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EFFECT OF BASAL DIET SUPPLEMENTATION DURING FLUSHING ON MERINO EWES PERFORMANCE IN THE FOOTHILLS AGRO-ECOLOGICAL ZONE OF LESOTHO

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ABSTRACT

The present study was conducted to evaluate the effect of flushing on the growth and reproductive performance of merino ewes in the Foothills Agro-ecolological Zone of Maseru district in Lesotho. One hundred and sixty (160) 4-5-year old ewes maintained on rangeland pasture were chosen in the month of May during normal breeding season and were randomly divided in treated (Group 1) and untreated group (Group 2) having 132 and 28 ewes consecutively. Group one ewes were offered the supplemental diet while group two ewes were kept on the rangeland to feed on the rangeland grasses (control). All ewes in group one was flushed for two weeks before mating and four weeks during mating period. Flushing was done in the morning before ewes went to graze, and supplemental feed was given to ewes at the rate of 200 g/ewe/day, three days in a week at alternate days. Ewes were naturally mated with rams at the ratio of 1:20. The growth performance and reproductive indices of pregnant ewes were recorded. The results obtained indicated that, basal diet supplementation improved live body weight of ewes significantly ($P < 0.05$) and flushed ewes had higher ($P < 0.05$) body weight gain and pregnancy rate.

Keywords: Rangeland forage, ewes, flushing, reproductive traits

1.0 INTRODUCTION

Global demand for meat and other farm animal protein products continues to rise with increasing human population, while low animal protein intake remains pronounced in developing countries

ISSN: 2455-6939

Volume: 11, Issue: 05 "September-October 2025"

like Lesotho. Whereas, in developed countries, animal products are the main source of protein, in developing countries cereals are often deployed as substitutes. The quality of protein from food consumed in developing countries is thus often limited and thereby reduces the availability of protein for efficient use in the human body (1). Animal source foods such as meat, dairy products, eggs, seafood and other products contain higher quantities and more balanced proportions of amino acids relative to human tissues, compared to plant source foods and good digestibility. Therefore, adequate consumption of animal source food is critical in achieving nutritionally balanced diet, and prevent under nutrition and nutritional deficiencies which have a positive impact on growth, cognitive function, better pregnancy outcome, physical activity of children and reduced morbidity from illness (2).

As demand for meat and dairy products in the developing countries of the world continues to increase, it has been suggested that livestock sector growth can be boosted by contributions from smallholder production (3), and small ruminant production is important to attain this goal. In Lesotho, small ruminants are kept for the purpose of milk, meat, wool and mohair production and income generation (4). These animals are important in subsistence agriculture because of their unique ability to adapt and maintain themselves in harsh environments (1). Merino sheep are widely distributed across the four Agro-ecological Zones of Lesotho, and they are kept grazing for most part of the year with the attendant low productivity because of the perennial scarcity of grasses and fodder. Sheep usually suffer weight loss due to feed stress during dry season which affects their production and reproductive performance at the beginning of the next rainy season (5). In dry spell, forage feed alone may not be adequate to meet the ewe's requirements for energy and protein at stages of high nutrient demand, like during late pregnancy and lactation or when forage quality is poor, hence additional ration is recommended for these animals (6), for sustainable production. Due to paucity of data on feeding of additional ration during breeding in Lesotho, this study was conducted to assess the effect of flushing on the performance of Merino ewes in the Foothills Agro-ecological Zone of Lesotho.

2.0 MATERIALS and METHODS

2.1 Experimental site

The experiment was done in the Ha-Matela area in Maseru District located between latitude 29° 27' 1.19"'S and longitude 27° 43' 13.79"'E (7), in the Foothills Agro-ecological zone (AEZ) in the Kingdom of Lesotho (Fig. 1). Maseru District has an elevation of 1600 m above sea level and the Foothills AEZ is in between lowlands and the highland, and occupies an estimated area of about 4600 km^2 representing 15% of the total land area of the country. The AEZ has fertile land that is associated with high agricultural productivity (8), with four seasons. Winter and spring are

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Volume: 11, Issue: 05 "September-October 2025"

usually dry whereas, summer and autumn are wet with an annual rainfall range of 600 – 900 mm. Winter temperature can be as low as -5 ºC, while summer temperature can be as high as 38 ºC (7).

