two cows was \$37.48 as against \$13.93 the first year and \$1.97 the sixth.

The average cost per pound of butter fat decreased from 26 cents the first year to 18 to 21 cents except during the sixth year when one of the cows made a very poor record. The decrease of practically 30% in cost per pound of butter fat from the first year to the second, third, and fourth indicates that the cows used much of the feed the first year to build up their bodies.

In table II are shown the successive records of cows nos. 7, 8, 9, 12, and 33. All of these were aged cows and due to old age were kept but three years in the college herd, where some of them produced heifer calves by purebred dairy bulls. The records of these heifers are shown in subsequent tables.

It will be noted that these five aged cows did not respond to improved feeding and management in such a way as to show increased production during succeeding lactation periods. However, it cannot be said that these cows did not increase in production after coming to the farm and receiving improved rations and care, as records of their production under the original conditions are not available.

TABLE II—AVERAGE YEARLY RECORDS OF THE FIVE COWS NOS. 7, 8, 9, 12, AND 33 THAT WERE AGED WHEN THEY CAME TO THE COLLEGE FARM

No. of Lactation Period	MILK		FAT		Net returns over feed cost	Cost of feed per pound of fat
	Lbs.	Increase or decrease from first lactation %	Lbs.	Increase or decrease from first lactation %		
1	3790.9		183.84		\$24.40	23c
2	2802.3	-26	135.50	-26	18.64	22c
3	2841.1	-25	141.60	-23	18.58	22c

Comparisons between tables I and II would indicate that the decrease between the first and second and the second and third lactation periods in the case of the old cows was due to advancing age. It will be noted that the cost of feed per pound of butter fat remained nearly constant for the three years and did not fall below twenty-two cents per pound, while in the case of the younger cows there was a greater decrease in cost.

In table III the cows that were four years old or over when they came to the farm are referred to as "original scrubs;" those that came as yearlings and calves, or were dropped on the college farm, are designated as "developed scrubs," while the terms Holstein x scrub, Guernsey x scrub and Jersey x scrub refer to the first generation heifers out of scrub cows and by purebred sires of those breeds. The comparisons are made between cows falling into these different classes and in this table the younger animals are not compared to their own dams but to all of the old cows taken as a group. In the comparison between the developed scrubs and the originals it will be noticed that the former have produced 13% more milk and 12% more butter fat while little difference is noted in percent of fat or length of lactation period. With seven cows in each group and the number of lactation periods, twenty-five and twenty-nine respectively, this increase is worthy of note. A direct comparison can not be made between dams and daughters in this case as but one record made by a scrub daughter of one of the old cows is available. The first generation of Holstein grades show an increase of 64% in amount of milk, 41% in pounds of fat, 15% in length of milking period and a decrease of 14% in percent of fat in milk.

The first generation Guernsey grades show an increase of 12% in quantity of milk, 6% in pounds of fat, 1% in length of lactation period and a decrease of 5% in percent of fat in milk. The smaller increase shown by these grades can not be charged

TABLE III — AVERAGE YEARLY RECORDS SHOWING INFLUENCE OF FEED AND MANAGEMENT AND THE USE OF PURE BRED DAIRY SIRES ON PRODUCTION

Lot	No. of cows	Lactation periods	Average Yearly Records				Per cent Increase over Lot 1			
			Lbs. of milk	Lbs. of fat	% fat	Days in milk	Lbs. of milk	Lbs. of fat	% fat	Days in milk
1. Original scrubs	7	29	3397.1	161.67	4.76	283				
2. Developed scrubs	7	25	3841.2	181.64	4.73	276	13	12	-1	-2
3. Holstein x scrubs	4	12	5561.6	227.94	4.10	326	64	41	-14	15
4. Guernsey x scrubs	4	8	3787.6	170.56	4.50	287	12	6	-5	1
5. Jersey x scrubs	1	2	3643.1	199.64	5.48	317	7	24	15	12

Fig. 5. Scrub cow no. 52. Best record, 4588.4 lbs. milk, and 201.67 lbs. fat. Six years old when photographed.

