THE INFLUENCE OF FLUSHING ON REPRODUCTION IN EWES

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TABLE OF CONTENTS

INTRODUCTION

The effect of environment on reproduction in the ewe is of interest not only to the sheep producer, but also to those interested in the physiology of reproduction. For a long time the producer has been attempting to increase the number of lambs a ewe would produce. These attempts have given rise to the practice of increasing the amount of feed given a ewe for a period of time before and during the breeding season. The process of causing the ewe to be gaining weight at breeding time is termed "flushing". Morrison (27) gives the following definition:

> "It is generally believed that ewes which are flushed at breeding time, or fed so that they are gaining in weight, are more apt to produce twins and triplets than those which are in poor flesh, and that they also breed earlier and more nearly at the same time and produce more vigorous lambs. Accordingly, with the farm flock it is advisable to flush the ewe for two or three weeks before the desired date of breeding; i.e., to supply an abundance of palatable, nutritious food such as rape, cabbage, good pasture or grain."

Flushing has been a common practice among many of the sheep breeders and has been recommended by authorities on sheep husbandry. The benefits credited to flushing by these writers are that it increases the size of the lamb crop, or increases the percent of twins and triplets produced, and decreases the number of barren ewes. It has also been claimed that the ewes come in heat earlier in the breeding season and the lambs are dropped earlier and over a shorter lambing period.

The above benefits were quoted by many, but experimental data were lacking as proof of these benefits. A series of experiments started in 1930 and terminated in 1939 have been conducted to find whether or not the merits credited to flushing are well founded.

REVIEW OF LITERATURE

The changes of environment due to domestication had a marked effect on reproduction in sheep. According to Clark (7), Darwin stated that wild species of sheep seldom produce twin lambs and often have but one estrous cycle a year. In many domestic breeds, however, a large percentage of twin lambs are produced and some breeds, such as the Dorset, have estrous cycles the year around. Other breeds have a period of anestrous in which they do not have heat cycles. This period usually lasts from the latter part of March until the latter part of August according to Hammond (16). Grant (14) and Asdell (1) found the breeding season to be from October to February. Hammond (16) stated that domestication seems to increase the number of eggs ovulated and also increase the number of atrophic fetuses. Clark (7) states that changes due to a favorable environment on reproduction were noted by Aristotle. The influences of heredity and environment are concerned with factors such as age, breed, season, individual differences, and nutrition.

The effect of age has been discussed mainly in relation to the number of lambs produced at the various ages. Carlyle and McConnell (3) found that the lambing rate increased until the ewe was five or six years old and then there was a decrease with the increasing age. Humphrey and Kleinheinz (19) found a gradual increase in the number of lambs produced up to four years of age and then a gradual decline. Bell (2), Jones and Rouse (22), Roberts (29), Marshall and Potts (23), and Johansson (21), found similar results. McKenzie and Terrill (26), found that the ovulation rate increased to three or four years of age and thereafter there was a decrease in the number of eggs ovulated.

McKenzie and Phillips (25), found that the period of estrus was longer for yearlings than for lambs. The tendency for age to increase the length of heat period was noted again by McKenzie and Terrill (25), but they found no variation in length of estrous cycle due to age.

Differences in the number of lambs produced by different breeds were noted by Carlyle and McConnell (3), Humphrey and Kleinheinz (19), Marshall and Potts (23). Likewise, breed differences were found in rate of ovulation by McKenzie and Terrill (26) and McKenzie and Phillips (25). Cole and Miller (10), found differences in the length of the heat periods due to breed. No influence on the length of estrous cycle due to breed was found by McKenzie and Phillips (25), Clark (7), nor by McKenzie and Terrill (26). However, McKenzie and Terrill (26) found that the duration of estrus was longer for Hampshires than for Shropshires and Southdowns.

Grant (14), observed that ovulation occurred during anestrum before the onset of the first estrous cycle. The first heat periods were short and gradually increased in length as the breeding season progressed. A peak in length is reached about the middle of the season after which the length of the periods becomes shorter. Grant (14) makes the following statement with regard to an earlier estrous period due to "flushing".

> "There is evidence to suggest that under highly favorable nutritive conditions such as are constituted by the farming practice of "flushing" these spurious ovulation periods may be converted into normal estrous periods at which the mating instinct is exhibited."

Cole and Miller (9) confirmed Grant's results and found that ovulation occurred after a discontinuance of the estrous cycles in the spring. Carlyle and McConnell (3), Roberts (29), Marshall and Potts (23), and Asdell (1) found that there was a larger number of multiple births

earlier in the lambing season. Clark (7), however, found that the number of corpus lutea was not higher earlier in the breeding season.

Elpaljevski (13) states that low temperature, dull weather, and precipitation, especially snow, reduced the number of ewes coming in heat and also influenced the length of the heat period. McKenzie and Phillips (24) ran a temperature trial in August and found that ewes kept in a cold cellar did not show evidence of estrus sooner nor did increasing the feed induce an earlier heat period.

