MONTANA STATE UNIVERSITY

The effect of flushing on reproductive performance of ewes managed under range conditions
by Arthur S Hoversland

A THESIS Submitted to the Graduate Faculty in partial fulfillment of the requirements for the degree of Master of Science in Animal Industry
Montana State University
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Abstract:
The trial reported herein was initiated to study the effect of supple mental feeding range ewes prior to and during breeding (flushing) on their subsequent reproductive performance and productivity. The experimental an imals consisted of a band of grade, whiteface ewes. Of a total of 2902 ewe-years, 2232 ewe-years are represented by mature ewes and 670 ewe-years are represented by two-year-old ewes. Supplemental feeding at the fate of one-half pound per head per day did not insure body weight gain. Significant differences in weight gain resulted due to treatment, years and year x treatment interaction. The weight advantage acquired by the flushed ewes during the flushing period was retained to a high degree during the entire pregnancy period.

On the average, over the three-year period flushing resulted in a reduced proportion of single births, an increased proportion of multiple births, an increased lambing percent based on ewes bred and alive at lambing and an increased lambing percent based on ewes lambing. This occurred in both age groups.

The increases and reductions in the factors aforementioned occurred consistently in Case of the mature ewes but not for the flushed two-year-old ewes. In addition, among the mature ewes, flushing consistently resulted in a decreased proportion of barren ewes. The frequency distribution of birth types among flushed two-year-old and mature ewes was significantly different than that of the controls. Ewes that gained weight during the experimental period reproduced at a higher rate in both age groupings as compared to the ewes that lost weight during this same period. Among mature ewes, the greater the gain in weight during the flushing period, the higher the reproductive fate the following spring. There was no indication that this phenomenon occurred among two-year-old ewes.

Flushing consistently Increased grease fleece weights in both age groupings in the amount of 0.30 and 0.28 pounds for the two-year-old and mature groupings, respectively. Flushing also increased the average pounds of lamb weaned per ewe bred in the amount of 3.6 and 4.9 pounds for the two-year-old and mature age groupings, respectively. This increase was consistent among the flushed mature ewes but not among the two-year-oId ewes. Flushing tended to hasten lambing, in both age groupings, resulting in an earlier average lambing date as compared to the controls. The data indicate that two-year-old ewes respond to a flushing program quite differently than do mature ewes. In addition, the reproductive fate and average lamb production of two-year-old ewes was considerably lower than for the mature ewes.

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THE EFFECT OF FLUSHING ON REPRODUCTIVE PERFORMANCE OF EWES MANAGED UNDER RANGE CONDITIONS

by

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ABSTRACT

The trial reported herein was initiated to study the effect of supplemental feeding range ewes prior to and during breeding (flushing) on their subsequent reproductive performance and productivity. The experimental animals consisted of a band of grade, whiteface ewes. Of a total of 2902 ewe-years, 2232 ewe-years are represented by mature ewes and 670 ewe-years are represented by two-year-old ewes. Supplemental feeding at the rate of one-half pound per head per day did not insure body weight gain. Significant differences in weight gain resulted due to treatment, years and year x treatment interaction. The weight advantage acquired by the flushed ewes during the flushing period was retained to a high degree during the entire pregnancy period.

On the average, over the three-year period flushing resulted in a reduced proportion of single births, an increased proportion of multiple births, an increased lambing percent based on ewes bred and alive at lambing and an increased lambing percent based on ewes lambing. This occurred in both age groups.

The increases and reductions in the factors aforementioned occurred consistently in case of the mature ewes but not for the flushed two-year-old ewes. In addition, among the mature ewes, flushing consistently resulted in a decreased proportion of barren ewes. The frequency distribution of birth types among flushed two-year-old and mature ewes was significantly different than that of the controls. Ewes that gained weight during the experimental period reproduced at a higher rate in both age groupings as compared to the ewes that lost weight during this same period. Among mature ewes, the greater the gain in weight during the flushing period, the higher the reproductive rate the following spring. There was no indication that this phenomenon occurred among two-year-old ewes.

Flushing consistently increased grease fleece weights in both age groupings in the amount of 0.30 and 0.28 pounds for the two-year-old and mature groupings, respectively. Flushing also increased the average pounds of lamb weaned per ewe bred in the amount of 3.6 and 4.9 pounds for the two-year-old and mature age groupings, respectively. This increase was consistent among the flushed mature ewes but not among the two-year-old ewes. Flushing tended to hasten lambing, in both age groupings, resulting in an earlier average lambing date as compared to the controls. The data indicate that two-year-old ewes respond to a flushing program quite differently than do mature ewes. In addition, the reproductive rate and average lamb production of two-year-old ewes was considerably lower than for the mature ewes.

INTRODUCTION

Range livestock production is a major industry in the western range area. Due to the peculiarities of soil, topography and limited precipitation, range livestock production will undoubtedly remain an important segment of the economy of this vast area.

Our economy today demands efficient production. If livestock production is to compete with other agricultural enterprises it must increase efficiency of production. One means of increasing efficiency of production is to increase the reproductive rate of range livestock. The day is passing when the producer desires only one lamb per ewe. Farm flock producers have long recognized the economic importance of having high reproductive rates in their flocks. Range sheep producers are becoming more conscious of the necessity of high reproductive rates to offset high production costs.

It is assumed that with increased reproductive rates the nutritive demands of the ewe will become greater. Fortunately, man's knowledge of the nutritive value of native forages and feedstuffs, as well as the requirements of animals grazed on the range, has increased considerably the past decade. Considerable research is in progress throughout the west to determine the proper levels of supplementation of range livestock under various conditions.

Today's nutritional and industrial technology makes possible the manufacture of pelleted concentrates, formulated to include those ingredients which are known to be deficient in range forage and required by livestock. With these factors in mind, it is assumed that the problem of meeting the increased nutritive requirements resulting from increased reproductive rates is of minor importance when we consider the increased productive potential which could result.

With the new advances in science and industry in the field of nutrition, combined with our economy demanding efficient production, it seems logical that range sheep producers will become more and more interested in increasing the level of fertility of their flocks.

Considerable research on flushing has been conducted however, some results are contradictory. The majority of the research carried out to date has been done under farm conditions. The problem of maintaining high reproductive rates is not one that plagues the farm flock producer but the range producer. Therefore, it was deemed important to investigate the possibility of increasing reproductive rates of range ewes by supplemental feeding prior to and during breeding.

LITERATURE REVIEW

Reproductive performance of domestic livestock is influenced by many variables in a given environment. Due to the interactions of the various factors involved it is difficult to assess the influence of each individual one. The effect of nutrition alone on reproduction is a very comprehensive field. Asdell (1949) reports that one rarely finds a case of malnutrition due to one specific factor; usually a multiple deficiency exists. The influence of individual factors may be enhanced by either a deficiency or an excess of others.

The effect of some of the more important factors on reproductive performance are reviewed herein.

Flushing

Although there are varied definitions of the word "flushing", there is a great deal of similarity among them. The majority of the authorities indicate that flushing means increasing the level of nutrition prior to and during breeding (Reeve, 1953; Ballinger, 1956; Anderson, 1947; Lush, 1945; Hultz and Hill, 1931; Underwood and Shier, 1941; Spencer, 1939; Richards, 1942; Cooper, 1933; Watkins, 1955; Miller, 1913; Bray, 1925; Pope, et al., 1956).

Other authors define flushing as increasing the condition of the ewe previous to breeding or having the ewe in a rising condition at mating (Winters, 1949; McKenna, 1953; Shearer, 1932; Anderson, 1934; Griswold, 1936; Reed, 1927; Marshall, 1927; Miller, 1939; Darlow, undated).

Another definition of flushing found in the literature is feeding ewes so they are gaining weight at the time of breeding (Weir and Albaugh, 1954;

Morrison, 1949; Kammlade, 1947; Adams, 1936).

Other definitions of flushing are found in the literature. Marshall (1952) defines flushing as artificially stimulating the ewes by means of a special food at the approach of the tupping (breeding) season. Williams (1954) defines "nutritional flushing" as causing breeding sheep to fall in condition followed by increased feeding 2 to 3 weeks before breeding. Webster (1952) defines flushing as the response of sheep to the combined stimuli of shorter days, cooler temperatures, and improved pasture following autumn rains. Marshall and Potts (1921) indicate that flushing is feeding ewes at breeding to increase the number of twins produced. Kleinheinz (1920) indicates that flushing means bringing the ewe from a thin condition into a good strong condition in a short time.

It is reported that two conditions must be fulfilled for successful flushing; (1) flushing must result in a significant gain in weight over the unflushed ewes; (2) the nutritional plane before flushing must be below the level which permits the highest possible lamb crop for that particular breed (Friedman and Turner, 1939; Clark, 1934; Darlow and Hawkins, 1933; Marshall and Potts, 1924).

The foregoing definitions clearly point out the fact that the word "flushing", as it is used by producers and research workers, has varied interpretations.

Marshall (1908) made an investigation on the influence of flushing in Scotland. His data indicated that the percent of lambs born for flushed flocks was almost invariably in excess of the average percent for flocks which received no flushing treatment. Marshall and Potts (1921) flushed Southdown ewes with grain and pasture and found both methods produced higher lamb crops. The average number of lambs dropped per 100 ewes lambing was 128.7 for the control ewes and 147.4 for the flushed ewes.

Table I summarizes the flushing trials conducted by the United States Department of Agriculture at Beltsville, Maryland and Middlebury, Vermont. At Beltsville the advantage of flushing is very consistent with one year producing no advantage and one year flushing reduced the lambing percent. At Middlebury the increase in lambing percent due to flushing was also consistent, however, one year flushing lowered the lambing percent. The data indicates in general that flushing increased the lambing percent a great deal more at the Beltsville station than at the Middlebury station.

Table II summarizes the flushing trials on pasture conducted at Beltsville, Maryland by the United States Department of Agriculture. The increase in lambing percent due to flushing on lush pasture was consistently greater.

Okulicev (1934) fed four groups of ewes, each numbering 115, different rations before breeding. The number of lambs born per 100 ewes bred was 103.5 for the controls and 120.3, 112,7 and 110,2 for the ewes fed various supplements initiated prior to breeding. The increase of lambing rate was due to higher percent of multiple births and lower percent of barren ewes in the supplemented groups.

Nichols (1924) reported lambing rates of 150 and 125 lambs per 100 ewes flushed and non-flushed, respectively. Nichols (1926) reported a

Table I. Increase in percent lambs born of ewes lambing, due to flushing 1/

Year	Beltsville, Md.	Middlebury, Vt.
1916-1920	+ 25.9%	+ 8.6%
1923	+ -- 2/	+ -- 2/
1924	+ 27.0%	+ 16.4%
1925	+ 23.0%	+ 17.0%
1926	+ -- 2/	+ 18.8%
1927	- 5.1%	- 9.4%
1928	No Difference	+ 20.0%
1929	+ 20.0%	--
1930	+ 25.0%	--
1931	+ 9.0%	+ 13.0% 3/
1932 4/	+ 10.0%	--

1/ The flushing was accomplished by lush pasture or grain feeding prior to 1927. For the year 1927 and those years following, flushing was accomplished by supplemental grain feeding except where otherwise noted.

2/ Reported an increase but no specific amount.

3/ The ewes in this group were flushed on hay, silage and grain.

4/ The above data was obtained from the Report of the Chief of Bureau of Animal Industry, United States Department of Agriculture for years indicated.

Table II. Increase in percent lambs born of ewes lambing due to pasture flushing at Beltsville, Md.

Year	Lambing percent 1/ Control	Flushed on pasture	Increase due to flushing
1927	128.5	133.3	+ 4.7
1929	124.0	145.0	+ 21.0
1930	116.0	160.0	+ 44.0
1931	143.0	164.0	+ 21.0
1932 2/	126.0	140.0	+ 14.0

1/ Lambing percent is based on number of lambs born per ewe lambing.

2/ Data obtained from the Report of the Chief of Bureau of Animal Industry, United States Department of Agriculture for years indicated.

lamb crop of 154 percent for 1,033 ewes kept under farm-flock conditions that were flushed and 140 percent for 4,054 ewes that were not flushed. McKenzie and Terrill (1937) reported that flushing Rambouillet ewes increased the number of ovulations from 1.06 per ewe to 1.15.

Polovceva et al. (1938) concluded that feeding concentrates beginning 20 days prior to breeding and continued until lambing, increased the number of multiple follicles and number of lambs born. Flushed ewes had a lamb crop of 133 percent as compared to 119 percent for control ewes. The addition of phosphates in these trials had no influence on lambing rate. Vita (1951), working with Italian Varese sheep, conducted two flushing trials. In the trial conducted during the winter, the flushed group was given concentrate and hay and the lambing rate was 155 percent as compared to 120 percent for the control ewes. On a second trial, conducted during the summer, the flushed ewes were grazed on rich alpine pasture and it resulted in 156 lambs per 100 ewes as compared to 124 lambs per 100 ewes in the control group.

Underwood and Shier (1941) report increased lambing rates when the ewes were brought down in condition prior to the beginning of flushing, followed by placing the ewes on very desirable pasture the two weeks previous to breeding and while the rams were with the ewes. The control group was maintained at approximately the same weight the period previous to breeding and while the rams were with the ewes. The flushed group produced 109 lambs per 100 ewes and the control group produced 91 lambs per 100 ewes. Wallace (1951) conducted a flushing trial to determine the effect of flushing and length of flushing period on lambing rate. The method of management was similar to that of Underwood and Shier (1941). Flushing had no effect in bringing the ewes into estrus earlier, but twinning was consistently higher in the flushed ewes. New Zealand workers (New Zealand Department of Agriculture, 1952) indicated that flushing should start 2 weeks before breeding to be most successful. Later work indicated that flushing should begin 3 weeks prior to breeding (Wallace, 1951; New Zealand Department of Agriculture, 1953).