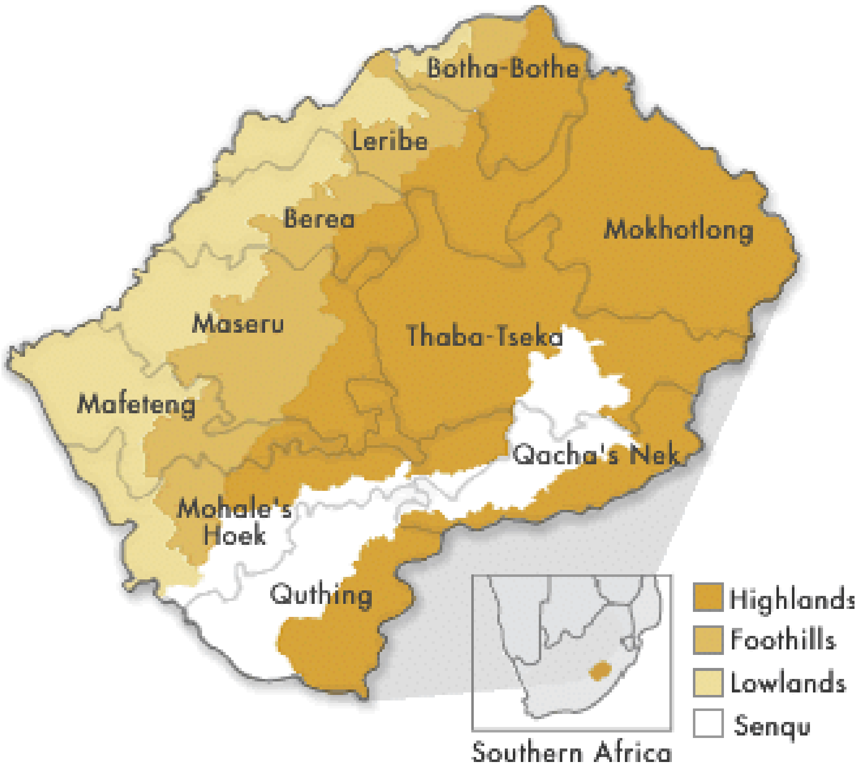

Figure 1: Agro-ecological Zones of Lesotho (9)

The Foothills AEZ enjoys cooler temperatures and higher rainfall than the Lowlands AEZ (Lesotho Meteorological Services, 2021). Vegetation cover consists of grasses, herbs and shrubs, and the predominant palatable grasses are *Eragrostis splana, Hyparrhenia hirta, Cynodon dactylon, Themenda triandra* and *Elinurus muticus*.

2.2 Experimental Diets and Preparation

Experimental diets consisted of natural rangeland forage (RF) and compounded supplement (Table 1). The compounded diet was formulated for supplementary feeding of experimental ewes during flushing. Supplemental diet consisted of fodders and concentrates, and they were formulated to meet ewes' nutrients requirement for flushing during production cycle. The natural rangeland pasture was grazed by all the experimental ewes. Maize stover, fodder sorghum and sunflower heads planted in the Ha-Matela Agricultural Resource Centre field were dried, separately milled with Hammer mill and mixed with crushed yellow maize, maxiwol, hominy chop and teff hay in compounding the supplemental diet at the start of the feeding trial.

ISSN: 2455-6939

Volume: 11, Issue: 05 "September-October 2025"

Table 1: Composition of the Supplemental Diet and Grass Species Consumed

Ingredients (%)	**Experimental Diets**	
	Flushing Diet (FD)	**Rangeland Forage Species (RF)**
Sunflower seeds	10.00	*Eragrostis splana*
Hominy chop	20.00	*Cynodon dactylon*
Crushed yellow maize	20.00	*Hyparrhenia hirta*
Maxiwol	5.00	*Elinurus muticus*
Maize stover	15.00	*Themenda triandra*
Fodder sorghum	15.00	
Teff hay	15.00	
Total	**100.00**	
Calculated nutrients		
Energy (MJ/kg)	10.99	
Crude protein **(%)**	9.63	
Calcium **(%)**	0.28	
Phosphorus **(%)**	0.35	