Bell (2) in an attempt to produce a strain of sheep that would produce all twins or triplets selected those ewes that were multi-nippled in the belief that that characteristic was linked with multiple birth. Castle (4) in his analysis of Bell's data concluded that the multi-nippled trait was hereditary, and that the twinning tendency was not inherited, but more apt to be due to feeding, age, and season. Smirnov (30) found that ewes producing single lambs at the first breeding were less fertile in subsequent years than those having multiple birth the first time they lambed.

Clark (6) in a discussion of the mode of twinning states that twins in sheep were produced by ovulation of two eggs rather than by a splitting of a single egg early in embryonic life. Similar conclusions were drawn by Chapman and Lush (5). Hammond (16) found that the number of eggs ovulated corresponds closely with the number of lambs dropped and that few losses occur due to unfertilized eggs or fetuses absorbed or aborted. Clark (7) confirmed these findings. According to Hammond's (16) data 87.1 percent of the ovulated eggs develop into normal lambs, 6.9 percent atrophic fetuses, and 6.0 percent of the eggs are missing or unfertilized. These losses are low as compared to known losses in swine

and rabbits. Hammond's contention is that as the number of eggs ovulated increases the losses become greater. Marshall and Potts (23) agree with these conclusions.

Marshall and Potts (23) state that the number of lambs dropped depends largely upon the number of barren ewes and the number of double and triple ovulations. They found that 78 percent of the twins dropped were born during the first half of the lambing season. This they attributed to the fact that the ewes that were better nourished came into heat sooner and produced two ova and that the feed and pasture were more nutritious in the early part of the breeding season. In their experimental work they compared flushed and unflushed lots with the following results:

Unflushed				Flushed			
Lot No.	Ewe No.	Av. Gain in Weight	Lambs Dropped	Lot No.	Ewe No.	Av. Gain in Weight	Lambs Dropped
1	15	2.58	126.7	2	25	4.32	140.0
3	10	4.75	110.0	4	15	17.13	140.0
5	19	4.58	136.8	6	20	6.30	140.0
7	17	1.03	129.4	8	13	2.85	161.5
9	15	3.03	120.0	10	14	12.31	150.0
12	25	.76	136.0	11	11	10.96	145.5
15	24	1.46	129.2	13	21	10.80	147.6
				14	21	3.76	152.4
				16	20	5.80	150.0
				17	17	10.00	142.5
Total	18	1.76	128.8		18	7.98	146.9

From these results they conclude that flushing increased the lamb crop by 18.1 percent. They state that the kind of feed used for flushing did not make a difference, but in order for flushing to be effective the ewes should gain at least seven pounds prior to or during the breeding season. Flushing had no influence on the estrous period nor on the conception date. These last two conclusions are confirmed by Clark (7).

Okuliov (28) found that flushing was beneficial in reducing the number of barren ewes and raising the percentages of multiple births. Coffey (8) makes a similar contention in his book, Productive Sheep Husbandry.

Smith (31) in an experiment at Miles City, Montana, found flushing increased the lamb crop 7.4 percent, but states that the average gain for those flushed lots was only 0.9 pound while the unflushed lots lost 3.6 pounds. In his conclusions he states that these results under the conditions in which the experiment was conducted, the feeding of cottonseed cake as a flushing feed was not economical.

Clark (7) studied the effect of flushing by a count of the corpus lutea at breeding time and obtained the following results.

Experiment I

	Ewes Showing Double Ovulation	Ewes Showing Single Ovulation	Total Gain in Weight	Days on Feed	Av. Rate Gain per day
Flushed	8	12	245.4	1074	.228
Unflushed	0	20	27.7	1262	.022

Experiment II

	Ewes Showing Double Ovulation	Ewes Showing Single Ovulation	Total Gain in Weight	Days on Feed	Av. Rate Gain per day
Flushed	10	10	136.8	646	.212
Unflushed	12	8	31.7	828	.038

He found no difference with respect to time that the ewes came in heat in either experiment and double ovulations occurred throughout the breeding season. The ewes in Experiment II were in better condition than the average farm flock. Clark states his conclusion:

> "The practice of flushing will lead to a higher ovulation rate, provided the ewes are not in high condition to start with."

McKenzie and Terrill (26) found, in a group of Western ewes, that flushing increased the ovulation rate (1.15 as compared with 1.06 for the unflushed). Most of the double ovulations took place before the first of November both in the flushed and unflushed group. (Seven of the ten in the flushed group and three of the four in the unflushed group.) The average end of the breeding season was nearly one and one-half months earlier for the unflushed group.

Hart and Miller (17) in an effort to find the relation of vitamin A to reproduction, reduced the amount of the vitamin in the ration as low as to induce night blindness, but normal conception still occurred in eleven out of seventeen cases. They concluded that vitamin A deficiency was not a limiting factor in conception rate.

