AN ABSTRACT OF THE THESIS OF

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Title: BIOLOGICAL AND ECONOMIC EFFECTS OF FLUSHING AND CREEP FEEDING IN SHEEP

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One hundred two mature blackface crossbred ewes were randomly divided into three equal groups to examine the effects of feeding management during mating on blood chemistry, weight change and subsequent reproductive performance.

Group I was kept in drylot from 17 days before through 17 days after the start of mating. At that time, they were returned to pasture. Group II was treated similarly, but ewes were put on pasture immediately after they were mated by a ram (assessed daily by raddle marks). Group I and II were fed 1.1 pound alfalfa hay and .5 pound barley per head per day plus grass-clover hay ad libitum. Group III spent the entire flushing and breeding season on improved dryland hill pasture. Bodyweight was recorded on all ewes and blood samples were collected on 20 ewes per group at two week intervals.

At lambing, ewes were randomly divided within feeding treatment groups to creep and non-creep feeding. Twenty-five creep and 26 non-creep lambs were bled for chemical analysis at weaning.

Feeding method during mating did not significantly affect weight change. However, there was significant variation in ewe weight with time. The analysis of variance of effects of various factors on ewe blood parameters showed highly significant (P<.005) differences among sheep and a highly significant treatment x time interaction. Blood chemistry levels did not follow the weight change pattern over the experimental period.

There were significant individual differences among sheep for blood protein, albumin, blood urea nitrogen (BUN) and weight (P<.005). Repeatability, however, was only 0.08, 0.10 and 0.11 for blood protein, albumin and BUN, respectively. Repeatability for weight was 0.71. Nutritional treatments did not affect blood chemistry levels.

An analysis of variance was completed to test the effects of nutritional treatment, weight and weight change on number of lambs born. Neither treatment nor weight change effects were significant. However, liveweight was positively related to twinning rate (P<.05). The regression coefficient was .007 lambs born per pound increase in liveweight.

The effects of feeding treatment and the treatment x creep interaction on total weight of lamb weaned per ewe lambing were not significant; however, ewes whose lambs had access to creep weaned 18 pounds more lamb than the non-creep group (P<.05).

Lamb blood chemistry did not affect weaning weight significantly, but the creep fed group had higher BUN (17.9 vs. 15.7 mg/100ml) and total weaning weight (104 vs. 95.9 pounds) (P<.01). At weaning, there were six lambs ready for slaughter in the creep group as compared to one in the non-creep group of lambs. Creep feeding did not influence subsequent post weaning weight gain.

Based on current lamb:feed price relationships and return per nutritional treatment, flushing in drylot and creep feeding, even though the latter resulted in more pounds of lambs weaned, are not viable investments in commercial western Oregon sheep production systems.

BIOLOGICAL AND ECONOMIC EFFECTS OF FLUSHING AND CREEP FEEDING IN SHEEP

by

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BIOLOGICAL AND ECONOMIC EFFECTS OF FLUSHING AND CREEP FEEDING IN SHEEP

I. INTRODUCTION

In commercial sheep production one measure of success is reproduction. Without sufficient offspring, there is no amount of capital, labor and management talent that can result in a profitable enterprise.

It has long been recognized that the reproductive system of sheep and other domestic animals can be stimulated by flushing (Marshall and Potts, 1921; Clark, 1934; McKenzie and Terrill, 1937). Variable results have been obtained by different workers as to the level and course of action of the extra supplement given to increase the number of offspring (Briggs et al., 1942; Papadopoulos and Robinson, 1957).

In western Oregon, meeting the ewe's feed requirement on the pasture during breeding poses a problem because of the unique weather pattern. Farmers breed their ewes from August to early October and lamb in December to February. The breeding season begins in the dry summer months and usually ends about when fall rains have begun. During this time the grasses are matured and dried. Consequently they become deficient in essential nutrients that can stimulate more efficient reproduction (Bedell, 1971). The fall rain is generally too late to be of value in stimulating pasture growth for the breeding season.

Another major impediment to successful sheep production is that the rain stops early in summer. One result is insufficient good pasture to allow lambs to be ready for market at weaning. As a result, farmers are forced to sell lambs when pasture quality deteriorates in mid- to late-June. There is not a good demand for feeder lambs at this time, so there is usually a price differential favoring slaughter lambs over feeders. This costs the farmer revenue. In addition, feeders are lighter in weight, so this also costs him money.

To alleviate the problem of poor pasture quality and quantity during breeding, farmers could raise irrigated pasture. Another alternative management practice that could be of help is drylot breeding. In drylot breeding, supplement could be provided at the optimum quantity for optimum reproduction. Furthermore, the supplement feeding could afford assurance of adequately meeting the nutrient quality requirements of these animals. Another potential advantage of breeding in drylot is that fewer rams per 100 ewes would be needed. Drylot breeding could result in reduction in total overhead cost by total elimination of irrigation.

Creep feeding was anticipated to be a management practice which might help in getting the lambs to fatten early, before cessation of rains and pasture quality deterioration in early summer.

However, both of these practices, drylot feeding and creep feeding, require harvested or manufactured feeds. The global demand for grain that once served as a cheap source of supplement for sheep as well as other livestock has caused changes in price. This in turn has greatly increased the production cost and hence reduced the existing low marginal profit in the sheep industry. In the past, literature dealing with flushing and creep feeding experiments usually placed little or no emphasis on the price of grain in recommending extra feeding of livestock. If livestock production is a form of business as we commonly assume, then it has to be treated and operated like a normal commercial enterprise. Cost and benefit of any input must be critically analyzed and alternatives considered before any final recommendation can be made.

The primary concern of this study was to explore and relate the biological and economic effects of drylot breeding and creep feeding as they relate to sheep production in western Oregon.

II. REVIEW OF LITERATURE

Several factors are known to influence prolificacy of the ewe. One of these factors is nutrition and specifically the level of nutrition immediately prior to mating. The practice of increasing the amount of feed supplied to animals before mating is called flushing. Flushing is defined as "the process of providing the ewes with unrestricted and good quality feeding at a level higher than that previously available" (Dufaur, 1967). In spite of the wide use of flushing in livestock production, controversy still exists as to the mode of action of the practice. Literature has grown from the general study of supplying extra feeding to the animal at breeding to the study of the specific influence of supplemental protein and energy. Study of the physiological mechanism involved in the flushing effect has led to the postulation that the primary effect of increased feeding is the stimulation of the release of gonadotropins from the anterior pituitary gland. Within recent years the effects on twinning of heavy liveweight *per se* have been added. As the study of flushing now stands, the controversy as to what actually is the chief cause of the improved prolificacy is not yet resolved. Literature will be reviewed concerning the influence of nutrition on reproduction, the influence of creep feeding on preweaning growth, and the relationships among various blood parameters and performance traits in sheep and other domestic animals.

Effects of Nutrition on Reproduction

That there is a reproductive response to nutritional changes has been recognized from ancient times. Clark (1934) recorded an observation by Aristotle that sheep in a favorable environment exhibited greater fertility. Bosman (1959) as reported by Ruttle and Montgomery (1972) found that Merino ewes on a high plane of nutrition produced an 85 percent lamb crop while those on a low plane produced 53 percent. Darroch et al. (1950) reported a 10 percent increase in fertility in grade Columbia ewes supplemented with beet pulp pellets during prebreeding, breeding and early pregnancy. Harris et al. (1956) observed that range ewes supplemented with protein and energy produced higher lamb crops (108 percent) than nonsupplemented ones (91 percent).

One early flushing study was conducted by Marshall and Potts (1921) using purebred Southdown ewes. The animals on test were given 1/2 to 1/4 pound of grain per day and were maintained on Bluegrass pasture or grazed forage crops. Over a period of five years the flushed ewes averaged 18.1 percent more lambs born than the untreated group. This work also showed that treated ewes came in heat earlier than the controls.

Clark (1934) conducted two different studies, one using 2-1/2 to 3-1/2 year old grade western whiteface ewes in poor condition and the second using Shropshires in good condition. In the first experiment, he found an average of 1.4 ova in the flushed group compared with an average of one ovum in the control. In the second experiment, average ovulation rate of controls was better than the average of the flushed group (1.7 vs. 1.5). Weight gains were 0.23 vs. 0.02 pound per day for flushed and the control group in the first experiment (using ewes in poor condition) and were 0.21 pound per day for the flushed and 0.04 pound per day for the control in the second trial. This experiment suggested that the response to flushing was dependent upon initial body condition of the ewes, but the difference could also have been due to breed or year.

Working with Clun Forest sheep, Williams (1954) found that flushing exerted a considerable influence on the prolificacy of mature ewes but had a negligible effect on that of ewe lambs. Also barrenness was not reduced by flushing of either ewes or ewe lambs. He observed also that the influence of flushing was usually very small when the sheep commenced reproductive life, but it gradually increased until the ewes were five to six years old. In contrast to Williams' results, Coop (1966) reported a reduction in barrenness as a result of flushing.

Effects of Nutrition on Embryo Mortality

In their work Robertson *et al.* (1951) set out to determine the effects of several factors on reproduction in gilts. Among the treatments applied was a variation in the amount of feed given; one group was full fed and the other was given 70 percent of the full feed. Half of the gilts in each group were slaughtered one to two days after the end of the heat period. The remainder were slaughtered 25 days post-breeding. The full fed (*ad lib*) group shed 1.1 more ova at the second estrus but also had fewer normal embryos at 25 days of gestation (43 percent vs. 67 percent) than the group that received limited feed.

