EFFECT OF PRE- AND POSTPARTUM SUPPLEMENTATION ON PERFORMANCE OF RED MASAI SHEEP AND SMALL EAST AFRICAN GOATS

BY

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1981

DECLARATION

a) This thesis is my original work and has not been presented for a degree in any other University.

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b) This thesis has been submitted for examination with our approval as University Supervisors.

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DEDICATION

Dedicated to my parents whose great sacrifice made my education possible.

TABLE OF CONTENTS

Page

Page

LIST OF TABLES

LIST OF FIGURES

LIST OF APPENDICES

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ABSTRACT

Two experiments were conducted at Kitengela Station, Machakos District, of Kenya to examine the effect of pre- and postpartum supplementation on performance of Red Masai sheep and Small East African goats under range conditions. Experimental animals grazed a predominantly *Themeda triandra* pasture and browsed *Acacia* spp. shrubs during the day and were penned at night. A set-stocking grazing system was employed.

In Experiment 1, three groups of pregnant ewes were steamed-up for 6, 4 and 2 weeks prepartum using 24.0, 20.0 and 16.0 kg of ewe-and-lamb nuts concentrate per ewe, respectively. A fourth group was not steamed-up. Four groups of pregnant does were put on similar treatments. After parturition, no supplement was fed, but performance of dams and their offsprings was monitered up to twelve weeks postpartum. In Experiment 2 ewes and does that were grazed on pasture alone throughout pregnancy were allocated to four postpartum concentrate supplementation levels of 0, 0.25, 0.50 and 0.75 kg per day. Supplementation started a day after parturition and lasted for twelve weeks weeks when lambs and kids were weaned. Lambs and kids were penned and given *Themeda triandra* hay *ad libitum* up to five weeks of age after which they were pastured. Routine management practices were observed for both dams and their offspring.

Steaming-up had a significant (P< 0.05) effect on weight gain of ewes prepartum. Ewes fed 24.0 kg concentrate gained weight faster (P< 0.05) than the control group. However, weight changes of dams during lactation were not significantly

(P> 0.05) affected by prepartum levels of supplementation. Birth weights, pre-weaning growth rates, weaning weights and body measurements of lambs and kids were not affected (P> 0.05) by level of supplementation of pregnant dams. Steaming-up did not affect (P> 0.05) weight changes of does pre- and post-partum.

Postpartum supplementation had no effect (P> 0.05) on weight changes of ewes and does during lactation. However performance of lambs and kids in terms of growth rates, weaning weight and body development was significantly (P< 0.05) improved by postpartum supplementation of dams. The effect of postpartum supplementation levels of 0.50 and 0.75 kg per day on performance of lambs was not different (P> 0.05). Performance of kids from does supplemented postpartum with 0.75 kg concentrate was superior (P< 0.05) to that of kids from does supplemented with 0.50 kg concentrate per doe per day. Throughout the preweaning growing period, heartgirth was highly (P< 0.05) correlated to liveweight of lambs and kids.

This study indicated that steaming-up of pregnant ewes and does was not necessary under Kenyan range conditions from the standpoint of lamb and kid performance and dam weight changes. However, it was deemed necessary to supplement ewes and does at a rate of 0.50 kg concentrate per day so as to improve lamb and kid performance through increased milk production. Although a higher supplemetnation level of 0.75 kg concentrate per dam per day promoted lamb and kid growth rate over and above the 0.50 kg per dam per day level, it was deemed uneconomical.

1. INTRODUCTION

Sheep and goats have been kept by many peoples of East Africa. The two species were common in almost every household in Kavirondo and the Rift Valley districts of Kenya (Lyne-Watt, 1942; Maher, 1945). Smallstock were not only raised by pastoral people of the Eastern and North Eastern Uganda, but also in the Central and Southern districts of the country (Uganda Protectorate, Department of Veterinary Services and Animal Industry, 1936). French (1942), and Staples, Hornby and Hornby (1942) reported the prevalence of sheep and goats in Tanzania. The development of smallstock production in East Africa involved the importation of dairy goats from India and Britain in the 1930's to cross with local breeds (Maule, 1966). Crossbreeding of local sheep with Blackhead Persian was conducted at Mpapwa (French, 1942); while at Mbarara Dorset-horn rams were imported for the same purpose (Uganda Government, Department of Veterinary Services and Animal Industry, 1962).

The population of sheep and goats has been growing at a very fast rate in Kenya. In 1968 there were about 4,186,600 sheep and 5,086,000 goats. With a growth rate of 0.38 and 1.75% per annum for sheep and goats, respectively, the population of sheep was estimated at 4,339,700 while that of goats at 7,065,600 in 1979 (Sheep and Goat Development Project, 1979). This indicated a total increase of approximately 24% for both species during that period. In Kenya, the largest number of smallstock are found in the Rift Valley Province followed by Eastern Province (Table 1).

Smallstock production has played a major role in the economy of range areas of Kenya in the past ten years. Sheep and goats contributed 26.3% to National output in 1975, while cattle in the same areas accounted for 13.5% (Semenye, 1977). It was further observed that, at farm level, smallstock were readily converted to cash so as to meet urgent financial requirements, like buying drugs. Earlier studies had indicated an annual offtake of 5% (Maher, 1945).

For appropriate feeding of sheep and goats, an adequate knowledge of their feeding habits is necessary. Various studies (Staples et al., 1942; Wilson, 1957; Musoke, 1980) suggest that goats are able to graze very short grass and browse on foliage. Sheep are grazers, eating selectively very close to ground level (Juko and Bredon, 1961; Faur, 1966). Under Kenyan conditions, feeding practices vary with ecological zones. In range areas, smallstock graze and browse on natural pasture; while in wetter areas, they are fed on farm-residues and graze along road-sides and on fallow land. Sheep are grazed on improved pastures found in settlement schemes and large scale mixed farms (Semenye, 1977).

In range areas, pasture quality and quantity change with climatic seasons (Bredon and Horrell, 1961; Karue, 1975). About 80% of the sheep and goats in Kenya, are raised in range areas and depend almost entirely on pasture

Table 1: Sheep and goat distribution and growth in population for all Provinces in Kenya ('000)

Province	1968		1979		Annual growth (%)		
	Sheep	Goats	Sheep	Goats	Sheep	Goats	Sheep and Goats
Western	167.1	141.8	174.8	150	0.42	0.51	0.93
Rift Valley	1858.2	1717	1680	2752	- 0.87	5.48	4.61
Nyanza	528	527	600	770.3	1.24	4.20	5.44
Eastern	927.9	1577	1097.7	1900.3	1.66	1.86	3.52
Coast	88.7	207	114	470	2.59	11.55	14.14
Central	269.3	118	192.1	317	- 2.61	15.33	12.72
North Eastern	N.A.[1]	738	479	704	N.A.	- 0.42	N.A.
Nairobi	1.4	N.A.	2.1	2.0	N.A.	6.36	N.A.

[1]Not assessed.

Source: Anon., (1970).
Sheep and Goat Development Project (1979).

for their nutrient requirements (Semenye, 1977). Fluctuations in pasture quality and quantity are reflected in birth and weaning weights of local sheep and goats. Experimental evidence (Wallace, 1948; Adu and Olaloku, 1979) suggests that steaming-up induces weight gains in pregnant ewes and improves birth weights of lambs. In addition ewes that are steamed-up lose less weight during lactation (McArthur, 1980). Supplementation of lactating ewes and does promoted growth rates of suckling lambs and kids (Wilson, 1957 ; Treacher, 1971). Lambs which got inadequate feed between birth and four months of age, had retarded growth rates and small mature body sizes (Schinkel and Short, 1961).

Birth weights, growth rates, weaning and mature weights of local sheep and goats could be improved by systematic steaming-up and postpartum supplementation of lactating ewes and does. However, no literature is available on the effects of such practices on goats and sheep reared on range. A study was, therefore, conducted to examine the effects of steaming-up during pregnancy and supplementation during lactation on performance of Red Masai sheep and Small East African goats.

2. LITERATURE REVIEW

2.1 SHEEP AND GOAT AGRICULTURE IN EAST AFRICA

2.1.1 Numbers and distribution

Sheep and goat farming has been growing rapidly throughout East Africa. The actual figures of smallstock in East Africa are difficult to assess since most of the tribesmen, who own up to 80% of the smallstock (Semenye, 1977) are unwilling to disclose such figures. In Kenya, estimates of sheep and goats are based on recorded output of skins and estimates of offtake per head of population obtained from the Sheep and Goat Development Project, Integrated Rural Surveys and Provincial Animal Production Officers (Semenye, 1977).

In 1977, Kenya, Tanzania and Uganda had 3.9, 3.0 and 1.1 million sheep and 4.3, 4.7 and 2.2 million goats, respectively (FAO, 1977). Annual growth rates of sheep and goats population during the past ten years have been estimated at 0.4 and 0.2; 0.6 and 0.6, 2.6 and 1.4% for Kenya, Tanzania and Uganda, in that order (FAO, 1977).

2.1.2 Socio-economic importance

Local sheep and goats are meat producers for various functions ranging from dowry to funeral rites in various East African Communities (Lowe, 1943; Devendra and Burns, 1970; Devendra, 1978; Nasibu, 1980). Among the Kikuyu, oil produced from bucks and rams was used in anointing children (Lyne-Watt, 1942). Of late, goat meat has become an invaluable constituent of the barbecue for local parties among elite groups (Nasibu, 1980).