Darlow and Hawkins (11) (12) have reported that in the early part of this experiment (1930-33) flushing did not influence the breeding date, but did in some way affect reproduction.

The object of this series of experiments was to study the effect

of "flushing" on reproduction in the ewe. "Flushing" is a common practice among many sheep producers, but the experimental evidence of the justification of increased feeding during the breeding season is limited and doubtful. There are large areas in the United States where early lamb production is very profitable and if "flushing" gives the benefits credited to it, it would be of great practical use.

METHOD OF PROCEDURE

Throughout the nine years of the experiment the ewes were housed in a suitable shelter, the experimental sheep barn, just off the Oklahoma A. and M. Campus. The ewes were tried with a "teaser" ram to note the onset of the estrous cycle and each estrous period. A system of "hand mating" was used. All heat periods and matings were recorded. The weight of each ewe was recorded at the beginning of the flushing period both for the "flushed" and "unflushed" lots and the ewes were weighed and the weights recorded every seven days until the end of the breeding season.

1930-31

The first year a preliminary trial was conducted on the sixty head of purchased grade Rambouillet ewes to eliminate any of those ewes that showed any irregularities in breeding behavior. The ewes were fed oats, bran and alfalfa hay and vaginal smears were made from ten of the ewes every day to note the changes in the number and kind of cells that were present during various phases of the estrous cycle. Records were also kept on the lengths of the gestation periods.

1932-33

The lambs were weaned July 1, 1931, and the ewes placed on native grass pastures until September 5. After August 1 they were tried daily with a "teaser" ram, but breeding did not start until after they were placed on the experimental rations. The ewes were divided into five

lots of nine each and the rations as tabulated in Table I were fed until December 2, the end of the breeding season. The ewes were then all grouped together and fed oats, bran, and alfalfa hay until after lambing.

1932-33

All of the lambs were weaned June 1 and from then on the ewes were tried with an "aproned" ram. On July 23, the ewes were divided into two lots of twenty-one ewes each, and fed as designated in Table II and the breeding dates, lambing dates, weight, etc., were recorded.

1933-34

Fifty head of grade Shropshire ewes with lambs were added to the grade fine wool ewes used in the preceding years. All of the ewes were put on a limited ration of prairie hay by May 1, and were given access to salt, bonemeal and ground limestone at all times. All of the lambs were weaned by July 1 and the ewes continued on prairie hay until August 15 when they were lotted and fed the experimental ration as designated in Table III. None of the ewes were bred before August 15. The ewes of Lots I, II, III, and V did not consume all of the feed given them. Lot III was given corn gluten meal and consumed the ration readily when fifteen percent of the concentrate consisted of the meal. The ewes of Lot II became very thin and ten percent of the sugar in the ration was replaced with yellow corn for the last thirty days of the experimental feeding period. On October 15, the lots were turned together and fed a ration consisting of oats, alfalfa hay and silage.

1934-35

All of the ewes were placed on a prairie hay ration May 1 and were given a mineral supplement. The lambs were weaned on May 30 and the ewes kept on the hay ration until July 10. The ewes were then divided into five lots with thirteen in each lot and were fed the ration indicated in Table V. Estrus was detected by a "teaser" ram and a system of hand breeding was used. They remained on the experimental ration until October 10, or a period of 92 days.

1935-36

The lambs were weaned July 12 and the experimental ewes were then separated into six lots July 13. In Lots I, II, III, and IV there were ten ewes each while Lots V and VI had only nine ewes. Lots II and III were placed on a native grass pasture and Lots I, IV, V, and VI were fed prairie hay. On September 8, the experimental feeding period was started and continued until all ewes were bred. The experimental rations were discontinued on November 9.

1936-37

A different method of allotting ewes to their respective lots was used in 1936-37. The allotment started on August 31 by placing the ewe which was first found in heat in Lot I, the second in Lot II, the third in Lot I and so on until there were ten ewes in each of Lots I and II. The remaining ewes were divided on the same basis between Lots III and IV. This division separated the ewes first found in heat in Lots I and

II and the remainder of the ewes were allotted to Lots III and IV. The experimental rations shown in Table VI were started August 31 and continued until October 13. Breeding began September 14 and continued until all of the ewes were bred.

1937-38

In 1937, twenty-four Hampshire ewes and twenty yearling Western ewes were placed on the experiment. The Hampshires were placed on a ration of two pounds of alfalfa hay on June 10 to reduce them in weight and condition before flushing was started. On June 12, the ration was changed to one pound cottonseed hulls and three-fourths pound of alfalfa hay. Lot III, the flushed Hampshires, was started on the experimental ration June 29. The ration is given in Table VII. The initial weight was made July 7 at the start of the experiment.