Christian and Nofziger (1952) in a similar experiment found that *ad lib* high protein fed gilts had an ovulation rate of 15.1 as compared with 13.4 for a low protein group ($P<.05$). The fertilization rate for *ad lib* was 83.2 percent as compared with 85.5 percent in the low protein control (P>.05). High protein *ad lib* gilts farrowed an average of 4.7 live pigs per litter compared with an average of 7.4 live pigs per litter in the low protein group (P<.01). Prenatal death rate was estimated as 62.9 percent for high protein gilts and 35.3 percent for low protein gilts.

El Sheikh *et al*. (1955) conducted a flushing experiment to determine the effect of high and medium planes of feeding on the development and functional activity of some reproductive organs. They flushed a group of ewes (mixture of Shropshire, Hampshire and Oxford) by supplementing two pounds of mixed grain on a sweet clover pasture. The other group was fed with hay and kept on pasture also. They reported that ewes on a higher plane of nutrition had a significantly lower (42.2 percent vs. 83.8 percent [two year average] P<.01) rate of embryo survival. The authors concluded that their result was in agreement with high mortality associated with post-breeding high plane of nutrition reported in swine by Robertson *et al*. (1951) and Christian and Nofziger (1952).

Lamond *et al*. (1973) conducted two experiments. The first was to examine lambing data on ewes maintained constantly on five different levels of nutrition. The second was to utilize the techniques of homologous and heterologous ovum transfer to determine the sources of reproductive failure in ewes maintained on over-nutrition and under-nutrition. Using low energy/low protein, high energy/low protein, high energy/high protein, low energy/high protein and pasture feeding in the first experiment, they were able to conclude that fertility in ewes receiving a high intake of nutrients was generally low. Prolonged high intakes of either protein or energy caused reduced fertilization rate. (In both experiments, 40 percent fewer lambs were born compared with pasture ewes.)

Effects of Specific Nutrients on Reproduction

After a relationship was established between nutrition and reproductive performance, the next question that interested researchers was the mode of action and the cause of response observed in flushing experiments. Satisfying this curiosity led to the study of the effects of specific nutrients such as protein and energy and of the physiological impacts of gonadotropin, blood urea nitrogen and body-weight on reproduction.

a. Effects of High Energy on Reproduction

In investigating the role of high energy feeding on reproductive performance, El Sheikh et al. (1955), working with high energy feed (grain) at the rate of two pounds of supplementation per day, found that ewes on high level of feeding had significantly higher ovulation rate, larger follicles (2 mm or more in diameter) and higher numbers of follicles than unflushed animals. Also they observed that fertilization rate was higher in high energy supplemented ewes ($P>.05$).

In their work, Zimmerman et al. (1960) fed glucose in addition to a basal ration for approximately two weeks prior to ovulation. They found that the test gilts shed more ova (number of Corpora lutea at third heat 11.8 to 9.7, $P<0.01$) than gilts receiving the basal diet. From this result they concluded that the energy intake during the time of follicular development had an important influence on ovulation rate in gilts.

McGillivray _et al_. (1962) reported increases in ovulation sites, number of total embryos, number of viable embryos and weight change between mating and slaughter 25 to 30 days post mating in gilts fed glucose before mating. Working on the same subject of energy feed, Rigor _et al_. (1963) in swine found a greater number of combined _Corpora lutea_ and follicles in high energy fed animals as compared with those on a basal ration (15.1 vs. 11.8, $P<.05$). However Kirkpatrick _et al_. (1967) found no difference in follicle size and number between high and low energy fed gilts.

Memon _et al_. (1969) reported a significant difference in the average number of _Corpora lutea_ (1.83 vs. 1.32, $P<.01$) and percent ovulations (78.3 vs. 28) in high energy fed compared with low energy fed whitefaced ewes. Torell _et al_. (1971) reported that an increased level of energy was necessary for maximum lambing performance.

b. Effect of Protein Feeding on Reproduction

Clawson _et al_. (1963) studied effects of protein and energy intake during pregnancy on livability and performance of the offspring in swine. They reported that the level of protein fed to the gilts appeared to have little effect on total pigs farrowed. The difference was not statistically significant. This was in agreement with Davidson (1930) who said that the proportion of ova accounted for by live pigs at birth was not reduced by a low protein intake during gestation. Wright _et al_. (1962) also found no significant increase in lamb production in ewes fed a higher level of protein before and at breeding time.

Using a factorial experimental design, Memon et al. (1969) fed ewes with rations containing two levels of protein and two levels of energy. They found that the differences in number of Corpora lutea and percent multiple ovulations due to differences in energy level were highly significant irrespective of protein level. Torell et al. (1971) concluded that increases in both protein and energy were necessary for maximum lambing performance.

c. Effect of Feeding on Gonadotropin Secretion

The increased ovulation rate produced in ewes and gilts by nutritional flushing suggests that the endocrine mechanism responsible for this function is subjected to modification by the increased level of feed. Mechanisms postulated to explain how flushing increases ovulation rates are (1) increased production and release of gonadotropin [follicle stimulating hormone (FSH) and luteinizing hormone (LH)] and (2) increased responsiveness of the ovary to gonadotropins. Since it has been established that follicular development is under the control of FSH from the pituitary gland, the possibility that the mode of action of extra feeding has been to increase these hormones has been investigated by many workers.

Bellows et al. (1963), working with sheep, found no increase in FSH and LH concentration as a result of increased feeding. But there was a marked increase in pituitary weight and consequently total FSH and LH potency. Increased potency was attributed to the increase in pituitary weight. In other work with mature ewes Howland et al. (1966)

recorded a similar result. However, they were of the opinion that grain fed ewes had higher LH concentration in all stages of production.

Kirkpatrick et al. (1967) measured the level of pituitary FSH and LH on days 3, 7, 11, 15 and 19 of the estrous cycle of gilts maintained on two feed levels. Analysis of the data showed no significant difference in average FSH and LH level. But, the study showed a significant difference ($P<.05$) between the two feed levels in quadratic regression of gonadotropin level on day of the cycle. FSH and LH of high energy gilts were lower early in the cycle, higher in the middle and again lower in the later part of the cycle when compared with low energy fed gilts.

One of the recent works on increased gonadotropin in response to feeding was that of Howland et al. (1966). They reported results of ewes maintained on two levels of nutrition. It was observed that ewes on high level feeding of grain had heavier adrenals than hay fed animals (5.65 vs. 5.06 gm) ($P<.05$). They also had 1.72 Corpora lutea at slaughter compared with 1.42 for ewes on hay ($P<.01$). Since pituitary gland weight was increased by grain feeding, it was assumed that the total hormone content was greater for both FSH and LH in the pituitaries of grain fed ewes than in the hay fed ewes. This assumption would help to explain the parallelism between total gonadotropin potency and follicular development as had been established by previous studies.

Liveweight Influence on Reproductive Performance

That liveweight alone is a very important factor in reproductive performance has been demonstrated by Coop (1962, 1966). From an analysis of a large body of data (11,258 Corriedale breeding performance records), twinning was found to increase by six percent for each ten pound increase in liveweight. Coop calculated that about half the flushing response recorded by earlier workers could be explained in terms of the increased liveweight. This study also found a good correlation between twinning and both liveweight gain and feeding conditions at mating.

Torell et al. (1972) reported that most of the flushing response they observed in each of four years was related to liveweight change during the flushing period. For every kilogram increase in the liveweight during flushing, lambing percentage increased by eight percent. On the contrary, Hohenboken et al. (1976a) reported a negative relationship between prolificacy and weight change in the ewe during mating (b=-.012 lambs born per Kg weight gained). Butcher (1968) reported a liveweight effect on barrenness. Ewes of higher liveweight (within breed) were reported to have a lower incidence of barrenness.

Dufaur (1967) reported a flushing experiment in which a group of mature ewes in good condition over the dry period were divided into two groups. One group was fed to gain weight while the other group was fed to lose weight. The result showed that the ewes fed to gain had 19 percent more lambs than those that lost weight. This work indicates that it is important that ewes should be gaining weight at the mating period.

However, bodyweight may be a poor measure in itself unless it is carefully qualified. Excessive bodyweight as a result of high plain of nutrition may be detrimental to embryonic survival (Foote et al., 1959; Christian and Nofziger, 1952; Self et al., 1953). Butcher (1968) reported that care must be taken in the use of increased bodyweight as a criterion in an attempt to increase production. One breed of sheep may have the genetic background for heavy body size as compared with other breeds. It is essential to evaluate and rate bodyweight in terms of genetic potential of each breed and not on general terms.

Creep Feeding

The practice of providing supplemental feeding for the young lambs apart from milk from their mother is called creep feeding. Before the turn of the century, researchers realized that lambs made quite rapid gains early in life (Perry et al. 1957). The desire to investigate the possibility of further increasing the lamb growth rate early in life so that a majority of them would reach market weight at a younger age led to creep feeding experiments. Work at Purdue showed that the period in the life of the lamb when supplement (grain) feeding was most important was before the grazing season began (Anonymous, Indiana Agric. Exp. Station Annual Report, 1933). Working with groups of suckling lambs supplemented with (1) grains and (2) no grains, the study found that the grain fed lambs gained four to five pounds more per head while on test and maintained the advantage when they were all turned back to pasture. In a follow-up experiment, Harper (1936) reported that lambs receiving grain as soon as they could eat had larger gains, cheaper gains, more satisfactory market finish and more profit per lamb than those receiving no grain.