Sheep and goats generate substantial income at farm level. For small holders, in particular, smallstock are considered a useful investment against the failure of cash crops (Semenye, 1977; Devendra, 1978). Most of the smallstock are sold at local markets, with very few reaching terminal points (Uganda Government, Department of Veterinary Services and Animal Industry, 1971). In Uganda about 42,300 sheep and goats were sold at local markets in 1970, yielding over half a million shillings. The major export item from sheep and goats industry is skins. About 3000 tons of hides and skins were purchased within Uganda in 1970; including 1,140,000 pieces of goat and 204,000 pieces of sheep skins all valued at over six million shillings. About 600,000 kg of goat and sheep skins were exported in the same year fetching approximately one million shillings (Uganda Government, Department of Veterinary Services and Animal Industry, 1971).

2.1.3 Husbandry Practices

Sheep and goats are raised under different systems of management depending on various ecological factors. Vegetation and rainfall are reflected in housing, feeding and breeding.

In drier areas sheep and goats are housed in simple, round night enclosures made of thorny twigs. In wetter areas, stalls and special huts are built for sheep and goats. In some cases families live with their stock in the same house. Timber or mud and wattle, grass thatched huts with raised floors are commonly used to house smallstock (Lyne-Watt, 1942).

Feeds and feeding for sheep and goats vary considerably in Kenya. In range areas, smallstock are grazed on natural pasture under a nomadic system (Williamson and Payne, 1978). In wetter areas sheep and goats are tethered on roadsides and sometimes supplemented with browse twigs, cassava tops and sweet-potato vines. Improved pasture for sheep is found on large mixed farms formerly owned by Europeans (Semenye, 1977). Feeding of local goats on improved pastures has not been reported in East Africa.

Local sheep and goats are bred at any time of the year. Mating ratios used are 1.6 and 5% for wetter and drier areas, respectively. First heat occurs at about six months in maiden does and one year of age in maiden ewes. In maiden does breeding is delayed until about twelve to eighteen months of age as a control measure against dystocia (Devendra, 1978). Some farmers use own or borrowed rams and bucks for breeding purposes. Wilson (1957) reported that about 2.3 services per conception are required for Small East African goats, but no figures are available on the fertility of Red Masai sheep.

Literature on disease control programme for local sheep and goats under traditional management system is scanty. However, in wetter areas shelters are built as a measure against rain and draughts which predispose the animals to pneumonia (Nasibu, 1980). On government farms routine disease control is recommended. Sheep and goats are drenched against roundworms, tapeworms and nasal worms at a frequency and rate determined by the worm challenge. Dipping is done weekly to control tick-borne diseases. Adults and weaners are vaccinated against blue tongue disease, once a year. Pregnant ewes and does are vaccinated against pulpy kidney, enterotoxaemia and tetanus one month prepartum. Foot-trimming is essential for all breeding groups prior to joining. Foot-rot is controlled by incorporation of a foot-bath in a crush, to which a disinfectant has been added. Diseases are diagnosed and animals treated promptly using drugs recommended by Veterinary Officers. The recommendations are contained in Working Paper No. 10 (Sheep and Goat Development Project, 1977).

2.1.4 Productivity

Local sheep and goats have not been selected for high productivity in terms of birthweight, growth rate, weaning and mature weight and carcass quality. Birth weights of Red Masai sheep and Small East African goats range from 2.9 to 3.01; and 2.0 to 2.5 kg, respectively (French, 1942; Wilson, 1958a; Sheep and Goat Development Project, 1975a). Red Masai sheep have a higher twinning rate of 14 compared to 10% for the Small East African goats. However, the Mubende goats in Uganda twin at a rate of about 30% (Mason and Maule, 1960; Sacker and Trail, 1966; Sheep and Goat Development Project, 1975a).

Mortality from birth up to weaning is reported as 4% for Red Masai lambs (Sheep and Goat Development Project 1975a); while no figure is given on mortality rate of kids from Small East African goats. Preweaning weight gain of lambs and kids is 146 and 72 g/day, respectively; while postweaning rate of weight gain is 45 and 52 g/day for lambs and kids, respectively (Sheep and Goat Development Project, 1975a). Mature weight of twelve month-old sheep and goat is about 30 kg (Devendra and Burns, 1970; Chelimo, 1980). and the killing out percent of sheep and goats is 44 and 43.5%, respectively. Total edible and total saleable proportions from local goats are 48.3 and 58.5%, respectively (Wilson, 1958b; Devendra, 1978).

2.2 EFFECT OF STEAMING-UP ON SHEEP AND GOAT PRODUCTIVITY

2.2.1 Dam weight changes prepartum

Tribe and Coles (1966) asserted that the objectives of feeding a pregnant ewe were threefold, namely to produce a live, healthy lamb of sufficient birth weight; to produce an adequate udder development in preparation for subsequent lactation and to maintain the health and productivity of the ewe. Peart (1970) noted that the body condition of ewes at parturition was partly dependent on pre-lambing feeding and acted as a buffer between nutrient intake and nutrient requirements for lactation. Louca, Mavrogenis and Lawlor (1974) reported that early lactation milk production was affected by the body condition of ewes at lambing, which in turn was influenced by level of feeding during late pregnancy.

Several workers have demonstrated that the plane of feeding during late pregnancy significantly affected weight changes of ewes prepartum. Thomson and Thomson (1949) observed that single and twin-bearing ewes on a high plane of nutrition gained 4.0 and 2.0 kg, respectively; whereas similar ewes on a low plane of feeding lost 10.0 and 12.0 kg, respectively, in the second half of pregnancy. Papadopoulos and Robinson (1957) noted that ewes on improved pasture gained 24.3 kg while those on unimproved pasture lost 9.1 kg between joining and lambing. Peart (1967) subjected Blackface ewes, ten weeks prepartum, to high, medium and low planes of nutrition based on blood plasma free fatty acids and ketone values. At parturition ewes on the high plane had gained more weight than ewes on medium and low planes of feeding.

Butterworth and Blore (1969) found that ewes grazed on good pasture and supplemented with concentrate six weeks prepartum gained more weight than ewes on good and poor grazing without supplementation. Black, Fitzsimons, Ferguson, Khalaf, Doxey and Baxter (1979) subjected Scottish halfbred ewes fifty six days prepartum to high and low energy intake. Single bearing ewes on a high energy intake gained 14.3 kg while triplet bearing ewes on low energy intake lost 13.8 kg.

Other studies, however, have shown no effect of steaming-up of ewes on body weight changes. Peart (1970) subjected Blackface ewes sixteen weeks prepartum to high and low levels of feeding. At eight weeks prepartum weight differences of 14 kg had been created between the two groups. When all ewes were rationed to provide for requirements during late pregnancy, both groups made similar weight gains. Maxwell, Doney, Milne, Peart, Russel, Sibbald and MacDonald (1979) fed Greyface ewes on high, medium and low planes of nutrition six weeks prepartum. There was no significant difference in average daily weight gain of single- and twin- bearing ewes on all prepartum treatments.

2.2.2 Lambing performance:

Lambing performance has been monitored in terms of abortions, dystocia, stillbirths and lamb survival rates up to ten days of age. Thomson and Thomson (1949) noted that thin ewes bearing small lambs often had rapid labours but twinning caused exhaustion. Papadopoulos and Robinson (1957) reported fewer lambing problems among ewes fed on a lower than on a higher plane of nutrition. Thomson and Thomson (1949) recorded 32% still births among twin-bearing ewes on a low plane of feeding. However, Coop (1950) found that ewes on a high and low plane of nutrition during late pregnancy had 12 and 10% stillbirths, respectively. McArthur (1980) observed that full supplementation reduced the occurrence of abortions which were more frequent in non or improperly supplemented ewes.

Studies on lamb mortality up to ten days of age suggest that the plane of feeding ewes during the last six to eight weeks of pregnancy is an important determinant of survival. Thomson and Thomson (1949) recorded 17 and 2% mortality among twin lambs on low plane and single lambs on a high plane of nutrition, respectively. Black et al. (1979) reported that lamb mortality from ewes on low plane of feeding was higher than that of lambs from ewes on medium and high plane of feeding.

2.2.3 Dam weight changes postpartum

McArthur (1980) working with Gaddic ewes in Afghanistan reported that steamed-up ewes lost least weight during the subsequent lactation. However, Peart (1967) reported that weight changes of ewes during lactation were similar irrespective of pre-lambing plane of feeding.

Treacher (1971) fed Dorset Horn ewes to make 20 and 10% liveweight gains in the last six weeks of pregnancy for ewes bearing twin foeti; and 16 and 6% for ewes bearing single foetus. The results showed that high and low planes of feeding had no effect on liveweight changes of ewes during the subsequent lactation. Maxwell et al. (1979) reported that daily weight changes during lactation were not different between ewes on high, medium and low planes of nutrition during the preceeding gestation. Furthermore, liveweights of single- and twin- rearing ewes were similar up to five weeks post-lambing.

2.2.4 Lamb and kid birthweight

The birthweight of a lamb is affected by the level of nutrition of the ewe during the last six weeks of pregnancy (Wallace, 1948; Thomson and Thomson, 1949; Schinkel and Short, 1961; Treacher, 1970; Adu and Olaloku, 1979). The vigour of the lamb was diminished when the ewe had been inadequately fed before lambing and the likelihood of loss of both lamb and ewe was increased (Peart, 1967; Black et al., 1979). The weight and vigour of the lamb at birth were important in enabling it to take full advantage of the potential milk supply of the dam (Wallace, 1948). Most studies (Treacher, 1970; Louca et al., 1974) have indicated that extreme underfeeding during late pregnancy reduced the birthweight of twin lambs by 50%.