The twenty head of Western ewes were placed on the same ration of hulls and hay on June 14. The Westerns were divided into two lots on June 22 and one lot was flushed by placing them on sudan grass pasture. The other lot of Western ewes receiving three-fourths pound alfalfa hay and one pound cottonseed hulls. This was decreased to one-half pound alfalfa hay and three-fourths pound hulls on July 27. After August 5, Lot I, received four pounds silage, one pound oats, and one-fourth pound cottonseed meal. The ewes were kept on the rations for ninety-one days, the duration of the breeding season. (Until October 10). The ewes were placed together and fed the same ration.

1938-39

The lots of ewes that were on the experimental rations in 1937-38

were reversed for the 1938-39 study; therefore, the Western ewes that were flushed the previous year became the unflushed Western ewes. The same procedure was followed with the two lots of Hampshires. The lots were placed on the rations, given in Table VIII, May 28 and remained on these rations until the end of the breeding season, October 10. The breeding was done by "hand mating" after the ewe had been in estrus about twelve hours.

EXPERIMENTAL RESULTS

1930-31

The vaginal smears that were taken gave an accurate measure of the phase of the estrous cycle. The time of estrus as denoted by the "teaser" ram and the smear technique were in close agreement. The length of estrous cycles varied from 13 to 21 days with an average length of 17.5 days. The average length of the gestation period for these grade Rambouillet ewes was 148 days.

1931-32

As shown in Table I there were no twin lambs produced on the experiment in 1931-32 in either the flushed or unflushed lots. The time of the first heat period was the same for both groups and there was no difference in the average breeding date.

1932-33

Because of the inadequate ration of two pounds of prairie hay, the ewes on the non-flushing ration lost considerable weight. They became thinner than ewes normally found in the average farm flock. Seven of these twenty-one ewes failed to come in heat on the prairie hay ration. The first breeding date for the flushed and unflushed lots was the same if the seven ewes not in estrus were disregarded. There was a greater number of returns to heat in the non-flushed group. Again no twin lambs were produced by either lot. Table II shows a summation of the results.

Table I

A Comparison of Different Levels of Nutrition upon the Breeding Behavior and Reproduction of Ewes, 1931-32

Lot number		I	II	III	IV	V
Ewes per lot		9	9	9	9	9
Rations:	Yellow corn	.487	.096	.487	.29	.765
	Linseed meal	.243	.144	.243	.58	.095
	Prairie hay	1.980	1.72	Cow peas	1.94	1.87
Total digestible nutrients		1.555	1.035	.581 plus cow peas	1.637	1.611
Nutritive ratio	1:	7.2	7.2	7.2 plus cow peas	4.6	9.1
Purpose of ration		Gaining	Maintenance	Maintenance plus cow peas	Gaining	Gaining
Average weight September 4, 1931		91.4	88.2	89.8	90.1	85.0
Average weight November 2, 1931		100.2	92.0	100.0	101.0	96.0
Average gain in weight during breeding		8.8	3.8	10.2	10.9	11.0
Average daily gain		.15	.07	.18	.19	.19
Number of ewes to conceive first service		7	7	6	7	8
Total number of returns		3	3	6	3	1
Average breeding date		Sept. 26	Sept. 25	Sept. 28	-----	Sept. 25
Number of ewes lambing		8	8	9	9	9
Number of lambs dropped		8	8	9	9	9
Percent lamb crop		89%	89%	100%	100%	100%

Table II

A Comparison of Different Levels of Nutrition upon the Breeding Behavior and Reproduction of Ewes, 1932-33

Lot number		I	II
Ewes per lot		21	21
Rations:	Alfalfa hay	1 pound daily	
	Cow peas	All they would consume	
	Oats	1 pound daily	
	Prairie hay		2 pounds daily
Total digestible nutrients		1.341	.984
Nutritive ratio	1:	4.67	17.9
Average first breeding date		August 6	August 6 (for 12)
Returns from first service		5	8
Returns from second service		1	4
			Seven failed to come in heat on the prairie hay ration.
Ewes settled after change of ration		0	5
Ewes that failed to come in heat		0	2
Number of ewes lambing		21	17
Number of lambs dropped		21	17
Percent lamb crop		100%	81%

1933-34

The various feeds fed to different lots in 1933-34 seemed to have very little effect on the reproduction of the ewes. All lots had approximately the same first breeding date. There was no correlation between that date of the first heat observed and the amount of gain made by the ewes in the lot. More of the ewes that received adequate rations failed to conceive to their first service than those ewes receiving insufficient amounts of nourishment. These results were the opposite of those of the previous year, but differed less than those of the 1933-34 season. The lambing percentage was very low, especially for those lots that lost weight or gained only a small amount. This was largely due to the number of barren ewes. Only three pairs of twins were dropped, one pair in each of Lots VI, VII, and VIII as shown in Table III. These were the lots that made the largest gain during the breeding season.

1934-35

In 1934-35 there was only one lot (III) which gained a sufficient amount to be called "flushed" according to the standard of Marshall and Potts (23). The other four lots were about maintained. The average first breeding date for all lots was about the same with no agreement, with regard to that date, and the gain in weight. The number of returns was greater for those lots losing weight, but the difference was by no means significant. Again the number of barren ewes was greater in the lots that lost weight, although the distribution of twin lambs was even between the flushed and unflushed lots. Table IV gives a summation of the results for 1934-35.