Williams (1954) reported that ewes flushed during the two year period produced 163 and 152 percent lamb crop per ewe lambing as compared to 140 and 141 percent lamb crop for the non-flushed ewes the same two years. His results indicated that in 1950 flushing raised the fertility of the ewe by 11.5 percent in terms of ewes mated and 23.8 percent in terms of ewes lambed. During the following year the respective increases were 9.8 and 11.1 percent. The increase in fertility was due to a higher percent of multiple births with practically no difference in the percent of barren ewes.

Experimental data concerning supplementing or flushing range ewes prior to and during breeding is more limited. Smith (1933) and U.S.D.A. workers (U.S.D.A., 1932) reported that flushing increased the lamb crop by 7.4 percent in a group of Rambouillet ewes. Richards (1942) concluded that phosphorus rich supplements fed prior to and during breeding resulted in higher conception rates and more twins dropped. Darroch, Nordskog and Van Horn (1950) reported that flock fertility was increased 10 and 9 percent by feeding supplement during the pre-breeding and breeding periods, respectively.

Ballinger (1956) cites a flushing trial conducted at the Canterbury Agricultural College, New Zealand, approximately 25 years ago. Flushed ewes, receiving pasture plus 1/2 pound of fowl wheat per ewe per day for three weeks before and two weeks during breeding, produced 25 percent more lambs than the comparable group of ewes on pasture only. Serebrjakov and Taran (1950) studied the effect of grazing ewes on green barley pasture prior to and during breeding on multifoetation in Karakul sheep. Lambing rate per 100 ewes was 121.5 and 107.3 for the barley pastured and control groups, respectively. Markus and Gaal (1952) fed carrots to ewes on carotene deficient pasture to determine its effect on the fertility of ewes. As the ewes exhibited estrus they were artificially inseminated. The percent of ewes exhibiting heat was ten percent higher in the carrot supplemented group. The percent of ewes lambing based on ewes inseminated was 74.5 and 58.0 percent for the supplemented and control groups, respectively. Lambing percent based on ewes inseminated was 84.7 and 70.0 percent for the supplemented and control ewes, respectively.

Research workers in New Zealand (New Zealand Department of Agriculture, 1950) attributed the increased lambing percent obtained among the flushed ewes to increased ovulation rate. Laing (1955) states that flushing increased the number of follicles matured and the number of ova fertilized. Hammond (1957) makes the following statement, "In all breeds the number of eggs shed at tupping, and hence the lambing percentage, can be increased by flushing the ewes before the rams are put in."

Friedman and Turner (1939) state that the practice of flushing sheep needs no defense by this time. Webster (1952) indicates that few sheep farmers are prepared to question the benefit of flushing ewes. Contrary to all the foregoing citations indicating that flushing increases lambing rate, Briggs et al. (1942) found no evidence over an eight year period that flushing increased lambing rate. Stoddart and Smith (1943) state, "Despite many unfavorable results in ewe flushing, the practice is widespread among sheep producers and is generally subscribed to by authorities." Darlow and Hawkins (1932) state, "The belief in flushing has had a firm hold on the minds of sheep men for so long that several well defined cases of poor results will not shake their belief in it." Unfortunately neither Stoddart and Smith (1943) nor Darlow and Hawkins (1932) cite any specific experiments to clarify their statements concerning "... many unfavorable results ..." and "... several well defined cases of poor results ..."

An extensive review of the literature indicates that flushing has not in all instances increased lambing rates; however, without doubt, the preponderance of the evidence indicates that flushing increases the ovulation rate and the number of lambs born per ewe lambing.

What to feed during flushing

A wide variety of feedstuffs have been recommended for flushing. Probably the most recommended and successful type of feed was green pasture (Friedman and Turner, 1939; Carlyle and Spencer, 1916; DuRant and Godley, 1955; Darlow, undated; Adams, 1936; Vita, 1951; Morrison, 1949; Hammond, 1941). Research workers of the United States Department of Agriculture (U.S.D.A., 1927) report, "Pasture is usually the cheapest and most effective means of securing larger yields of lambs."

Many authorities recommend specific pastures such as rape (Iddings, 1927; Marshall and Millin, 1927; Hislop, 1917; Carlyle and Spencer, 1916; Arkell and Ben, 1915; Shearer, 1932; Anderson, 1934; Miller, 1937; Woll, 1921). Timothy pastures were highly recommended for flushing (Marshall and Millin, 1927; Anderson, 1934; Miller, 1937), as well as blue grass pastures (Marshall and Millin, 1927; Shearer, 1932; Miller, 1937).

Grain pastures consisting of volunteer oats (Adams, 1936), wheat (Arkell and Ben, 1915) and rye, (Arkell and Ben, 1915) have been recommended for flushing. Other pasture crops recommended are soybean, (Anderson, 1934) cowpeas (Adams, 1936) clover (Arkell and Ben, 1915) (Shearer, 1932) (Anderson, 1934) and alfalfa (Arkell and Ben, 1915) (Cooper, 1933).

Grains have been reported useful for flushing ewes (Joseph, 1922; Anderson, 1934; Woll, 1921; Marshall and Potts, 1921). Some of the specific grains that have been recommended have been oats (Marshall and Millin, 1927; Iddings, 1917; Carlyle and Spencer, 1916; Shearer, 1932). The combination of oats and bran for flushing has been recommended (Iddings, 1917) as well as oats and corn (Shearer, 1932).

Such feedstuffs as aftermath in hay meadow have been reported useful for flushing ewes (Joseph, 1922) (Anderson, 1934). Similarly, grain stubble fields have been useful for flushing (Anderson, 1934) (Cooper, 1933). Other feedstuffs probably not so common but which have been recommended for flushing are silage (Darlow, undated), pumpkins (Marshall and Millin, 1927) roots, (Iddings, 1917; Arkell and Ben, 1915), cabbage (Woll, 1921; Hammond, 1941) and young mustard (Hammond, 1941).

If hay is available a small amount could be fed each day during the flushing period (Bray, 1925; Joseph, 1922; Darlow, undated). When the sheep are on the range, cottonseed cake has been used or recommended for flushing (U.S.D.A., 1932; Bray, 1925). If no additional supplement is being fed, it is recommended to reserve pasture or range specifically for flushing (Moles, Koogler and Neale, 1924; Stoddart and Smith, 1943). Underwood and Shier (1941), as well as Wallace (1951), obtained good results from pasture management alone.

Marshall and Potts (1921) reported no difference in kind of feed used for flushing, pasture or grain. Darlow (undated) suggests simply increasing the ration the ewes are receiving or feed anything that tends to cause the ewes to gain in flesh. Any fodder that is of good quality and palatable is recommended for flushing (Geary, 1956; Bray, 1925).

Work by Richards (1942) indicates that the addition of phosphorus to a flushing supplement, fed to ewes bred on the range, increased lambing percent. Harris et al, (1956) found that the combination of phosphorus and protein added to a supplement for range feeding was beneficial in increasing lambing percent. If a gain in weight is the desired result during flushing, a high protein concentrate would tend to be the most desirable if weight gains during winter feed treatments can be used as an indicator (Van Horn, et al., 1952).

Nutrition and environment in general

Aristotle (1910) commented on the increased fertility of sheep in a favorable environment. Darwin (1905) states, "The amount of feed affects the fertility of the same individual, thus sheep which on mountains never produce more than one lamb at birth, when brought down to lowland pastures frequently bear twins." Heape (1899) found that the fertility of a flock depends greatly on its management and the quality and quantity of food supplied.

Marshall (1908) reported that the lambing percent of ewes bred in Scottish mountains varied from 80 percent to 100 percent in 12 flocks. The lambing percent of flocks bred on the lowlands during the same season varied from 140 percent to 190 percent. White and Roberts (1927) reported that Welsh ewes that remained on the mountains before breeding produced 90 lambs per 100 ewes, while those kept on the lowlands where the level of nutrition was more desirable, produced 123 lambs per 100 ewes.

Hawkins and Darlow (1935) stated that initial estrus in the ewe in a given breeding season may be inhibited by very unfavorable nutritional conditions. They further state that fertile matings are fewer among ewes which are reduced and retained in an emaciated condition, even though the ewes may come in heat.

Roux (1936) found that reduction of the ration reduced the duration of the sexual season of Merino sheep and it was particularly evident in younger sheep. Kelley (1937) reported that the plane of nutrition had no association with the failure of estrus to appear.

McKenzie and Terrill (1937) report that ewes kept on a low plane of nutrition had a shorter breeding season, longer estrual cycles and lower ovulation rates, but showed no differences in the duration of estrus when compared with similar ewes kept on a high plane of nutrition.

In comparing the reproductive performance of cattle kept on low and high nutritional planes, Joubert (1955) found that the low plane females required fewer services per conception. This phenomena had been reported earlier by Asdell (1952). Differences in the occurrence of post partum estrus in cattle due to plane of nutrition have been reported. High plane heifers came in heat only after weaning their calves but low plane heifers required nearly a year in addition to regain depleted body reserves before sexual activity was restored (Joubert, 1955).

Hammond (1955) reports that in sheep silent heats occur both under conditions of low plane of nutrition and also when the darkness-daylight ration begins to become unfavorable. Hafez (1952) reported that substantial reduction of live weight by underfeeding did not delay onset of the breeding season if the sub-maintenance diet was started two months before the expected onset. Estrus was inhibited after the normal onset with the occurrence of silent heats which were more frequent in yearlings than adult ewes. More than one service was generally required even at the peak of the breeding season in the under-fed ewes. Laing (1955) reports that starvation and heavy internal parasitism delays puberty in young animals and the estrus cycle is depressed in those that are older.

In cattle Eckles (1920) records that heifers fed heavily, experienced their first heat earlier than those lightly fed; the difference for Jerseys was 65 days, for Ayrshires, 100 days, and for Holsteins, 126 days. Other work confirms this phenomena that underfed heifers are late experiencing their first estrus (Allen, 1943; Quinlan, 1929).

Snell (1936) fed two groups of ewes differently to determine the effect of nutrition on productivity. One group was full fed and the other limited to one-third the amount of the full fed group. The full fed ewes had a higher percent of ewes lambing, higher lambing percent born, higher percent of lambs raised, higher milk production and greater wool production.

Whitehair and Gallup (1955) reported on a study of disorders in cows and ewes associated with the feeding of low quality roughage during pregnancy. Ewes fed only the low quality roughage lost as high as 50 percent of their body weight, had a high death loss, had a high incidence of pregnancy toxemia, lacked maternal instinct and poor milking ability at lambing time and had a high rate of lamb mortality.

Specific nutrients

Montana grasses are reported to be deficient in protein and phosphorus eight to nine months of the year (Payne, 1952). Carotene was abundant 6 to 7 months of the year and not seriously deficient the remainder of the year. These foregoing deficiencies are based on National Research Council recommendation for breeding cows and estimated forage intake of known chemical analysis for the nutrients in question.

One of the earliest accounts indicating that phosphorus deficiency was a factor in reproductive disorders, is that of Tuff (1923) in Norway.

Phosphorus has been reported an important nutrient associated with fertility in cattle. Asdell (1949) indicates that phosphorus deficiency tends to occur when diets low in protein are fed or under conditions resembling those found on the range when the grass is dry. Deficiency symptoms also occur when the soil is definitely deficient in phosphorus and in border-line areas when the cows are lactating but are not fed an adequate protein and mineral supplement (Asdell, 1949). Eckles et al. (1926), working with cattle in Minnesota, reported considerable breeding troubles which were corrected by phosphate supplementation. On many farms one calf crop was obtained every two years and heifers sometimes did not come in heat until they were past two years of age. Normal reproduction occurred after supplementation was practiced.

Eckles et al. (1932) reported that phosphorus deficient cows tended to have one or two heat periods after they calve. If they became pregnant at this time, the calves were carried to term; if not, they tended to show anestrum for the remainder of their lactation. After weaning, heat periods returned and they had a normal chance of conception.

Palmer et al. (1941) found phosphorus deficiency delayed first heat in heifers, followed by ovulations without heat which occurred at normal intervals. Riddell et al. (1934) also reported absence of heat in cows on a phosphorus deficient ration. Theiler et al. (1918) reported a calf crop of 51 percent in phosphorus deficient herds, and this was restored to 80 percent in herds with a phosphate supplement. Laing (1955) reports phosphorus deficiency reduces fertility in older animals and delays puberty in young ones.

Keith *et al.* (1955) reported that ewes fed low phosphorus rations during pregnancy and lactation had a greater loss in body weight during pregnancy and lactation and had higher lamb mortality the first 48 hours of the lamb's life.

Asdell (1949) in a review of literature concluded that from all the data available, it appeared that phosphorus deficiency interferes with ovarian function, causing probably a lower estrogen secretion. In more severe conditions, follicular development is interferred with. If pregnancy occurs, little effect is seen until the end of gestation, when parturition may be difficult and the calves may be born weak or dead.

Vitamin A deficiency is reported to have no affect on the estrual cycle or ovulation in sheep but will cause death in utero late in pregnancy or lambs often die shortly after birth (Hart and Miller, 1937). Ewes grazed on green grass in California during the growing season stored sufficient vitamin A in their bodies so that the lamb crop was not affected even though the ewes were kept on a low vitamin A ration for 4 or 5 months. Other work also indicates that sheep apparently have a slow depletion rate of stored vitamin A (Cunha *et al.*, 1946; Weir *et al.*, 1949; Pierce, 1954).