Thomson and Thomson (1949) using Cheviot ewes induced a weight loss of about 5% during the second half of pregnancy in a low plane of nutrition group; and a weight gain of up to 30% in a high plane of nutrition group. Birthweights of single and twin lambs from ewes on the high and low plane of nutrition were 4.8 and 3.5 kg; and 3.7 and 2.3 kg, respectively. Schinkel and Short (1961) studied the effects of low and high plane of nutrition of pregnant ewes on the performance of their lambs. Lambs from ewes on the low plane of nutrition were 34% lighter at birth.

Butterworth and Blore (1969) subjected Persian Blackhead ewes to rich and poor grazing with and without concenntrate supplementation from six weeks prepartum. Birthweights of all lambs were significantly affected by the prenatal plane of nutrition of the pregnant ewes. Sheehan and Lawlor (1972) fed pregnant ewes on silage _ad libitum_ and on silage supplemented at various levels with rolled barley and pelleted milled dried grass. Birthweights of single and twin lambs from ewes fed silage alone were lower than birthweights of lambs from the supplemented groups. Birthweights of twin lambs may be a valuable criterion of the adequacy of the diet of ewes during late pregnancy (Sheehan and Lawlor, 1972).

Lodge and Heaney (1975) observed significant differences in birthweight of single lambs from ewes fed at 57 and 80% above maintainance requirements. Adu and

Olaloku (1979) reported differences in birthweight of lambs from West African Dwarf ewes fed at 249, 435 and 538 g of digestible organic matter per day. Mavrogenis, Hancock and Louca (1980) recordedsignificant differences in birthweight of lambs from Chios, Awassi and Cyprus fat-tailed ewes fed on high medium and low plane of nutrition six weeks prepartum.

Other researchers, however, have not observed significant effects of steaming-up of ewes on birthweight of lambs. Coop (1950) fed gestating ewes on low and high planes of nutrition and reported increased birthweight of only 0.23 kg. On 30-acre paddocks of unimproved pasture and 60-acre paddocks of improved pasture, Papadopoulos and Robinson (1957) reported that birthweight of single and twin lambs was not significantly affected by level of prepartum feeding of Merino or Border Leicester or crossbred ewes. Treacher (1971) subjected Dorset Horn ewes to high and low planes of nutrition to gain 20 and 10% of liveweight, respectively for ewes bearing twin lambs and 16 and 6%, respectively for ewes bearing single lambs, during the last six weeks of pregnancy. Birthweight of either twin or single lambs were not significantly affected by the prepartum plane of nutrition of ewes.

Louca et al. (1974) allocated Chios and Awassi ewes to high, medium and low plane of nutrition six weeks prepartum. Birthweight of single lambs was not reduced by either high or low plane of prepartum feeding of their dams. McArthur (1980) fed Gaddic sheep 100 to 450 g of barley grain for twenty six to seventy days prepartum and reported that birthweight of lambs was not significantly affected. There is paucity of data on the effects of steaming-up of does on dam and kid performance.

2.2.5 Lamb and kid growth rate

Contradicting results have been reported on the effects of steaming-up of ewes on growth rates of lambs. Robinson and Forbes (1968) fed two and four levels of energy and protein intake, respectively to Border Leicester and Blackface ewes. Lamb growth rate from birth to three weeks of age decreased with decreasing level of protein intake of the gestating ewe. Butterworth and Blore (1969) noted that growth rate of Persian Blackhead lambs up to four weeks of age was significantly affected by prenatal plane of nutrition. This effect was less pronounced from four to twelve weeks of age. Sheehan and Lawlor (1972) observed that lambs from ewes which had been fed on silage *ad libitum* plus 23 kg of rolled barley grew faster than lambs from ewes which had been fed silage alone.

Other studies, however, have indicated minor or no effect of steaming-up of ewes on subsequent performance of lambs. Coop (1950) indicated that growth rate of lambs were not affected by either high or low plane of nutrition of gestating ewes prepartum. Similar results were reported by Papadopoulos and Robinson (1957) from a study involving Romney Marsh x Merino and Border Leicester x Merino crosses. Peart (1967) allocated gestating Blackface ewes to high, medium and low plane of nutrition. After parturition all ewes were fed a pelleted concentrate ad libitum. From birth up to five weeks of age, twin lambs from high and medium groups of ewes made similar weight gain as twin lambs from the low plane group. Between the sixth and twelfth week of suckling, growth rate of twin and single lambs from ewes on the high plane of feeding were similar. Growth rates of single lambs were similar on all planes of nutrition upto twelve weeks of age.

2.2.6 Weaning weight of lambs and kids

Very few studies have been conducted to investigate the effects of steaming-up on weaning weight. Butterworth and Blore (1969) indicated that the effect of steaming-up diminished gradually between four and twelve weeks of suckling. Other studies (Coop, 1950; Peart, 1967; McArthur 1980) have shown that pre-lambing feeding levels have no discernible effects on growth rate of single lambs. Only twin lambs from very poorly fed ewes were affected by pre-lambing feeding levels (Faur, 1966). Weaning weight of lambs seem to be independent of level and duration of steaming-up (Coop, 1950; Treacher, 1970; McArthur, 1980).

2.3 EFFECT OF POSTPARTUM SUPPLEMENTATION ON PERFORMANCE OF SHEEP AND GOATS

2.3.1 Dam weight changes

Experimental evidence suggests that weight losses of lactating dams can be reduced by supplementation. Coop (1950) observed that ewes fed on a high plane of nutrition during lactation were about 4.5 kg heavier at the end of lactation than ewes fed on a low plane. When ewes were fed *ad libitum* during lactation lean and fat ewes gained weight at a rate of 356 and 250 g daily, respectively (Peart, 1970). Jordan and Hanke (1977) restricted intake of shelled maize of lactating ewes between the sixth and tenth week postpartum and reported a weight loss of ewes of about 5.0 kg.

2.3.2 Lamb and kid growth rate

Various studies (Coop, 1950; Wilson, 1958a) have shown beneficial effects of supplementation of lactating ewes on performance of the offsrping. Coop (1950) grazed lactating ewes on either high or low quality pastures and reported that the level of feeding during lactation accounted for all differences in pre-weaning weight gains of suckling lambs. Papadopoulos and Robinson (1957) indicated that lamb growth up to weaning was affected by postnatal plane of nutrition.

However, Torres-Hernandes and Hokenboken (1980) noted that average daily gain of lambs may be affected more by litter size than actual plane of feeding. Single lambs gained more weight than individual twin lambs during suckling; but total gains of twin sets was much greater than gains of single lambs,

Wilson (1958a) subjected East African dwarf does to either low or high plane of feeding during lactation. When kids weighed 9.1 kg, half of the kids and does from each level of feeding were switched to the opposite treatment. Male and female kids on a high plane of feeding during the latter part of the experiment attained 15.0 kg liveweight at twenty and thirty one weeks of age, respectively; while all kids on the low plane during the same period weighed 15.0 kg at fourty eight weeks of age.

2.3.2 Disease incidence and mortality

Lambs receiving a high proportion of milk or other high quality feed in their diet, are less likely to suffer from serious worm infestation under grazing conditions (Spedding, 1970). Milk production can be increased, in part, by postpartum supplementation of the ewe. When ewes produce adequate milk, their lambs spend less time on pasture, thereby reducing chances of worm infestation. Lambs getting adequate milk from ewes are more vigoruous and able to withstand predisposing factors such as inclement weather

(Williamson and Payne, 1978). Coop (1950) observed that a low level of nutrition during lactation increased lamb loss from birth to weaning.

2.3.4 Weaning weight

Experimental evidence suggests that supplementation of lactating ewes improves weaning weights of lambs. Wallace (1948) reported that lambs from ewes that were on a high plane of feeding during lactation, were 40.1% heavier than those from ewes on a low plane of feeding. Coop (1950) observed that feeding lactating ewes and lambs on high plane of nutrition increased weaning weights of single and twin lambs by 4.3 and 5.9 kg, respectively. However, Jordan and Hanke (1977) reduced intake of shelled maize of lactating ewes from 0.91 to 0.23 kg per ewe daily, between the sixth and tenth week of lactation; and showed that the weaning weights of lambs were not affected.

2.3.5 Maturity and reproduction

Mature weight of sheep may be affected by plane of nutrition during early postnatal life. Coop and Clark (1955) reared Corriedale ewe lambs on either improved or unimproved pasture up to twelve months of age. Ewe lambs on improved pasture were heavier than those on unimproved pastures, at sexual maturity. Schinckel and Short (1961) reported that lambs reared on a high plane of feeding were

9.8 % heavier at maturity than those reared on a low plane of feeding. Quirke (1979) fed lambs a concentrate diet either ad libitum or restricted. Maiden ewes on the high plane of feeding were heavier at puberty than those reared on the low plane of feeding. However, the conception rate and number of young born of maiden ewes on high and low plane of nutrition were not different.

Longevity, measured as the breeding life of ewes can be affected by plane of feeding during rearing. Coop and Clark (1955) indicated that low plane of feeding during rearing increased the culling rate of the resultant ewes by about 20%.

3. MATERIALS AND METHODS

3.1 Introduction

Two experiments reported herein were conducted at Kitengela Station, Machakos District, Kenya, to examine the effects of pre- and postpartum supplementation on performance of Red Masai sheep and Small East African goats under range conditions.