Table III

A Comparison of Different Levels of Nutrition upon the Breeding Behavior and Reproduction of Ewes, 1933-34

Lot number		I	II	III	IV	V	VI	VII	VIII
Ewes per lot		8	10	10	9	9	10	10	10
Rations:	Casein			.48	.08		.12		.08
	Cane sugar		.32		.28		.41		.28
	Yellow corn					.48			
	Oats							.33	
	Wheat bran							.33	
	Prairie hay	1.48	.95	1.43	.97	1.44	1.43	1.00	.99
	Alfalfa hay							.50	
	Green cow peas								2.99
Total digestible nutrients		.709	.775	1.165	.825	1.093	1.215	1.170	1.164
Nutritive ratio		1: 11.00	19.4	1.2	5.9	10.7	5.9	6.0	5.1
Average initial weight Aug. 15		72	68	67	72	72	71	73	65
Average final weight Oct. 18		68	62	78	76	75	85	89	77
Average total gain per head		-4	-6	11	4	3	14	16	12
Ewes bred before change in ration		7	6	9	6	7	10	10	9
Average first breeding date		Sept. 1	Sept. 7	Sept. 6	Sept. 8	Aug. 29	Sept. 4	Sept. 12	Sept. 8
Total returns		1	3	4	1	1	1	2	3
Number ewes lambing		5	4	7	5	5	10	9	8
Number of lambs dropped		5	4	7	5	5	11	10	9
Percent lamb crop		63%	40%	70%	56%	56%	110%	100%	90%

Table IV

A Comparison of Different Levels of Nutrition upon the Breeding Behavior and Reproduction of Ewes, 1934-35

Lot number		I	II	III	IV	V
Ewes per lot		12*	13	12*	13	12*
Ration:	Casein	.248	.078	.078		
	Sugar		.274	.274		
	Corn				.500	
	Linseed oil meal					.487
	Prairie hay	1.104	.955	.952	1.500	.730
	Darso silage			2.151		
Total digestible nutrients		.777	.809	1.182	1.138	.728
Nutritive ratio	1:	1.66	5.07	7.89	10.72	3.14
Average initial weight July 10		82	79	80	90	79
Average final weight Oct. 10		80	84	94	87	78
Average gain per head		-2	5	16	3	-1
Average first breeding date		Aug. 2	Aug. 12	Aug. 25	Aug. 25	Aug. 25
Returns from first service		3	4	1	2	3
Returns from second service		0	1	0	0	1
Number not in heat		2	1	0	1	3
Number of ewes lambing		10	12	12	11	9
Number of lambs dropped		12	12	13	11	10
Percent lamb crop		100%	92%	108%	85%	83%

* One ewe in Lots I, III, and V died in course of the tests.

1935-36

As shown in Table V there was no marked gain in weight by any of the lots; however, Lot III lost a large amount of weight for the short period of time. The first breeding date was the same for all lots. Returns to estrus from the first breeding occurred only in Lots V and VI, two of the lots on a gaining ration. The number of barren ewes was evenly distributed between the lots. The lambing percentage was highest in those three lots that seemed to be on the lowest plane of nutrition.

1936-37

In the 1936-37 experiment a definite attempt was made to bring Lots II and IV to a flushed condition and hold Lots I and III at maintenance. This purpose was quite well accomplished. The average first breeding date was slightly earlier for the unflushed lots although the difference was not appreciable. The only returns from the first breeding occurred in Lot IV, a flushed lot. The number of barren ewes and the twins produced was about the same for the flushed and unflushed lots. These results are presented in Table VI.

Table V

A Comparison of Different Levels of Nutrition upon the Breeding Behavior and Reproduction of Ewes, 1935-36

Lot number		I	II	III	IV	V	VI
Ewes per lot		10	10	10	10	9	9
Ration:	Casein					.12	
	Cane sugar					..42	
	Yellow corn						.50
	Linseed oil meal	.575	.86	.50	.66		
	Prairie hay	.75	1.28	.75	.98	1.46	1.50
Total digestible nutrients		.749	1.283	.749	.984	1.236	1.147
Nutritive ratio	1:	3	3	3	3	6	11
Average initial weight Sept. 8		95	112	112	88	90	88
Average final weight Nov. 9		91	113	100	94	98	92
Average gain per head		-4	1	-12	6	8	4
Average breeding date		Oct. 8	Oct. 12	Oct. 10	Oct. 8	Oct. 14	Oct. 12
Returns from first service		0	0	0	0	1	2
Number of ewes bred		9	10	9	10	9	8
Number of ewes lambing		8	10	9	9	8	7
Number of lambs dropped		11	15	12	11*	10	7
Percent lamb crop		110%	150%	120%	110%	111%	78%

* Includes one set of triplets.