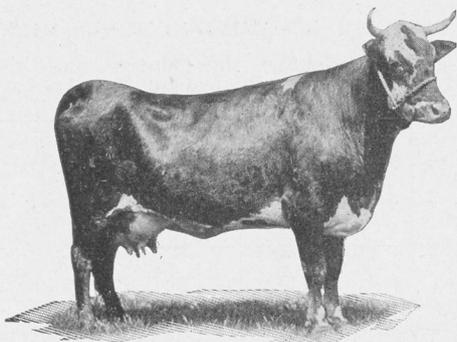


Fig. 6. Holstein x Scrub no. 69, out of scrub no. 52. Four year old record, 6822.8 lbs. milk and 283.75 lbs. fat, an increase of 49% in milk, 41% in fat and \$22.38 in profit over dam's best record. Age three years when photographed.

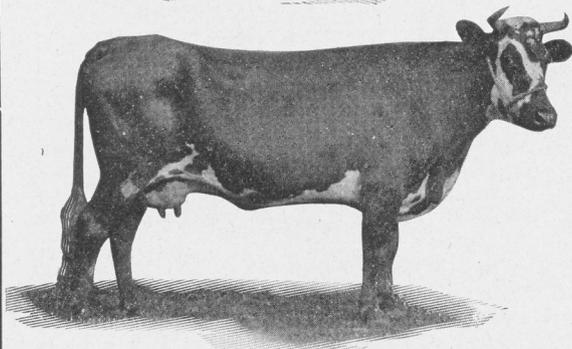
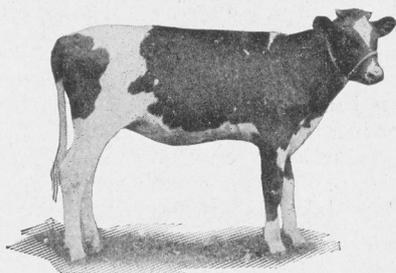


Fig. 7. Second generation Holstein grade heifer calf no. 281 of Holstein x Scrub cow no. 69, age 7 months when photographed. Not until second generation do most Holstein grades show white markings typical of purebreds.



to the breed of the sire but to the fact that no mature records are available and further that before the college owned a herd of Guernseys a bull was borrowed and his daughters, while not mature, have not equalled their dams' records, while a two-year-old grade by our present Guernsey herd bull has produced over 101% more milk and 107% more butter fat than her scrub dam, developed here at the station, produced in her best year.

Only one first generation Jersey grade has freshened and her two lactation periods show an increase of 7% in quantity of milk, 24% in pounds of fat, 15% in per cent of fat and 12% in length of milking period as compared to group of original scrubs.

## RELATIVE MONTHLY MILK PRODUCTION

Chart I shows the relative monthly milk production of the college herd of purebred cows, representing the four leading

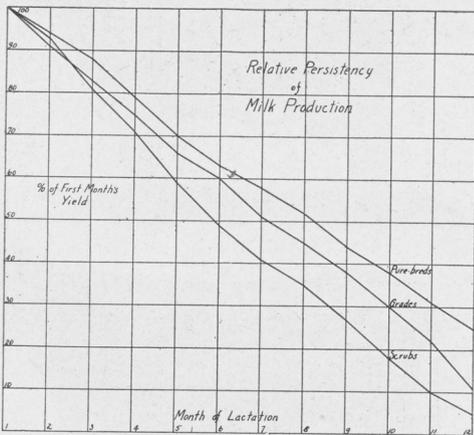


Chart 1. Showing relative monthly milk production of College herd

dairy breeds; the first generation grades resulting from the use of purebred sires on the scrub cows; and the scrub cows.

In making this chart the records of seventy-one purebred cows of various ages for 160 lactation periods, nine grades for twenty-two early lactation periods, and fourteen scrubs for fifty-four lactation periods were used. Records for succeed-

ing thirty day periods of each lactation to the purebreds, produced considerably more milk than did the scrubs and did not decrease so rapidly between the fifth and ninth months. This last point of relative persistency is more clearly shown in chart II which is made from the same records.