The Station is situated at an altitude of 1660 metres above sea level, in ecological zone IV (Pratt, Greenway and Gwyne, 1966). Vegetation is open grassland type, characterised with a few scattered trees and thorny shrubs. Annual rainfall is 500 mm. First rains start in March, peak in April and end in May. Second rains are short and occur in November and December. Minimum and maximum temperatures are 10 and 26^{O}C, respectively (Anon, 1970).

3.2 Experiment 1

Objective: To investigate the effect of steaming-up on pre- and postpartum performance of Red Masai sheep and Small East African goats.

3.2.1 Experimental design

A completely randomised design was employed consisting of four treatments shown in Table 2. No supplement was fed to animals on experiment 1 after parturition. Performance

Table 2: Periods and levels of the steaming-up programme used on ewes and does.

Treatment	Dams/treatment		Weeks before parturition			Calculated level of steaming-up, kg.
			6-4	4-2	2-0	
	Ewes	Does	Concentrate[1] fed, kg/dam/day			
A	6	4	0	0	0	0
B	6	4	0.25	0.50	0.75	21.0
C	6	4	0	0.50	0.75	17.50
D	6	4	0	0	0.75	10.50

[1]Concentrate fed was ewe-and-lamb nuts for ewes and does.

was, however, monitored up to twelve weeks postpartum, when the offsprings were weaned.

3.2.2 Experimental materials

Twenty-four Red Masai ewes and sixteen Small East African does bred in July-August 1980 were used. Ewes and does weighed 35.5 ± 1.2 and 30.6 ± 1.3 kg, respectively, six weeks prepartum. Experimental animals were grazed under a set-stocking system on natural pasture of mainly *Themeda triandra*. There were, as well, browse plants of the *Acacia spp*. The concentrate, ewe-and-lamb nuts used for supplementation was purchased from Unga Limited, Nairobi.

3.2.3 Experimental procedure

Experimental animals grazed together with rest of the flocks during the day and stayed in fenced enclosures at night. Between 1200 and 1400 hours every day, experimental animals were sorted out into different pens and given a ewe-and-lamb nuts concentrate according to treatments. Mineral licks were always available in the pens. Water was offered three times daily at 07.00, 12.00 and 18.00 hours. Animals were dipped weekly using "Bacdip[1]"; drenched at monthly intervals with Ranide[2] against liverflukes, hookworms and nasal worms. All ewes were vaccinated against pulpy kidney, enterotoxaemia and tetanus using a lambivac[3]

[1]Bayer, Nairobi.
[2]Pfizer Laboratories Limited
[3]Wellcome Kenya Limited

vaccine four weeks before lambing. Lambing and kidding was watched carefully but no assistance was offered to ewes or does. After parturition each dam and its offspring were housed in individual pens for twenty four hours to avoid mismothering. The dam was subsequently returned to pasture; whereas the offspring was put in a group pen according to treatment. During the first five weeks, lambs and kids suckled at midday for one hour and overnight. Themeda triandra hay was offered to lambs and kids free choice in pens. After five weeks of age, lambs and kids were pastured.

Each dam was weighed at the beginning of the experiment and at weekly intervals pre- and postpartum. Bodyweight was also taken a day before and after parturition. Lambs and kids were weighed at birth and at weekly intervals. Height at withers, heartgirth and body length were measured a day after parturition and subsequently at monthly intervals according to methods outlined by Donald (1958) and Wilson (1958a).

Pasture samples were taken randomly over the grazing area at monthly intervals. This was done by cutting thirty 1 m^2 quadrats over the grazing area at 2.5 cm above the ground level (McArthur, 1980). Shrubs commonly browsed by goats were sampled monthly by plucking terminal buds at random.

3.3 Experiment 2:

Objective: To investigate the effects of postpartum supplementation on productivity of Red Masai sheep and Small East African goats.

3.3.1 Experimental design

A completely randomised design was used. The supplementation programme and concentrate levels offered are shown in Table 3.

3.3.2 Experimental materials

Twenty four Red Masai ewes and twelve Small East African does grazed on pasture alone during pregnancy were used. Ewes and does were allocated to post-partum dietary treatments one day after parturition. Ewes and does weighed 32.6 $\pm$ 0.78 and 29.5 $\pm$ 0.58 kg, respectively. Pasture type grazed and concentrate fed were as described for experiment 1.

3.3.3. Experimental procedure

Supplementation of dams started a day after parturition and lasted for twelve weeks when the offsprings were weaned. The rest of the experimental procedures were as described for experiment 1.

Table 3: Supplementation levels for lactating ewes and does.

Treatments	Dams/treatment		Level of supplementation[1], kg/dam/day
	Ewes	Does	
E	6	3	0
F	6	3	0.25
G	6	3	0.50
H	6	3	0.75

[1]Concentrate fed during postpartum supplementation was ewe-and-lamb nuts for all dams.

3.4 Analyses

3.4.1 Chemical

Pasture samples were sorted out into leaves, stems and whole plant for quality determinations. Determination of proximate principles in the grazed material and concentrate followed standard procedures (A.O.A.C., 1975). Acid detergent fibre and *in vitro* digestibility were determined using the methods of Van Soest (1963) and Tilley and Terry (1963), respectively. Energy values were determined using the Adiabatic Oxygen Parr Bomb Calorimeter.

3.4.2 Statistical

The data were analysed as a completely randomised design with significance reported at the 5 percent level of probability (Steel and Torrie, 1980). Significance between treatment means were tested using Duncan's New Multiple Range Test and simple correlations relating body weight and other body measurements were tested as outlined by Steel and Torrie (1980).

4. RESULTS

4.1.1 Chemical composition of pasture, browse plants and concentrate

Chemical composition of grazed pasture, browsed plants and concentrate fed is shown in Tables 4 and 5.

There was little variation in fibre fraction, crude protein (CP) and gross energy (GE) in pasture and browse plants during the study period (November, 1980 to March, 1981). Crude protein, acid detergent fibre (ADF) and lignin content of pasture ranged between 2.8 and 3.8; 55.7 and 60.5; 11.4 and 13.0%, respectively. When seperated into leaves and stems, values of 4.3 and 3.0 CP; 52.7 and 59.7 ADF; 8.2 and 15.1% lignin for leaves and stems, respectively were obtained. Crude protein content of browse plants ranged between 15.0 and 19.1 whereas ADF and lignin values varied between 25.7 and 35.5 and 9.1 and 19.1%, respectively. Concentrate (ewe-and-lamb nuts) fed contained 13.1% CP, 10.3% ADF and 3.2% lignin.

4.1.2 Estimated in vitro digestibility of pasture, browse plants and concentrate

The estimated *in vitro* digestibility of grazed pasture, browsed plants and concentrate fed is shown in Tables 4 and 5.

Table 4: Chemical composition and digestibility of grazed pasture and cocentrate fed (DM basis)

	Pasture[1]						Concentrate[2]
	Whole plant		Stems		Leaves		
Proximate composition, %	Mean	(range)	Mean	(range)	Mean	(range)	Mean
Crude protein	3.2	(2.8-3.8)	3.0	(2.6-3.3)	4.3	(3.3-5.3)	13.1
Ash	10.0	(9.0-11.3)	5.7	(4.7-7.2)	14.7	(12.0-17.5)	9.5
Organic matter	82.7	(80.5-84.0)	87.1	(84.9-88.2	77.9	(75.7-80.1)	80.5
Gross energy (kcal/g)	4.10	(3.90-4.54)	4.20	(4.03-4.32)	3.68	(3.52-3.86)	4.78
Van Soest fibre fraction, %							
Acid detergent fibre	57.9	(55.7-60.5)	59.7	(57.9-62.2)	52.7	(50.3-53.9)	10.3
Lignin	12.2	(11.4-13.0)	15.1	(14.5-15.7)	8.2	(7.1-9.3)	3.2
In vitro digestibility, %							
Dry matter	29.8	(25.1-33.0)	24.3	(22.7-25.5)	39.2	(37.5-43.1)	76.5

[1]Pasture, predominantly *Themeda triandra*, was sampled monthly from November, 1980 to March, 1981.

[2]Ewe-and-lamb nuts

Table 5: Chemical composition and digestibility of browse[1] plants (DM basis).

	Browse plants					
	Acacia nilotica		Acacia mellifera		Balinites aegyptiaca	
Proximate composition, %	Mean	(range)	Mean	(range)	Mean	(range)
Crude protein	15.9	(15.1-17.3)	18.8	(18.5-19.1)	15.7	(15.0-16.2)
Ash	7.0	(5.7-8.5)	6.5	(5.6-8.2)	10.4	(8.5-12.9)
Organic matter	82.8	(81.3-84.5)	84.3	(82.7-85.7)	79.8	(78.3-82.6)
Gross energy (kcal/g)	4.54	(4.38-4.79)	4.52	(4.48-4.55)	4.71	(4.53-5.01)
Van Soest fibre fraction, %						
Acid detergent fibre	34.2	(32.6-35.5)	30.1	(25.7-32.2)	29.1	(27.1-30.8)
Lignin	16.3	(8.8-19.1)	11.6	(9.1-15.1)	14.9	(12.2-17.6)
In vitro digestibility, %						
Dry matter	54.9	(52.2-57.1)	62.3	(60.7-63.2)	64.9	(62.1-66.0)

[1]Sampled monthly from November, 1980 to March, 1981, during the study.