Table VI

A Comparison of Different Levels of Nutrition upon the Breeding Behavior and Reproduction of Ewes, 1936-37

Lot number		I	II	III	IV
Ewes per lot		10	10	12	11
Ration:	Alfalfa hay	.5	1.	.5	1.
	Silage	2	2.5	2	2.5
	Ground yellow corn		1		1
	Linseed oil meal		.20		.20
Total digestible nutrients		.600	1.999	.600	1.999
Nutritive ratio	1:	4.2	4.26	4.2	4.25
Purpose of ration		Maintenance	Flushing	Maintenance	Flushing
Average initial weight Aug. 31		110.9	112.4	108.3	101.0
Average final weight Oct. 13		107.5	123.0	103.5	118.5
Average gain per head		-3.4	10.6	-4.8	17.5
Average breeding date		Sept. 23	Oct. 13	Sept. 17	Sept. 20
Returns from first service		0	0	0	3
Total number of returns		0	0	0	5
Total number of ewes lambing		7	6	12	11
Number of lambs dropped		10	8	14	15
Percent lamb crop		100%	80%	117%	136%

1937-38

Before being placed on the experimental ration in 1937-38, the Hampshire ewes that were secured for the experiment were given a sub-maintenance ration to get them down to a thin condition. According to Clark (7) ewes must be in a thin condition before the benefits due to flushing would be expressed to the fullest extent. The Western ewes were in a thinner condition at the beginning of the experiment, but the unflushed Hampshire ewes lost a good deal more weight during the course of the experiment than the unflushed Westerns. There was no significant difference in the first breeding dates of the lots and the number of returns from the first service is about equal for flushed and unflushed groups. The number of returns was very high, probably due to the sterility of the rams in the early part of the summer. The number of barren ewes, however, did not exceed the number for preceeding years. Table VII shows that the number of twins produced was a bit higher for the unflushed lots, but the difference was not significant. One of the unflushed ewes became so weak and thin that it was impossible to breed her except in a sling. This ewe was taken off of the experimental ration and fed alfalfa hay and oats. She settled to the next service, seventeen days later.

Table VII

A Comparison of Different Levels of Nutrition upon the Breeding Behavior and Reproduction of Ewes, 1937-38

Lot number		I	II	III	IV
Breed of ewes		Western	Western	Hampshire	Hampshire
Ewes per lot		10	10	12* (11)	12
Ration:	Alfalfa hay		.50	.25	
	Corn silage	4		2	.50
	Cottonseed hulls		.75		.75
	Oats	1		1	
	Cottonseed meal	.25		.125	
	Pasture	Until Aug. 5		July 19	
Total digestible nutrients		1.603	.579	1.29	.579
Nutritive ratio		1: 6.13	8.8	5.9	8.8
Purpose of ration		Flushing	Maintenance	Flushing	Maintenance
Average initial weight July 7		77.0	77.1	156.1	162.8
Average final weight Oct. 10		97.5	71.7	179.6	141.2
Average gain in weight		20.5	-5.4	23.5	-21.6
Average first breeding date		July 23	July 21	July 25	July 20
Returns from first service		9	7	11	12
Total returns		15	17	37	40
Average lambing date		Jan. 5	Jan. 15	Feb. 12	Feb. 3
Number of ewes lambing		8	9	11	11
Number of lambs dropped		8	9	13	17
Percent lamb crop		80%	90%	108%	142%

* One died Aug. 21.

1938-39

The ewes were placed in the same lots as they were in the previous year, but the unflushed lots of 1937-38 were given a flushing ration and the flushed lots of the previous year were given a maintenance ration. The average first breeding date was later for the flushed lots than for the unflushed lots. The number of returns was large, but there was no difference between lots. Semen smears of the Hampshire rams were studied under a microscope and several of the semen samples contained no living sperm. The samples were studied about the middle of August. This condition, no doubt, accounted for the high number of returns in the last two years when breeding was started early in the summer. As shown in Table VIII, the flushed lots produced a few more twin lambs than did the unflushed lots, but there was not a significant difference.

Table VIII

A Comparison of Different Levels of Nutrition upon the Breeding Behavior and Reproduction of Ewes, 1938-39

Lot number	I	II	III	IV
Breed of Ewes	Western	Western	Hampshire	Hampshire
Ewes per lot	10	10	8	10
Ration: Alfalfa hay	.5		.5	
Prairie hay	.5		.75	
Oats		.5		1.
Cottonseed meal		.125		.125
Pasture		Pasture		Pasture
Total digestible nutrients	.497	-----	.620	-----
Nutritive ratio	1: 10.8	-----	7.67	-----
Purpose of ration	Maintenance	Flushing	Maintenance	Flushing
Average initial weight May 28	89.5	87.4	159.4	148.2
Average final weight Oct. 10	72.9	114.7	123.7	172.9
Average gain per head	-16.6	27.3	-35.7	24.7
Average first breeding date	June 24	July 30	July 16	Aug. 14
Returns from first service	9	5	8	7
Total returns	22	14	17	16
Number of ewes lambing	8	9	7	8
Number of lambs dropped	8	11	9	13
Percent lamb crop	80%	110%	113%	130%

DISCUSSION

The results of these experiments are difficult to study because of the small number of ewes in each lot. The failure of a ewe to lamb or the production of a pair of twins by one ewe causes great fluctuation in the percent crop of a lot. The amount of twinning, however, was within the range expected for the particular breeds that were used in the study according to the figures given by Marshall and Potts (23).