This chart shows the relation of each succeeding month's record of the first month's production of that group. In this chart it will be noted that the purebred cows are much more persistent, especially from the sixth month on, than the grades. The grades, however, do not decline nearly as rapidly from the fifth month on as do the scrubs.

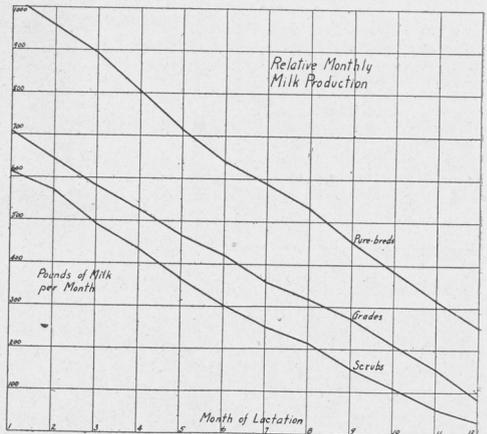


Chart 2. Showing relation of production of college herd in succeeding months to first month's production

In table IV comparison is made between a number of the scrub cows and their daughters by purebred sires. This is not a breed

Fig. 8. Scrub cow no. 56. Best record, 4975.0 lbs. milk and 253.13 lbs. fat. Age five years when photographed.

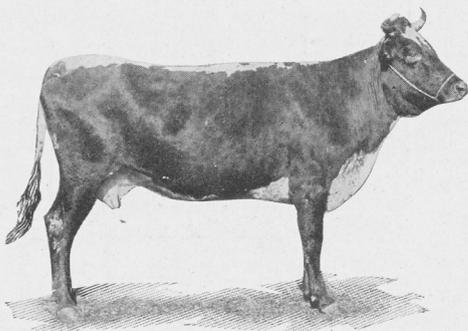


Fig. 9. Holstein x Scrub no. 77, out of scrub cow no. 56. Four year old record, 8689.3 lbs. milk and 321.31 lbs. fat, an increase of 75% in milk, 27% in fat and \$6.80 in profit over dam's best record. Age five years when photographed.

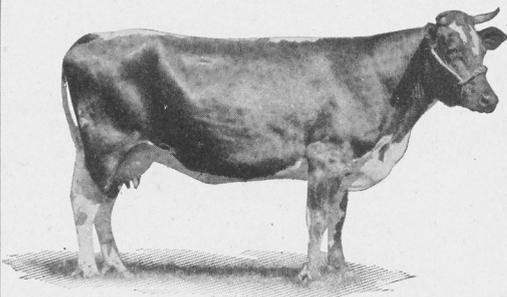
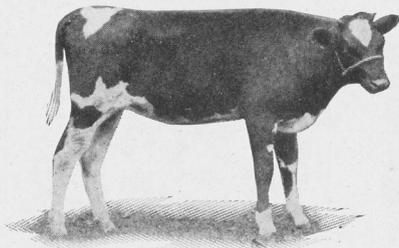


Fig. 10. Second generation Holstein grade no. 282 out of Holstein x Scrub cow 77. Age seven months when photographed.



comparison in any way as none of the scrub cows have daughters, by more than one purebred sire, in milk. The variation in the production of the dams themselves, and the fact that for this preliminary report the records of such a small number of heifers of purebred sires are available, also renders this impossible. Furthermore, the sires were not selected with this in view but were the bulls in use in our purebred herds with one exception, which is noted later.