2.3 Experimental Animals and Management

Merino ewes were used as the experimental animals for flushing. Management of the experimental ewes irrespective of their treatment groups, was done according to the traditional grazing practice among farmers in Lesotho, whereby animals were allowed to graze during the day and in the evening they were kept in enclosures. Animals spent about an hour to reach rangelands located close to water points in the morning, and to return in the afternoon. The supplemental diet was randomly assigned. Each animal in dietary treatment group was fed supplemental ration at the rate of 200 g/day at alternate days weekly, two weeks pre-mating and four weeks during mating period. Supplemental ration was given in addition to daily natural grazing by the experimental ewes. A total of 160 randomly selected merino ewes between four to five years old contributed by nine farmers from the Ha-Matela community in the Maseru District were used for flushing in a 7-week feeding trial. They were selected between May and June 2020, during the breeding season and tagged. The animals were divided into two dietary groups namely flushing diet (FD) group and the rangeland forage (RF) group with 128 and 32 ewes, respectively. The unequal group sizes were due to practical constraints in flock availability to be used as control. The ewes fed flushing diet were also allowed to graze the basal rangeland forage, while the ewes on the rangeland forage group (control) fed on the rangeland forage. The supplemental ration was offered to the ewes in

ISSN: 2455-6939

Volume: 11, Issue: 05 "September-October 2025"

FD, two weeks pre-mating and 4 weeks during mating. Ewes were naturally mated with rams at the ratio of between 1:20.

2.4 Data Collection

2.4.1 Performance data

Data collected were live animal weight at the start of the trial and weekly, weight of the supplemental diet consumed, and number of ewes mated, pregnant ewes, lambed ewes,

mortality and, number of single lambs and twinned lambs born and lambs that survived at 7 days of lambing. The feed intake and body weight were determined using TCS Series Electronic platform scale.

2.4.2 Chemical analyses

Chemical analyses of dietary samples were replicated three times, to determine dry matter (DM), crude protein (CP), neutral detergent fibre (NDF), acid detergent fibre (ADF), acid detergent lignin (ADL) and, calcium and phosphorus. All the nutrients were determined in the Animal Science Laboratory, The National University of Lesotho, Lesotho, except CP which was determined at the Lesotho Agricultural College, Maseru. Dry matter, crude protein and ash content were determined according to Standard Methods (10); ADF, NDF and ADL were determined as described earlier (11), and hemicellulose and cellulose were calculated:

i. Hemicellulose = NDF - ADF
ii. Cellulose = ADF – ADL

Other calculated indices were:

i. Dry matter intake (DMI) = 120 ÷ % NDF …………………....... (12).
ii. Dry matter digestibility (DMD) = 88.9 - (0.779 × % ADF) ….. (13).
iii. Metabolisable energy (ME) = 0.17× % DDM - 2.0…………… (14).
iv. Pregnancy rate (%) = number of ewes pregnant / ewes mated × 100.
v. Lambing rate (%) = number of ewes with live lambs / number of ewes available at lambing × 100.
vi. Twinning rate (%) = number of ewes with twin lambs / number of pregnant ewes available at lambing ×100.
vii. Single lambing rate (%) = number of ewes with single lambs / number of pregnant ewes available at lambing × 100.
viii. Average litter size = number of lambs / number of pregnant ewes at lambing.

ISSN: 2455-6939

Volume: 11, Issue: 05 "September-October 2025"

ix. Lamb survival rate at 7 days (%) = number of alive lambs at 7 days / number of lambs born alive × 100.

2.5 Statistical analysis

Data collected were subjected to the completely randomised design using SPSS (15) IBMS SPSS version 20. Significant differences were tested at 95% level. Reproductive parameters were analysed using Chi-square, a non-parametric analytical tool.

