LIVESTOCK BREEDING RESEARCH

at the U. S. Range Livestock Experiment Station

Agriculture Information
Bulletin No. 18

U. S. DEPARTMENT OF AGRICULTURE

The United States Range Livestock Experiment Station was founded in 1924 by an act of Congress which transferred the Fort Keogh Military Reservation from the War Department to the United States Department of Agriculture. This act made possible experimental work in cooperation with the Montana Agricultural Experiment Station.

The Fort Keogh Military Reservation was established by an act of Congress in 1876–77 setting aside 100 square miles of land in a block 10 miles square to be known as Fort Keogh, named for Captain Miles Keogh, Adjutant to General Custer. In 1912, Fort Keogh became a Remount Post for the Army and during World War I more horses were processed through Fort Keogh than any other post in the Army. At the end of World War I, the Post was abandoned. In 1924, the land was transferred to the Department of Agriculture.

The station comprises approximately 56,300 acres of land in an area nearly 10 miles square. The reservation is bounded on the east by Tongue River. In the Yellowstone River flat, approximately 1,000 acres are under irrigation. The remainder of the station is rough, broken "badlands," typical of much of the range in eastern Montana. The entire area is fenced and cross-fenced into 52 pastures ranging in size from 30 to nearly 4,000 acres. The facilities allow separate breeding pastures and enough large pastures for spring, summer, fall, and winter range.

The station breeds from 600 to 700 cows each year in 20 to 25 breeding herds. Yearling heifers for replacement, steers on feed, and calves make up the remainder of the inventory. The total may be as high as 2,000 head and may be as low as 1,000 head, according to the time of year. These cattle are all owned by the Montana Agricultural Experiment Station.

Approximately 42 acres of land has been set aside for swine research. The number of swine varies from less than 100 head to more than 600 head according to the time of year. Normally, about 60 sows are bred each year.

The station has some of the finest saddle horses in eastern Montana. Two Remount stallions of Thoroughbred breeding are available for service.

LIVESTOCK BREEDING RESEARCH

At the U. S. Range Livestock Experiment Station

By J. R. QUESENBERRY, *Director, U. S. Range Livestock Experiment Station, Bureau of Animal Industry, Agricultural Research Administration*

In Cooperation With the Montana Agricultural Experiment Station

CATTLE INVESTIGATIONS

The U. S. Range Livestock Experiment Station is located in the heart of the range area and is especially suited to beef-cattle research. It is also in a position to make definite recommendations that should assist in the improvement of commercial herds of beef cattle in the United States.

RECORD OF PERFORMANCE FEEDING TESTS IN HEREFORD CATTLE

One of the principal projects conducted at the Station is to determine whether ability to make economical gains can be appraised by observation of the live animal. An analysis of data from 181 steers fed out under record of performance methods showed that there were apparent hereditary differences between the progeny of different sires in ability to gain, in weight for age, and in conformation characteristics. Table 1 gives the results of feeding tests during 1948–49 of 8 steers from each of 13 bulls showing approximately the variation that may be expected during most years.

Between the best and the poorest progeny groups there was 119 pounds' difference in weaning weight, and 211 pounds' at the end of the feeding period. In net returns above feed and marketing cost there was $45 per head difference between the progeny of the best and poorest bull. On the 8 calves, therefore, the best bull returned $360 more than the poorest bull. Such differences are by no means exceptional, as shown by performance testing. A full report of this work can be found in Montana Agricultural Experiment Station Bulletins 397 and 417.

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FIGURE 1.—Herd bulls at the United States Range Livestock Experiment Station being driven out to spring pasture.

TABLE 1.—*Average results of record-of-performance feeding of 8 steers from each of 13 bulls in 1948–1949*

Bull number	Sire number	Birth weight	Weaning weight	Final weight	Daily gain	Slaughter grade	Returns above feed costs
		Pounds	*Pounds*	*Pounds*	*Pounds*		*Dollars*
T1	166	83	401	934	2. 12	G−	113
T2	167	82	394	940	2. 17	G+	116
T3	168	81	433	1, 004	2. 27	G+	123
T4	169	79	399	965	2. 25	G	126
T5	170	82	397	966	2. 26	G+	121
T6	171	73	374	893	2. 06	G	112
T7	173	81	493	1, 079	2. 32	G+	148
T8	174	82	460	1, 040	2. 30	G	136
T9	177	92	464	1, 054	2. 34	G+	137
T10	178	81	422	981	2. 22	G+	126
T11	182	84	418	998	2. 30	G	126
T12	189	80	438	959	2. 07	G	116
T13	188	83	392	868	1. 89	G−	103