In the case of the heifers by the Holstein sire it will be noted that when the best record made by each heifer is compared to the

TABLE IV — SCRUB COWS COMPARED TO FIRST GENERATION DAUGHTERS BY PURE BRED SIRES

DAMS							DAUGHTERS								
No. of cow	No. of Lact.		Milk Lbs.	Fat Lbs.	Age yr. mo.	Net returns over fd. cost	No. of cow	No. of Lact.		Milk Lbs.	Fat Lbs.	Age yr. mo.	Net returns over fd. cost	Per cent increase over dams	
														Milk	Fat
HOLSTEINS															
8	3	Ave. Best	2339.5 2912.7	124.35 154.77	Mature Mature	\$13.74 19.98	68	3	Ave. Best	4704.2 4865.3	190.46 205.10	4 yr. 1 mo. 5 yr. 6mo.	\$21.44 32.06	101 67	53 33
52	6	Ave. Best	3856.4 4588.4	174.53 201.67	5 yr. 6 mo. 8 yr.	19.29 16.27	69	4	Ave. Best	5757.4 6822.8	242.31 283.75	4 yr. 3 mo. 4 yr. 11 mo.	31.57 38.65	49 49	39 41
56	3	Ave. Best	3554.7 4975.0	177.18 253.13	4 yr. 4 yr.	19.54 35.21	77	4	Ave. Best	6114.9 8689.3	235.72 321.31	3 yr. 0 mo. 4 yr. 8 mo.	27.93 42.01	72 75	33 27
60	5	Ave. Best	2875.9 3534.3	156.34 190.29	4 yr. 8 mo. 3 yr. 9 mo.	21.18 33.02	207	1	Ave. Best	5137.7 5137.7	251.85 251.85	1 yr. 5 mo. 1 yr. 5 mo.	14.51 14.51	78 45	61 32
GUERNSEYS															
33	3	Ave. Best	4338.5 4916.0	183.49 204.91	Mature Mature	15.87 17.23	87	3	Ave. Best	3558.0 4286.8	151.91 193.59	3 yr. 5 mo. 2 yr. 4 mo.	14.00 23.34	-18 -13	-17 -6
6	7	Ave. Best	3897.4 5556.7	173.82 244.79	7 yr. 4 yr.	23.59 32.14	110	3	Ave. Best	3298.7 4467.3	140.50 197.96	3 yr. 4 mo. 2 yr. 3 mo.	7.79 20.46	-15 -20	-19 -19
58	3	Ave. Best	2627.5 3028.6	131.73 149.95	3 yr. 3 mo. 3 yr. 4 mo.	20.34 25.58	175	1	Ave. Best	6078.5 6078.5	310.95 310.95	2 yr. 3 mo. 2 yr. 3 mo.	50.06 50.06	131 101	136 107
53	6	Ave. Best	5361.0 6680.5	238.37 302.99	5 yr. 6 mo. 8 yr.	38.55 43.22	180	1	Ave. Best	3651.7 3651.7	176.31 176.31	2 yr. 3 mo. 2 yr. 3 mo.	8.09 8.09	-32 -45	-26 -42
JERSEY															
31	7	Ave. Best	3437.5 4258.6	166.74 215.02	7 yr. 7 yr.	24.39 42.81	174	2	Ave. Best	3643.1 4232.2	199.64 236.24	2 yr. 6 mo. 2 yr. 0 mo.	21.01 19.58	6 -1	20 10

best record of her dam, these heifers have produced in quantity of milk, from 1603.4 to 3714.3 pounds, or 45% to 75% more than their dams and 50.33 to 82.08 pounds, or 27% to 41%, more butter fat. When the average records for each are compared, in spite of the fact that mature records of the scrubs are compared with immature records of the heifers, as in the case of the best records, it will be noted that the Holstein grades have produced from 1901.0 to 2560.2 pounds, or 49% to 101%, more milk and 58.54 to 95.51 pounds, or 33% to 61%, more butter fat than their dams.

In the net returns column it will be noted that with the exception of no. 207, whose only record was made at one and a half years of age, there is a good increase in returns in favor of the heifers. No. 207, was bred too young and during her first lactation period required a great deal of feed for body growth, consequently her returns are not as great as her dam's. The other heifers show a considerable increase in net returns over their dams. This increase ranges from \$6.80 to \$22.38 when the best records are compared and the average net returns per lactation are \$7.70 to \$12.28 more than that of their dams.