Table 6: Effect of steaming-up on weight changes of ewes

	Treatments				
	A	B	C	D	
Ewes/treatment	6	6	6	6	
Concentrate/ewe, kg[1]	0	24	20	16	SEM[2]
Initial liveweight, kg	35.75	35.0	35.75	35.50	0.58
Weight gain prepartum, kg	1.17[a]	3.42[b]	1.67[a]	1.05[a]	0.21
Average daily gain (ADG), g	21.67[a]	73.90[c]	53.87[b]	45.90[b]	4.55
Liveweight of ewes, kg					
One day prepartum	36.92	38.42	37.42	36.55	0.66
One day postpartum	33.42	32.67	33.17	32.90	0.68
Weight loss at lambing, kg	3.50[a]	5.75[b]	4.25[a]	3.65[a]	0.24
Liveweight of ewes, kg					
4 weeks postpartum	29.50	31.58	30.75	30.0	0.50
8 " "	28.82	29.50	28.92	27.60	0.46
12 " "	27.83	28.47	28.0	27.30	0.11
Average daily weight loss, g					
0-4 weeks postpartum	139.88	41.67	86.31	103.57	11.92
5-8 " "	24.40	74.40	65.48	85.71	9.60
9-12 " "	35.12	36.90	32.74	10.71	8.58
Overall average daily weight loss, g	66.47	50.99	61.51	66.67	6.13
Weight loss during lactation, kg	5.58	4.28	5.17	5.60	0.55

[1]Levels used for steaming-up were apparently higher than planned due to some ewes lambing later than expected.

[2]Standard error of mean.

[abc]Means with similar superscripts within a row are not different ($P > 0.05$).

Figure 1: Liveweight of ewes steamed-up prepartum, during the twelve weeks of subsequent lactation.

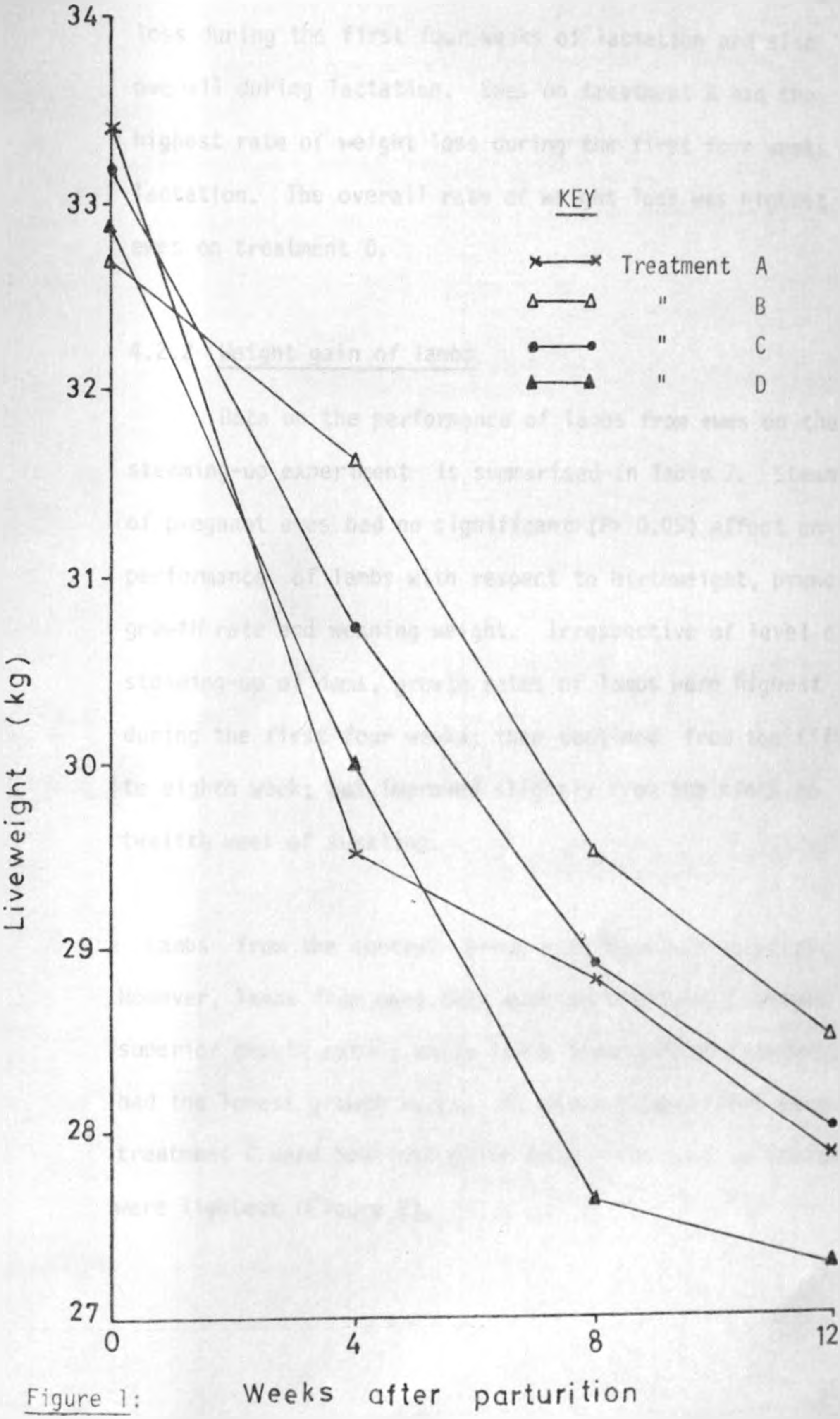

34
33
32
31
30
29
28
27
Liveweight (kg)
0
4
8
12
Weeks after parturition
KEY
Treatment A
" B
" C
" D

Figure 1:

for six weeks (treatment B) had the lowest rate of weight loss during the first four weeks of lactation and also overall during lactation. Ewes on treatment A had the highest rate of weight loss during the first four weeks of lactation. The overall rate of weight loss was highest for ewes on treatment D.

4.2.2 Weight gain of lambs

Data on the performance of lambs from ewes on the steaming-up experiment is summarised in Table 7. Steaming-up of pregnant ewes had no significant (P> 0.05) effect on the performance of lambs with respect to birthweight, preweaning growth rate and weaning weight. Irrespective of level of steaming-up of dams, growth rates of lambs were highest during the first four weeks; then declined from the fifth to eighth week; but improved slightly from the ninth to twelfth week of suckling.

Lambs from the control group were heaviest at birth. However, lambs from ewes that were on treatment C showed superior growth rates; while lambs from ewes on treatment D had the lowest growth rates. At weaning lambs from ewes on treatment C were heaviest while lambs from ewes on treatment D were lightest (Figure 2).

Table 7: Effect of steaming-up on liveweight gain of lambs

	Treatments[1]				
	A	B	C	D	
Lambs/treatment	6	6	6	6	SEM[2]
Liveweight of lambs, at birth, kg	3.20	3.02	3.03	3.04	0.08
4 weeks of age	6.28	6.20	6.48	6.0	0.19
8 " " "	7.08	6.75	7.58	6.52	0.22
12 " " "	8.02	7.65	8.77	7.30	0.26
Average daily gain (ADG), g					
0-4 weeks of suckling	110.0	113.67	123.31	105.71	5.25
5-8 " " "	28.69	20.83	39.28	18.45	3.22
9-12 " " "	33.46	33.33	43.26	28.06	3.96
Preweaning ADG, g	57.38	55.16	68.25	50.71	2.68
Weight gain between birth and weaning, kg	4.82	4.63	5.73	4.26	0.22

[1]Treatments to which dams were allocated during pregnancy.

[2]Standard error of mean.

Figure 2: Liveweight of lambs from ewes steamed-up using different levels of concentrate for varying lengths of time.