CROSS-BREEDING BEEF CATTLE

Another project was to determine the advantages of cross-breeding in range herds in the Northern Great Plains area. This study was designed to test the possibility of maintaining hybrid vigor through the use of sires from three beef breeds and of crossbred females for each succeeding generation. The crossbred steers were fed out each generation and compared with the purebred Hereford steers used in record of performance studies. The first generation was the result of crossing Shorthorn bulls on Hereford cows. The second generation resulted from crossing Aberdeen Angus bulls on first-generation cows, and the third generation from crossing Hereford bulls on second-generation cows. In general, the crossbred steers weighed more at any age, gained more rapidly in the feed lot, had a higher final weight, and sold for more per pound, than the purebred Hereford steers. The crossbred females also grew more rapidly and weighed more at any age than the Hereford females. The crossbred females had higher calf-crop percentages than the Hereford cows. The crossbred females made excellent range mothers and the second- and third-generation calves profited as much from the fact that they were out of crossbred females as they did from the fact that they were crossbred themselves. Crossbreeding can be carried on most profitably where the range producer is able to crossbreed systematically and where he either feeds his own steers or sells direct to the feeder. A full report of this experiment may be found in United States Department of Agriculture Circular 810.

HERITABILITY ESTIMATES OF ECONOMIC CHARACTERISTICS IN BEEF CATTLE

Four reports published by the Station constitute the only reports yet available on the heritability of economic characteristics in beef cattle. The first two reports indicated the relatively high influence

of heredity in determining rate of gain in the feed lot and weight for age. A third report was of a study of rate of gain during different periods of development of the animal and the results confirmed again the relatively high influence of heredity in determining growth rate. The fourth report confirms the earlier reports, and, because much larger numbers are involved, more reliability may be placed on the new estimates. These revised estimates of heritability are:

	Percent		Percent
Birth weight	53	Weaning score	28
Weaning weight	28	Slaughter steer grade	45
Weight at 15 months	86	Carcass grade	33
Rate of gain on feed	65	Area of eye muscle	68

These estimates are valuable to both the practical breeder of cattle and the research worker in animal husbandry. Some of these high estimates have since been confirmed by the Texas Agricultural Experiment Station. Based on these studies, a Nation-wide beef-cattle breeding project has been initiated to aid materially in the further improvement of beef cattle for efficiency of beef production. These reports were published in the Journal of Animal Science.[1 2 3]

RELATIONSHIP BETWEEN SCORES AND GAINS

Early in the record of performance program of research it was found that there was little or no association between type of animal and ability to grow. It has been common belief among cattlemen that they could select the faster-gaining, more efficient animals by using conformation characteristics as a criteria. A recent analysis indicates that there is no association between conformation points and ability to gain. Conformation characteristics are inherited, as well as ability to grow, but selection by visual appraisal of feeder calves for ability to gain is ineffective.

WEIGHT AND GAINS OF CATTLE BY INTENSITY OF GRAZING

An experiment was designed to determine the effects of three rates of stocking on native short grass range vegetation and on Hereford breeding cows and their calves. The three rates of stocking were: Light rate, 38.8 acres per cow per year; moderate rate, 30.5 acres per cow per year; and heavy rate, 23.1 acres per cow per year. The average weaning weight of the calves from the heavily stocked range was 33 pounds less than that of those from the other two rates of stocking. After weaning and when on hay free choice during the first winter, the calves originally from the heavily stocked pastures were still significantly lighter than those from the other two pastures. At 18 months of age, after running on moderately stocked range the second summer, the cattle originally from the heavily stocked range during the suckling period continued to be significantly lighter than those from the mod-

[1] KNAPP, BRADFORD, JR., and NORDSKOG, A. W. HERITABILITY OF GROWTH AND EFFICIENCY IN BEEF CATTLE. Jour. Anim. Sci. 5: 62–70. 1946.