This study was made on the numbers of lambs dropped rather than on the number of corpus lutea or ovulations. According to Hammond (16) the number of lambs born agrees closely with the number of ovulations. The chances of a partially sterile ram decreasing the lamb crop was eliminated by using the same rams on both groups.

Lamb Production

In order to be able to sum up the data from the series of experiments, the lots were divided into three classes. The lots that had gained more than seven pounds during the breeding season were termed flushed, according to the suggestion by Marshall and Potts (23). Those lots that gained up to seven pounds or lost seven pounds in weight were considered maintained and those that lost more than seven pounds were placed in the sub-maintenance group. This arbitrary grouping of the lots gave the grouping shown in Table IX.

Table IX

A Grouping of Experimental Lots with a Similarity of Live Weight Gain, 1931-39

Treatment	Number of Ewes	Number of Lambs	Percent Lamb Crop
Flushed	159	172	108.18
Maintenance	166	149	89.76
Sub-Maintenance	40	46	115.00
Total	365	367	100.55

As Table IX shows, the flushed group had a higher percent lamb crop than did the maintained group, but those that lost considerable weight had a higher lambing rate than either of the other two groups.

A similar criterion of live weight gain during the breeding period was used in dividing the ewes in the last four years of the experiment into three groups, (1) flushed, (2) maintenance, and (3) sub-maintenance. The rations fed were disregarded and the sole basis for the divisions was the gain in weight. The number of lambs produced by these 182 ewes is shown in the following table.

Table X

A Grouping of Experimental Ewes with a Similarity of Live Weight Gain 1935-39

Treatment	Number of Ewes	Average Gain in Weight	Number of Lambs	Percent Lamb Crop
Flushed	66	+20.33 lbs.	77	116.67%
Maintenance	54	-2.26 lbs.	59	109.26%
Sub-Maintenance	62	-19.29 lbs.	67	108.06%
Total	182		203	

Table X shows that the sixty-six ewes that gained in weight during the experiment from 1934-35 had a higher lambing percentage than either the maintenance or sub-maintenance group. The analysis of these data is shown in Table XI.

An F. value of .3378 was secured; whereas, a value of 3.06 represents the 5 percent point and a value of 4.75 the 1 percent point. The results in Table XI show the difference not to be significant when the data is analyzed according to the method of Snedecor (32).

Table XI

An Analysis of Variance of the Effect of Live Weight Gain During Breeding Upon the Size of the Subsequent Lamb Crop

Source	Degrees of Freedom	Sum of Squares	Mean Squared	F value	P
Total	181	71.58			
Between Lots	2	.27	.135	.3378	< .05
Within Lots	179	71.31	.3996		

Estrous Cycle

A study was made of the length of estrous cycles for the last three years of the investigation. There was a sufficient number of cycles to study because of the large number of returns during those years.

The average length of the estrous cycle for the unflushed Western ewes the last two years of the study was 17.57 days, for the flushed group 16.93 days. The difference was highly significant as shown by the analysis of variance in Table XII.

Table XII

An Analysis of Variance of the Effect of Live Weight Changes in the Length of Estrous Cycles of Western Ewes, 1937-38 1938-39

Source	Degrees of Freedom	Sum of Squares	Mean Squared	F value	P
Total	55	47.500			
Between Lots	1	5.906	5.906	7.67	>.01
Within Lots	54	41.594	.770		

There was a significant difference between flushed Hampshires and unflushed Hampshires in estrous cycle length as shows in Table XIII. The unflushed ewes had a mean estrous cycle of 17.17 days and the flushed group 16.50 days.

Table XIII

An Analysis of Variance of the Effect of Live Weight Changes in the Length of Estrous Cycles of Hampshire Ewes, 1937-38 1938-39

Source	Degrees of Freedom	Sum of Squares	Mean Squared	F value	P
Total	105	146.567			
Between Lots	1	10.532	10.532	8.052	>.01
Within Lots	104	136.035	1.308		

There was no difference for the year 1936-37, between the length of estrous cycle for the flushed and unflushed groups. The ewes were grade Shropshires and mature Western ewes. The results for 1936-37 were combined with those in Tables XII and XIII and the three years

results were analyzed as a unit. The analysis showed that the flushed ewes had a highly significant shorter estrous cycle.