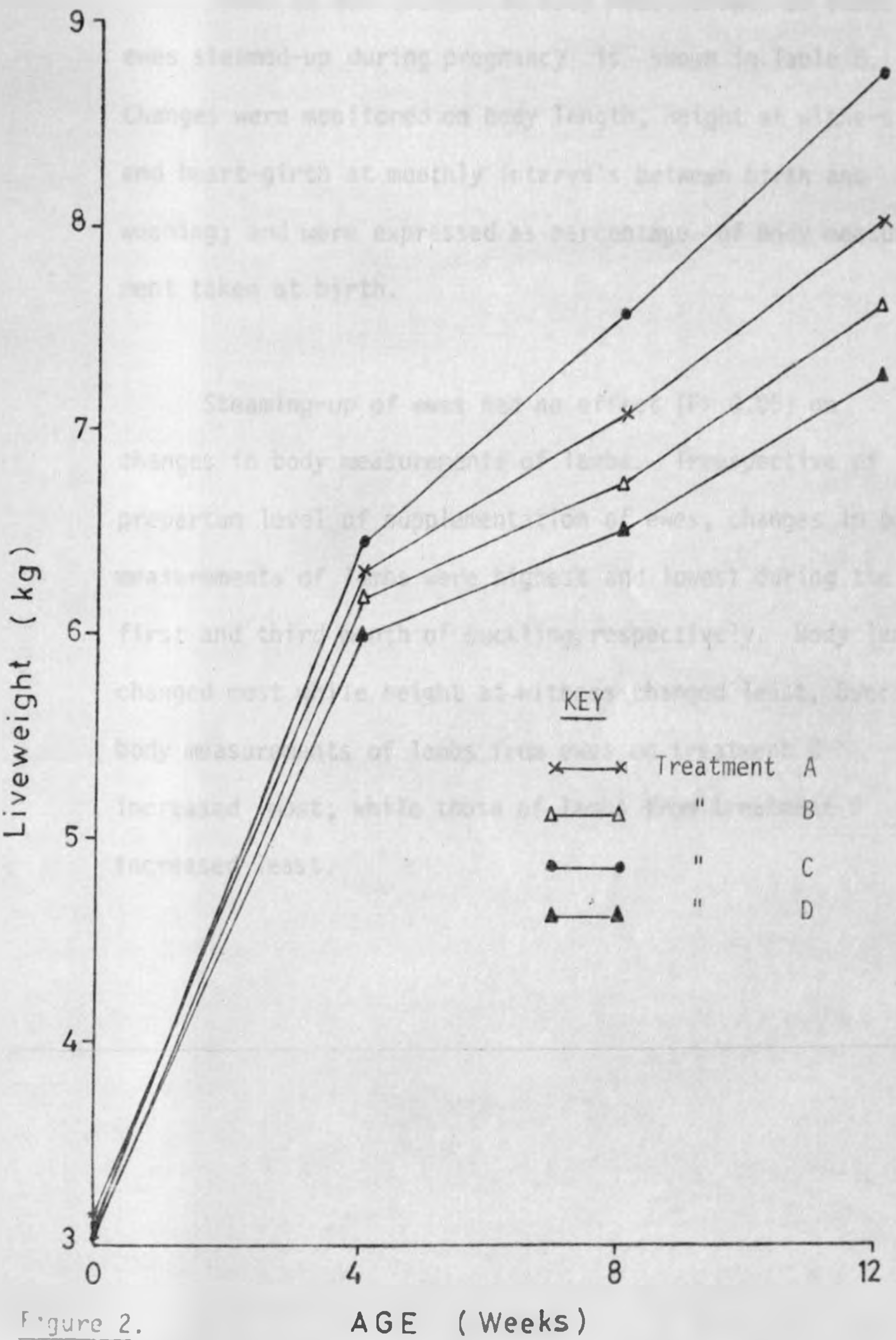


Figure 2.

4.2.3 Changes in body measurement of lambs

Data on the changes in body measurements of lambs from ewes steamed-up during pregnancy is shown in Table 8. Changes were monitored on body length, height at withers and heart-girth at monthly intervals between birth and weaning; and were expressed as percentage of body measurement taken at birth.

Steaming-up of ewes had no effect (P> 0.05) on changes in body measurements of lambs. Irrespective of prepartum level of supplementation of ewes, changes in body measurements of lambs were highest and lowest during the first and third month of suckling, respectively. Body length changed most while height at withers changed least. Overall, body measurements of lambs from ewes on treatment C increased most; while those of lambs from treatment D increased least.

Table 8: Body measurements of lambs from ewes steamed-up using different levels for various periods.

	Treatments[1]				
	A	B	C	D	
Lambs/treatment	6	6	6	6	SEM[2]
At birth (cm)					
Body length	31.2	31.2	31.3	31.0	0.19
Height at withers	37.7	37.7	37.50	37.2	0.38
Heartgirth	38.0	37.7	37.50	37.3	0.34
Increase in body length, %					
First month of suckling	21.3	20.8	21.8	21.0	0.64
Second " " "	6.9	7.5	8.5	7.0	0.55
Third " " "	1.6	1.1	1.6	1.1	0.40
Preweaning increase in body length %	29.8	29.4	31.9	29.0	0.78
Increase in height at withers,%					
First month of suckling	17.7	17.4	18.2	17.5	0.64
Second " " "	5.3	4.4	5.2	4.0	0.41
Third " " "	2.6	3.1	3.1	2.7	0.44
Pre-weaning increase in height at withers, %	25.7	24.9	26.5	24.2	0.61
Increase in heartgirth, %					
First month of suckling	16.6	17.8	18.7	17.0	0.81
Second " " "	7.1	6.1	8.0	6.2	0.37
Third " " "	3.19	3.1	4.0	2.7	0.73
Pre-weaning increase in heartgirth, %	26.8	27.0	30.7	25.9	1.19

[1]Treatments of dams pre-partum.

[2]Standard error of mean.

4.3 Experiment 2

Effect of postpartum supplementation on performance of Red Masai sheep

4.3.1 Performance of ewes

Table 9 and Figure 3 summarise the data on the performance of lactating Red Masai ewes supplemented with the following levels of concentrate: E (control, no supplementation); F (0.25 kg per ewe per day); G (0.50 kg per ewe per day); H (0.75 kg per ewe per day) throughout the twelve weeks of lactation.

Supplementation had a significant ($P< 0.05$) effect on liveweight of ewes at eight weeks postpartum; but not at four and twelve weeks. At eight weeks postpartum, ewes on the control treatment were lighter ($P< 0.05$) than the supplemented ewes. However, differences between liveweights of ewes on treatments F, G and H were not significant ($P> 0.05$).

The rate of body weight loss during lactation was not significantly ($P> 0.05$) affected by the level of supplementation. However, the rate of weight loss was highest for all ewes during the first four weeks of lactation. The rate of weight loss of supplemented ewes was lowest between the fifth and eighth week postpartum. Overall, ewes on treatment E lost weight at the highest rate whereas ewes on treatment G lost weight at the lowest rate during the twelve weeks of lactation.

Table 9: Effect of postpartum supplementation on performance of ewes

	Treatments				
	E	F	G	H	
Ewes/treatment	6	6	6	6	
Concentrate/ewe/day, kg	0	0.25	0.50	0.75	SEM[1]
Liveweight of ewes, kg					
One day postpartum	30.33	33.0	33.08	33.83	0.78
4 weeks "	27.17	30.58	31.0	32.33	0.77
8 " "	25.83[a]	30.0[b]	30.50[b]	31.75[b]	0.73
12 " "	25.25	29.0	29.92	30.25	0.80
Average daily weight loss, g					
0-4 weeks postpartum	113.09	89.31	74.40	53.57	11.50
5-8 " "	47.62	20.83	17.80	20.83	9.75
9-12 " "	20.83	23.81	20.83	53.57	8.96
Overall average daily weight loss, g	60.52	44.6	37.70	42.66	4.59
Weight loss during lactation, kg	5.08	4.5	3.7	4.3	0.38

[1]Standard error of mean

[ab]Means with similar superscripts within a row are not different (P> 0.05).

Figure 3: Liveweight of ewes supplemented during lactation using different levels of concentrate.

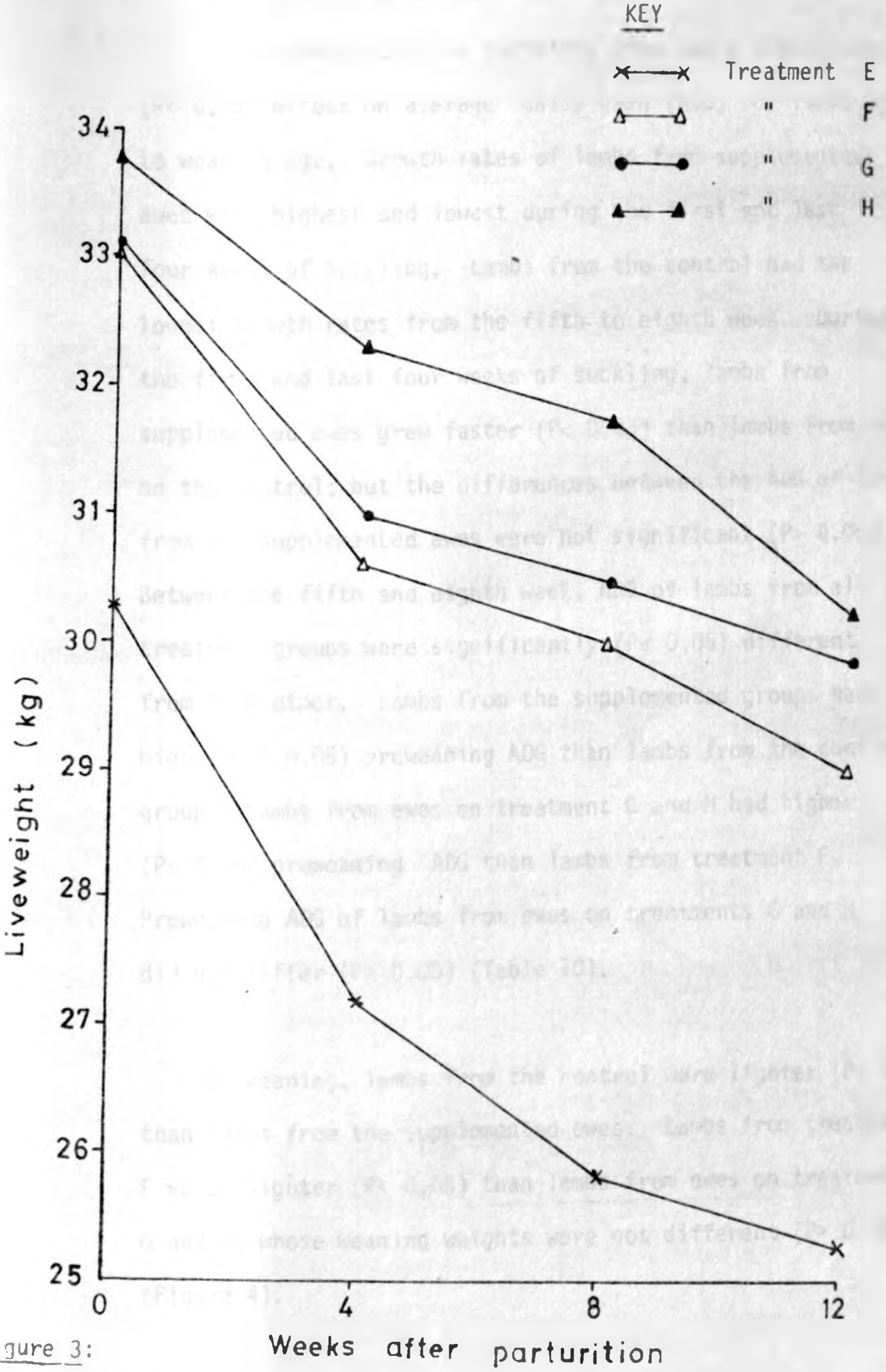

KEY
Treatment E
" F
" G
" H
34
33
32
31
30
29
28
27
26
25
Liveweight (kg)
0
4
8
12
Weeks after parturition