[2] PAYNE, M. G., and KINGMAN, H. E. CAROTENE BLOOD LEVELS AND REPRODUCTIVE PERFORMANCE IN RANGE HEREFORD CATTLE. Jour. Anim. Sci. 6: 50–55. 1947.

[3] KNAPP, B., JR., and CLARK, R. T. REVISED ESTIMATES OF HERITABILITY OF ECONOMIC CHARACTERISTICS IN BEEF CATTLE. (Article submitted to Jour. Anim. Sci. for publication.)

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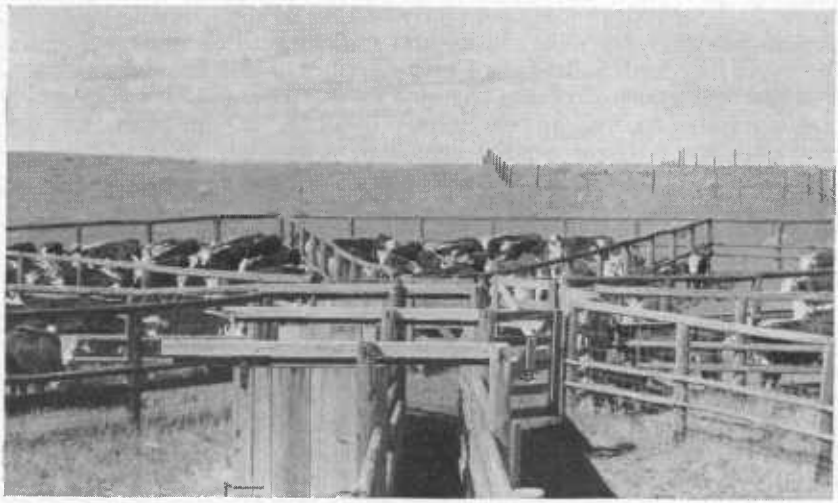

FIGURE 2.—Cattle chute designed and built at the United States Range Station.

erately and lightly stocked range. This work was conducted cooperatively by the Forest Service, the Montana Agricultural Experiment Station, and the Bureau of Animal Industry. A full report of this experiment may be found in Montana Agricultural Experiment Station Bulletin 463.

GROWTH AND PRODUCTION FACTORS IN RANGE CATTLE

An analysis of 770 calves from 112 head of cows that had been in the breeding herds at the Station for at least 9 years was made to study the efficiency of production of the range cow. Breeding cows reached mature weight at approximately 5 years of age although little change in weight occurred after 3½ years of age. Maximum birth weights of calves were obtained from 4-year-old cows and maximum weaning weights from 6-year-old cows. Male calves averaged 377 pounds at weaning time, or approximately 6 months of age, and were 22 pounds heavier than the female calves of the same age. The best producing years for a range cow are from 4 to 8 years of age. Cows should be culled from the herd at 10 years of age. A full report may be found in Montana Agricultural Experiment Station Bulletin 400.

FERTILITY OF RANGE CATTLE

An analysis of the breeding and calving records was made on 4,753 cow years over an 18-year period. The average calf crop was 83.1 percent. The effect of yearly variations due chiefly to environmental causes was statistically significant. Analysis showed that there was not a significant effect of age of cow on fertility. More than 50 percent of the shy breeding cows could be identified by the time they reached 4 years of age and approximately 80 percent by 6 years of age. There was a highly significant difference between bulls in percentage calf crop; a variation from 45.5 to 94.0 percent was observed. In a com-

parison between single- and multiple-bull breeding units, single-bull herds had approximately 6 percent more calves than multiple-bull herds. Recommendations to the range cattle producer were proposed that would aid in increasing the calf-crop percentage. A full report of this study was made by Baker and Quesenberry.[4]

MISCELLANEOUS RECORD OF PERFORMANCE REPORTS

Three reports were published that dealt with the design and experimental methods in record of performance testing of beef cattle. The first report was in regard to the number of animals and length of feeding period to progeny test a beef bull for rate of growth. From five to eight animals would be required to prove a beef bull. A feeding period of not less than 140 days was required and, to measure carcass quality, a longer feeding period for calves was to be recommended. A second study involved a comparison between limited and full feeding to test growth ability. When all animals were held to a limited feeding program, all animals grew alike and therefore genetic growth ability was not measured. However, when all animals were full fed, there were measurable differences between the progeny of various sires. The third study dealt with variations in the occurrence of bloat in the progeny groups of various bulls. The steers from some bulls definitely had a greater tendency to bloat than the progeny of other bulls. Since these differences were significant, it is assumed that there are some genetic differences in bulls. Reports of this work were published in the Journal of Animal Science.[5 6]