Miller (1939), reporting on creep feeding practices of California farmers, found that lambs given any form of grain as supplement generally finished at an earlier age, attained heavier weight and shrank considerably less when shipped to market than lambs not creep fed. One other main advantage of creep feeding reported by Miller was that it provided a means of finishing twin lambs almost as well as single lambs. An experiment conducted on a farmer's premisis involved three bands of ewes and their lambs: Band 1 was composed of ewes with early born single lambs, band 2 was ewes with late born single lambs and band 3 was early and late born twins and their dams. The two groups of ewes with single lambs were allowed to raise their lambs without creep while the twin lambs were exposed to creep. At weaning, fat lambs produced by each group were 91 percent, 55 percent and 91 percent respectively. Average weight of single lambs was 81 pounds while that of creep-fed twins was 77 pounds.

Numerous other experiments since the 1940's have examined various aspects of creep feeding. Many of these involved the time period before ewes were placed on pasture so are not comparable to the current experiment. Many involved comparing different energy sources or levels and are not relevant to results of the present study. Nearly all of the studies confirmed early reports that creep feeding had a beneficial effect on rate of gain, degree of market finish, and time required to reach market weight.

Blood Urea Nitrogen as a Measure of Protein Adequacy in Feed

Determination of blood urea concentration has been used as an index of the protein utilization in ruminants by many researchers

(Abou Akkada and Osman, 1967). The protein entering the rumen in feed is broken down to ammonia by micro-organisms present there, and the resulting ammonia is partially converted to microbial protein (McDonald, 1948 and 1954). The ensuing microbial protein is absorbed into the blood to be transported throughout the body for cell utilization. To estimate the level of protein available to the animal, development was made in testing the level of blood urea nitrogen (BUN) present in the blood. Houpt (1959) found that ruminants can utilize blood urea as a source of nitrogen. Plasma urea concentration was suggested to be a realistic predictor of both nitrogen utilization (Egan and Kellaway, 1971) and nitrogen intake (Nolan et al. 1970) in ruminants.

Lewis (1957), working with Clun Forest sheep fitted with fistulas to determine protein degradation in the rumen and the level of urea nitrogen in the blood, reported that range ewes in normal grazing condition had relatively constant blood urea levels. With varied level of protein however, his work showed clearly that the extent to which ammonia is formed from protein in the feed is reflected in the blood urea concentration. Furthermore, he reported that the changes in dietary protein and levels of BUN concentration could be correlated with different rumen ammonia concentrations. Also the changes in blood urea concentration followed increases or decreases in rumen ammonia. The correlation was computed between concentration of urea nitrogen in the plasma and nitrogen intake. The report also showed that the quantity of the absorbed nitrogen was reflected in the level of circulating blood urea. Several other workers have reported significant statistical correlations between ruminal and blood urea in sheep administered with various proteins (Tagari et al. 1964; Abou Akkada and Osman, 1967).

McLaren et al. (1960) fed sheep a semipurified diet supplemented with urea or crude biuret. It was reported that the urea supplemented group of animals had higher levels of blood urea than those supplemented with biuret. This result agrees with part of Lewis's (1957) conclusions in which a relationship between level of ammonia in the rumen and that in the blood was suggested.

Preston et al. (1961a) working with rations of different protein: energy ratio in sheep asserted that BUN level in blood was dependent on the quality of protein. This work also found that nitrogen absorption or level in the blood was influenced by intake of carbohydrates (energy). In another project with cattle, Preston et al. (1961b) noticed a marked decrease in the BUN level of stilbestrol implanted steers when compared with other groups not implanted. Preston et al. (1963), working with lambs, reported further that BUN was directly proportional to dietary protein level and inversely proportional to the dietary energy level. Preston et al. (1965) found a good relationship between BUN and digestive protein intake from their work with growing and finishing lambs.

Torell et al. (1972) reported in their work with Corriedale ewes on different level of feed that BUN levels measured in plasma samples collected at breeding reflected the nutritional status of the ewes. No difference was noticed in the mean BUN levels between ewes on the range and the group supplemented twice weekly. However, a marked increase in the mean BUN was observed in ewes supplemented daily in drylot and those maintained on improved pasture. These results suggest that mean BUN levels may be useful predictors of the effectiveness of a flushing treatment. A good correlation (0.943) between BUN levels and lambing performance was reported.

That many other factors affect blood urea nitrogen level in ewes was suggested by many workers. Leibholz (1970) investigated the impact of starvation and feeding of low nitrogen feed on BUN in crossbred wethers. Among the feed levels she used were (1) control diet (8 gm nitrogen, 730 gm DM daily), (2) low nitrogen diet (.5 gm nitrogen, 520 gm DM daily), and (3) wethers starved for 12 and 20 day experimental periods. Analysis of plasma showed that urea level in the starved sheep was greater than in the sheep on the low nitrogen diet. This high value was attributed to more rapid catabolism of body protein to compensate for the dietary deficiency.

Torell _et al._ (1974), working to determine the effects of animal age and time of day on BUN level in ewes, found no significant effects. They did report significant differences between animals within age classes.

III. MATERIALS AND METHODS

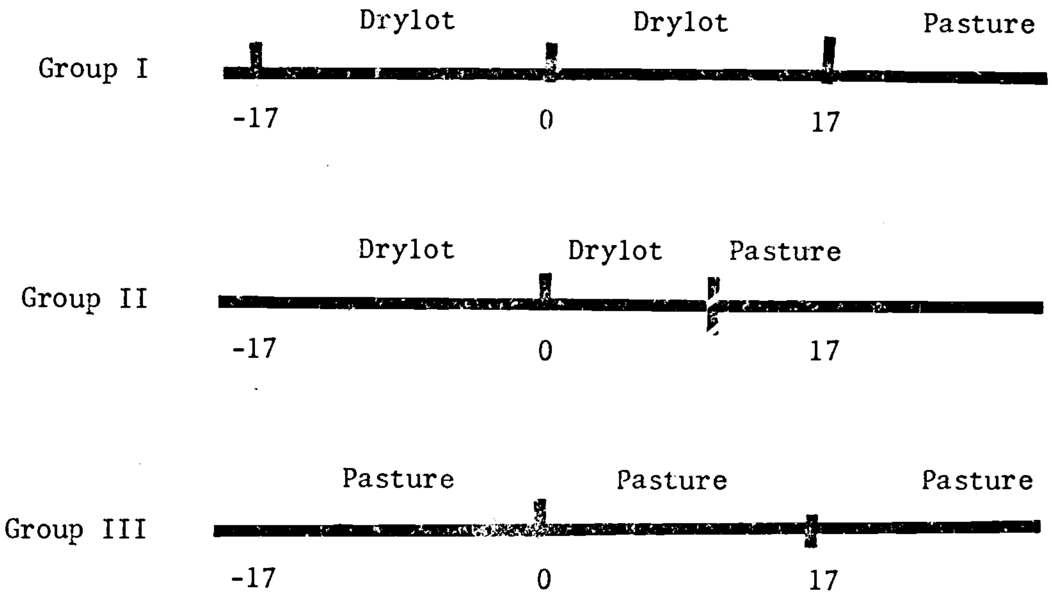
Experimental Design

The study was conducted during the 1974-1975 production year at the Oregon State University Hill Pasture Sheep Farm. One hundred two mature blackface crossbred ewes in good condition were used to examine the effect of drylot breeding on reproductive performance. The ewes were procured from Shoestring Sheep Company, Lapine, Oregon, early in September of 1974.

The ewes were randomly divided into three equal groups of 34 each. Group one was designated to be drylot fed from -17 days to +17 days of the breeding season (Table 1). Day zero represented the day that the bucks were introduced to all the groups. Group two ewes were fed in the same drylot from -17 days to the day they were bred. Breeding was determined by the raddle mark. Marked ewes were returned to dryland hill pasture with the control group. Group three was at the same time designated to be the control group. They were assigned to spend the entire breeding season on an improved hill pasture typical for sheep farming in this area of Oregon.

Groups one and two were provided grass clover hay _ad libitum_ plus supplementation of 1.1 pound of alfalfa hay and .5 pounds of barley per head per day. All groups were allowed an ample supply of water. During lactation the following spring, ewes were rerandomized within flushing treatments to creep fed or non-creep fed groups. Lamb production was compared to determine biological and economic effects of these management practices.

TABLE 1: EXPERIMENTAL DESIGN



Day of season, where day 0 is the day rams were turned in.

Ewe and Lamb Management

a. Breeding Season

Drylot ewes (group one and two) were fed once daily at an average rate of 1.1 pound of alfalfa hay and .5 pound barley per head. To eliminate any advantage of one ewe over another, enough feeding space was provided and the feed was evenly spread in the feeding trough. The grass hay was provided *ad libitum*. Ewes in group three that served as control were not given any supplement. They remained on dry hill pasture for the entire breeding time.

Breeding started by the introduction of the rams to the ewes on September 30, 1974. The rams used were Finn x Rambouillet yearlings. Two rams each were used in drylot and pasture bred groups. The rams were all fixed with colored grease on the brisket so that any mounted ewe would be marked with the paint. The color of the paint was changed after 17 days in order that the repeat breeders could be identified whenever they were mounted again. As the breeding progressed within ewes in the drylot, any marked ewe belonging to group two was taken out every morning and placed with the pasture group. Those marked in group one were left there until day 17 at which time all group one ewes and all remaining group two ewes were put on dry pasture with group three controls. Rams stayed with the pooled ewes for an additional 17 days, to October 5, 1974.

b. Gestation and Lambing

From the end of the breeding season to lambing time, the whole group of ewes were maintained together on an improved hill pasture comprised mainly of ryegrass (*Lolium perenne*), some tall fescue (Festuca arundinacea) and subterranean clover (Trifolium subterraneum). Adequate water was available on the pasture. During this time, the animals were checked twice weekly to see if any extra care were needed. Feed availability was closely monitored while the animals were on the pasture. They were moved from one field to another as soon as it was noticed that the forage was becoming scarce. Because of a moderate incidence but constant threat from foot rot, the animals were footbathed in a five percent formalin and foot trimmed at an interval of two weeks and before moving them to a new pasture. During the later gestation period, the ewes were fed molasses besides their regular pasture feeding as a precaution against ketosis. During this period, the ewes were also vaccinated against enterotoxemia, sore mouth, pneumonia and wormed with tramizole. A few days prior to the expected time of lambing, the ewes were all hauled to the central OSU sheep barn for close observation and help during the lambing period. Help was available to any ewe at any time during the lambing.