Figure 3:

4.3.2 Weight gain of lambs

Supplementation of lactating ewes had a significant ($P < 0.05$) effect on average daily gain (ADG) of lambs up to weaning age. Growth rates of lambs from supplemented ewes were highest and lowest during the first and last four weeks of suckling. Lambs from the control had the lowest growth rates from the fifth to eighth week. During the first and last four weeks of suckling, lambs from supplemented ewes grew faster ($P < 0.05$) than lambs from ewes on the control; but the differences between the ADG of lambs from the supplemented ewes were not significant ($P > 0.05$). Between the fifth and eighth week, ADG of lambs from all treatment groups were significantly ($P < 0.05$) different from each other. Lambs from the supplemented groups had higher ($P < 0.05$) preweaning ADG than lambs from the control group. Lambs from ewes on treatment G and H had higher ($P < 0.05$) preweaning ADG than lambs from treatment F. Preweaning ADG of lambs from ewes on treatments G and H did not differ ($P > 0.05$) (Table 10).

At weaning, lambs from the control were lighter ($P < 0.05$) than lambs from the supplemented ewes. Lambs from treatment F were lighter ($P < 0.05$) than lambs from ewes on treatments G and H, whose weaning weights were not different ($P > 0.05$) (Figure 4).

Table 10: Effect of postpartum supplementation of ewes on weight gain of lambs

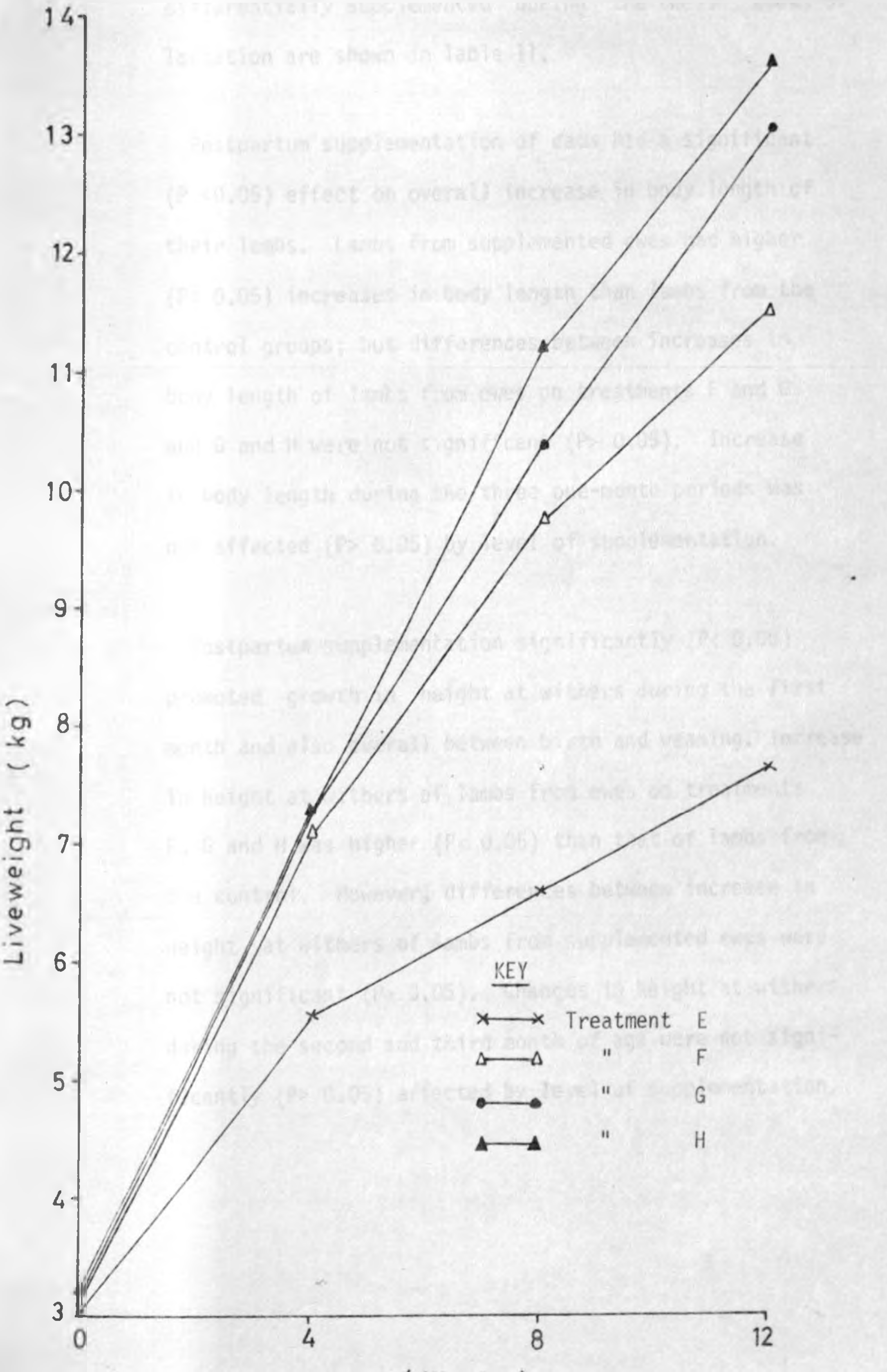
	Treatments[1]				
	E	F	G	H	
Lambs/treatment	6	6	6	6	SEM[2]
Liveweight of lambs, kg					
At birth	3.0	3.12	3.17	3.17	0.06
4 weeks of age	5.58[a]	7.12[b]	7.30[b]	7.30[b]	0.15
8 " " "	6.58[a]	9.75[b]	10.37[b]	11.23[c]	0.21
12 " " "	7.68[a]	11.75[b]	13.07[c]	13.67[c]	0.28
Average daily gains (ADG), g					
0-4 weeks of suckling	92.14[a]	142.86[b]	147.50[b]	147.52[b]	4.10
5-8 " " "	35.71[a]	93.93[b]	109.64[c]	140.36[d]	3.57
9-12 " " "	39.29[a]	71.43[b]	96.43[b]	87.14[b]	6.62
Pre-weaning ADG, g	55.71[a]	102.74[b]	117.86[c]	124.95[c]	3.06
Weight gain between birth and weaning, kg	4.68[a]	8.63[b]	9.90[c]	10.50[c]	0.26

[1]Treatments to which the dams were subjected.

[2]Standard error of mean

[abcd]Means with similar superscripts within a row are not different (P> 0.05).

Figure 4: Liveweight of lambs from ewes supplemented during lactation using different levels of concentrate.


Liveweight (kg)
14
13
12
11
10
9
8
7
6
5
4
3
0
4
8
12
KEY
Treatment E
" F
" G
" H

4.3.3 Changes in body measurements of lambs

Body measurements of lambs from ewes that were differentially supplemented during the twelve weeks of lactation are shown in Table 11.

Postpartum supplementation of dams had a significant (P <0.05) effect on overall increase in body length of their lambs. Lambs from supplemented ewes had higher (P< 0.05) increases in body length than lambs from the control groups; but differences between increases in body length of lambs from ewes on treatments F and G and G and H were not significant (P> 0.05). Increase in body length during the three one-month periods was not affected (P> 0.05) by level of supplementation.

Postpartum supplementation significantly (P< 0.05) promoted growth in height at withers during the first month and also overall between birth and weaning. Increase in height at withers of lambs from ewes on treatments F, G and H was higher (P< 0.05) than that of lambs from the control. However, differences between increase in height at withers of lambs from supplemented ewes were not significant (P> 0.05). Changes in height at withers during the second and third month of age were not significantly (P> 0.05) affected by level of supplementation.

Table 11: Body measurements of lambs from ewes supplemented during lactation using different levels of concentrate

	Treatments[1]				
	E	F	G	H	
Lambs/treatment	6	6	6	6	SEM[2]
At birth (cm)					
Body length	31.2	31.3	31.7	31.3	0.16
Height at withers	37.0	37.3	37.8	37.8	0.26
Heartgirth	37.0	37.3	37.7	37.5	0.35
Increase in body length, %					
First month of suckling	20.8	23.4	23.1	25.0	0.63
Second " " "	5.4	6.4	7.9	8.0	0.84
Third " " "	1.1	2.6	2.6	2.6	0.49
Preweaning increase in body length, %	27.2[a]	32.5[b]	33.7[bc]	35.7[c]	1.02
Increase in height at withers, %					
First month of suckling	16.4[a]	22.3[b]	22.7[b]	22.9[b]	0.87
Second " " "	6.8	9.9	11.1	12.3	0.85
Third " " "	2.7	3.1	3.6	4.8	0.47
Preweaning increase in height at withers, %	25.9[a]	39.3[b]	38.0[b]	40.1[b]	1.45
Increase in heartgirth, %					
First month of suckling	17.6[a]	24.1[b]	25.2[b]	26.2[b]	0.97
Second " " "	8.1[a]	13.8[b]	13.7[b]	14.2[b]	0.79
Third " " "	3.6	6.7	7.1	8.9	0.71
Preweaning increase in heartgirth, %	27.6[a]	40.3[b]	45.9[c]	49.4[c]	1.45

[1]Treatments of dams during lactation

[2]Standard error of mean

[abc]Means with similar superscripts within a row are not different (P> 0.05).