WINTERING AND SUMMER-GRAZING TRIALS WITH HEIFERS

Experiments comparing alfalfa hay and western wheatgrass hay were carried out with 108 yearling heifers between 1927 and 1929. Approximately 12 percent more alfalfa hay than wheatgrass hay was required to produce similar winter gains. These gains were followed by similar summer gains, regardless of the kind of hay fed. The western wheatgrass hay valued at the same price per ton as alfalfa was therefore slightly less expensive from the standpoint of winter feed costs. A full report of this experiment may be found in United States Department of Agriculture Technical Bulletin 635.

WINTERING BEEF COWS ON RANGE

Experiments over a 5-year period were conducted to determine the effect of wintering breeding cows on the range with and without a supplement of cottonseed cake. Winter gains or losses in weight, feed costs, and subsequent calf crop were considered in evaluating the two systems of wintering cows. Cottonseed cake proved a valuable supplement to native range, but for economical production its use

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[4] BAKER, A. L., and QUESENBERRY, J. R. FERTILITY OF RANGE BEEF CATTLE. Jour. Anim. Sci. 3: 78–87. 1944.

[5] KNAPP, BRADFORD, JR., and BLACK, W. H. DISCUSSION OF LENGTH OF FEEDING PERIOD IN BEEF CATTLE RECORD OF PERFORMANCE TESTS. Jour. Anim. Sci. 1: 65. 1942. [Abstract]

[6] HANKINS, O. G.; KNAPP, BRADFORD, JR.; and PHILLIPS, R. W. THE MUSCLE-BONE RATIO AS AN INDEX OF MERIT IN BEEF AND DUAL-PURPOSE CATTLE. Jour. Anim. Sci. 2: 42–49. 1943.

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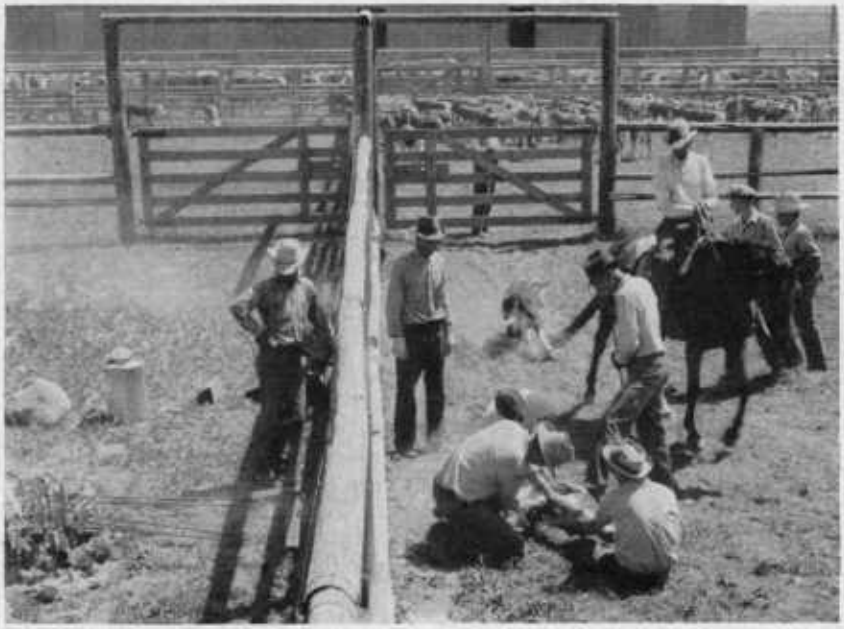

FIGURE 3.—Branding calves at the United States Range Station headquarters. The calves were for use in record of performance testing.

should be limited to seasons in which range conditions are severe. One pound of cottonseed cake fed on the range replaced approximately 10 pounds of hay fed in the feed lot. Differences in birth weight and weaning weight of calves from the two groups were not significant. A full report of this experiment may be found in United States Department of Agriculture Technical Bulletin 603.