After lambing, the ewe and lamb(s) were restricted to a jug for one or two days before putting them together in a large group. On the second day following lambing the lambs were docked and castrated with rubber bands and weighed. A permanent identification number was assigned to each lamb at this time and a vitamin ADE injection was administered also.

At about a week of age the lambs and ewes were divided into creep and non-creep groups. Those in the creep group were introduced to creep feed while they were still in the small mixing pens.

Both creep and non-creep groups were taken to the hill pasture after about two weeks in the barn.

c. Lactation

During lactation the ewes in each of the three nutritional treatments were randomly divided into creep and non-creep groups. Randomization was constrained to provide as nearly as possible equal numbers of single and twin births from each nutritional treatment group into each of the two divisions.

The lambs of the ewes in the creep group were fed creep feed while the ewes were on pasture. A fence was constructed around the creep trough to prohibit the ewes from eating the creep feed. The creep ration presented in Table 2 was formulated to give 68 percent TDN and 13 percent protein.

The two groups were on pastures that were as similar as possible in forage quantity and quality until June 19, 1975, when the lambs were weaned at an average age of 107 days. Within this time, management practices included vaccination for sore mouth and enterotoxemia and periodic footbathing. At weaning, fat lambs were sent to market, replacement ewes were selected and the remaining lambs were sent to the feedlot.

Data Collection

a. Weighing Procedures

All 102 ewes were weighed before the flushing started on September 13, 1974. The main purpose of this was to monitor the change in weight as the flushing and breeding season progressed. Many workers, Coop (1966), Torell (1972) and Ruttle and Montgomery

TABLE 2: CREEP RATION

Ingredients	Percent of Ration
Steam Rolled Barley	62
Ground Alfalfa	7
Soybean Oil Meal	20
Wheat Mill Run	4
Molasses	7
Trace Mineralized Salt	20 lb/ton
Antibiotics	50 gm/ton

(1972) have shown that heavy ewes have a higher lambing percent than light ewes on a within breed basis. For the duration of the flushing and breeding season, all ewes were reweighed at two week intervals. A total of four weights was taken on each of the ewes during this phase of experiment.

b. Bleeding Procedures

Twenty randomly selected ewes from each of the three nutrition treatment groups were bled on the same day that weight of the animals was taken. The first bleeding was carried out on September 13, 1974. Subsequent bleedings were made at two week intervals. Blood samples were withdrawn from the jugular vein of the experimental animals from each group. Ten ml size vacuum tubes containing sodium heparin (143 USP units) to prevent blood coagulation were used. The blood samples were taken to the laboratory as soon as possible for processing. In the laboratory, they were centrifuged and the serum transfered to a labelled glass vial. The vials were covered with cellophane tape and stored frozen at -5°C until analyzed for total blood protein, serum albumin and blood urea nitrogen. Twenty-five lambs from creep and 26 lambs from the non-creep group were bled at weaning and the plasma analyzed for blood protein, serum albumin and blood urea nitrogen.

Laboratory Analysis

a. Blood Protein

Determination of protein was made by the Lowry procedure (Lowry et al. 1951). Values for each sample were obtained on a Bausch and Lomb spectrometer. Reading against the blank was made at optical density 500. A standard curve was prepared from the readings obtained by the use of a protein standard (protein standard solution stock No. 540-10) read against the blank at the same optical density 500. Reading of the values obtained on the spectrometer on individual blood serum was read on the standard curve.

b. Blood Serum Albumin

Albumin level of the serum was measured by the use of the Sigma method for the colorimetric determination of albumin (Sigma Technical Bulletin No. 630). The use of standard (protein standard solution stock No. 540-10) was employed in the final reading of the values. Calculation of the values was by the method set forth in Bulletin 630.

$$\text{Serum Albumin (gm/100ml)} = \frac{\text{A Test}}{\text{A Standard}} \times 5.0$$

In this case 5.0 is the volume in ml of the color reagent used (color reagent stock 630-2).

c. Blood Urea Nitrogen

Measurement was by the Sigma method for BUN determination (Sigma Technical Bulletin No. 640). This method is dependent upon the action of urease (from urease solution) to produce ammonia that is subsequently measured colorimetrically. Absorbance reading was taken at optical density 650. The result was determined by the calculation using the standard.

$$\text{Serum Urea Nitrogen (Mg/100ml)} = \frac{\text{A Test}}{\text{A Standard}} \times 30$$

where 30 is the solvent (water) volume used in the dilution of the original urease.

Statistical Analysis

Weight and blood chemistry of the ewes was analyzed by split plot analysis of variance as presented by Gill and Hafs (1971).

Because of unequal subclass numbers, the least squares analysis of variance was used for lamb records and for all other analyses (Harvey, 1960).

IV. RESULTS AND DISCUSSION

This experiment was designed to answer specific questions that pose problems at different stages of the commercial sheep production cycle (mating season, lambing season and weaning time). Results here are presented to answer these questions as they arose.

Mating Season

Table 3 summarizes split-plot analyses of variance which tested the effects of feeding treatment, individual sheep, time, and the treatment x time interaction on ewe weight and blood chemistry at two week intervals during the mating season. Ewe weight varied significantly among sheep within treatments ($P<.005$). Repeatability, or the intraclass correlation among repeated weights on the same individual, was 0.71. The treatment x time interaction was also significant ($P<.005$). Thus weight change over time differed among treatment groups. The data are plotted in Figure 1. In group three (controls) there was a gradual increase in weight over the first two weeks, while the ewes in groups one and two (the drylot groups) had a moderate loss in weight. The following two weeks showed the control group leveling off in gain. At this period (two to four weeks), the drylot ewes (groups one and two) were gaining more rapidly than group three. All the groups had a drop in weight during the final two week period.

Several reasons could have accounted for the loss in weight of drylot ewes. First the animals originally were brought from a central Oregon range band; therefore it is possible that they were going through an adjustment period, since none was allowed before the

TABLE 3: TESTS OF SIGNIFICANCE FOR EFFECTS OF VARIOUS FACTORS ON EWE BLOOD PARAMETERS AND WEIGHT

		F Ratio for:			
Source of Variation	df[1]	Wt.	Blood Protein	Albumin	BUN
Treatment	2	1.08	0.48	1.06	34.75**
Sheep/Treatment	54	46.93**	2.67**	3.13**	3.45**
Time	3	6.04**	.69	1.43	34.92**
Treatment x Time	6	15.20**	25.01**	22.56**	131.30**