3.0 RESULTS

3.1 The Chemical Composition of the Experimental Diets

The chemical composition of the diets used in the flushing phase is presented in Table 2. The CP, NDF, ADF, P and cellulose contents differed significantly ($P < 0.05$), and likewise DMI, DMD and the ME. The supplementary diet had significantly higher ($P < 0.05$) nutrient content than the rangeland forage mixture in CP (21.01 ± 1.34% vs 5.49 ± 0.69%, DMI (2.58 ± 0.11% vs 1.60 ± 0.52%), DMD (66.83 ± 1.38 vs 52.43 ± 1.49%)) and ME (9.36 ± 0.23 MJ/kg vs 6.91 ± 0.25 MJ/kg). Whereas, the rangeland forage mixture was significantly ($P < 0.05$) higher than the supplementary diet in NDF (75.64 ± 2.38% vs 47.00 ± 2.31%), ADF (47.07 ± 1.85% vs 28.33 ± 1.76%), P (0.39 ± 0.45% vs 0.32 ± 0.60%) and cellulose (43.31 ± 2.59 vs 26.88 ± 2.04%). The dry matter, ADL, ash, Ca and hemicellulose did not differ significantly ($P > 0.05$) among the experimental diets.

International Journal of Agriculture and Environmental Research

ISSN: 2455-6939

Volume: 11, Issue: 05 "September-October 2025"

Table 2: Chemical Composition and Feed value of Experimental Diets for Flushing (Mean ± SE)

Nutrient (%)	Experimental Diets: Supplementary dietary treatment	(Rangeland forage mixture (Control)	p-value
Dry Matter	$91.67^{a} \pm 2.03$	$80.21^{a} \pm 4.58$	0.179^{ns}
Crude Protein	$21.01^{a}\pm1.34$	$5.49^{b.}\pm0.69$	0.001*
NDF	$47.00^{b}\pm2.31$	$75.64^{a}\pm2.38$	0.001*
ADF	$28.33^{b}\pm1.76$	$47.07^{a}\pm1.85$	0.001*
ADL	$1.08^{a}\pm0.14$	$3.75^{a}\pm0.98$	0.262^{ns}
Ash	$3.44^{a}\pm1.15$	$10.03^{a}\pm2.53$	0.107^{ns}
Calcium	$0.09^{a}\pm0.07$	$0.13^{a}\pm0.01$	0.306^{ns}
Phosphorus	$0.32^{b}\pm0.60$	$0.39^{a}\pm0.45$	0.001*
Hemicellulose	$18.67^{a}\pm2.40$	$28.58^{a}\pm2.13$	0.430^{ns}
Cellulose	$26.88^{b}\pm2.04$	$43.31^{a}\pm2.59$	0.005*
Calculated Values			
DMI	$2.58^{a}\pm0.11$	$1.60^{b}\pm0.52$	0.001*
DMD	$66.83^{a}\pm1.38$	$52.43^{b}\pm1.49$	0.001*
ME (MJ/kg)	$9.36^{a}\pm0.23$	$6.91^{b}\pm0.25$	0001*

^{ab} = Means in the same row with different superscripts are significantly (P < 0.05) different, * = (P < 0.05), ^{ns}=not significant (P > 0.05)
SE = Standard Error

3.2 Chemical Composition and Feed value of the Rangeland Forage

The chemical composition of grass species consumed by experimental ewes during flushing and the calculated DMI, DMD and ME values are presented in Table 3. The dry matter, ADF, ADL, cellulose, P, DMD and ME varied significantly (P < 0.05) among the rangeland grasses.

ISSN: 2455-6939

Volume: 11, Issue: 05 "September-October 2025"

Table 3: Chemical Composition and Feed value of the Rangeland Grasses Consumed (Mean ± SE)