In the case of the first generation Guernsey grades it will be noticed that three of the four have thus far produced less than their dams. By way of explanation, it may be stated that lack of maturity of the heifers at the time records were made is no doubt a factor of great importance, as is the fact that the scrub cows nos. 6, 33, and 53, the dams of these three heifers, have the highest average records of any of the scrubs with daughters by purebred bulls. However, it is evident that a much greater factor is the variation in the ability of different sires within a breed to transmit dairy qualities. Heifers nos. 87 and 110 were sired by a Guernsey bull loaned to the station before a Guernsey herd was owned by the college. Unfortunately records of his purebred daughters as compared with their dams are not available. However, the best record we have had from a first generation heifer was made by no. 175. As a two year old this heifer produced 6078.5 pounds of milk and 310.95 pounds of fat, or 3049.9 pounds, or 101% more milk and 161 pounds, or 107% more fat, and \$24.48 more profit than her dam's best record. This halfblood Guernsey was sired by our present herd bull and her record compared to the other first generation Guernsey grades clearly indicates that variation in the ability of sires to transmit dairy qualities is a factor of importance and worthy of close study by the man selecting a sire when the bull is to be used on a scrub herd, as well as when selection is made for a high grade or purebred herd.

The one first generation Jersey grade that has freshened to date shows a good increase over her dam in butter fat production,

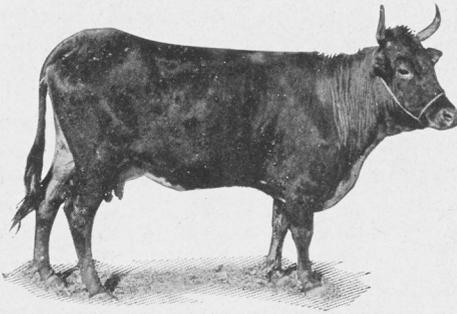


Fig. 11. Scrub cow no. 33. Best record 4916.0 lbs. milk and 204.91 lbs. fat. Mature when photographed.

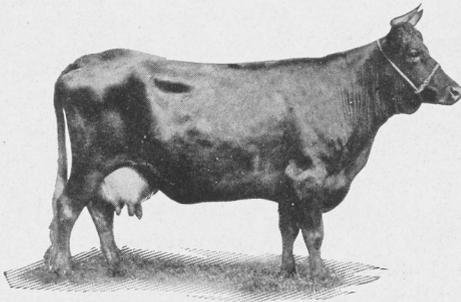


Fig. 12. Guernsey x Scrub cow no. 87, out of scrub cow no. 33. Two year old record, 4286.8 lbs. milk and 193.59 lbs. fat, decrease of 13% in milk and 6% in fat from best mature record of dam, due to heifer's immaturity and lack of prepotency of sire. Age six years when photographed.

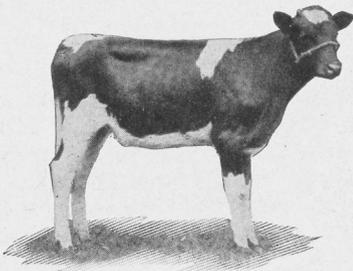


Fig. 13. Second generation Guernsey grade heifer calf no. 296, out of Guernsey x Scrub cow no. 87 and by Rouge II's son. Color, red fawn, white markings. Age five months when photographed.

in spite of the fact that her dam was one of the two scrub cows that came to the college when four years of age and has made comparatively good records.

The question naturally arises in the mind of the practical dairy farmer as to whether or not the bulls used on these scrub cows were high priced animals and therefore beyond his reach. Consequently it should be stated that none of the bulls used were bought at high prices although they were all well bred from the production standpoint. Young bulls of equal breeding can be bought for very nominal prices.

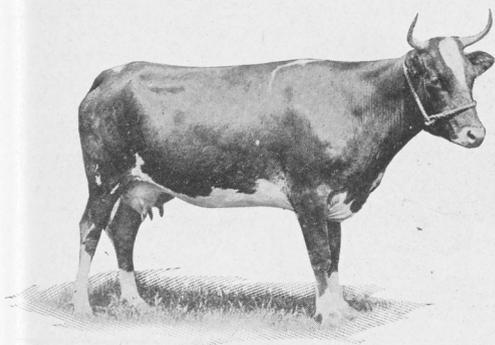


Fig. 14. Developed Scrub no. 60. Best record 3534.3 lbs. milk and 190.29 lbs. fat. Age four years when photographed.