There was a difference in length of estrous cycle between the Western and Hampshire ewes studied in 1937-38 and 1938-39. The Westerns averaged 17.25 days to an estrous cycle and the Hampshires averaged 16.77. The difference was significant, but not highly significant as shown in Table XIV.

The Hampshire ewes produced a larger lamb crop in both of the last two years than did the Westerns.

Table XIV

AnaAnalysis of Variance of the Effect of Breed on the Length of the Estrous Cycle in Breeding Ewes

Source	Degrees of Freedom	Sum of Squares	Mean Squared	F value	P
Total	161	202.383			> .05
Between Breeds	1	8.166	8.166	6.727	< .01
Within Breeds	160	194.217	1.214		

Statistical analysis indicated there was no significant difference in length of estrous cycle nor in the size of the lamb crop due to an age increase of one year from 1937-38 to 1938-39, in either the flushed or unflushed groups.

These results secured on a small number of ewes should not be regarded as too important in light of their disagreement with the more extensive study made by McKenzie and Terrill (26).

There seem to be but two means in which nutrition could affect the number of eggs ovulated at a given heat period (1) by directly increasing the supply of nutrients to the ovary or (2) indirectly by increasing

the amount of hormone produced by the anterior pituitary and supplied to the ovary to stimulate the egg production. Just how much of an increase in body metabolism is necessary to produce the desired increase in ovulation is questionable. This gives rise to the question of whether or not a group of ewes can be considered "flushed" because of being fed a ration that is nutritionally better than a so called "non-flushing" ration or whether a gain in weight should be used as a measuring stick. It would seem that in order to have some tangible measure, the gain in weight would be the only possible means that could be used. Marshall and Potts (23) have arbitrarily set the gain in weight at seven pounds for the flushing period. They, however, do not adher to this standard when they give credit to "flushing" for an 18.1 percent increase in lamb crop. As shown on page 5, they refer to several lots, namely, two, six, eight, fourteen and sixteen which gained on an average only 4.32, 6.30, 2.85, 5.76, and 5.80 pounds respectively, as flushed lots. These lots are equaled in gain in weight by several in the unflushed lots and produced a large lamb crop. If these lots were considered to be "non-flushed" the lambing rates of the flushed and unflushed lots would be approximately equal.

Smith (31) in his experiment states that the small gain in weight of the flushed lots in his experiment did not produce a "flushing" condition. In only one case did a flushed lot gain as much as seven pounds. His results are very probably not significant and the seven and four-tenths percent difference is apt to be due to chance.

Clark's (6) results show a marked difference in the first year of the experiment between the flushed and unflushed lots in the number of corpus lutea in the ovaries in favor of flushing. The second year, however, the ovaries of the unflushed lots showed a few more double ovula-

tions than did the flushed lots. The difference, however, is not great enough to be significant, but there was no benefit due to flushing.

Although flushing does have some effect on reproduction, in that influence on the length of estrous cycle, it does not affect the number of lambs dropped. It is possible that the rise in nutrition causes an increase in the amount of follicular stimulating hormone from the anterior pituitary which causes a more rapid maturation of the follicles, but does not increase the number of follicles. The rapid maturing of the follicle may cause an earlier heat period and therefore, a shorter cycle. Why then does it not cause the flushed ewes to come into estrous earlier in the season, especially if Grant's finding, that one or several ovulations take place without the accompanying heat period, is correct? In this experiment it was found that the unflushed ewes came in heat as early in the season as did the flushed ewes. Direct increase of the nutrients to the ovary would offer no better explanation of the results obtained.

The estrous cycles of the ewes did not become shorter as the breeding season advanced. The mean length of the first estrous cycle of the breeding season was 16.96 days, the second cycle 16.79 days, the third 17.34 days and the fourth (17 in number) 16.82 days. These data, secured over a period of eight years, do not furnish any further explanation of the mode in which nutrition affects the reproductive organs.

CONCLUSIONS

1. Throughout these experiments the ability of flushing to increase the number of lambs dropped has not been substantiated in any single year nor in a summation of the eight year results.

2. No difference was noted between the flushed and unflushed lots as to time of the first estrous period.

3. The difference in estrous cycle length between the flushed and unflushed lots showed that nutrition did affect the reproductive organs in some manner.

4. The first heat periods for the ewes were in July and August, but at that time the fertility of the rams was low.

5. Individual differences were noted between ewes in the number of lambs produced, length of estrous cycle, and in gain in weight.

6. The cost of increasing the amount of feed fed during the breeding season was not justified by an increase in lamb crop.

7. The twin lambs dropped were dispersed evenly throughout the lambing season.

8. There was no significant difference in the length of estrous cycle between the yearlings and two-year-olds, nor was there a difference in the number of lambs produced under the condition of the experiment.

9. There was a significant difference between breeds, both in number of lambs produced and in the length of estrous cycle. The Hampshire ewes had a shorter estrous cycle and produced more lambs than did the Westerns.

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