Nutrient (%)	Rangeland Grasses					p-value
	Themeda triandra	*Eragrostis splana*	*Cynodon dactylon*	*Hyparrhenia hirta*	*Elinurus muticus*	
Dry Matter	$84.50^{a} \pm 0.50$	$92.83^{a} \pm 0.17$	$71.83^{ab} \pm 0.88$	$88.7^{a} \pm 1.09$	$63.17^{b} \pm 15.82$	0.008*
Crude Protein	$7.01^{a} \pm 0.51$	$5.84^{ab} \pm 1.05$	$5.55^{ab} \pm 1.05$	$2.92^{b} \pm 0.58$	$6.13^{ab} \pm 0.88$	0.057^{ns}
NDF	$79.89^{a} \pm 2.89$	$75.00^{a} \pm 1.00$	$66.67^{a} \pm 0.88$	$78.33^{a} \pm 5.13$	$78.33^{a} \pm 0.17$	0.395^{ns}
ADF	$47.00^{b} \pm 0.58$	$54.00^{a} \pm 1.53$	$43.00^{b} \pm 1.00$	$45.33^{b} \pm 0.88$	$46.00^{b} \pm 1.53$	0.001*
ADL	$9.77^{a} \pm 0.58$	$1.22^{b} \pm 0.56$	$1.05^{b} \pm 0.11$	$4.33^{b} \pm 0.75$	$2.39^{b} \pm 1.77$	0.001*
Ash	$7.40^{a} \pm 0.34$	$4.58^{a} \pm 0.26$	$14.14^{a} \pm 0.15$	$6.23^{a} \pm 0.13$	$17.82^{a} \pm 6.43$	0.233^{ns}
Phosphorus	$0.45^{b} \pm 0.00$	$0.36^{b} \pm 0.05$	$0.23^{c} \pm 0.00$	$0.68^{a} \pm 0.01$	$0.22^{c} \pm 0.00$	0.001*
Calcium	$0.067^{a} \pm 0.05$	$0.16^{a} \pm 0.01$	$0.13^{a} \pm 0.00$	$0.16^{a} \pm 0.04$	$0.14^{a} \pm 0.02$	0.581^{ns}
Hemicellulose	$32.89^{a} \pm 2.46$	$21.00^{a} \pm 1.15$	$23.67^{a} \pm 1.20$	$33.00^{a} \pm 2.65$	$32.33^{a} \pm 8.95$	0.950^{ns}
Cellulose	$37.23^{b} \pm 2.91$	$52.78^{a} \pm 1.53$	$41.95^{b} \pm 1.07$	$41.00^{b} \pm 0.27$	$43.61^{b} \pm 1.66$	0.020*
Calculated Values						
DMI	$1.50^{a} \pm 0.11$	$1.60^{a} \pm 0.20$	$1.80^{a} \pm 0.26$	$1.59^{a} \pm 0.41$	$1.53^{a} \pm 0.20$	0.320^{ns}
DMD	$52.29^{a} \pm 0.45$	$46.83^{b} \pm 1.19$	$55.40^{a} \pm 0.78$	$53.56^{a} \pm 0.71$	$54.07^{a} \pm 1.51$	0.001*
ME (MJ/kg)	$6.89^{a} \pm 0.08$	$5.96^{b} \pm 0.20$	$7.42^{a} \pm 1.33$	$7.10^{a} \pm 0.42$	$7.19^{a} \pm 0.20$	0.001*

^{abc} = Means in the same row with different superscripts are significantly ($P < 0.05$) different, * = ($P < 0.05$), ^{ns} = not significant ($P > 0.05$)
SE= Standard Error

Elinurus muticus contained significantly ($P < 0.05$) lower DM content than the other grasses except *Cynodon dactylon*. *Hyparrhenia hirta* had significantly ($P < 0.05$) lower CP content of 2.92% than *Themeda triandra* which had the highest CP of 7.01%, and did not significantly ($P > 0.05$) differ from the other grasses consumed by the ewes. *Eragrostis splana* contained significantly ($P < 0.05$) higher ADF than other grasses but, but the ADF content in the other grass species were similar ($P>0.05$). *Themeda triandra* had significantly ($P < 0.05$) higher ADL value of 9.77% than other grass species with ADL of 1.05 ± 0.11% to 4.33 ± 0.75%. *Hyparrhenia hirta* had a significantly ($P < 0.05$) higher P content of 0.68 ± 0.01%, followed by *Themeda triandra* and *Eragrostis splana*, and *Cynodon dactylon* and *Elinurus muticus*, which had comparable ($P > 0.05$) P levels. Cellulose was significantly ($P < 0.05$) higher in *Eragrostis splana* than in the other rangeland grasses, which did not differ significantly ($P > 0.05$) from each other. Dry matter digestibility and metabolisable