Limiting the protein intake of adult ewes during the breading season had little effect on the number of lambs produced (Hart and Miller, 1937). Rations low in both protein and phosphorus lowered the fertility of ewes (Hart and Miller, 1937; Miller, Hart and Cole, 1942).

Gain in weight prior to and during breeding

Millin (1924) indicates that it is a well known fact among observing sheep men the world over that ewes that are gaining during the breeding season produce a heavier percentage of lambs than those that are just holding their own or those that are losing in condition.

Terrill and Stoehr (1939) reported a highly significant correlation (.38) between gain or loss during breeding and the percent of lambs born of ewes having lambs born at full gestation. The ewes in their study which gained weight during the breeding season produced about 6 per cent more twins than those which lost weight during the same period.

In summarizing the flushing trials conducted on the range by the U.S. Department of Agriculture (U.S.D.A., 1932) it was reported that ewes which gained weight during the breeding season produced 122 lambs per 100 ewes, whereas, the ewes not gaining weight during this period produced 108 lambs per 100 ewes.

Marshall and Potts (1921) divided their ewes into three catagories based on the amount of weight gain during the flushing period. Their data indicates that the ewes that gained the most weight produced the greater proportion of twins. This was not confirmed by Briggs et al. (1942).

Barton (1955) states that for flushing to be successful it is imperative that the ewe be rapidly gaining weight for 3 weeks before mating. Contrary to this statement, Miller, Hart and Cole (1942) concluded that gain in weight during the breeding season is not essential for high fecundity in ewes that are in good condition. Terrill and Stoehr (1939) found that regardless of whether range ewes gained or lost weight during breeding there was practically no affect upon the percent of ewes lambing.

Condition of the ewe

Clark (1934) reported higher ovulation rates resulted from flushing thin wester ewes, however, flushing did not increase the ovulation rate in a group of Shropshire ewes in good condition. Darroch, Nordskog and Van Horn (1950) found that flushing white face range ewes only during the period 14 days before breeding result in 15.8 and 2.8 percent more lambs born for poor and good condition ewes, respectively. Of all ewes lambing, the ewes in good condition at breeding averaged 11 percent more lambs born and also 11 percent more lambs weaned than those in poor condition.

Hammond (1940) states "On the condition of the flock at tupping (breeding) depends the fall of lambs the following season." Ballinger (1956) reports that the most important factor which influences lambing percent is the condition of the ewes. Darroch, Nordskog and Van Horn (1950) concluded that ewe condition appeared to be the most important factor determining the number of lambs born and weaned. Miller, Hart and Cole (1942) concluded "The results of various investigators seem uniformly to indicate that flushing is beneficial to ewes if they are thin. No one has yet ascertained whether it is better to keep the ewes relatively thin and then allow them to gain rapidly during the breeding season, or to keep them uniformly in good condition." Kelley (1943) states that ewes should be deliberately brought down in condition and then changes to a highly nutritious, succulent diet about a month before mating.

It is not recommended to flush the overfat ewe as it will only make a bad matter worse (Griswold, 1936). Miller (1937) recommends special treatment for overfat ewes and stresses the desirability of preventing this condition by proper management. The author suggested gradually reducing body weight prior to breeding by controlling feed intake. Weir and Albaugh (1954) suggest keeping ewes on poor feed from the time of weaning until flushing begins.

Age

Goot (1951) reported that age of ewe is by far the most important factor responsible for the variations in the fertility of ewes. The biggest rise in fertility takes place between age of 2 and 3 years and gradually increased up to 5 years of age and decline in certain components of fertility thereafter. The percent of ewes lambing of ewes bred was 82.1 and 91.4 for ewes of 2 years and 5 years of age respectively. The lambing percent of ewes lambing was 123.5 percent and 148.2 percent of ewes 2 years and 5 years of age respectively. Terrill and Stoehr (1939) found there was a steady increase in percent of ewes lambing, percent of lambs born of ewes having mature lambs at birth and in percent of live lambs born per ewe bred, as the age increased up to 5 years of age. The breeds in this study included Rambouillet, Columbia, Targhee and Corriedale ewes.

Many workers are in general agreement that there is a rise in prolificacy until the 5th or 6th year and then a gradual decline (Smirnov, 1935;

Hammond, 1948; Beigert, 1938; Marshall and Potts, 1921; Carlyle and McConnell, 1902; Nozdracev, 1939; Harris, et al., 1956; Humphrey and Kleinheinz, 1907; Nichols, 1924; Johansson 1932; Roberts, 1921; Jones and Rouse, 1920; Langlet, 1933). In Ossimi sheep it is reported that the highest reproductive rate occurred at 6 to 7 years of age indicating breed differences (Asker and Ragab, 1954). In early maturing breeds of sheep the maximum fertility may be attained at 3 years of age while in late maturing breeds it is not attained until 5 to 6 years of age (Lopyrin, 1938). Johanson (1932) indicates that the increase in lambs per 100 ewes from the first lambing to the fourth is about 22 percent.

In hogs, Lush and Molln (1942) concluded that the number of pigs farrowed rises to about 2 years of age, remains at a high level until about 4 ½ years of age after which it slowly declines. In range cattle, Lassley and Bogart (1943) reported that fertility was lowest in 2 year old heifers, highest in cows 5 to 7 years of age and declines again in cows 9 to 10 years of age.

McKenzie and Terrill (1937) found ovulation rate increased to 3 or 4 years of age (at breeding) with slight decrease as age increased beyond this point. Lambs and yearlings had shorter estrual periods and lower ovulation rates as compared to mature ewes. McKenzie and Phillips (1930) reported the period of estrus was longer for yearling ewes than for ewe lambs.

Schott, Phillips and Spencer (1939) found that yearlings tended to come in heat later than mature ewes. deBaca et al. (1954) reported that age had no effect on expression of heat in purebred ewes on irrigated pastures; however, this was not true in a group of cross bred ewes on native pasture.

Breed

Johansson (1932) states that the differences in lamb yield between Swedish breeds are small and possibly due to environmental influences. The breeds studied by Johansson were Oxford Downs which produced 153.2 lambs per 100 ewes and the Cheviots which produced 140.9 lambs per 100 ewes. It is assumed this data is based only on ewes lambing. It is stated by the author that the two breeds were not maintained under the same environmental conditions.

Terrill and Stoehr (1939) made an extensive study on reproduction of range ewes. Their data was collected over a 10 year period at the U. S. Sheep Breeding Laboratory at Dubois, Idaho. During this period, there were 8000 matings among the 4 breeds represented; namely, Rambouillet, Targhee, Columbia and Corriedale.

The percentage of lambs born per ewe lambing was 129, 127, 122 and 118 for the Targhee, Columbia, Rambouillet and Corriedale ewes respectively. The percentage of live lambs born per ewe bred was 102, 92, 92 and 93 for Targhee, Corriedale, Rambouillet and Columbia ewes respectively. Breed differences in percent of ewes producing lambs were 88, 88, 85 and 85 for Corriedale, Targhee, Columbia and Rambouillet ewes respectively.

Smirnov (1935), in working with Russian Romanov ewes, reported that the average number of lambs born for 6030 ewes was 2,38. In one district, 5.45 percent of the births were singles and 90.16 percent were multiple births. Nichols (1924) found that Suffolk ewes produced fewer lambs when bred to rams of different breed; however, Dorset horn ewes were more prolific when mated to the down breeds. Carlyle and McConnell (1902) reported increased lambing percent due to cross breeding. Marshall and Potts (1921) found breed differences in lambing percent born. The Rambouillet 2-year-old ewes as well as the mature ewes showed the lowest percent lamb crop born of the 9 breeds studied. The Dorset two-year-old ewes as well as the Dorset mature ewes had the highest lambing percent born. Nichols (1924) found that the lambing percent varied with the breeds studied. The highest lambing percent in his study occurred among the Border Leicester ewes and the lowest occurred among the Hampshire ewes.

McKenzie and Terrill (1937) found that Hampshires had longer estrual periods than Shropshires, Southdowns and Rambouillets. Hampshires also had higher ovulation rates than Rambouillets. deBaca, et al. (1954) reported breed difference in average date of first heat among the purebred ewes with the following rank, Hampshire earliest, Romney Marsh intermediate, and Southdown latest.

Time of breeding

Grant (1934) found the first estrus of the season tended to be shorter than succeeding periods. Grant (1933) also noted that the first estrus of the season was preceded by one or more cycles of ovulation which were unaccompanied by estrus. Cole and Miller (1935) and Laing (1955) confirmed this phenomena. Cole and Miller (1935) reported a similar situation following the close of the breeding season.

Asker and Ragab (1954) conducted their work south of the equator and found that ewes bred in May had the highest lambing percent. The corresponding month in the northern hemisphere would be November. Marshall and Potts (1921), Beigert (1938), Johansson and Hansson (1943), and Hammond (1944) report similar results indicating that in the northern hemisphere the most opportune time to breed to insure a high lambing percent is near November 1.

Johansson (1932) presented data from Sweden indicating that mating during September and October, when the environmental temperature is falling, tended to increase multiple pregnancy in sheep. Pregnancies initiated prior to and following these two months produced fewer multiple births. McKenzie and Terrill (1937) found that as the breeding season progressed there was an increase in the length of the estrual cycle. Ovulation rate tended to be lower early in the breeding season then rise to a peak during mid season and fall off again during the latter part of the season. In the trials of McKenzie and Terrill (1935) the monthly interval with the highest ovulation rate was September 16 to October 15. During the next monthly interval, the ovulation rate declined considerably in Rambouillets but remained approximately the same for the mature Hampshire ewes.

Nozdracev (1951) reported that the lambing percent of ewes mated during September and October was 153 percent as compared to 127 percent for ewes mated in November and December.

Body weight of ewe

Johansson and Hansson (1943) found a significant increase in average litter size in sheep with an increase in body weight within breeds. Nozdracev (1939) also found a positive correlation between body weight and fertility in Merino ewes. Ewes in this study that weighed 62-68 kilograms gave 26.8 percent more twins than ewes 42-46 kilograms in body weight. Smirnov (1935), working with Russian Romanov ewes, found that on one farm ewes weighing 55-65 kilograms produced 2.6 lambs per lambing and ewes weighing 25-30 kilograms produced 1.62 lambs per lambing.

Terrill and Stoehr (1942) found that the number of lambs per 100 ewes lambing rises with an increase in body weight. Joseph (1931) states "Preliminary results on the inheritance of lamb producing ability indicate that the size of a ewe is a more accurate measure of her ability to raise heavy lamb crops than is the lamb producing ability of her dam."

Climatic factors associated with reproduction

Meteorlogical factors have been shown to have a marked influence on the occurrence and the length of the heat period in sheep (Epaljevski, 1934). Low temperature, especially below 15° C., reduced the number of sheep exhibiting estrus by 25.8 percent. This effect of cold was enhanced by windy weather with North, Northwest and East winds being the most detrimental. Cloudy, dull weather also had a harmful influence, which was most marked if associated with wind. Precipitation, especially snowfall, reduced the number of ewes exhibiting estrus by 17.5 to 30.0 percent. Bonfert (1933) concluded more ewes were in heat during fine weather than on rainy days.

Beigert (1938) reported lambing rates were higher after summers during which the mean temperature was moderate and below average and the amount of precipitation above average as compared to the reverse conditions. This may indicate higher precipitation could increase feed supply or forage available prior to and during the breeding season. Langlet (1934) reported a correlation between fertility and average rainfall during the period of 8 weeks prior to mating in successive years. Stewart and Moir (1943) report that in the dry areas of Australia the percentage of lambs obtained follows the pattern of rainfall. Kelley (1939) indicated a striking correlation between the incidence of twinning in a Merino flock and the average rainfall during and immediately before mating season. Nichols (1927) studied the effect of meteorological factors on fertility in sheep. He reported that no definite conclusions could be drawn but there may be some slight association between high mean temperature at tupping (breeding) time and high yield in the Cheviot flock. He also reported that rainfall in inches or number of rainy days at breeding has no significant association with lambing percentage in either breed except in case of rainy days in the Blackface, where a negative coefficient may have been suggestive.

Wallace (1907) reported from England that a low nutritive condition, especially if associated with exposure to wet and cold, is often a cause of temporary barrenness in cattle.

Marshall and Hammond (1948) report that the occurrence of any unfavorable climatic conditions such as a snowstorm or drought during breeding will cause a corresponding scarcity of twin births the following lambing season. Millin (1924) indicates that one of the greatest factors influencing size of lamb crop is the weather conditions. He further states that inclement weather during breeding is frequently the cause of low lambing percentages.

Singhand Nelson (1955), of Michigan, made a study of the importance of some environmental factors on reproduction of ewes. Each additional hour of daily sunshine during the breeding season resulted, on the average, in a decrease of 2.4 in the percent of multiple births. Each degree increase of average temperature during the breeding season resulted, on the average, in a decrease of 0.7 in the percent of multiple births. It was estimated that in the Michigan flock approximately 3 percent of the variation between years in percent of multiple births could be accounted for by differences in average daily temperature during the breeding season, and 10 percent by differences in average hours of daily sunshine during the same period. Joint affects of these two variables accounted for approximately another 8 percent of the variation. Rainfall during the months of

August and September had little, if any effect on the size of the lamb crop.