Fig. 15. Holstein x Scrub no. 207, out of scrub cow no. 60. Record at one and one-half years old, 5137.7 lbs. milk, 251.85 lbs. fat, an increase of 45% in milk and 32% in fat over dam's record of three and one-half years. Age two and one-half years when photographed.

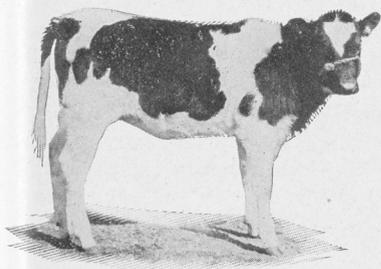


Fig. 16. Second generation Holstein grade no. 311, out of Holstein x Scrub cow no. 207 and by purebred Holstein bull.

Not only have these first generation heifers proved to be very much superior to their dams in production, and thus clearly demonstrated the value of a purebred dairy sire as an investment for a common or scrub herd as well as for a high grade or purebred herd, but a study of the illustrations also brings out the great improvement in constitution, capacity, mammary development, straightness of top line, quality and type. This improvement is more marked in the second generation grades.

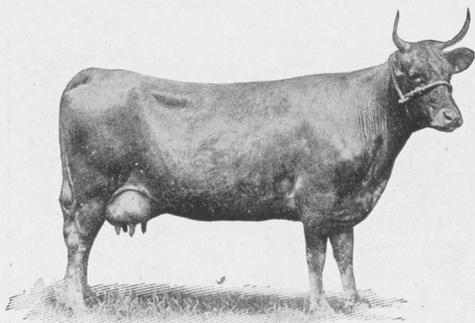


Fig. 17. Developed scrub no. 58. Color, brindle. Best record, 3028.6 lbs. milk and 149.95 lbs. fat. Age five years when photographed.



Fig. 18. Guernsey x Scrub no. 175 out of scrub cow no. 58. Color, brindle. Two year old record 6078.5 lbs. milk and 310.95 lbs. fat, an increase of 101% in milk, 107% in fat and \$24.48 in profit over dam's best record. Age three and one-half years when photographed.

#### DIGESTIVE AND FEEDING ABILITY OF SCRUB AND GRADE CALVES

It has been found at the Missouri Agricultural Experiment station that the chief difference between high producing and low producing dairy cows does not lie in the coefficient of digestion or in the maintenance requirements, but is due to the fact that a heavy milking cow has a greater capacity than a poor cow for

Fig. 21. Second generation Guernsey x Scrub heifer no. 236 out of Guernsey x Scrub cow no. 87. Color, fawn with white markings. Age one and one-half years when photographed.

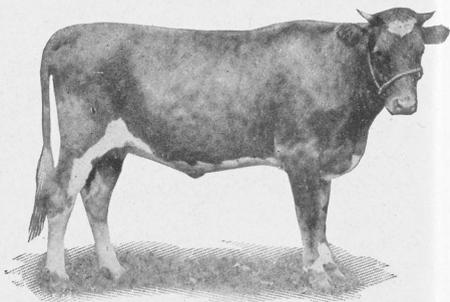


Fig. 19. Scrub cow no. 31. Color, brindle and white. Best record 4258.6 lbs. milk, 215.02 lbs. fat. Age eight years when photographed.