ISSN: 2455-6939

Volume: 11, Issue: 05 "September-October 2025"

energy varied significantly (P < 0.05) among the rangeland grasses consumed by the experimental ewes. The DMD of *Cynodon dactylon (*55.40 ± 0.78%)*, Elinurus muticus (*54.07 ± 1.51%) *and Hyparrhemia hita (*53.56 ± 0.71%) and *Themeda triandra (*52.29 ± 0.45%) did not differ significantly (P>0.05) but were significantly (P < 0.05) different higher than *the DMD of Eragrostis splana* (46.83 ± 1.19%). The ME content of the rangeland grasses varied from 5.96 to 7.42 MJ/kg DM, and showed the same statistical trend as the DMD. Crude protein, NDF, ash, hemicellulose, calcium and DMI did not vary significantly (P > 0.05) among the rangeland grasses.

3.3 Effect of Flushing on Body Weight of Ewes

The result for the effect of flushing on the live weight of ewes is presented in Table 4. The result showed that experimental diets had significant (P < 0.05) effect on both the final live weight and the body weight gain of the ewes, and in both, the ewes in the supplemental dietary group had higher significant values.

Table 4: Effect of Flushing on Body weight of Ewes (Mean ±SE)

Ewe live weight (kg)	Experimental Diets		p-value
	Supplemental dietary treatment	Rangeland forage mixture (Control)	
Initial weight	$41.22^{a} \pm 0.31$	$40.22^{a} \pm 0.66$	0.159^{ns}
Final weight	$46.53^{a} \pm 0.35$	$44.44^{b} \pm 0.76$	0.008*
Body weight gain	$5.31^{a} \pm 0.19$	$4.22^{b} \pm 0.41$	0.014*

^{ab} = Means in the same row with different superscripts are significantly (P < 0.05) different,
* = (P < 0.05), ^{ns} = not significant (P > 0.05)
SE=Standard Error

3.4 Effect of Experimental Diets on the Reproductive performance of Ewes

The reproductive performance of the experimental animals is presented in Table 5. The result indicated that that ewes in the supplemental treatment had significantly (P < 0.05) higher pregnancy rate of 98.40% than ewes in the control group with a pregnancy rate of 84.40%. Percentage of lambed ewes among the treatments was not significantly (P > 0.05) different. Similarly, the experimental diets did not affect single lambing rate significantly (P>.0.05) across the treatments. Twining rate was not significantly (P > 0.05) different among the dietary groups and likewise, the ewe mortality rate significant (P > 0.05).

ISSN: 2455-6939

Volume: 11, Issue: 05 "September-October 2025"

Table 5: Effect of Flushing on Reproductive Performance of Ewes

Reproductive indices	Experimental Diets		p-value
	Supplemental dietary treatment	Rangeland forage mixture (Control)	
Number of ewes mated	128	32	
Number of pregnant ewes	126	27	
Pregnancy rate (%)	98.4[a]	84.4[b]	0.001*
Number of ewes died	1	1	
Ewe mortality rate (%)	0.78	3.13	0.86[ns]
Number of ewes available at lambing	79	19	
Total number of lambs born	84	21	
Lambed ewes (%)	62.70	70.37	0.451[ns]
Number of ewes with single lambs	74	17	
Single lambing rate (%)	93.67	89.47	0.524[ns]
Number of ewes with twin lambs	5	2	
Twinning rate (%)	6.33	10.53	0.524[ns]
Average Litter size (% of lambed ewes)	1.06	0.89	

[ab] = Means in the same row with different superscripts are significantly ($P < 0.05$) different, * = ($P<0.05$), [ns] = not significant ($P>0.05$)

4.0 DISCUSSION

4.1 Chemical Composition and Feed value of the Experimental Diets

The supplemental diet was similar to the rangeland forage in having a high DM content which contained energy, and protein, fibre and minerals as vital nutrients. Dry matter content provides