[1] Degrees of freedom for residual are 162

** P<.005

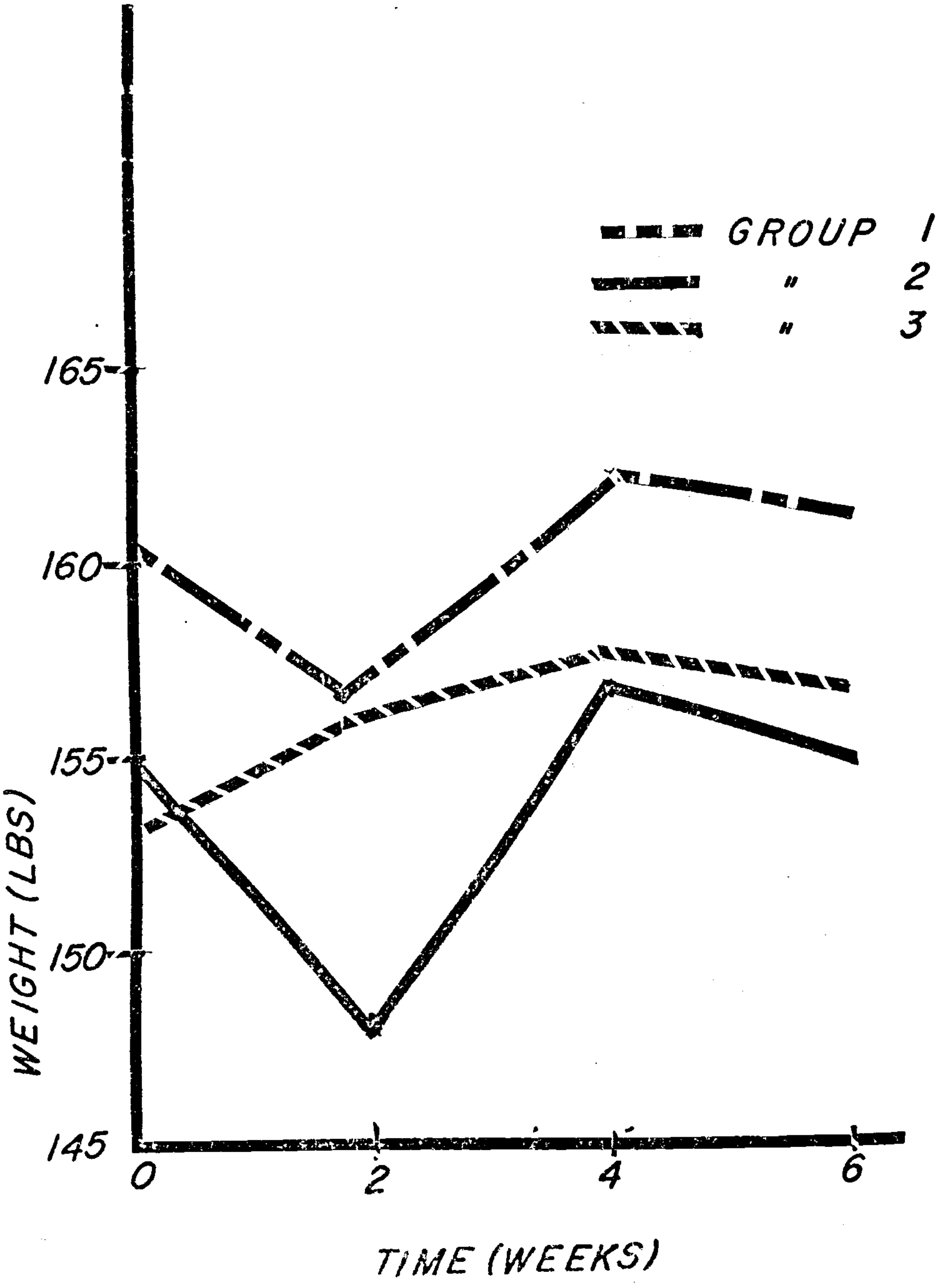


FIGURE 1

Mean Weight of Ewes Over the Mating Season test began. This, however, should also have affected control group ewes. Second, the dusty condition of the drylot may have affected the animals adversely. Third was the stress that the daily handling (feeding and screening of those marked by the buck) put on the animals. Fourth, the animals were generally in good condition (154 to 161 pounds) at the commencement of the experiment; this may have contributed to the lack of response in weight change of the drylot groups. Finally, the ration which was supplied was shown to be marginally inadequate to support weight gain. The NRC (1968) requirement for ewes averaging 150 pounds and in the first 15 weeks of gestation is 55 percent TDN and 9 percent protein. In this experiment, the ration, on an estimated 2.4 percent of bodyweight feed intake, was calculated to provide 51 percent TDN and 9.4 percent protein; thus the ration was inadequate to meet the ewe's TDN requirement. One effect of the deficient energy was weight loss during the first two-week period.

The analyses of variance (Table 3) also showed highly significant differences among sheep within treatments for blood protein ($P<.005$), albumin ($P<.005$) and BUN ($P<.005$). This indicated that there was a positive correlation between repeated measures of these parameters on individuals. Despite the significant differences among sheep, repeatabilities were only 0.08, 0.10 and 0.11 for blood protein, albumin and BUN, respectively. Thus there was considerable fluctuation in blood chemistry within sheep over time.

The significant treatment x time interaction for blood urea nitrogen is plotted in Figure 2. Blood urea nitrogen for the control

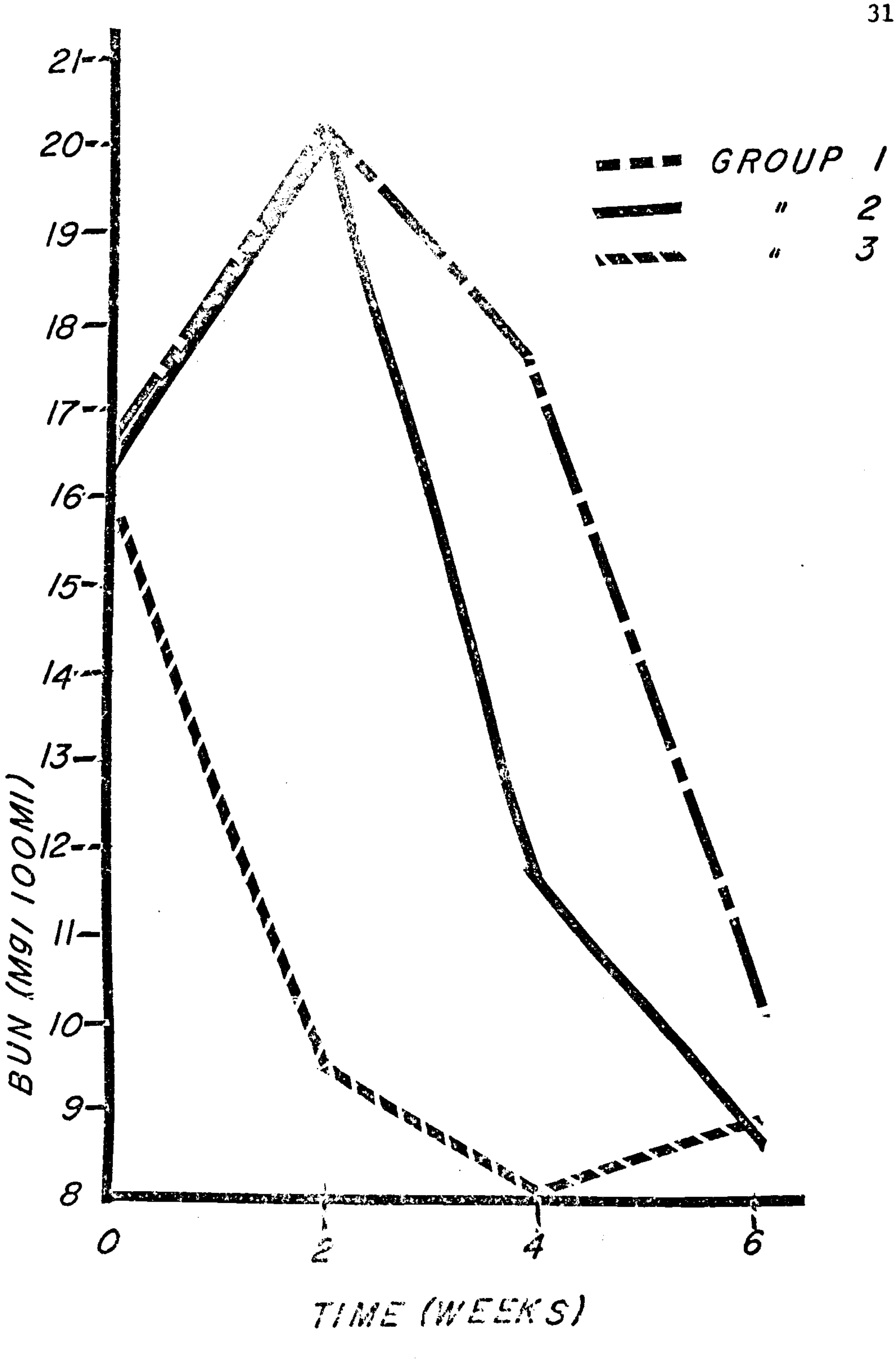


FIGURE 2

Mean Blood Urea Nitrogen Level of Ewes
Over the Mating Season

group (treatment three) that was under limited handling showed a steep drop (9.3 mg/100ml) during the first two weeks on the pasture. A gradual upward movement began at the end of the fourth week.

The blood urea value of the two drylot groups (one and two) had almost identical increases between zero and the second week (20.5mg/100ml), but between the second and fourth week group two ewes dropped off more rapidly. The ewes in this group that were marked by the buck were gradually taken from the lot and turned onto dry pasture. The drop is probably a response to dry pasture, such as was seen in group three ewes during the first two weeks of the experiment. Group one ewes experienced a similar drop when they left the drylot after the first 17 days of mating. It is interesting to note that the weight change in all the treatment groups during the first two weeks was a mirror image of the BUN change. The weight loss of drylot groups probably resulted from inadequate energy coupled with dusty conditions and handling stress. Therefore, the increasing BUN of these groups was possibly a reflection of the animals' catabolizing their tissue protein to make up for the deficient energy. The excess nitrogen from the body protein is left in the blood as urea. Leibholz (1970) reported a high BUN level in wethers that were starved for 12 and 20 day experimental periods.

The comparison of liveweight changes of the three nutritional treatment groups over time (Figure 1) and the mean blood urea nitrogen changes of the three groups over time (Figure 2) showed that the blood chemistry did not follow the body weight change pattern. The marked difference in Figures 1 and 2 and the TDN level of total feed supplied drylot ewes reflected the nutritional status of each group. Lewis (1957), Preston et al. (1961) and Torell, Hume and Weir (1972) showed BUN level to be a good predictor of the nutritional status of ruminants.

The treatment x time interaction for blood protein and albumin (Figures 3 and 4) are highly significant (P<.005). Thus blood protein and albumin differ among treatment groups over time, but the differences are not readily interpretable nor particularly important biologically.

Lambing Season

The principal question that this section was designed to answer was whether the nutritional treatments affected reproduction of the ewes.

Table 4 presents the least squares analysis of variance of treatments and blood chemistry on number of lambs born per ewe bred. This analysis was based on data collected from the 20 randomly chosen representatives of each group and not on the entire population. There were no significant treatment or blood chemistry effects on the number of lambs born. This result is contrary to those obtained by Marshall and Potts (1921) who reported 18.1 percent more lambs born to ewes fed one-half to one-fourth pounds of grain per day over five years.

The regression of number born on blood protein (mg/100ml) was negative (b = -.106) and approached significance at P = <.05 (Table 5). This result suggests that there is a negative relationship between blood protein during mating and subsequent prolificacy.