Associated phenomena

Marshall and Potts (1921) found that 78 percent of the ewes dropping twins lambed during the first half of the lambing period. Many other reports are in agreement with this finding (Nichols, 1924; Beigert, 1938; Heape, 1899; Marshall and Hammond, 1948; Carlyle and McConnell, 1902). Underwood and Shier (1941) found that flushing had no effect in bringing about a greater percentage of twins early in the season.

Asker and Ragab (1954) reported great differences in lambing percent between years. Their lowest lambing percent was 106 percent and highest was 143 percent. Marshall and Potts (1921) and Desai and Winters (1951) also reported difference among years but attributed it mainly to changes in feeding and management. Big differences in lambing percent born have been reported even though management and feeding as a whole were the same (Van Horn, et al., 1952).

de Baca et al. (1954) reported a marked year to year difference in average date of estrual onset in ewes. The difference (11 days) exhibited by ewes on improved irrigated pasture was less than that shown by ewes on native hill pasture (25.3 days).

Underwood and Shier (1941) found that flushed ewes did not conceive to first service as readily as unflushed ewes. This is in agreement with Marshall and Potts (1924) who reported there were more ewes in the flushed group that returned for second and third service. New Zealand workers

(New Zealand Annual Report, 1950; Wallace, 1951) reported that the practice of flushing makes ewes more difficult to get with lamb, causing the mean lambing date to be later and lambing to be less concentrated. Estrual cycles of the flushed ewes tended to be shorter than that of the control ewes.

El Sheikh et al. (1955) found that yearling ewes on high feed levels had higher ovulation rates and higher embryonic mortality rates as compared to ewes on medium nutritive levels. Robertson et al. (1951); Christian and Nofziger (1952) and Self et al. (1952) have reported the same phenomena in gilts.

Marshall and Potts (1921) found that twin born ewes were 4.7 percent more prolific than single born ewes. These authors concluded that there did not appear to be any connection between lamb production and the fact that the sire and dam of the individual were of twin or single birth. Asker and Ragab (1954) found no significant difference in twinning ability of ewes born as twins or single. Belogradskii (1940) reported the reproductive rate of ewes born as singles, twins, triplets and quadruplets. The number of lambs born per 100 ewes was 217, 236, 263 and 301 respectively. The ewes in this trial were under very desirable conditions as stated by the author.

Nikoljskii (1933) working with Karakuls, concluded that the probability of twin births is greater in a ewe that has already produced twins, but dams which were themselves twins do not give a higher percentage of twins than those born single. Nozdracev (1951), working with fine wooled mutton sheep and Rambouillets, reported that the lambing percentage for daughters of dams producing only singles was 146.9 as compared with 168.7 for daughters from dams producing only twins.

Asdell, Bogart and Sperling (1949) found in the rat, that reproduction is a stimulus to subsequent reproduction. de Baca et al. (1954) reported that ewes which lambed and lactated came into heat earlier in the subsequent season than ewes which were dry due to ram sterility. Lassley and Bogart (1943) found that lactation had no depressing effect on fertility of range cows, and that dry cows required a greater number of inseminations per calf than did those lactating.

Esplin, Madsen and Phillips (1940) reported higher lambing percentages among a group of two-year-old ewes which had been lot fed their first winter as lambs as compared to another group of two year old ewes which had been under range conditions during their first winter as weanling lambs. Later work from the same station indicates that the effect of wintering weanling ewe lambs on the farm or desert range had no significant effect on their reproductive performance at two years of age. (Ercanbrack, 1948; Argyle, 1956).

Face cover has been reported to be a factor influencing sheep fertility. Terrill (1949) compared reproduction in open faced ewes as compared to closed faced ewes in the following factors: percent of ewes lambing (95.5 versus 91.9) in number of lambs born per one hundred ewes lambing (126.7 versus 119.7) and in percent of lambs alive of all lambs born (91.9 versus 90.0). The Texas Agricultural Experiment Station (1945) also reported that a higher percent of the open faced ewes dropped lambs as compared to closed face ewes.

Inkster (1955) reported over a period of five seasons that open faced ewes had a higher conception rate (89 percent) as compared to closed faced ewes (74 percent). Barton (1955) reported lambing percentages were 27 percent lower for wooly-faced ewes than for open faced ewes.

Coop (1955) found that covered faced ewes had 3 percent more barren ewes and 10 to 15 percent fewer lambs born per ewe lambing. Closed faced ewes were smaller in size although of the same genetic background. This indicates the possibility that face covering hindered forage intake.

Rae (1955) reported from New Zealand that in a group of yearling ewes which were open faced, 53 percent settled at first breeding while only 23 percent of the closed faced yearlings settled at first breeding. In another group of yearlings which had formerly been closed faced but had the wool sheared off the face prior to breeding, 26 percent settled at first breeding.

CONDITIONS OF THE EXPERIMENT

Experimental animals

The sheep used in this study were grade ewes of Rambouillet, Targhee, and Columbia breeding, bred and owned by the Montana Agricultural Experiment Station. The Rambouillet ewes were of only Rambouillet breeding, however, the Targhees and Columbias were the result of second, third and fourth topcrosses of Targhee and Columbias. The ages varied from coming two-year-olds at lambing to coming eight-year-olds.

Description and location of the range

Spring-Fall Range

The spring-fall range was located approximately 15 miles northwest of Livingston, on the eastern slope of the Bridger range of mountains. This range was in the 15" to 19" precipitation belt. About 60 percent of this precipitation fell during the months of April through September. Most of this range was in good to excellent condition on the higher areas. The lower meadows were mostly in fair condition with some livestock concentration areas in poor condition. The range was well supplied with water by natural streams and undeveloped springs.

The general vegetation aspect of this range was that of alternating grassland and forest with the timbered portion occupying slightly more than half of the acreage. The most abundant tree of the timbered type was Douglas fir (Pseudotsuga taxifolia). Other trees encountered were timber pine (Pinus flexilis), aspen (Populus tremuloides), and scattered stands of willow (Salix sp.) in moist areas.

Big sagebrush (Artemisia tridentata) was the dominant plant on much of the non-timbered upland area. The most abundant grasses associated with big sagebrush were sheep fescue (Festuca ovina) and bluebunch wheatgrass (Agropyron spicatum). Some of the grasses of less importance were western wheatgrass (Agropyron smithii), Junegrass (Koeleria cristata) and cheatgrass brome (Bromus tectorum). Forbs of importance were lupine (Lupinus sp.), arrowleaf balsamroot (Balsamorrhiza sagittata) and sticky geranium (Geranium viscosissimum).

Areas adjacent to permanent streams were largely occupied with Kentucky bluegrass (Poa pratensis), dandelion (Taraxicum officinale), Geranium mountain brome (Bromus marginatus), Timothy (Phleum pratense) and other species present in minor amounts.

Breeding range

The range used at time of breeding was mixed native grassland and land retired from cultivation. The native range was mostly in good to excellent condition while the previously plowed lands were in poor condition. The most abundant species on the native range were bluebunch wheatgrass (Agropyron spicatum), needle-and-thread (Stipa comata), western wheatgrass (Agropyron smithii), threadleaf sedge (Carex filifolia), and junegrass (Koeleria cristata). On the previously plowed lands, cheatgrass brome (Bromus tectorum) was the most abundant species. Other common species on the abandoned cropland were crested wheatgrass (Agropyron desertorum), sweetclover (Melilotus officinale), western wheatgrass and needle-and-thread.

Precipitation on the breeding and winter range was about 14.5 inches annually, over 60 percent of which fell during the months of April through September. Snow was usually blown from the ridge tops a few days after each snowfall; therefore, only short periods of hay feeding were necessary. The average January temperature was about 26 degrees Fahrenheit and the average July temperature was about 68 degrees Fahrenheit.

Winter range

The principal forage species found on the winter range were bluebunch wheatgrass (Agropyron spicatum), needle-and-thread (Stipa comata), junegrass (Koeleria cristata), western wheatgrass (Agropyron smithii), and sandberg bluegrass (Poa secunda).

Small amounts of fringed sagewort (Artemisia frigida), threadleaf sedge (Carex filifolia), big sagebrush (Artemisia tridentata), rabbitbrush, (Chrysothamnus spp.), were found on the range. Phlox (Phlox spp.) and club moss (Selaginella sp.) were observed on some sites. Whitepoint loco (Oxytropis serecia) occurred in the area and particularly on the ridgetops.

PROCEDURE

1951-52

Pre-breeding

At the start of the experimental trial, the band of ewes was located on the spring-fall range. Each ewe was individually weighed on a portable scale on November 1, 22 days prior to the beginning of the breeding season. The ewes were divided into two groups at random within each breed and age group. At this date, the ewes to be flushed (supplemented) were branded with a small blue O on the right shoulder. This brand facilitated separation each morning by means of a small enclosure and cutting chute. Each morning after this date, the ewes were separated into the two groups and the flushed ewes were group fed 1/2 pound of supplemental pellet per head. Immediately after supplemental feeding, which usually was accomplished in less than 1 hour, the entire group of ewes was herded together.

Breeding

On November 22, the ewes were moved to the breeding range and the following day the ewes were again individually weighed. The band was divided into three breed bands and rams of the three breeds were turned into their respective breed band at the rate of 3 rams per 100 ewes. Breeding began the evening of November 23 and during the first 21 days two groups of rams were rotated. Each band of ewes was herded in a separate area and each herder had available at his camp a small enclosure and cutting chute, as well as a supply of supplement. Each morning the flushed ewes were

Figure 1. Weighing and branding ewes by treatment at the beginning of the trials.

group fed 1/2 pound of supplement per head. Immediately following supplemental feeding, both groups of ewes were herded as a band on the range. Following the first 21 days of the breeding period, the three individual breed bands were united and Targhee rams were allowed to graze with the ewes. Flushing continued until the close of breeding, which occurred on December 27. At this date, all ewes were again individually weighed and the flushing period was concluded.

Post-breeding

At the close of the flushing period, the ewes were started on a winter supplementation study. The ewes were assigned to eight winter treatments at random within breed, age and previous treatment groupings. The most severe treatment consisted of range forage with no supplementation and the highest fed groups on the range received 2/3 pound of supplement per head per day. The remaining 5 groups were wintered on the range receiving 1/3 pound of supplemental concentrate. The feeding program during the winter is noted in Table III. The ewes in lot 5, fed hay, were removed from the band on December 27 and transported to the experimental farm and wintered in a small lot and just prior to lambing were trucked to the lambing camp.

Winter supplemental feeding was accomplished by means of chutes and two sets of cutting gates. Each ;morning the ewes were separated and group fed their allotted amount of supplement. This process of supplemental feeding the 7 groups each morning was accomplished in approximately

Table III. Supplemental rations fed ewes on winter range (1951-1952)

Group No.	No. sheep on experiment	Amount of Supplement (lbs.)	Amount protein in pellet, %	Roughage
0	70	None	----	Range forage
1	200	1/3	11.8	Range forage
2	200	1/3	20.1	Range forage
3	200	1/3	30.6	Range forage
4	200	1/3	39.2	Range forage
5	70	1/3 1/3	20.0 18.9 1/	Mixed grass & alfalfa hay
6	70	2/3	11.4	Range forage
7	70	2/3	16.6	Range forage

1/ A dehydrated alfalfa pellet.

Table IV. Feed composition of supplemental concentrates (1951-1952).

Group 1/	1	2	3	4	6	7
	%	%	%	%	%	%
Barley	62.8	41.7	20.7	----	64.3	48.5
Wheat	26.5	17.7	8.9	----	27.4	19.7
Cane molasses	6.0	6.0	6.0	6.0	6.0	6.0
Cottonseed meal	----	10.1	20.3	30.3	----	7.3
Linseed meal	----	10.1	20.2	30.3	----	7.3
Soybean oil meal	----	10.2	20.3	30.3	----	7.3
Monosodium phosphate	3.3	2.6	1.9	1.2	1.6	3.0
Limestone 2/	0.0	0.2	0.3	0.5	0.0	0.2
Salt (iodized)	1.0	1.0	1.0	1.0	0.5	0.5
Trace mineral mixture 3/	0.3	0.3	0.3	0.3	0.15	0.15
A-D supplement 4/	0.1	0.1	0.1	0.1	0.05	0.05
	100.0	100.0	100.0	100.0	100.00	100.00

1/ Group 5 has been omitted because the 20 percent protein supplement fed was a commercial feed of unknown composition. In addition this group received a dehydrated alfalfa pellet as indicated in Table III.

2/ Additional calcium added to equalize calcium content of the four pellets.

3/ "Tra-Min" furnished gratis by Midland-Western, Inc., Madison, Wisconsin. Contains iodine, manganese, copper, cobalt, iron and zinc.

4/ "AD-SEAL-IN" furnished gratis by Dawe's Laboratories, Inc., Chicago, Illinois. Contains 10,000 units vitamin A and 1,000 units vitamin D per gram.

Table V. Supplemental rations fed range ewes on winter range (1952-53 and 1953-54).

Group No.	No. of sheep on experiment	Amount protein supplement fed		Amount protein in supplemental pellet		Roughage
		1st Half winter (lbs.)	2nd Half winter (lbs.)	1st Half winter %	2nd Half winter %	
0	125	None	None	None	None	Range forage
1	125	1/3	1/3	12.5	12.5	Range forage
2	125	1/3	1/3	18.3 1/	18.3 1/	Range forage
3	125	1/3	2/3	12.5	31.1	Range forage
4	125	2/3	1/3	31.1	12.5	Range forage
5	125	2/3	2/3	31.1	31.1	Hay
6	125	2/3	2/3	31.1	31.1	Range forage
7	125	Depending on weather		12.5 2/	12.5 2/	Range forage

1/ A dehydrated alfalfa pellet.