WINTER AND SUMMER FEEDING OF BEEF CALVES

A total of 206 Hereford calves were carried from the winter of 1926 through the summer grazing season of 1929 to determine the effects of feeding (1) alfalfa hay alone, (2) alfalfa hay with cottonseed cake, and (3) alfalfa hay with corn silage, on winter gains, feed costs, and subsequent summer gains on the range. The results indicate that alfalfa hay of good quality, without supplement, is a satisfactory feed for wintering feeder and stocker calves in the northern Great Plains. A full report of this experiment may be found in United States Department of Agriculture Technical Bulletin 529.

WINTERING AND SUMMER-GRAZING STEERS TO 2½ YEARS OF AGE

Hereford steers were winter fed as calves and as yearlings in three groups on high, medium, and low levels of feeding. The rations differed mainly in amounts of alfalfa hay and straw fed each day. The feed and range costs per head for the steers at 2½ years of age were as follows: $20.11 for the high level, $13.56 for the medium level, and $10.87 for the low level of nutrition. The average weights of

the three groups were 1,068, 1,036, and 1,031, respectively. While significantly greater gains were made by the steers wintered on a high level of nutrition, significantly cheaper gains and larger gains during the grazing season were made by steers on the low level of nutrition. Where good quality straw is available as a supplement to alfalfa hay, wintering costs can be reduced approximately 30 to 40 percent for calves and yearlings without material reduction in ultimate size, if the steers are carried through two or more grazing seasons and marketed off grass in the fall. A full report of this experiment may be found in United States Department of Agriculture Technical Bulletin 667.

SWINE INVESTIGATIONS

Although investigations on the breeding and feeding of hogs have been conducted at the Station since 1925, only the most important are reported here. Results of various studies have been published in Department publications and livestock periodicals.

CROSS-BREEDING

In connection with investigations on Wiltshire sides, a large amount of data on the production of crossbred market hogs was obtained. Comparative feeding trials with more than 800 purebred and crossbred pigs showed an economy of production in favor of the crossbreds amounting to approximately $1.50 per market hog produced. These data were published in condensed form in Iowa Station Bulletin 380.

A NEW BREED OF HOGS

A project was inaugurated to develop a strain of black hogs from crosses of the Danish Landrace and American Hampshire breeds with the purpose of incorporating the best characteristics of the two breeds into the single strain.

The foundation Hampshires used to cross with the Landrace hogs were totally black in color. The first generation of crossbred pigs varied from almost white through all degrees of spotting to a grey or blue roan. In the second generation some solid black pigs were produced and from these foundation animals the present black strain has been obtained.

The plan followed in the development of this strain was to use different intensities of inbreeding and different proportions of Hampshire and Landrace ancestry, in combination with selection on a progeny basis to fix desirable characters, such as prolificacy, economy of production, and desirable meat type conformation. The breeding in this strain is now approximately 55 percent Landrace and 45 percent Hampshire.

The imported Danish Landrace hogs were from lines of outstanding prolificacy. Prime consideration was given to maintaining this productivity. At Miles City, 337 litters from the black strain averaged 10.7 pigs at birth, 8.0 pigs weaned, and a litter weight of 237.5 pounds at 56 days of age.

Each year for the 7 years 1942–44 and 1946–49, a representative group of 4 pigs from the more promising litters were fed out in dry

lot under experimental conditions, from weaning at 56 days of age to a marketable weight of approximately 225 pounds. During these years, 504 pigs were fed out in these tests. The average daily gain was 1.43 pounds and the average feed per 100 pounds of gain was 369 pounds.

In 1946, 48 record of performance hogs averaging 221 pounds of live weight were shipped to the University of Nebraska, where they were slaughtered and careful carcass analyses made by Prof. W. J. Loeffel, meat specialist of the Nebraska Experiment Station. The five primal cuts—ham, loin, picnic shoulder, shoulder butt, and bacon—averaged 47.1 percent of the live weight, with an average back-fat thickness of 1.5 inches. The data indicate that this strain yields a very creditable meat type carcass.