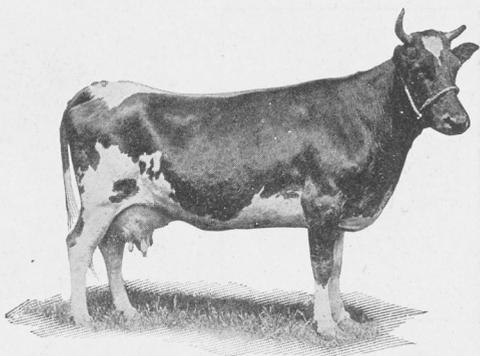
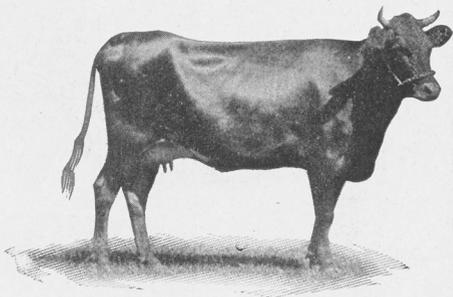


Fig. 20. Jersey x Scrub cow no. 174 out of scrub cow no. 31. Color, dark fawn. Two year old record, 4232.2 lbs. milk and 236.24 lbs. fat, an increase of 10% in fat over dam's record. Age two years when photographed.



utilizing food above her maintenance requirement.<sup>5</sup> The above work was conducted with purebred animals all of which had been kept under similar conditions.

In connection with the work on scrub cows already described, feeding and digestion trials were conducted with calves from the scrub cows and sired by a scrub bull while grade Shorthorn and Angus calves were used as a check lot.

Four scrub and four grade calves were used originally, there were two bulls and two heifers in each lot, but as one of the

<sup>5</sup> Eckles, C. H. and Reed, O. E. *A Study of the Cause of Wide Variation in Milk Production by Dairy Cows.* Res. Bull. Missouri Ag. Exp. Sta. 2. April, 1910.

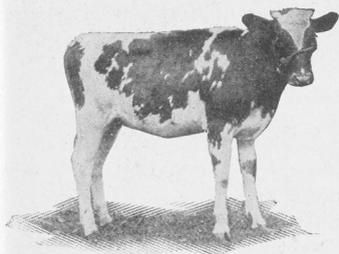


Fig. 22. Guernsey x Scrub heifer calf no. 288 out of scrub cow no. 31. Color, fawn, white markings. Age six months when photographed. First generation calves by present Guernsey herd bull are all well marked but those by first were not.

Fig. 23. Jersey x Scrub heifer calf no. 235, out of scrub cow no. 6. Color, dark fawn. Age 4 months when photographed.

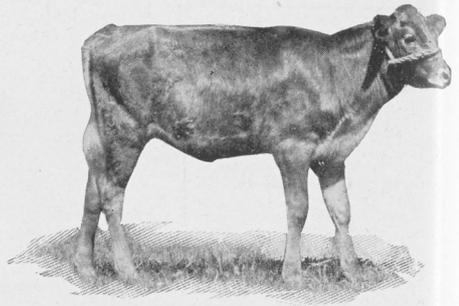


Fig. 24. Jersey x Scrub heifer calf no. 241, out of scrub cow no. 60. Color, light fawn. Age 4 months when photographed.

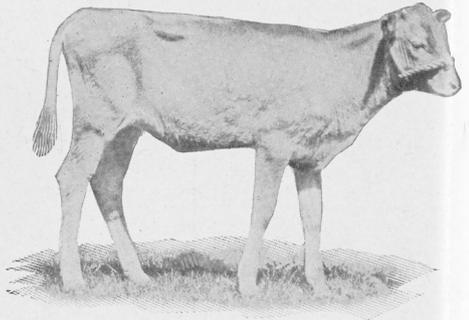
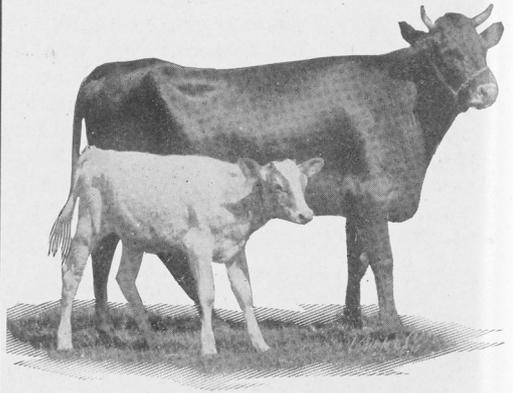


Fig. 25. Jersey x Scrub cow no. 174, and heifer calf no. 245 by a solid colored Jersey bull.



grade females proved to be unhealthy it had to be dropped from the experiment. They were four months old when the experiment started. The feeding trial lasted 196 days, in which two digestion trials of ten days each were made.