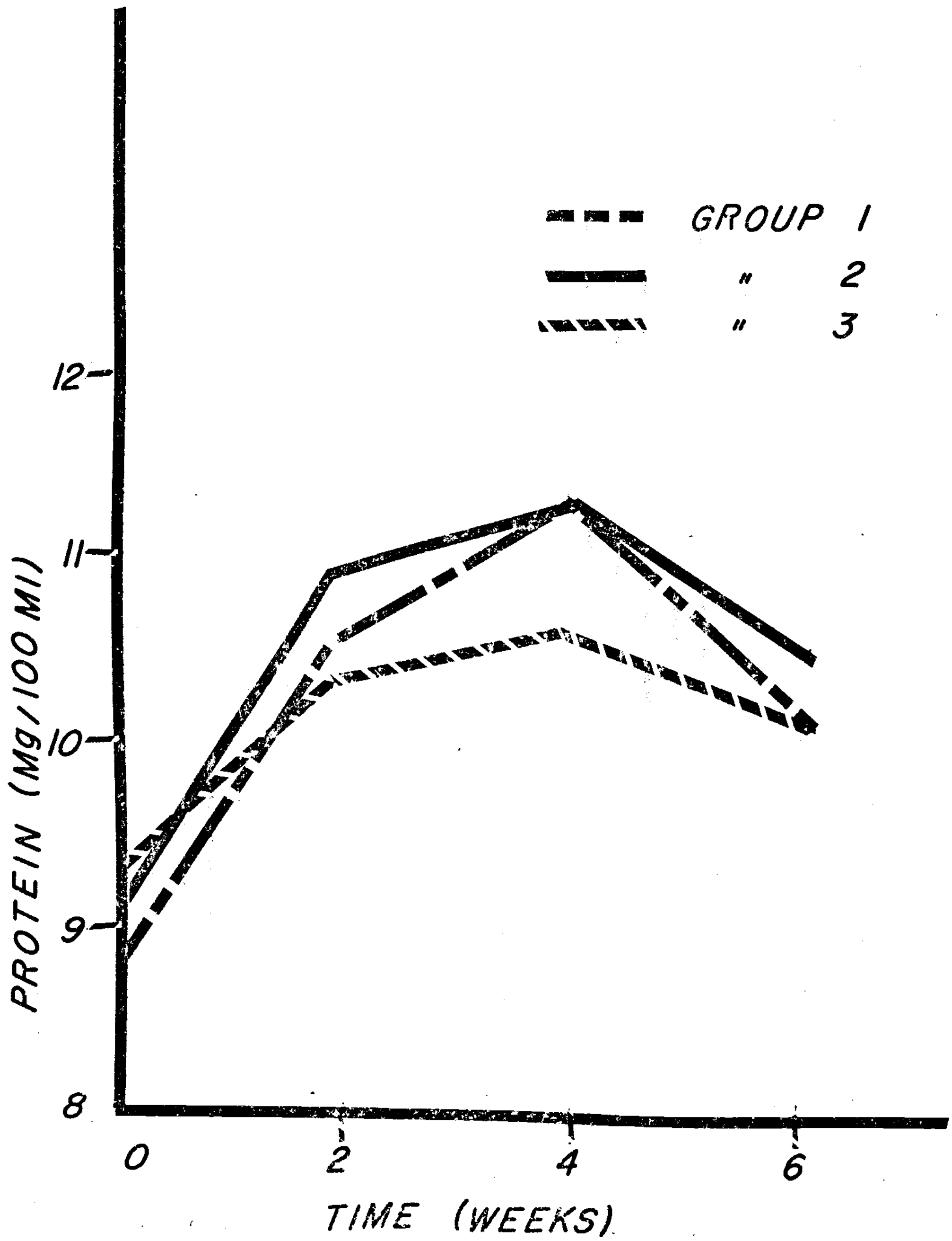


FIGURE 3

Mean Blood Protein Level of Ewes
Over the Mating Season

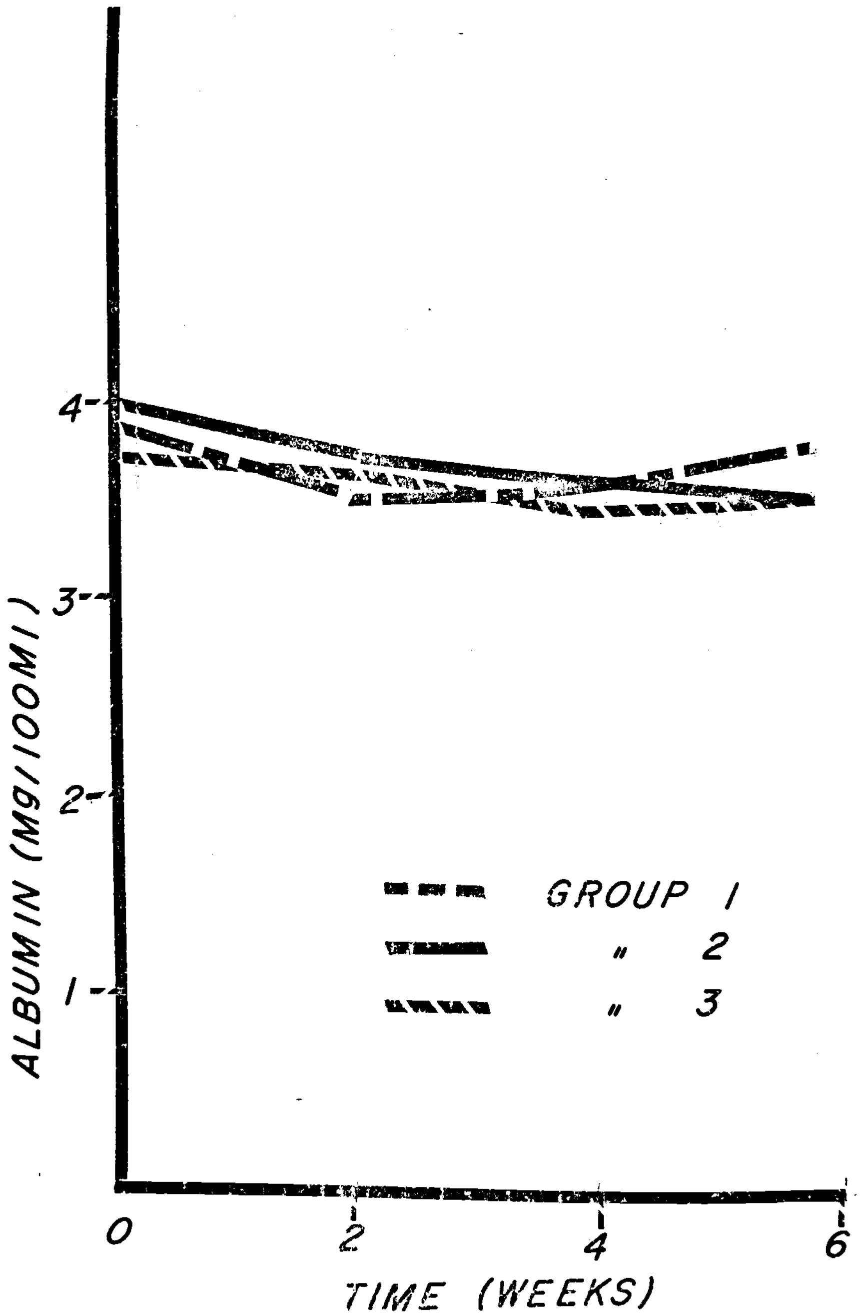


FIGURE 4

Mean Albumin Level of Ewes
Over the Mating Season

TABLE 4: ANALYSIS OF VARIANCE OF FEEDING TREATMENT AND BLOOD CHEMISTRY ON NUMBER OF LAMBS BORN

Source of Variation	df	Mean Square	F
Treatments	2	.29	.80
Weight	1	1.24	3.45
Weight Change	1	.23	.64
Blood Protein	1	1.18	3.28
Blood Albumin	1	3.59	1.00
Blood Urea Nitrogen	1	.08	.22
Error	51	3.59	

TABLE 5: ANALYSIS OF VARIANCE OF WEIGHT AND WEIGHT CHANGE ON NUMBER OF LAMBS BORN USING THE ENTIRE POPULATION

Source of Variation	df	Mean Square	F
Treatments	2	.89	2.58
Weight	1	1.52	4.38*
Weight Change	1	.50	1.44
Error	97	.35	

* P<0.05

Contrary to the result obtained by Torell (1972), in which a good correlation between BUN levels and lambing performance was established, the result in this work was far from being significant. The regression of number born on blood urea nitrogen was positive (b = 0.013) but not significant.

As will be discussed in another part of this paper, it is possible that the results, particularly for number of lambs born per ewe, were affected by the breeding time. Breeding in October likely reduced the percentage of flushing response for ovulation rate. Hafez (1972) showed that ovulation rate of the ewe tends to increase from early to peak in the middle of the breeding season and then to decrease toward the end. Since October is in the middle of the breeding season for ewes, it is possible that flushing in reality served little purpose in increasing ovulation capacity of the ewes. They may, due to seasonal influences, have been ovulating at or near their biological potential, in which case they would be largely refractory to further flushing stimulae. It is therefore legitimate to question whether a better flushing response and a higher correlation between BUN and number born would have been obtained, like Torell, if the ewes had been bred earlier.

A further statistical analysis of variance of nutritional treatments, weight, and weight change on number born was carried out using the entire population (Table 5). Both treatment and weight change effects were not significant, while the liveweight effect on number of lambs born was significant ($P<.05$). The regression was .07 lambs per ten pound increase in liveweight. A result like this was envisaged since Coop (1962, 1966) reported a six percent increase in twinning for each ten pound increase in liveweight of Corriedale ewes.

Means for reproductive data of the treatment groups are presented in Table 6. None of the differences was significant. Treatment group three as the control in this experiment had a lamb crop percentage of 167. This result is higher than expected for ewes maintained and bred on dry hill pastures. One possible explanation for this is the ewes' age. A positive relationship between age (maturity) and reproductive efficiency has been established and documented in the literature (McKenzie and Terrill, 1937; Torell, 1972). Maturity has also been shown to have a great influence on multiple births and on reduction in number of dry ewes (Torell, 1972; Coop, 1962). Therefore the remarkable 65 percent twinning obtained in the control group as well as those of drylot groups is possibly influenced by age. All the ewes in the experiment were mature, estimated to range from four to six years of age.