ISSN: 2455-6939

Volume: 11, Issue: 05 "September-October 2025"

the animal with energy needed for various physiological activities. Both diets therefore appeared promising to yield dietary energy for sustenance of ewes. The crude protein content of the supplementary diet was significantly higher than that in the rangeland forage, and the CP for the two experimental diets was lower than 30.3% and 27.4% CP in a protein mixture plus ground corn and protein mixture, respectively (16). Protein and energy are most considered nutrients in animal feeds. Protein affects production and reproduction and insufficient protein levels can result in poor appetite, decreased feed intake which causes poor growth, poor muscular development and reduced reproductive efficiency. It has been reported that extremely low protein levels cannot maintain rumen microbes (17).

The NDF content of rangeland forage was significantly higher than NDF content of supplemental diet. An earlier finding reported 15.8% NDF in grain mixture, which is better than 47.00 ± 2.31% for the supplemental diet and 70.0/75.64 ± 2.36% NDF for rangeland pasture in the present study (18). The NDF can be used to predict forage intake and low NDF is desirable. Hence, it is a valuable measure in forages used for ruminant feeding. The greater the NDF digestibility the higher the forage intake. The ADF of the supplemental diet was significantly lower than that of rangeland forage. It has been observed that ADF of 11.40% for grain mixture and 42.9% for pasture forage which are lower than the respective ADF content in supplemental diet 28.33 ± 1.76% and rangeland forage 47.07 ± 1.85% (19). ADF constitutes the least digestible plant components consisting of cellulose and lignin. High ADF content decreases forage digestibility, and thus are inversely related to digestibility indicating that forages with low ADF concentrations are high in energy (20). This supports the present result in which the ADF of the supplementary diet is lower in ADF and higher in dietary energy than the rangeland forage mixture. Lignin represents the highly indigestible portion of plant components, and it is associated with fibre, and useful as an indicator for evaluating the nutritive value of forage (21). The lower ADL in the supplementary diet, seemed nutritionally advantageous to the ewes than the rangeland forage mixture. It has been reported that the greater the lignin content of the plant, the lower the digestibility of forage (20). The hemicellulose and cellulose contents in the supplemental diet were lower than in the rangeland forage mixture which can be due to the comparatively higher lignin in the forage. Hemicellulose and cellulose can be fermented to varying degrees by microorganisms in animals with either a rumen, a caecum or large bowel (22).

Ash content of 10.03% ± 2.53 in rangeland forage was higher than 3.44% ± 1.15 in the supplemental diet. It has been reported that, if the ash content of forage is high, there is the possibility of contamination with soil, which is not desirable, because high ash content in feed can affect forage energy and dry matter intake estimates which can be misleading (23). Furthermore, too much ash may end up causing crystals to form in the urinary tract, and can also cause bone and joint problems in animals, while low ash contents are helpful in controlling urinary tract problems

ISSN: 2455-6939

Volume: 11, Issue: 05 "September-October 2025"

(24). Therefore, feeds with high ash content should be avoided. Some workers reported 8.10% ash for concentrate supplement higher than that in the supplemental diet fed in this study but lower than in the rangeland grass pasture (25).

Phosphorus levels of 0.32% and 0.39% in both the supplemental diet and rangeland forage mixture, respectively were within the range of 0.26% to 0.39% P for ewes of 50 – 90 kg body weight (26). Phosphorus is required by the ewe and a deficiency can lead to a reduction in cellulose digestion, microbial protein synthesis and feed intake (6). The calcium content for both the supplemental diet (0.09 ± 0.07%) and rangeland forage mixture (0.13 ± 0.01%) were below the 0.53 – 0.61% calcium requirement for ewes (26). Dietary calcium did not meet the requirement of the experimental ewes, however, this mineral element is not critical during flushing but becomes particularly important during late gestation