All calves received the same amount of separated milk and in addition each one was given what grain and alfalfa hay it could

consume to advantage. The grain mixture consisted of three parts, cracked corn, two parts ground oats and one part wheat bran.

TABLE V—FEED CONSUMPTION AND GAINS FOR SCRUB AND GRADE CALVES

Lot	No. of Calves	Average Daily Feed			Average Daily Gain lbs.	Average Feed for 100 lbs. gain		
		Milk lbs.	Grain lbs.	Alf. hay lbs.		Milk lbs.	Grain lbs.	Alf. hay lbs.
Scrubs	4	15.14	2.45	1.80	1.12	135.2	21.9	16.0
Grades	3	15.14	4.17	1.82	1.61	93.9	25.9	11.3

While both lots consumed about the same amount of hay the grades utilized much larger quantities of grain — their consumption per head being about 70% more than that of the scrubs.

TABLE VI—DIGESTION OF FEED BY CALVES<sup>6</sup>

Lot	Dry matter %	Carbo-hydrates %	Fat %	Protein %	Fiber %	Ash %
Scrubs	73.96	81.91	75.49	78.22	45.07	50.85
Grades	74.78	81.37	76.33	82.10	44.49	53.12

This table shows that the powers of the scrubs and grades to digest the various food constituents are practically the same.

At the end of this 196 day feeding trial these calves were turned over to the Animal Husbandry section for a continuation of the work and it is expected that a more detailed report will be published later.

### SUMMARY

The results of the eight years' work as given in this preliminary report may be summarized as follows:

1. The scrub cows that came to the station when young (four years old) increased in production rapidly and steadily up to the fourth lactation period, after reaching the station, when they produced 59% more milk and 54% more fat than during the first period.

2. The scrub cows that came to the station advanced in age did not increase in production after the first year. However it cannot be said that their production was not greater than it had been under their original environment.

<sup>6</sup>The analytical work for these digestion trials was done by W. G. Gaessler of the Chemical Section.

3. The scrub heifers developed at the station averaged 13% more milk and 12% more fat than did the scrub cows that came to the station when four years old or over.

4. The daughters of all except one purebred bull have proved to be much better producers, as two and three-year-olds, than their dams as mature cows. However, this can not be considered a breed comparison for the reasons brought out in the discussion of table IV.

5. The average of all the records made by first generation heifers by a purebred Holstein sire show an increase of 2314.5 pounds, or 71%, in milk and 67.15 pounds, or 42%, in fat, at an average age of 3½ years, over the record of their scrub dams at an average age of six years.

6. The average record of the one first generation Jersey grade that has freshened is 205.6 pounds, or 6% more milk and 32.9 pounds, or 20%, more fat at an average age of 2½ years than the record of her scrub dam at an average age of seven years.

7. The greatest increase shown by any of the first generation grades is that of no. 175 by the second Guernsey bull used. This heifer as a 2-year-old produced 3451.0 pounds, or 131%, more milk and 179.22 pounds, or 136%, more fat than the average record of her scrub dam reared at the station. However, the average records at an average age of three years made by the first generation grades by the first Guernsey sire used, are not quite equal to those of their mature dams.

8. Variation in the ability of sires to transmit dairy qualities is a factor to be considered in selecting a purebred bull to head a scrub or common herd as well as for a high grade or purebred herd.

9. In persistency of milk production the grades were intermediate between the scrub and the purebred cows in the herd.

10. The first generation grades are much superior to their dams in dairy conformation.

11. Many of the first generation grades show the characteristic color of their sire's breed; however, in the case of the Holsteins this was not so pronounced until the second generation.

12. There was no appreciable difference between the scrub and grade calves so far as coefficient of digestion is concerned, but the grades had a greater capacity for handling concentrates than had the scrubs.