In 1947, the cooperating agencies decided on the name Hamprace for this new breed of hogs. From 1944 to the present time, 84 boars and 151 bred females have been sold to experiment stations and farmers for trial under conditions of commercial production. About 50 herds of purebred Hamprace hogs are now in the hands of commercial producers, mostly in Montana, Nebraska, Iowa, and Illinois.

The Hamprace is a solid black hog. The back is slightly arched; the sides are smooth and uniformly deep. The hams are thick and carry well down to the hocks. The legs are medium in length. The head is small, rather narrow, and medium in length, with a neat jowl. Their disposition is very quiet and docile.

Purebred animals of this breed, tracing their ancestry direct to the Miles City Station, are registered under the name of Montana No. 1 by the Inbred Livestock Registry Association of St. Paul, and as Hamprace by the Hamprace Swine Breeders Association of West Lafayette, Ind. A description of this breed of hogs may be found in Montana Agricultural Experiment Station Bulletin 454.

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FIGURE 4.—Hamprace sow and her litter of pigs farrowed in the spring of 1948.

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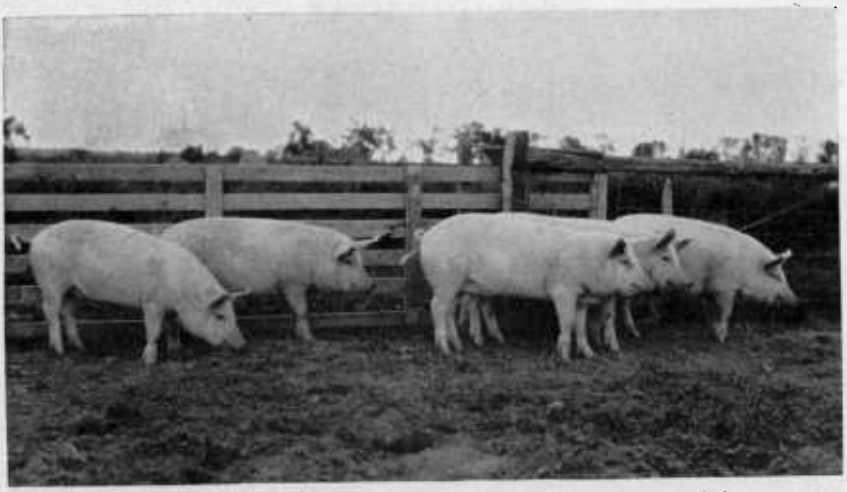

FIGURE 5.—Yorkshire × Duroc crossbred pigs. About 80 percent of these crosses were suitable for Wiltshire sides.

PRODUCING HOGS FOR WILTSHIRE SIDES

A project dealing with the production of hogs suitable for Wiltshire sides was carried on from 1927 to 1932.

Herds of purebred Yorkshires and Chester Whites, and reciprocal crosses of the two breeds were used. The small-grain areas of the northwestern United States were found suitable for the production of hogs that can be converted into Wiltshire sides. Where proper systems of breeding, feeding, and management are followed, Wiltshire sides can be produced which compare favorably with the best Canadian Wiltshires. This series of experiments was reported in the U. S. Department of Agriculture Circular 532.

SHEEP INVESTIGATIONS

Although sheep were maintained at the Station from 1924 to 1941, only one publication by the United States Department of Agriculture was ever printed dealing directly with the results of research with sheep. Data from the Station were combined with data from other sources in several publications.

STOCKING NORTHERN GREAT PLAINS SHEEP RANGE

An experiment was designed to determine the effects of three rates of stocking on Northern Great Plains range vegetation and on yearling range ewes. This work was conducted cooperatively by the Forest Service, the Montana Agricultural Experiment Station, and the Bureau of Animal Industry. Three pastures of 332, 476, and 847 acres were stocked each year with yearling ewes. The same number of ewes were placed in each pasture each year, though the number varied from year to year from 35 to 104 according to the vegetation available.