The lamb crop for group one of 161 percent came as expected, that is at least lower than that of group two. The longer flushing time (34 days) may have increased embryonic mortality as the multiple birth percentage (59 percent) manifested. The effect of liberal feeding on embryonic mortality has been shown by Foote et al. (1959), Christian and Nofziger (1952) and Self (1953).

Treatment group two gave the best result of the experimental groups. The lamb crop (182 percent) and multiple birth (77 percent) percentages were both spectacular (Table 6). Major reasons that may have been responsible for this result are increased ovulation

TABLE 6: EFFECTS OF SUPPLEMENTATION AND DRYLOT BREEDING ON REPRODUCTIVE PERFORMANCE OF EWES

Measurement	Treatment Group 1	2	3
No. of Ewes	34	34	34
Percent Dry Ewes	3	3	3
Lamb Crop (%)[1]	161	182	167
Multiple Birth (%)	59	77	65
Average birth day within lambing season	9	9	8

[1] Based on ewes lambing

rate from drylot feeding and decreased embryonic mortality. The increase in ovulation rate which is responsible for both high lamb crop and twinning is in agreement with Christian and Nofziger (1952) and Robertson _et al_. (1951), both of whom found increased ovulation rate of animals on higher feeding level. One other reason that may be responsible for the increased lamb crop and twinning is enhanced embryonic survival. The implication of this result is that the animals in group two had higher survival of eggs than those in treatment group one. Clark (1934) and El Sheikh _et al_. (1955) had previously reported higher embryo survival in unflushed animals.

Weaning Time

The analysis of variance of individual lamb weaning weight (Table 7) showed a significant advantage of creep fed lambs (77 pounds) over the non-creep fed group (68.7 pounds). This 8.3 pound advantage manifests promising results that are desired in any commercial lamb production operation. These results are in agreement with those of Miller (1939) where lambs given any form of grain at an early age attained heavier weight than those not given any grain.

Treatments were significant ($P<.05$). Average weaning weight of treatment groups one, two and three were 75.4, 72.7 and 70.6 respectively. The treatment x creep interaction was not significant. Thus the effect of creep feeding did not depend on the type of nutritional treatment that the ewes were on.

The effect of twin versus single birth was highly significant. The average weaning weight advantage of single lambs (78.5 pounds) versus twin lambs (67.3 pounds) was comparable to reports in the

TABLE 7: ANALYSIS OF VARIANCE OF INDIVIDUAL LAMB WEANING WEIGHT

Source of Variation	df	Mean Square (lb^2)	F
Treatments	2	317.9	3.04*
Creep vs. non-creep	1	2547.0	24.36**
Treatment x Creep	2	101.0	.97 ns
Single vs. Twin	1	2879.3	27.54**
Wether vs. Ewe	1	591.0	5.65*
Regression on Age	1	6240.6	59.69**
Error	140	104.6	

* P<.05

** P<.01

ns non significant

literature (Singh et al. 1967; Holtmann and Bernard, 1969; Sidwell and Miller, 1971; Dickerson et al. 1972; and Hohenboken et al. 1976b).

Wether (74.9 pounds) versus ewe lambs (70.9 pounds) also differed significantly, in spite of the fact that sex was corrected for in the final weaning weight. Singh et al. (1972) and Hohenboken et al. (1976b) have reported similar results.

Regression of weaning weight on age in days was highly significant. For every added day of age, a lamb was expected to be 1.13 pounds heavier. This result showed that heavier lambs could have been obtained if matings had been earlier. In effect, breeding the ewes earlier in the season would result in more weight available for sale and in more fat lambs at weaning.

Birth weight was also analyzed; the advantages of single (11.2 pounds) versus twin (9.7 pounds) are comparable to differences reported in the literature (Singh et al. 1967; Holtmann and Bernard, 1969; and Dickerson et al. 1972).

An additional analysis of variance was performed to test the effect of nutritional treatment during breeding and of creep feeding on total pounds of lamb weaned per ewe lambing. The effects of treatment and the treatment x creep interaction were not significant (Table 8). Average production per ewe lambing for the three treatment groups varied only from 110 to 118 pounds (Table 9) with highest productivity from ewes drylotted for a full 34 days. Creep versus non-creep was significant ($P<.05$). The average production figure for non-creep groups was 104 pounds compared to 122 pounds for all

TABLE 8: ANALYSIS OF VARIANCE OF TREATMENT AND CREEP EFFECTS ON TOTAL LAMB WEANED PER EWE LAMBING

Source of Variation	df	Mean Square (lb^2)	F
Treatments	2	637.3	.54 ns
Creep vs. non-creep	1	7140.5	6.08*
Treatment x Creep	2	1738.7	1.48 ns
Error	87	1174.3	

* $P<.05$

ns non significant

TABLE 9: GROUP AVERAGES FOR NUMBER OF LAMBS AND POUNDS OF LAMB WEANED

	Treatment Group		
	1	2	3
Lambs weaned/ewe lambing	1.56	1.57	1.52
Lambs weaned/ewe bred	1.51	1.53	1.47
Lb. of lamb weaned/ewe lambing	118.0	112.0	110.0
Lb. of lamb weaned/ewe bred	114.4	108.7	106.6

the creep-fed groups (Table 10). For the first treatment group, the mean lamb production per ewe lambing was 110 pounds for the non-creep group and 126 pounds for the creep group. An advantage of 35 pounds production per ewe lambing of creep over non-creep in group two ewes was remarkable. The marked advantage that existed of creep over non-creep treatments was not obvious, however, in the control group.

Another area of concern in this study was the relationship between lamb blood chemistry and lamb weight. Correlation analysis and least squares analysis of variance were performed to determine whether any of the blood chemistry parameters were affected by treatments and whether they had predictive value for lamb growth. This analysis was based on data from a random 25 creep fed lambs and 26 non-creep lambs at weaning time. The results are presented in Table 11. The effects of treatments, treatments x creep interaction, singles vs. twins, wethers vs. ewes and regression on lamb age on lamb blood chemistry were not significant. However, the creep feeding did affect blood urea nitrogen (15.7 vs. 17.9 mg/100ml for non-creep vs. creep respectively). Preston _et al._ (1961) reported a significant difference of BUN level in animals of different feed levels. Abou Akkada and Osman (1967) found that BUN can be used as an index of protein utilization.

Correlations among blood chemistry and individual weaning weight are shown in Table 12. Correlations between blood protein and albumin, blood urea nitrogen and weight were small and negative. The correlation between albumin and BUN was also near zero. There was

TABLE 10: MAIN AND JOINT EFFECTS OF NUTRITIONAL TREATMENTS DURING MATING AND OF CREEP FEEDING ON POUNDS OF LAMB PRODUCTION PER EWE LAMBING

	Nutritional Treatment			
Creep Treatment	1	2	3	Av.
Creep	126	129	111	122
Non-creep	110	94	108	104
Average	118	111.5	109.5	overall 113

TABLE 11: TESTS OF SIGNIFICANCE FOR EFFECTS OF VARIOUS FACTORS ON LAMB BLOOD PARAMETERS AND WEIGHT

	F Ratio for:		
Item	Blood Protein	Albumin	BUN
Treatments	2.83	1.38	.65
Creep Feeding	1.59	1.56	8.27**
Treatments x Creep	.84	.00	.62
Single vs. Twin	.01	.69	.00
Wether vs. Ewe	.01	.53	.66
Regression on Age	.00	2.37	1.10

* P<0.05

** P<0.01

TABLE 12: CORRELATIONS BETWEEN BLOOD CHEMISTRY LEVELS AND INDIVIDUAL WEANING WEIGHT

	Albumin	BUN	Wt.
Blood Protein	-0.11	-0.06	-0.03
Albumin		0.03	0.59
Blood Urea Nitrogen			.03

a high correlation between albumin and weaning weight (.59). Blood urea nitrogen was not correlated with weaning weight.

The effects of blood chemistry, creep, sex, type of birth and age on weaning weight were analyzed (Table 13). Single versus twin, blood protein and blood urea nitrogen were not significant. However, creep, sex, age and albumin were significant sources of variation in weaning weight. The regression of weight on albumin was 0.14.

In commercial lamb production, great emphasis is put on the number of lambs and pounds of lamb weaned. Table 9 illustrates the average figures for lamb crop weaned per treatment group. There were minor differences in either lambs weaned/ewe lambing or lambs weaned/ ewe bred among the treatment groups. Not included in these figures are those lambs fostered either due to the dam's death or because of lack of milk as a result of mastitis infection. Grafted lambs were regarded as a product of the ewe group to which they were grafted.

Pounds of lamb weaned/ewe lambed and pounds of lamb weaned/ewe bred (Table 9) manifest no marked advantage of treatment group two over the control group. However, an advantage of eight pounds existed between nutritional treatment one and the control group. The figures used here were calculated by adjusting only for the sex but not for type of birth, rearing and age. Because one important aspect of this study was to evaluate management effects of lambing under these three treatment groups, we are therefore holding each ewe and group responsible for the day of lambing within lambing season and for the number of lambs born.