Dry matter intake of the supplemental diet was 2.58% ± 0.11 compared with 1.60% ± 0.52 for the rangeland forage. There is correlation between voluntary feed intake and NDF content whereby, fibre affects the occupation of ruminal space by the forage (27). Feeds with high NDF thus, have their intake restricted. This is in agreement with the result obtained in this study. It has been reported that the presence of fibre, especially low quality can limit dry matter intake (28). This was supported by (29) who found higher dry matter intake in diets with lower content of fibre as in this current study. The DMD content of the supplemental diet was significantly higher than that of rangeland forage. Dry matter digestibility is the amount of nutrients absorbed by an animal, which represents the availability of nutrients for growth and reproduction. The DMD in this study was 66.83% ± 1.38 for supplemental diet, which agrees with 65.9% for supplementary pellets (30). As observed in this study, the digestibility of the diets is related to intake and their chemical composition. The ME content of supplemental diet was significantly higher than that of rangeland forage. A value of 9.30 MJ/kg ME for supplemental pellets (30), which is comparable with 9.36 ± 0.23 MJ/kg ME for the supplemental diet in the present study and higher than 6.91 MJ/kg ± 0.25 for the rangeland forage mixture. The difference in ME content between supplemental diet and rangeland forage implies that, the rangeland forage alone would not be able to provide adequate energy to meet the requirement of ewes during flushing for metabolic activities. Energy is the most common limiting factor in small ruminant nutrition due to poor quality pastures and roughage or inadequate amounts of feed, and therefore insufficient energy intake can lead to weight loss as observed in the ewes fed on the rangeland forage in this study.

4.2 Effect of Flushing on the Body Weight of Ewes

The result of the body weight of the sheep indicated higher final live body weight (46.53 ± 0.35 kg vs 44.44 ±0.76 kg) and body weight gain (5.31 ± 0.19 kg vs 4.22 ± 0.41 kg) in the ewes on the supplemental diet compared to ewes that depended solely on the rangeland forage. Improved body

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condition is associated with enhanced reproductive efficiency, including ovulation and potential litter size benefits. Earlier studies (31, 32) found that body weight of flushed and non-flushed ewes differed significantly and in favour of the flushed ewes, which agrees with the present study. Sufficiently high live weights of does is essential in maintaining good reproductive and growth performance as well as survival rate of kids (16). Weight change of dams during pregnancy often indicates pre-natal development of foetus and there is correlation between birth weight of the offspring and body weight of the dam (33). Improving body weight of dam at mating will thus serve as a stimulus to increase ovulation rate and therefore litter size. This makes flushing a good management practice.

4.3 Effect of the Experimental Diets on the Reproductive Performance of Ewes

The occurrence of higher pregnancy rate of 98.40% in the supplemental dietary group might be correlated with higher body weight gain in that group, due to supplementation compared to 84.40% in the control group. The significantly lower pregnancy rate of the ewes observed in control diet group may be explained by the unimpressive reproductive outcomes due to the low nutritional status of the rangeland grass mixture consumed. This is a physiological situation that highlights the importance of keeping a good body condition of breeding dams (34, 35), and makes flushing an invaluable aspect of good management practice during dry season. It has been reported that under such marginal metabolic condition, ewes may re-direct their scarce nutrient pool toward vital physiological and metabolic activities other than the neuroendocrine ovarian activation and remain anoestrous (36, 37). This decreased metabolic status may also lead to a reduced responsiveness to the male effect (38).

Mortality rate was lower in the supplemental dietary group than in the control group. This showed the practical importance of a good diet in survivability of ewes. The ewes on the supplemental diet had a higher single lambing rate of 93.67% relative to 89.47% for ewes on the rangeland grass mixture control diet, while it was the opposite for the twinning rate. This portrays an inverse relationship between single lambing and twinning rates in a flock. In the present study, higher average litter size was observed in supplemented ewes which agrees with the result of (19).

5.0 CONCLUSION AND RECOMMENDATION

Flushing improved reproductive performance of merino ewes with high pregnancy and their growth performance with high live body weight gain. It is recommended that Merino ewes on grazing should be provided with supplemental feeds for reproduction during mating periods so as to generate sufficient body reserves to meet production and reproduction requirements.

LIMITATION

The study used unequal number of ewes in the dietary groups because of the unwillingness of farmers to provide their ewes to be used as control animals. Secondly, the study was part of national research covering this agro-ecological zone.

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CONFLICT OF INTEREST

The authors declare that there was no conflict of interest.

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