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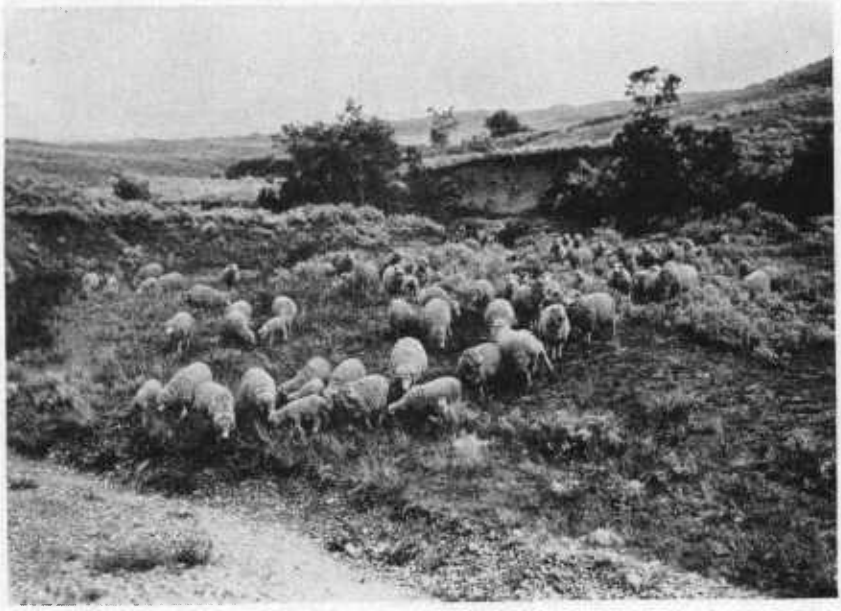

FIGURE 6.—Sheep on the range near Miles City, Mont.

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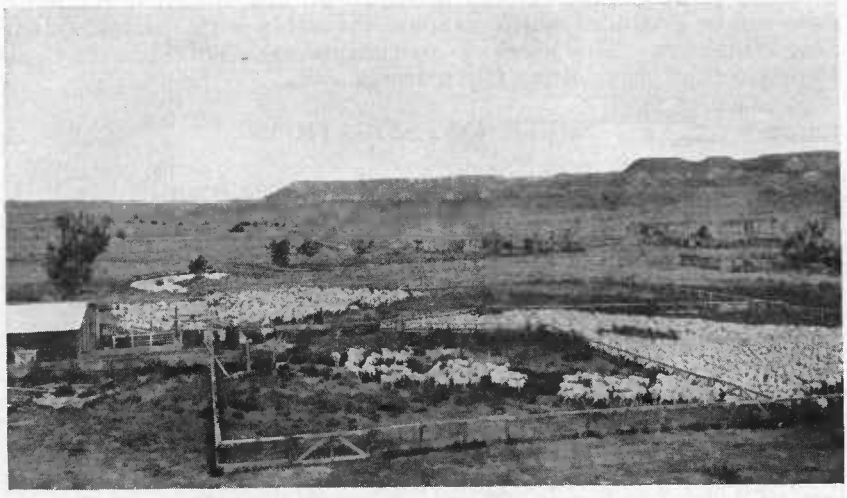

FIGURE 7.—Sheep in corrals at U. S. Range Livestock Experiment Station, Miles City, Mont.

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FIGURE 8.—Sheep crossing bridge, near Miles City, Mont.

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FIGURE 9.—Flooded pasture. Miles City, Mont., in the distance.

On heavily stocked range, the yearling ewes gained significantly less weight during the average grazing season than those on the conservatively and lightly stocked ranges. A minimum of 5.4 acres for an 8-month grazing season is recommended for normal development and maintenance of a dry yearling ewe. A full report of this experiment may be found in U. S. Department of Agriculture Circular 804.

WATER CONSERVATION

IRRIGATION WITH FLOOD WATER

In 1936 a research project was undertaken to determine the possibility and practicability of improving the vegetative cover of range lands through the conservation and use of flood water normally lost through runoff. Runoff from a watershed of about 5.4 square miles yielded about 120 acre-feet of water in 1 year. This runoff, spread over the greater part of 500 acres by a system of dikes, produced enough winter pasture for 300 head of cattle, or over twice the number of animal units that were grazed on the tract during the previous year. Automatic spreading of flood waters by diversion dams and dikes greatly increases the growth of native grasses and permits the use of crested wheatgrass and brome grass to improve the vegetation cover. Flood waters from rough, steep range lands may be diverted onto more level grazing lands. Thus, the number of livestock that a given area will support may be materially increased, and greater stability to range operations provided. A full report of this project may be found in Montana Agricultural Experiment Station Bulletin 380.

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