2/ The supplemental pellet used for Group 7 was the same as used for Group 1.

1 hour.

During the last week in March, the ewes were removed from the range to the lambing camp and were fed hay. Supplemental feeding continued until April 10. After this date, all ewes were handled as one group and fed alfalfa hay and 1/2 pound per head per day of a commercial 20 percent protein pellet.

1952-53

Pre-breeding

The same management as described for the previous year was continued with a few alterations. During this period, the band was herded on the spring-fall range and the flushing period began on November 1. A different supplemental pellet was used for flushing. This 30 percent protein pellet contained 20 percent dehydrated alfalfa. The composition of this pellet is shown in Table VI.

Breeding

Breeding began November 21, and the flushing period continued until December 11, 20 days after the start of breeding. The management of the ewes and rams was the same as noted for the previous year.

Post-breeding

On December 12, all ewes were again united into one band and Targhee rams were allowed to graze with the ewes an additional 14 days. Winter experimental feeding began on December 12 and continued until 10 days prior to the start of lambing. A new winter nutritional trial was initiated this

Table VI. Feed composition of supplemental concentrates (1952-53 and 1953-54).

Pellet No.	1	2
	%	%
Ingredients:		
Barley	63.4	11.8
Wheat	22.5	----
Cane molasses	6.0	6.0
Cottonseed meal	----	20.3
Linseed meal	----	20.3
Soybean meal	----	20.4
Dehydrated alfalfa meal	----	20.0
Monosodium phosphate	4.3	----
Limestone	2.4	----
Salt	1.0	1.0
Trace mineral 1/	0.3	0.15
AD-SEAL-IN 2/	0.1	0.05
	100.0	100.00
Percent crude protein	12.5	31.1

1/ "Tra-Min" furnished by Whitmoyer Laboratories.

2/ "AD-SEAL-IN" furnished by Dawes Laboratories, Inc.

year as noted in Table V. Groups 0, 1 and 5 were treated identically as in previous years, however, the treatments for the remainder were changed. Groups 2, 3, 4 and 6 received different kinds and amounts of supplement and at different times. Group 7 was "fed by the weather" with temperature, wind velocity and snow cover on the ground, regulating the amount of supplemental feed given each morning. The feeding program for group 7 is noted in Table VII. Starting three weeks prior to lambing, this group received 1/2 pound of a 20 percent protein pellet per head per day.

The last week in March, the ewes were moved from the range and fed hay in dry lot. Management in dry lot was the same as previous years. Supplemental feeding continued as scheduled until 10 days before lambing when all ewes were fed 1/2 pound of a 20 percent protein pellet and only alfalfa hay.

1953-54

Pre-breeding

The band of ewes was not on spring-fall range prior to breeding as it was the previous years. The sheep were moved to the breeding range at the beginning of the flushing period. The ewes were individually weighed November 5, and flushing was started. A supplemental pellet of the same composition as the previous year was used and ewes were fed at the same rate, 1/2 pound per head per day.

Breeding

Breeding began November 22, and management of the ewes and rams was

Table VII. Feeding program for ewes fed by the weather (Group 7).

Bare Ground to 3 inches of Snow			
No Wind		Windy - 15 MPH or above	
Degrees of F.	Pounds per ewe	Degrees of F.	Pounds per ewe
+ 5 and above	No feed	+ 25 and above	No feed
+ 5 to - 5	1/3 lb.	+ 15 to + 25	1/3 lb.
- 5 to - 15	1/2 lb.	+ 5 to + 15	1/2 lb.
- 15 and colder	1 lb.	+ 5 to - 5	1 lb.
		- 5 and colder	1 1/3 lb.

Three Inches of Snow or More			
No Wind		Windy - 15 MPH or above	
Degrees of F.	Pounds per ewe	Degrees of F.	Pounds per ewe
+ 15 and warmer	No feed	+ 25 and warmer	No feed
0 to + 15	1/3 lb.	+ 15 to + 25	1/3 lb.
0 to - 10	1/2 lb.	+ 5 to + 15	1/2 lb.
- 10 to - 20	1 lb.	+ 5 to - 5	1 lb.
- 20 and colder	1 1/3 lb.	- 5 and colder	1 1/3 lb.

The pellet used in the above feeding program contained 12.5 percent protein.

the same as for previous years. The experimental flushing period continued 20 days during breeding and ended December 11. After this date, Targhee rams were left with the ewes as in previous years.

Post-breeding

On December 12, winter nutritional trials began and these were identical to those used in 1952-53. On January 1, the sheep were trucked to White Sulphur Springs, approximately 70 miles to the north, and winter nutrition trials continued on the range.

Management during spring and summer - all years

The ewes in these trials lambed in a shed lambing plant similar to that used by many range producers. A portion of the shelters were tents, set up each year at the lambing camp. The ewes lambed in dry lot adjacent to the tents and sheds. As the ewe lambed she was placed in a jug (small enclosure) with her lamb or lambs. The ewe and lamb remained in the jug from 12 to 24 hours. While the lambs and the ewes were confined to this small area, each lamb was weighed, eartagged, docked, and if a male, it was also castrated. Docking and castration was done by means of an elastrator and rubber rings.

The ewes and lambs were gradually "doubled up" or moved to larger pens containing more sheep and lambs. Ewes with multiple births received closer attention and more feed than ewes with single lambs. Two-year-old ewes were also handled separately after lambing and remained in an area where it would be possible to give them more attention.

Figure 2. The drop band at the lambing camp.

The ewes were sheared each year on or near June 10. The band of ewes and lambs was herded in the mountains during July and August on forest grazing allotment. Individual lamb weights were taken at weaning, which occurred on or near September 7. The oldest lambs at this date would be approximately 140 days of age with the mean being nearer 125 days of age.

Figure 3. Each lamb was permanently identified shortly after birth by placing an aluminum ear tag in each ear.

RESULTS AND DISCUSSION

Effect of treatment on body weight change

The body weight and production data as influenced by flushing, have been analyzed as two age groups within the two treatments, namely, ewes bred as yearlings and lambing at two years of age and all older ewes which are designated as mature ewes.

Two-year-old ewes

The influence of supplemental feeding on body weight change is shown in Table VIII. During the fall of 1951, the coming two-year-old ewes in both treatments lost weight prior to breeding and both gained weight during breeding. The flushed and control ewes lost a total of 0.9 and 2.3 pounds respectively, over the entire period. Flushing reduced the weight loss by 1.4 pounds.

During the fall of 1952, two-year-old ewes in both treatments lost weight during the pre-breeding and breeding periods, totaling 4.3 and 9.0 pounds for the flushed and control ewes, respectively. Flushing did not produce a weight gain, but reduced weight loss by 4.7 pounds.

During the fall of 1953, the flushed group gained weight prior to breeding as well as during breeding. The control group gained weight prior to breeding, but lost weight during breeding. The flushed and control ewes gained a total of 5.2 and 0.6 pounds, respectively, during the entire flushing period. Flushing increased weight gain by a total of 4.6 pounds. The difference in weight gain or loss due to treatment was highly significant (P $<$ .01) all years of the trial. Analysis of

Table VIII. Effect of flushing on body weights of coming two-year-old ewes.

Treatment	body weight Nov. 1 (lbs.)	Weight Change Pre-Brdg. (lbs.)	Breeding (lbs.)	Total (lbs.)	body weight April 1 (lbs.)
			1951-52		
Flushed	123.3	-3.7	+2.8	-0.9	126.3
Control	122.9	-4.9	+2.6	-2.3	124.8
Difference in weight change		1.2	0.2	1.4**	
			1952-53		
Flushed	130.2	-1.2	-3.1	-4.3	123.2
Control	131.2	-3.0	-6.0	-9.0	119.7
Difference in weight change		1.8	2.9	4.7**	
			1953-54		
Flushed	119.5	+3.0	+2.2	+5.2	126.9
Control	119.7	+1.1	-0.5	+0.6	125.8
Difference in weight change		1.9	1.7	4.6**	

** ($P < .01$)

variance tables combining all years appear in Table X. Analysis of variance tables for each year appear in Table I in the Appendix.

The body weights of the coming two-year-old ewes are shown in graph form in Figures 4, 5 and 6. From these graphs, it is evident that most of the weight advantage obtained during the flushing period was retained during the winter. This is particularly apparent for the winters of 1951-52 and 1952-53. During the winter of 1953-54, the flushed two-year-old ewes did not retain as much of the weight advantage as occurred the previous years.

Mature ewes

The influence of flushing on body weight change of mature ewes is recorded in Table IX. During the flushing period in 1951, both the flushed and control groups lost weight prior to breeding and both gained weight during breeding, resulting in a net weight gain for both groups for the entire period. A weight gain advantage of 2.2 pounds is noted for the flushed ewes.

During the second year of the trial, the flushed and control groups showed an average net loss in body weight of 2.1 and 8.5 pounds, respectively. Flushing reduced the weight loss to 6.4 pounds.

During the fall of 1953, both the flushed and control groups gained 8.6 and 3.1 pounds, respectively. The flushed ewes gained 5.5 pounds more during the experimental period than did the controls.

The differences in weight change due to flushing were highly significant ($P < .01$) each year. Analysis of variance tables combining the

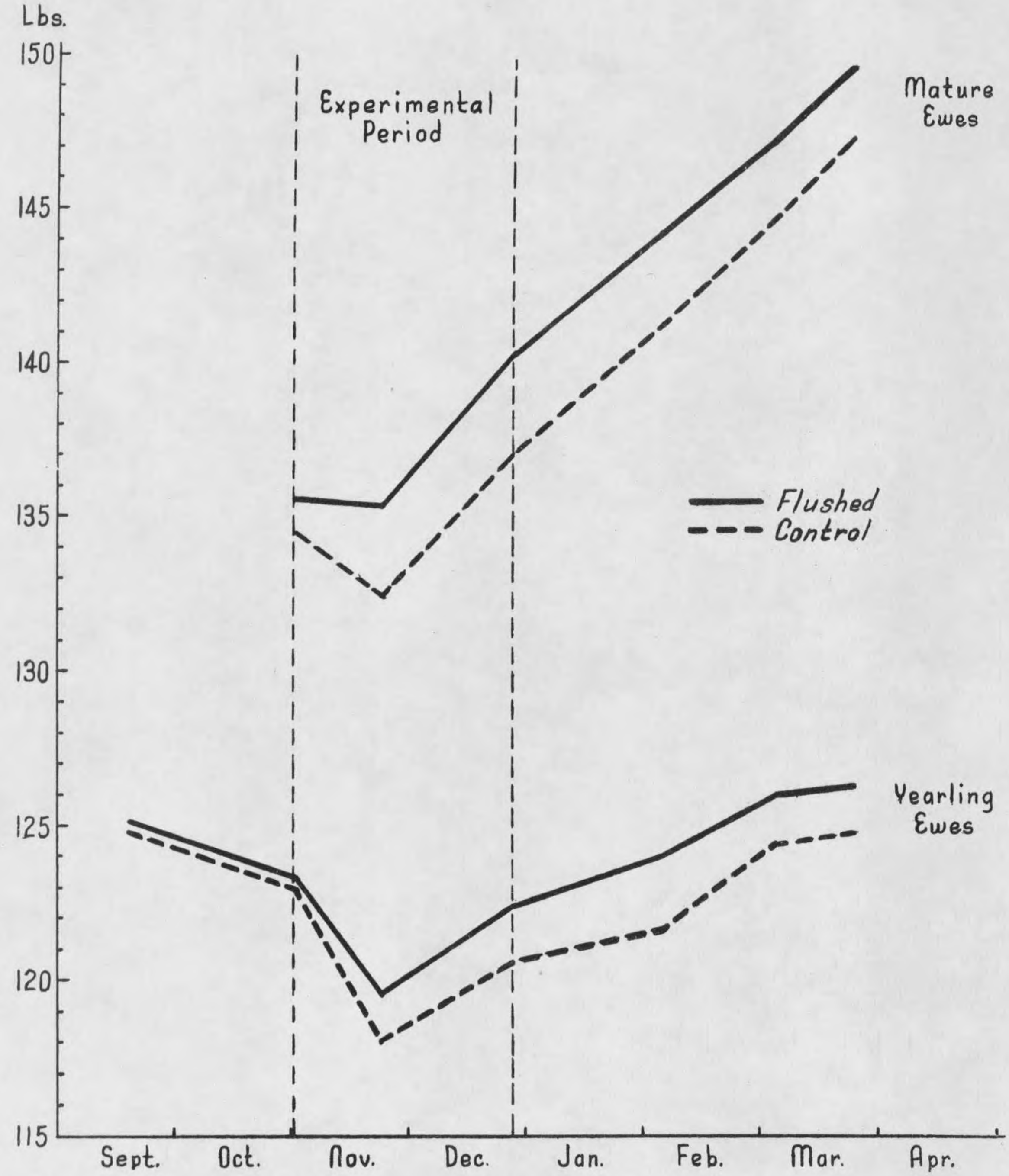

Figure 4. The effect of flushing on live body weights during the fall and winter of 1951-52.