TABLE 13: ANALYSIS OF VARIANCE OF WEIGHT AS INFLUENCED BY BLOOD CHEMISTRY, CREEP, SEX, TYPE OF BIRTH AND AGE

Source of Variation	df	Mean Square	F
Creep vs. non-creep	1	742.3	11.1***
Wether vs. Ewe	1	452.8	6.8*
Single vs. Twin	1	21.2	.3
Age	1	706.7	10.6***
Blood Protein	1	55.4	.8
Blood Albumin	1	885.5	13.3***
Blood Urea Nitrogen	1	105.2	1.6
Error	43	66.8	

* P .01

*** P .005

The number of fat lambs harvested at weaning from creep and non-creep groups was compared to evaluate any possible feeding advantage. At weaning, the creep group had six lambs ready for slaughter compared to only one from the non-creep group. Fat lambs were determined on the basis of lambs weighing 95 pounds and above and having sufficient external fat cover to grade USDA choice. The very low proportion of lambs ready for slaughter in both groups is largely a function of the late lambing season. The ewes lambed from February 23 to March 30. Normal lambing for western Oregon is mid-January to late February.

The possible effect of creep feeding on gain after weaning was tested by t test to see if the preweaning nutritional treatment had any influence on subsequent post-weaning weight gain. The slight advantage of creep fed lambs was not significant. Testing was by evaluating the weight change in lambs from the time of weaning to two months later. Creep feeding does not appear to have any marked influence on lamb gain beyond weaning.

Economics of Flushing and Creep Feeding

The important question that this economic section set out to explore was the cost and benefit of the extra investment for supplemental feed.

Flushing and creep feeding are widely accepted practices in livestock production. But the scarcity of grain to farmers caused by global demand for a once ample supply has altered the price. The resulting increase in price has increased the total per ewe variable cost. Therefore, the output per unit of input must be examined.

The calculations are presented here on a per ewe basis, and the production result of ewes bred on dry pasture with lambs not creep fed is used as a base. Gain or loss is therefore the deviation from the record of this control group.

The total flushing ration provided to groups one and two was composed of:

1202#	barley	at	\$120/ton	=	\$ 72.18
2405#	alfalfa hay	at	\$ 70/ton	=	84.18
4810#	grass hay	at	\$ 25/ton	=	60.12
	Total flushing cost			=	\$216.48

This total amount was partitioned between nutritional treatment one and two that were flushed in drylot; the division was on the basis of number of sheep and number of days on supplemental feeding.

Group I (Average 34 days) Total flushing cost = \$122.70

Group II (Average 26 days) Total flushing cost = \$ 93.78

$$\text{Cost per ewe bred} \quad \text{Group I} = \frac{\$122.70}{33} = \$3.72$$

$$\text{Group II} = \frac{\$\ 93.78}{34} = \$2.76$$

Total feed consumed by creep lambs equalled 5,643 pounds. The creep ration and cost are presented in Table 14.

$$\text{Cost/ewe bred} = \frac{\text{Total creep cost}}{\text{Total creeped lambs}} \times \text{lamb weaned/ewe bred}$$

$$\text{Creep feed cost/ewe bred} = \text{Group 1} = \frac{\$377.03}{75} \times 1.56 = \$7.84$$

$$\text{Group 2} = \frac{\$377.03}{75} \times 1.57 = \$7.89$$

$$\text{Group 3} = \frac{\$377.03}{75} \times 1.52 = \$7.64$$

Based on the above calculations, the final return per ewe bred in

TABLE 14: CREEP RATION AND COST

Steam rolled barley	62%	=	3499#	at	$125/ton	=	$218.56
Ground alfalfa	7%	=	395	at	$80/ton	=	15.80
Soybean meal	20%	=	1128	at	$178/ton	=	100.39
Wheat mill run	4%	=	226	at	$148/ton	=	16.72
Molasses	7%	=	395	at	$80/ton	=	15.80

Trace mineralized salt	20#/ton at $4/cwt	=	$ 2.00
Antibiotics 50/gm/ton at 5.5¢/gm		=	7.76
	Total Cost	=	$377.03

both creep and non-creep groups of each original three nutritional treatment groups is presented in Table 15.

The final analysis of return per ewe (Table 15) showed that none of the nutritional treatments gave a net return better than that of group one (the group that was not flushed and their lambs not creeped), the base group. The lowest return per ewe bred ($33.64) was from group three (the group that was removed from flushing when bred and whose lambs never received creep feed). Average loss per ewe bred (measured as deficiency from group one) was $5.03. This amount is a substantial amount in the sheep business. The blanket conclusion on the basis of these records is that flushing and creep feeding were not feasible under the environmental and economic conditions existing at the time of the experiment. Also the figures here were calculated without any account for the extra labor cost for the drylot and creep groups. The inclusion, which is a normal aspect of farmer's calculations for cost, would widen the gap between the base group and the others.

But on the production side, groups that received creep feeding (two, four, six - Table 15) all gave better production than our base group; the best production (125 pound/ewe bred) resulted from the group in which ewes were flushed until bred and the resulting lambs were creeped. This particular result corroborated the advantages of flushing and creeping that had been established before by Harper (1936), Miller (1939) and others. Of the groups whose lambs were not creeped but the dams flushed, one gave a

TABLE 15: COST AND RETURN PER EWE BRED IN ALL NUTRITIONAL TREATMENT GROUPS

	Production/ Ewe lbs.	$ Value/ Ewe	Extra Flushing Cost/Ewe $	Creep Cost/ Ewe $	Total Extra Cost/Ewe $	Return Value-Extra Cost $
1. Non-flushed non-creeped pasture group (control)	105	42	0	0	0	42
2. Non-flushed, creep fed pasture group	108	43.20	0	7.84	7.84	35.36
3. Drylot removed after breeding non-creep	91	36.40	2.76	0	2.76	33.64
4. Drylot removed after breeding creeped	125	50.00	2.76	7.89	10.65	39.35
5. Drylot flushing 34 days, lambs non-creeped	107	42.80	3.72	0	3.72	39.08
6. Drylot flushing 34 days, lambs creeped	122	48.80	3.72	7.64	11.36	37.44

slightly better production per ewe bred (107 pounds) than the base group.

At a glance, one would be tempted to conclude that flushing and creep feeding are not an economically viable means of aiding lamb production. But looking at pounds of lamb produced at weaning, the superiority of flushed ewes whose lambs were creeped (125 pounds) over non-flushed ewes whose lambs were not creeped (105 pounds) was large enough to require reevaluation of the practices each time economic conditions change. If feed were cheaper and lambs more valuable, the practices could be favorable economically.

V. SUMMARY AND CONCLUSIONS

One hundred two mature blackface crossbred ewes were used to examine and answer specific questions that often pose problems in some phase of sheep production.

The ewes were randomly divided into three equal parts. Groups one and two were supplemented and bred in drylot while group three, the control group, spent the entire breeding season on dry pasture characteristic of western Oregon foothills.

Feeding method during mating did not significantly affect weight change among the groups, however, there was significant variation in ewe weight with time. Repeatability, or the intraclass correlation among repeated weights on the same individual was 0.71. There was a significant treatment x time interaction. Thus weight change over time differed among treatment groups. Average ewe weight per group varied from 147 to 161 pounds.

The analysis of effects of various factors on ewe blood parameters showed highly significant differences among sheep and a highly significant treatment x time interaction ($P<.005$). Hence the blood chemistry of the animals in the different groups varied over time. Despite the significant differences among sheep, repeatability was only 0.08, 0.10 and 0.11 for blood protein, albumin and BUN respectively.

Analysis of variance of the effects of feeding treatment and of blood chemistry showed no significant effects from these variables on number of lambs born per ewe bred. The regression of number born on blood protein was negative ($b = -.106$) but not significant, while the regression of number born on BUN was positive (b = 0.013) but not significant. Weight change during the mating season did not affect number of lambs born, but liveweight itself was positively associated with prolificacy (P<.05). The regression of number of lambs born on liveweight was 0.007.

A significant effect of creep feeding on individual lamb weaning weight was found in this experiment. The weight differential was 77 pounds to 68.7 pounds for creep and non-creep respectively. The effect of twin (67.3 pounds) versus single (78.5 pounds) rearing on weaning weight was highly significant (P<.01). So also was wether (74.9 pounds) versus ewe (70.9 pounds) lambs. The regression of weaning weight on age in days was highly significant. For every day older a lamb was expected to be 1.13 pounds heavier. Neither feeding treatment during mating nor the treatment x creep feeding interaction affected individual lamb weaning weight.

The effects of treatment and treatment x creep interaction on total lamb weaned per ewe lambing were not significant. Treatment groups means for pounds of lamb weaned per ewe lambing varied from 110 to 118 pounds with highest productivity from the ewes fed for the full 34 days. The creep (125 pounds) versus non-creep (105 pounds) effect on pounds of lamb weaned per ewe bred was significant.

From analysis of blood chemistry and weight of the 25 creep and 26 non-creep lambs sampled at weaning time, the correlation between albumin and BUN was near zero. There was a high correlation (.59) between albumin and weaning weight. Analysis of variance of blood chemistry, creep, sex, type of birth and age on weaning weight showed significant effects for creep, sex, age and albumin. The regression of weight on albumin was .23. Blood protein, BUN and single versus twin were not significant.

The possible creep feeding effect on gain after weaning was tested to see if the preweaning nutritional treatment had any influence on subsequent postweaning weight gain. The slight advantage observed was not significant.

Flushing and creep feeding, based on results of this project, are not economically viable investments. But on the production side, lambs from flushed ewes that were later creep fed resulted in more pounds of lamb weaned (125 pounds) per ewe bred than from pasture bred ewes whose lambs were not creep fed (105 pounds). This advantage in pounds weaned would warrant the continual practice of supplemental feeding under certain economic conditions. With better management, costs can be reduced and production per ewe increased. If the present demand for animal protein continues, it is possible that the market trend will be such that will make this practice successful.

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