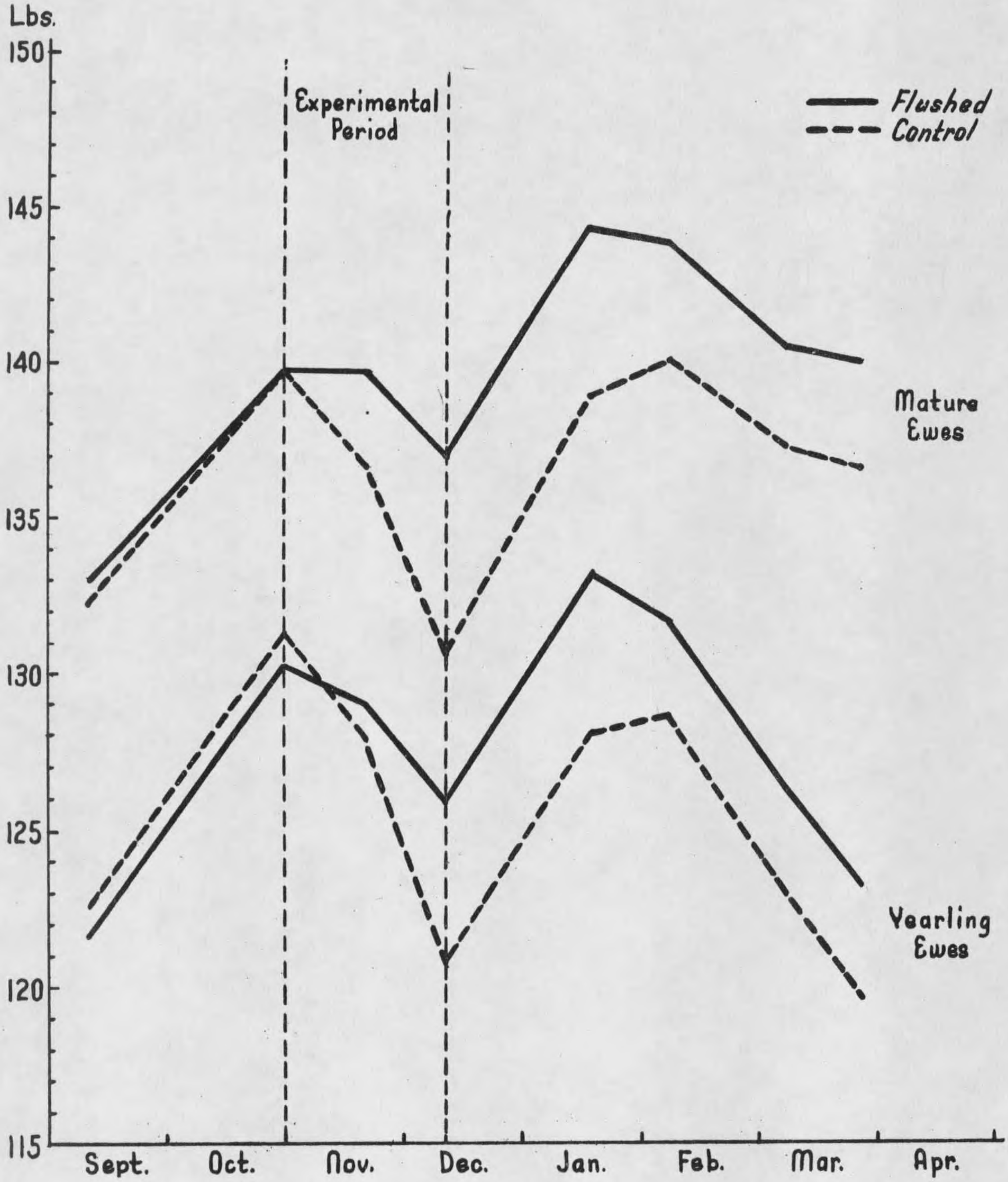

Figure 5. The effect of flushing on live body weights during the fall and winter of 1952-53.

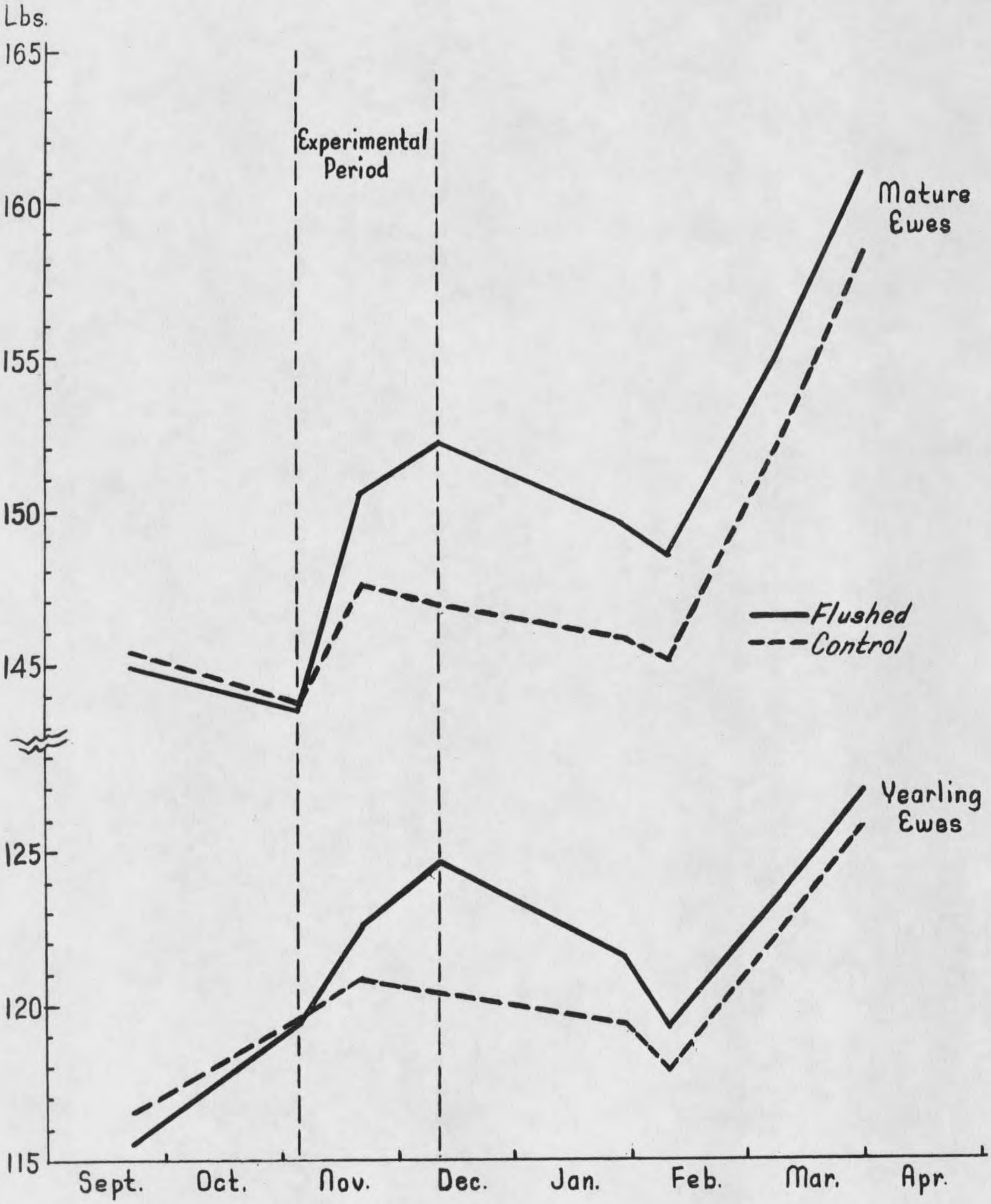

Figure 6. The effect of flushing on live body weights during the fall and winter of 1953-54.

Table IX. Effect of flushing on body weights of mature ewes.

Treatment	Body Weight Nov. 1 (lbs.)	Weight Change Pre-Brdg. (lbs.)	Weight Change Breeding (lbs.)	Weight Change Total (lbs.)	Body Weight April 1 (lbs.)
			1951-52		
Flushed	135.6	-0.3	+5.0	+4.7	149.7
Control	134.5	-2.1	+4.6	+2.5	147.3
Difference in weight change		1.8	0.4	2.2**	
			1952-53		
Flushed	142.1	+0.5	-2.6	-2.1	144.5
Control	141.8	-2.8	-5.7	-8.5	141.3
Difference in weight change		3.3	3.1	6.4**	
			1953-54		
Flushed	143.6	+7.1	+1.5	+8.6	161.0
Control	143.8	+3.8	-0.7	+3.1	158.4
Difference in weight change		3.3	2.2	5.5**	

** ($P < .01$)

data for all years appear in Table X. Analysis of variance tables of weight gains for mature ewes for each individual year appear in Table II in the Appendix.

As noted in Table X, in addition to finding a significant ($P < .01$) treatment effect, there also occurred a significant ($P < .01$) year effect, as well as a significant ($P < .01$) year and treatment interaction. It is unknown what specific components of the environment were responsible for the different year effect and year-treatment interaction. It is assumed that such factors as varied climatic and range conditions exerted a great influence on weight gain or loss during this experimental period.

Graphs showing the body weight change during the flushing period, as well as the following winter appear in Figures 4, 5 and 6. Most of the weight advantage obtained during the experimental period by the flushed mature ewes was retained during the winter. This is in agreement with the work of Richards (1942).

The feeding of one-half pound of supplement daily to ewes on the range did not insure body weight gain. This is especially true of the two-year-old ewes. It did however, produce a significant ($P < .01$) weight differential.

Table X. Analysis of Variance of Gain in Weight During Flushing.

Source of variation	Degrees of Freedom	Mean Square	F
	Two-year-old ewes (all years)		
Years (Y)	2	5176.78	287.85**
Treatments (T)	1	2193.14	121.95**
Y x T	2	351.33	19.54**
Among ewes	638	17.98	
	Mature ewes (all years)		
Years (Y)	2	25456.22	1112.75**
Treatments (T)	1	11840.24	517.56**
Y x T	2	1003.80	43.88**
Among ewes	2171	22.87	

** ($P < .01$)

Reproductive Performance

The influence of flushing on reproductive performance was the major objective of this study.

Two-year-old ewes

The number of two-year-old ewes that gave birth to singles, twins, and the number that aborted as well as the number of ewes that did not lamb or show any sign of abortion are shown in Table XI. The major point shown in this Table that is not covered in Table XII is that the number of ewes not lambing and the number of abortions appear separately. It was desired to observe if there were any differences in abortions as influenced by the flushing treatment. The number of abortions occurring in the flushed and control groups was identical for each year, indicating no differences in abortions could be traced to the treatment during the period prior to and during breeding.

The highest percent of abortions occurred during the spring of 1953. All aborting animals were taken to the Montana Veterinary Research Laboratory to determine if vibrionic abortion was involved. All tests were negative.

It is noted in Figure 5 that during the winter of 1952-53 the ewes were losing weight the latter part of pregnancy. The ewes receiving the lowest levels of supplementation were losing the most weight and also had the highest incidence of abortion. The two-year-old ewes that aborted were thin and emaciated.

Table XI. Type of birth distribution of two-year-old ewes.

	TYPES OF BIRTH							
	Singles		Twins		Dry1/		Abortion	
	Number	Percent	Number	Percent	Number	Percent	Number	Percent
				1951-52				
Flushed	96	73.8	21	16.2	13	10.0	0	0.0
Control	104	78.2	21	15.8	8	6.0	0	0.0
Difference 2/		-4.4		+0.4		+4.0		0.0
				1952-53				
Flushed	67	63.2	17	16.0	13	12.3	9	8.5
Control	75	69.4	3	2.8	21	19.5	9	8.3
Difference		-6.2		+13.2		-7.2		+0.2
				1953-54				
Flushed	73	78.5	8	8.6	11	11.8	1	1.1
Control	75	82.4	4	4.4	11	12.1	1	1.1
Difference		-3.9		+4.2		-0.3		0.0
				Summary all years				
Flushed	236	71.7	46	14.0	37	11.3	10	3.0
Control	254	76.5	28	8.4	40	12.1	10	3.0
Difference		-4.8		+5.6		-0.8		0.0

1/ The column entitled dry includes animals that did not lamb and also showed no noticeable outward indication of aborting.

2/ If the percent indicated in the flushed group is larger than the controls the difference is positive and if smaller than the controls the difference is negative.

The ewes not lambing and ewes known to have aborted are combined into a group entitled barren, as shown in Table XII. It is assumed that more ewes aborted than the records indicate. It is conceivable that under range conditions that an abortion could occur without visual evidence. Under commercial conditions all ewes not lambing during the normal lambing period would fall into the barren group making this group comparable.

In the spring of 1952, the lambing percent was reduced 3.6 percent in the flushed group. The flushed ewes had 0.4 percent more multiple births, 4.4 percent less single births, and 4.0 percent more barren ewes as compared to the control ewes. The reduction in lambing percent was mainly due to the higher percent of barren ewes. When just the ewes lambing are considered, flushing resulted in an increase of 1.1 percent more multiple births and 1.1 percent increase in lambing percent.

The data for 1953 is somewhat different than the preceeding year. Flushing reduced the number of barren ewes by 7.0 percent, reduced single births by 6.2 percent, and increased multiple births by 13.2 percent, resulting in an increase in lambing percent per ewe bred and alive at lambing by 20.3 percent. When basing results on ewes lambing, flushing increased the percent of multiple births by 16.4 percent.

Lambing data for 1954, indicate that flushing reduced the percent of barren ewes by 0.3 percent, reduced the proportion of single births by 3.9 percent and increased the proportion of multiple births by 4.2 percent. This resulted in an increased lambing percent, based on ewes bred and alive at lambing, of 4.5 percent. When the data are based only on ewes lambing,

Table XII. Reproduction Data of Two-Year-Old Ewes.

	Distribution of Types of Births: Multiple %	Single %	Barren 1/ %	Multiple Births of all births %	Lambing percent: Per ewe Bred 2/ %	Per ewe lambing %	Ratio of Single:Multiple
				1951-52			
Flushed	16.2	73.8	10.0	17.9	106.2	117.9	4.6:1
Control	15.8	78.2	6.0	16.8	109.8	116.8	5.0:1
Difference 3/	+0.4	-4.4	+4.0	+1.1	-3.6	+1.1	
				1952-53			
Flushed	16.0	63.2	20.8	20.2	95.3	120.2	3.9:1
Control	2.8	69.4	27.8	3.8	75.0	103.8	25.0:1
Difference	+13.2	-6.2	-7.0	+16.4	+20.3	+16.4	
				1953-54			
Flushed	8.6	78.5	12.9	9.9	95.7	109.9	9.1:1
Control	4.4	82.4	13.2	5.1	91.2	105.1	18.8:1
Difference	+4.2	-3.9	-0.3	+4.8	+4.5	+4.8	
				All years			
Flushed	14.0	71.7	14.3	16.3	99.7	116.3	5.1:1
Control	8.4	76.5	15.1	9.9	93.4	109.9	9.1:1
Difference	+5.6	-4.8	-0.8	+6.4	+6.3	+6.4	

1/ Barren refers to ewes not lambing as well as abortions.

2/ Refers to ewes bred and alive at lambing.

3/ If the percent indicated for the flushed ewes is greater than controls the difference is positive and if smaller than controls it is negative.

the flushed ewes produced 4.8 percent more multiple births, resulting in a 4.8 percent increase in lambing percent as compared to the controls.

The ratios of single to multiple births indicate that during each year of the trial the flushed ewes produced more multiple births when compared to the controls. There is a striking difference among years. It is noted that in the spring of 1952, the ratios are very similar while the spring of 1953 the ratios are extremely different.

When the three years of data are combined, the practice of flushing long-yearling ewes to lamb at two years of age reduced the number of barren ewes by 0.8 percent, reduced the number of single births by 4.8 percent, increased the number of multiple births by 5.6 percent. Lambing percent per ewe bred and alive at lambing was 6.3 percent greater for the flushed ewes. When based only on ewes lambing, the flushed ewes produced 6.4 percent more twin births and the lambing percent was 6.4 percent higher.

It was desired to know if the distribution of birth types was significantly different due to treatment. The Chi-square analysis was used to test for goodness of fit. The data from the control ewes over the three-year-period was used to determine the expected frequency of birth types in the flushed group. The observed and expected frequency distribution of birth types of two-year-old ewes are shown in Table XIII. The Chi-square value resulting was 13.1415 and highly significant ($P < .01$). This indicates that the difference in frequency distribution of birth types due to the flushing treatment was significantly different.

Table XIII. The observed and expected frequency distribution of birth types from the flushed two-year-old ewes.

	Birth Types				
	Barren	Single	Twin	Triplet	Chi square
Observed	47	236	46	0	13.1415**
Expected	49	252	28	0	

** ($P < .01$)

The fact that flushed two-year-old ewes had lower ratios of single to multiple births all years would suggest higher ovulation rates. The data also suggests some associated complication causing embryonic and/or fetal mortality.

It is interesting to note that flushing resulted in an increased percent of barren ewes in 1952. Williams (1954) reports the same phenomenon occurring in flushed ewe lambs of the Clun Forest breed in England. In the report of Williams, the flushed ewe lamb group had a higher percent of barren ewes. One year the lambing percent per ewe lambing was greater among the flushed ewe lambs and another year the lambing percent was lower than the controls.

When checking the influence of flushing on distribution of birth types, it is noted that the percentage of single births was consistently lower in the flushed group. Furthermore, the reduction of single births was of similar magnitude each year, varying from a low of 3.9 percent to a high of 6.2 percent. When one compares the influence of flushing on barrenness and multiple births, it is noted that no consistent pattern exists among years. Flushing increased the percentage of multiple births and reduced the proportion of barren ewes the last two years of the trial. The year that is extremely different with respect to the distribution of types of birth among flushed two-year-old ewes is the first year of the trial. The increase in the proportion of multiple births among flushed ewes this year was practically nil (+0.4 percent). Associated with this condition there also occurred an increase in the proportion of barren ewes (4.0 percent) in the flushed group. It is postulated that in 1952, flushing possibly induced more multiple ovulations but may have been followed by a higher embryonic mortality rate. This would explain the reason for the higher percent of barren ewes in the flushed group which was also associated with practically no increase in the proportion of multiple births. This postulation is based on the work of El Sheikh <u>et al</u>. (1955), indicating that high levels of nutrition were conducive to higher ovulation rates and also accompanied with higher embryonic mortality rates, as compared to ewes on moderate nutritive levels.

<u>Mature ewes</u>

The data on reproductive performance of mature ewes is noted in Tables XIV and XV. Table XIV indicates the number and percent of ewes in the following categories at lambing time: single birth, twin birth, triplet birth, dry (not lambing) and abortions.

The percent of triplet births was consistently greater in the flushed group each year. Over the three-year-period, 1.6 and 0.8 percent of all ewes alive at lambing gave birth to triplets in the flushed and control groups, respectively.

There is no consistent pattern indicating more abortions occurred in either group. Over the three-year-period, 1.0 and 0.9 percent of the flushed and control ewes aborted.

A more comprehensive coverage of the data on reproduction appears in Table XV. All twin and triplet births are grouped under the heading, multiple births. No births occurred with more than three lambs to one ewe. The column entitled barren includes ewes aborting as well as ewes not giving birth to any lambs.

The most striking result is the consistency of reproductive performance. Each year flushing reduced the percent of barren ewes, decreased the percent of single births, increased the percent of multiple births and increased the lambing percent.

During the years 1952, 1953 and 1954, respectively, flushing influenced reproductive performance of mature ewes as follows: increased the proportion of multiple births by 7.3, 11.0 and 12.3 percent; reduced the number of single births by 7.1, 9.0 and 7.1 percent; reduced the number of barren ewes by 0.2, 2.0 and 5.2 percent; increased lambing percent based on ewes bred and alive at lambing by 8.1, 13.2 and 19.0 percent; increased lambing percent based on ewes lambing by 8.3, 11.4 and 11.3 percent; increased the percent of multiple births based on ewes lambing by 7.6, 11.2 and 10.0 percent. The ratios of single to multiple births indicate that more multiple births occurred in the flushed group of ewes each year of the trial.

In summary, over the three year period, the effect of flushing mature ewes is noted as follows: increased the percent of multiple births by 9.9 percent; reduced the number of single births by 7.7 percent; reduced the

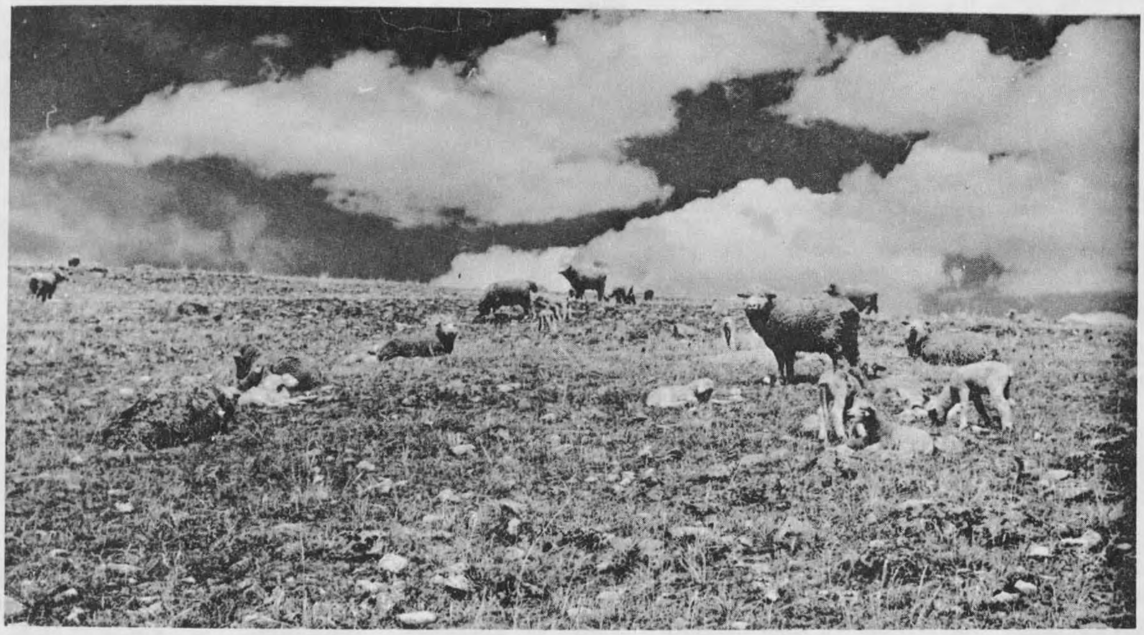

Figure 7. Ewes with lambs of approximately two weeks of age at their side.

Table XIV. Type of birth distribution of mature ewes.

	TYPES OF BIRTH									
	Single		Twins		Triplets		Dry 1/		Abortions	
	Number	Percent	Number	Percent	Number	Percent	Number	Percent	Number	Percent
					1951-52					
Flushed	176	43.5	203	50.1	6	1.5	19	4.7	1	0.2
Control	200	50.6	172	43.5	3	0.8	20	5.1	0	0.0
Difference 2/		-7.1		+6.6		+0.7		-0.4		+0.2
					1952-53					
Flushed	199	50.9	157	40.1	4	1.0	21	5.4	10	2.6
Control	236	59.9	116	29.4	3	0.8	32	8.1	7	1.8
Difference		-9.0		+10.7		+0.2		-2.7		+0.8
					1953-54					
Flushed	105	35.7	170	57.8	7	2.4	12	4.1	0	0.0
Control	133	42.8	146	46.9	3	1.0	26.	8.4	3	0.9
Difference		-7.1		+10.9		+1.4		-4.3		-0.9
					Summary All years					
Flushed	480	44.0	530	48.6	17	1.6	52	4.8	11	1.0
Control	569	51.7	434	39.5	9	0.8	78	7.1	10	0.9
Difference		-7.7		+9.1		+0.8		-2.3		+0.1

1/ Dry includes animals that did not lamb or show any noticeable outward sign of aborting.
2/ If the percent indicated in the flushed group is larger than the controls the difference is positive and if smaller than the controls it is negative.

Table XV. Reproduction Data of Mature Ewes.

	Distribution of Types of Births: Multiple %	Single %	Barren 1/ %	Multiple Births of all births %	Lambing percent: Per ewe Bred 2/ %	Per ewe lambing %	Ratio of Single:Multiple
				1951-52			
Flushed	51.6	43.5	4.9	54.3	148.1	155.8	0.8:1
Control	44.3	50.6	5.1	46.7	140.0	147.5	1.1:1
Difference 3/	+7.3	-7.1	-0.2	+7.6	+8.1	+8.3	
				1952-53			
Flushed	41.2	50.9	7.9	44.7	134.3	145.8	1.2:1
Control	30.2	59.9	9.9	33.5	121.1	134.4	2.0:1
Difference	+11.0	-9.0	-2.0	+11.2	+13.2	+11.4	
				1953-54			
Flushed	60.2	35.7	4.1	62.8	158.5	165.2	0.6:1
Control	47.9	42.8	9.3	52.8	139.5	153.9	0.9:1
Difference	+12.3	-7.1	-5.2	+10.0	+19.0	+11.3	
				All years			
Flushed	50.2	44.0	5.8	53.3	146.0	154.9	0.9:1
Control	40.3	51.7	8.0	43.8	133.1	144.7	1.3:1
Difference	+9.9	-7.7	-2.2	+9.5	+12.9	+10.2	

1/ Barren refers to ewes not lambing as well as abortions.
2/ Refers to ewes bred and alive at lambing.
3/ If the percent indicated for the flushed ewes is greater that controls it is positive and if smaller than controls it is negative.

number of barren ewes by 2.2 percent; increased the percent of multiple births based on all births by 9.5 percent; increased lambing percent based on ewes bred and alive at lambing by 12.9 percent and increased lambing percent based on ewes lambing by 10.2 percent.

Chi-square analysis was used to test for goodness of fit. The data from the control ewes over the three-year-period was used to determine the expected frequency distribution of birth types in the flushed group. Table XVI reports the observed and expected frequency distribution of each birth type in the flushed group. The Chi-square value of 49.7704 is highly significant ($P \leq .01$), indicating that the observed frequency distribution of birth types was significantly different than the expected frequency distribution.

Table XVI. The observed and expected frequency distribution of birth types from the flushed mature ewes.

	Birth Types				
	Barren	Single	Twin	Triplet	Chi-square
Observed	63	480	530	17	49.7704**
Expected	87	564	430	9	

** ($P \leq .01$)

The ratios of single to multiple births were 0.9 to 1 in the flushed group and 1.3 to 1 in the control group. Among flushed ewes, multiple births were more frequent than single births, while among control ewes single births were more frequent than multiple births.

The increased lambing percent in the flushed group of ewes can be accounted for by the higher percent of the ewes lambing, lower percent of single births and higher percent of multiple births. The higher proportion of multiple births would suggest that flushing increased the ovulation rate.

Other workers have previously reported that flushing reduced the percent of barren ewes (Richards, 1942 and Okulicev, 1924). The increase in multiple births in these trials is in agreement with Richards (1942), Vita (1951), Wallace (1951), Williams (1954), Nichols (1924, 1926), Okulicev (1924) and Marshall and Potts (1924).

In comparing the reproductive performance of the mature and two-year-old ewes, it is noted that a great deal of difference exists. Two-year-old ewes consistently had a higher percent of barren ewes, higher proportion of single births and lower proportion of multiple births. This is in general agreement with previous reports.

With the preponderance of the flushing trials indicating that flushing has increased reproductive rates one is prompted to review the work of Briggs et al. (1942). They reported no increase in reproductive rate following a flushing program. It is noted that some years in their trial that yearling ewes composed a part of the experimental flock. Because the yearling ewes at the Montana Station did not respond similarily to older ewes, it is assumed this may have been one factor in the discrepancy. The trial reported by Briggs was conducted during the heat of the summer and the author reported that a check of ram semen indicated that it was of low quality. Furthermore, it is assumed that many of the ewes had not begun, or were just beginning to cycle that early in the summer. Previous work cited in this paper indicates that when ewes begin to cycle in the summer the tendency is to have a lower ovulation rate than during the mid-part of the estrual season. Also a portion of the ewes in their trial were brought down in condition by lowering nutrient intake. These factors may have played a part in causing their results to be quite different than those of the majority of other workers who have made investigations in this field.

The effect of the degree of weight change during the experimental period on reproductive performance.

Previous research work indicated that a gain in weight during breeding resulted in higher lamb crops as compared to ewes losing weight during this period (Terrill and Stoehr, 1939 and Report of the Chief of the Bureau of Animal Industry, 1932). Furthermore, Marshall and Potts (1921) reported that the ewes which gained the most weight during the flushing period tended to produce the most lambs. Briggs, et al. (1942) did not substantiate the findings of Marshall and Potts (1921).

Previous trials are not in agreement on the relationship of the amount of weight gain during the flushing period and lambing rate the following spring. Therefore, it was desired to investigate this further. The question which arises is whether a weight gain prior to and during breeding is advantageous as far as reproductive performance is concerned and if so, is a higher rate of gain the most desirable? The same question arises, pertaining to loss in weight during this period. Is it more disastrous than weight maintenance or gain in weight and if so, does the greater loss in weight prove the most disastrous as far as reproductive performance is concerned?

Two-year-old ewes

Table XVII reports the effect of weight gain prior to and during breeding on reproductive performance of two-year-old ewes. In this table the ewes

Table XVII. The effect of weight gain prior to and during breeding on reproductive performance of two-year-old ewes. Years and treatments combined.

Weight gain interval (lbs.)	No. of ewes	Lambing percent of ewes lambing	Lambing percent of all ewes alive at lambing	Percent Barren 1/	Percent multiple births of all births
+ 6 or more	62	113.2	96.8	14.5	13.2
+ 1 to 5	151	114.9	107.3	6.6	14.9
- 0 to 4	221	114.4	96.8	15.4	14.4
- 5 to 9	141	110.0	85.8	22.0	10.0
- 10 or more	85	111.0	95.2	14.1	11.0
Gain	213	114.4	104.2	8.9	14.4
Loss	447	112.4	93.1	17.2	12.4
Difference	---	2.0	11.1	8.3	2.0
Totals and Averages	660	113.1	96.7	14.5	13.1

1/ This column combines ewes aborting and ewes not lambing.

2/ When the number of animals within a five pound weight gain interval did not number fifty, all the animals which had a weight gain beyond the interval in question were combined.

are grouped by five-pound gain intervals. All the ewes that gained more than six pounds are grouped together as well as all the ewes that lost more than ten pounds. The purpose of this was to have groups which totaled at least fifty animals, thereby reducing the effect of individual animals on average reproductive performance.

Approximately twice as many two-year-old ewes lost weight during the period as those that gained. There was no consistent pattern indicating that as two-year-old ewes gained more weight they reproduced at a higher rate or that as the ewes lost more weight they reproduced at a lower rate. However, if all the ewes that gained during this period are compared to all the ewes that lost, some differences exist in reproductive performance. The two-year-old ewes that gained weight produced 2.0 percent more multiple births, had 8.3 percent less barren ewes and thereby increased the lamb drop of all ewes alive at lambing by 11.1 percent. The higher percent of barren ewes was the most striking result of weight loss during the flushing period.

Mature ewes

Table XVIII reports the effect of body weight gain or loss on reproductive performance of mature ewes. The lambing percent of the ewes lambing increased consistently as the ewes gained more weight. The percent multiple births also consistently increased as the ewes gained more weight. The percent of barren ewes is not as consistent; however, the lowest figure occurred in the group that gained the most weight.

The ewes that gained weight reproduced at a higher rate as compared with the ewes that lost weight. Other factors which weight gain influenced are as

Table XVIII. The effect of weight gain prior to and during breeding on reproductive performance of mature ewes. Years and treatments combined.

Weight gain interval (lbs.)	No. of ewes	Lambing percent of ewes lambing	Lambing percent of all ewes alive at lambing	Percent Barren 1/	Percent multiple births of all births
+ 11 or more 2/	195	162.0	155.4	4.8	59.4
+ 6 to 10	460	157.2	147.6	6.1	56.2
+ 1 to 5	572	150.7	139.3	7.5	49.3
- 0 to 4	458	147.2	137.6	6.6	45.6
- 5 to 9	319	141.2	127.9	9.4	40.1
- 10 or more	186	136.8	128.0	6.5	36.8
Gain	1227	155.0	145.0	6.4	53.6
Loss	963	143.2	132.5	7.5	42.1
Difference	---	11.8	12.5	1.1	11.5
Totals and Averages	2190	149.8	139.5	6.9	48.6

1/ This column combines ewes aborting and ewes not lambing.

2/ When the number of animals within a five-pound weight gain interval would not number fifty head, all the animals which had a weight gain beyond the interval in question were combined.

follows: lambing percent per ewe lambing increased by 11.8 percent; lambing percent per ewe bred and alive at lambing increased by 12.5 percent; percent of barren ewes reduced by 1.1 percent and percent of multiple births increased by 11.5 percent.

From Table XVIII, it can be seen that a loss in weight during this period prior to and during breeding, is detrimental to high reproductive rate in mature ewes under range conditions. Maintainance of body weight during this period is more desirable than loss in weight; however, gain in weight is the most desirable. Furthermore, the greater the gain in weight, the greater the reproductive rate in mature ewes, within the limits of gains encountered in this study.

Mature ewes gaining weight during the experimental period produced 11.5 percent more multiple births than did ewes losing weight. This is considerably higher than the 6 percent reported by Terrill and Stoehr (1939). In the trials of Terrill and Stoehr, ewes of all ages were included in the report and no experimental flushing treatments were involved.

The lambing percent per ewe alive at lambing in the present study was 12.5 percent greater for the mature ewes gaining weight as compared to those losing weight. This increase is of similar magnitude (14 percent) to that reported by the United States Department of Agriculture (Report of the Chief of the Bureau of Animal Industry, 1932).

If the data from both age groupings were combined and rearranged according to weight change irrespective of treatment, the lambing percent of the ewes bred and alive at lambing was 139.0 percent and 120.0 percent for the ewes that gained and lost weight, respectively. Other factors enter in besides just weight gain and loss. When all the ewes on this trial are grouped by whether they gained or lost weight during flushing, one can readily note that differentially a mucht higher percent of two-year-old ewes, lambing for the first time, fall into the group that lost weight. Numerous reports indicate that two-year-old ewes lambing for their first time have a much lower reproductive rate than do older ewes (Terrill and Stoehr, 1939; Goot, 1951; Harris, et al., 1956). Therefore, the advantage of 19 percent in lambing percent of ewes gaining weight compared with those that lost weight is confounded by differences in age distribution in the two groupings.

Lamb Production

The ultimate purpose of flushing is to produce more lambs which in turn makes possible higher total lamb production at weaning.

Two-year-old ewes

Lamb production of the two-year-old ewes is reported in Table XIX. The average pounds of lamb weaned per ewe was 6.3 pounds lower for the flushed ewes in 1952, followed by 15.7 pounds and 3.4 pounds per ewe greater for the following two years. Over the three-year period, flushing increased the average lamb production per ewe by 3.6 pounds. Statistical analysis was not applied to these data.

Mature ewes

Lamb production of the mature ewes is recorded in Table XX. Flushing increased the pounds of lamb weaned per ewe by 3.2, 3.5 and 9.1 pounds for

Table XIX. The effect of flushing on lamb production of two-year-old ewes.

Treatment	Total pounds weaned	No. ewes Bred	Pounds weaned per ewe bred	Difference due to "flushing"
		1951-52		
Flushed	6836	133	51.4	
Control	7736	134	57.7	- 6.3
Totals	14572	267	54.6	
		1952-53		
Flushed	4741	108	43.9	
Control	3098	110	28.2	+15.7
Totals	7839	218	36.0	
		1953-54		
Flushed	4907	94	52.2	
Control	4445	91	48.8	+ 3.4
Totals	9352	185	50.6	
		Average of all years		
Flushed	16484	335	49.2	
Control	15279	335	45.6	+ 3.6
Total	31763	670	47.4	

Table XX. The effect of flushing on lamb production of mature ewes.

Treatment	Total pounds weaned	No. ewes Bred	Pounds weaned per ewe bred	Difference due to "flushing"
		1951-52		
Flushed	32721	422	79.6	
Control	30852	404	76.4	+ 3.2
Total	63573	815	78.0	
		1952-53		
Flushed	26322	398	66.1	
Control	25097	401	62.6	+ 3.5
Total	51419	799	64.4	
		1953-54		
Flushed	25841	300	86.1	
Control	24477	318	77.0	+ 9.1
Total	50318	618	81.4	
		Average of all years		
Flushed	84884	1109	76.5	
Control	80426	1123	71.6	+ 4.9
Total	165310	2232	74.1	

the years 1952, 1953 and 1954, respectively. The average increase in lamb production due to flushing over the three-year period was 4.9 pounds per ewe.

Some of the feed treatments on which the ewes were placed after breeding did not maintain body weight during the gestation period. It is postulated that flushing followed by sub-maintenance diet during gestation may be more detrimental than advantageous from a lamb production standpoint. One cannot conclude that the average increase of 3.6 and 4.9 pounds of lamb weaned due to flushing in the two-year-old and mature groupings, respectively, would be the maximum that could result had all the gestation feed treatments been adequate.

In Table XXI the years are rated as to which year had the highest lambing percent and highest average lamb production. Lambing percent is based on total lambs born (dead and alive) and total number of ewes bred and alive at lambing. The year that the lambing percent was the highest, average lamb production was also the highest. Conversely, the year lambing percent was the lowest the average lamb production was also the lowest. This situation existed in both age groupings.

When we rate the years as to which year flushing resulted in the greatest increase in lambing percent and average lamb production it is found that the year when flushing produced the greatest increase in lambing percent was also the year that flushing produced the greatest increase in average lamb production. The year that flushing produced the least advantage in lambing percent was also the year that flushing produced the least advantage in average lamb production. This phenomenon occured in both age groupings. This would point out that high lamb production is dependent on a high lambing percent born.

Table XXI. Comparison of year effect with flushing effect.

	1951-52	1952-53	1953-54
Rating years as to:			
Highest lambing percent (2 yr. old)	1st	3rd	2nd
Highest avg. lamb prod. (2 yr. old)	1st	3rd	2nd
Highest lambing percent (mature)	2nd	3rd	1st
Highest avg. lamb prod. (mature)	2nd	3rd	1st
Rating years as to the greatest increase due to flushing on the following:			
Avg. lambing percent (2 yr. old)	3rd	1st	2nd
Avg. lamb production (2 yr. old)	3rd	1st	2nd
Avg. lambing percent (mature)	3rd	2nd	1st
Avg. lamb production (mature)	3rd	2nd	1st

When a further study is made of the information in Table XXI, some interesting indications are evident. Among two-year-old ewes, the year that lambing percent and lamb production were the highest (1951-52) was also the year that flushing resulted in a lowered lambing percent and also lowered lamb production as compared to the controls. The year that had the lowest lambing percent and lamb production was the year that flushing gave the greatest increase in lambing percent and average lamb production. This situation did not exist among mature ewes, in fact, somewhat of a reverse situation is indicated. The year that lambing percent and lamb production was the highest for the mature ewes, was also the year that flushing produced the greatest increase in lambing percent and lamb production. Among mature ewes, the year that had the lowest lambing percent and lamb production was not the year that flushing produced the least increase in lambing percent and lamb production. This is further evidence that ewes bred as long yearlings to lamb at two years of age do not respond to a flushing program in the same manner as do older, more-mature ewes.

Wool Production

Two-year-old ewes

Grease fleece weights are recorded in Table XXII. The flushed two-year-old ewes produced 0.11, 0.65 and 0.19 pounds more grease wool per ewe than the control ewes for the years 1952, 1953 and 1954, respectively. Analysis of variance data for individual years are recorded in Table III in the Appendix. These differences in grease fleece weight due to treatment were significant ($P < .01$) only in 1953. The average increase in grease fleece weight due to flushing for the three-year period was 0.30 pounds per ewe and was highly significant ($P < .01$). Analysis of variance data summarizing all years is reported in Table XXIV. In addition to a significant ($P < .01$) treatment effect occurring there also occurred a significant $P < .05$) year effect.

Mature ewes

The effect of flushing on grease fleece weights of mature ewes is noted in Table XXIII. Flushing increased the average grease fleece weights by 0.13, 0.45 and 0.29 pounds for the years 1952, 1953 and 1954, respectively. Analysis of variance data for individual years are recorded in Table IV in the Appendix. These differences due to treatment were significant ($P < .05$) in 1953 and 1954. The average increase in grease