Increase in heartgirth of lambs during the first and second months of suckling and overall between birth and weaning were significantly ($P < 0.05$) affected by post-partum supplementation of ewes. During the first and second month of suckling, lambs from the control had lower ($P < 0.05$) change in heartgirth than lambs from the supplemented ewes, whose changes were not significantly ($P > 0.05$) different from each other. At weaning, lambs from the control group also had smaller ($P < 0.05$) heartgirths than lambs from supplemented ewes. Lambs from ewes on treatment F had small ($P < 0.05$) heartgirths than lambs from ewes on treatments G and H whose heartgirths were not different ($P > 0.05$). Level of supplementation had no effect ($P > 0.05$) on the change in heartgirth of lambs during the third month of suckling.

4.4 Effect of steaming-up on performance of Small East African goats

4.4.1 Performance of does

Table 12 and Figure 5 summarise the data on ~~the~~ performance of Small East African does steamed-up using the following treatments: A (control, no steaming-up); B (18 kg per doe for six weeks); C (14.75 kg per doe for four weeks); D (11.75 kg per doe for two weeks).

Steaming-up had no significant (P> 0.05) effect on either the average daily gain (ADG) prepartum or weight loss at kidding. However, does on treatment B had the highest ADG and also lost most weight at kidding, while does on the control had lowest ADG. Does on treatment D lost least weight at kidding.

Steaming-up had no significant (P >0.05) effect on weight change of does postpartum. During the first four weeks of lactation, does on treatment B lost weight at the lowest rate while does on treatments A and C lost weight at the highest rate.

Does that were on treatment A had the highest overall rate of weight loss during lactation while does that were on treatment D had the lowest rate.

Table 12: Effect of steaming-up on weight changes of does

	Treatments A	B	C	D	
Does/treatment	4	4	4	4	
Concentrate/doe, kg[1]	0	18	14.75	11.75	SEM[2]
Initial liveweight, kg	29.50	34.0	31.12	27.75	1.27
Average daily gain (ADG), g	28.43	47.41	30.98	30.11	2.68
Liveweight of does, kg					
One day prepartum	30.62	35.75	31.87	28.25	1.28
One day postpartum	27.50	31.12	28.25	25.50	1.09
Weight loss at kidding, kg	3.12	4.63	3.63	2.75	0.29
Liveweight of does, kg					
4 weeks postpartum	25.74	30.0	26.50	24.25	0.85
8 " "	24.25	28.62	25.25	23.62	0.81
12 " "	23.50	28.25	24.62	23.37	0.75
Average daily weight loss, g					
0-4 weeks postpartum	62.50	40.18	62.54	44.64	13.50
5-8 " "	53.57	49.18	44.64	22.32	7.35
9-12 " "	26.78	13.39	22.32	26.78	5.98
Overall average daily weight loss, g	47.62	34.23	43.15	25.30	5.84
Weight loss during lactation, kg	4.0	2.87	3.63	2.13	0.49

[1]Levels used for steaming-up were generally lower than the calculated values because most does kidded earlier than expected.

[2]Standard error of mean.

Figure 5: Liveweight of does steamed-up prepartum, during the twelve weeks of subsequent lactation.

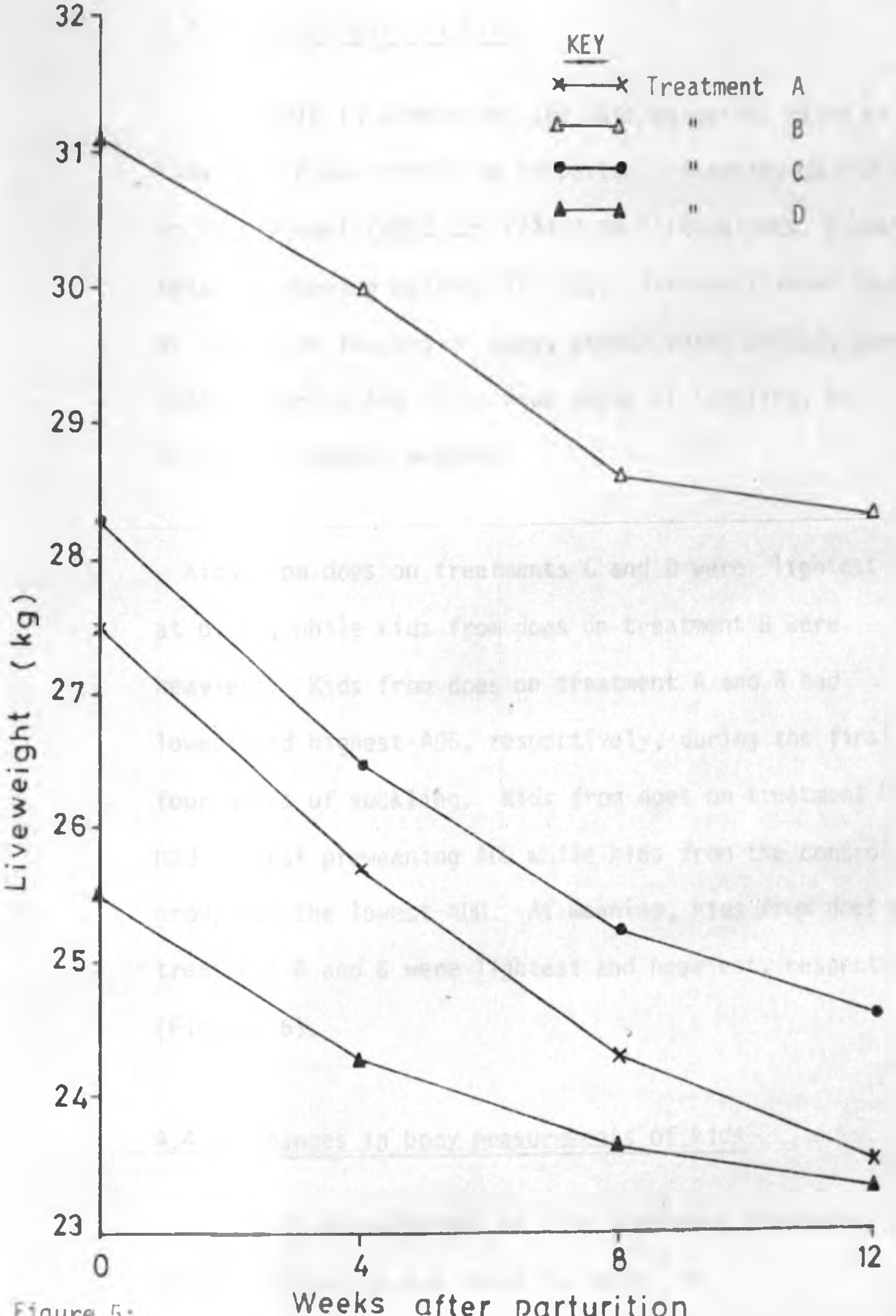

KEY
Treatment A
" B
" C
" D
Liveweight (kg)
Weeks after parturition
32
31
30
29
28
27
26
25
24
23
0
4
8
12

Figure 5:

4.4.5 Weight gain of kids

Table 13 summarises the data on weight gains of kids from does steamed-up prepartum. Steaming-up had no significant ($P > 0.05$) effect on birthweights, growth rate and weaning weights of kids. Irrespective of level of prepartum feeding of dams, growth rates of kids were highest during the first four weeks of suckling; but slackened towards weaning.

Kids from does on treatments C and D were lightest at birth, while kids from does on treatment B were heaviest. Kids from does on treatment A and B had lowest and highest ADG, respectively, during the first four weeks of suckling. Kids from does on treatment B had highest preweaning ADG while kids from the control group had the lowest ADG. At weaning, kids from does on treatment A and B were lightest and heaviest, respectively (Figure 6).

4.4.3 Changes in body measurements of kids

Body measurements of kids from does steamed-up during pregnancy are shown in Table 14.

Steaming-up of does had no significant ($P > 0.05$) effect on increase in body measurements of kids. Irrespective of level of steaming-up, increases in body

Table 13: Effect of steaming-up on liveweight gain of kids

	Treatments[1]				
	A	B	C	D	
Kids/treatment	4	4	4	4	SEM[2]
Liveweight of kids, kg					
At birth	2.4	2.45	2.37	2.37	0.10
4 weeks of age	4.3	4.72	4.65	4.52	0.13
8 " " "	5.12	5.80	5.60	5.30	0.13
12 " " "	5.77	6.35	6.20	5.85	0.15
Average daily gain, g					
0-4 weeks of suckling	67.86	83.93	81.25	76.76	2.88
5-8 " " "	29.46	35.71	33.93	27.68	2.35
9-12 " " "	18.75	17.86	21.43	19.64	2.41
Overall ADG between birth and weaning, g	40.18	46.43	45.54	41.37	1.19
Weight gain, birth to weaning, kg	3.37	3.90	3.82	3.47	0.09

[1]Treatments to which dams were allocated during pregnancy.

[2]Standard error of mean.

Figure 6: Liveweight of kids from does steamed-up prepartum using different levels of concentrate for varying lengths of time.

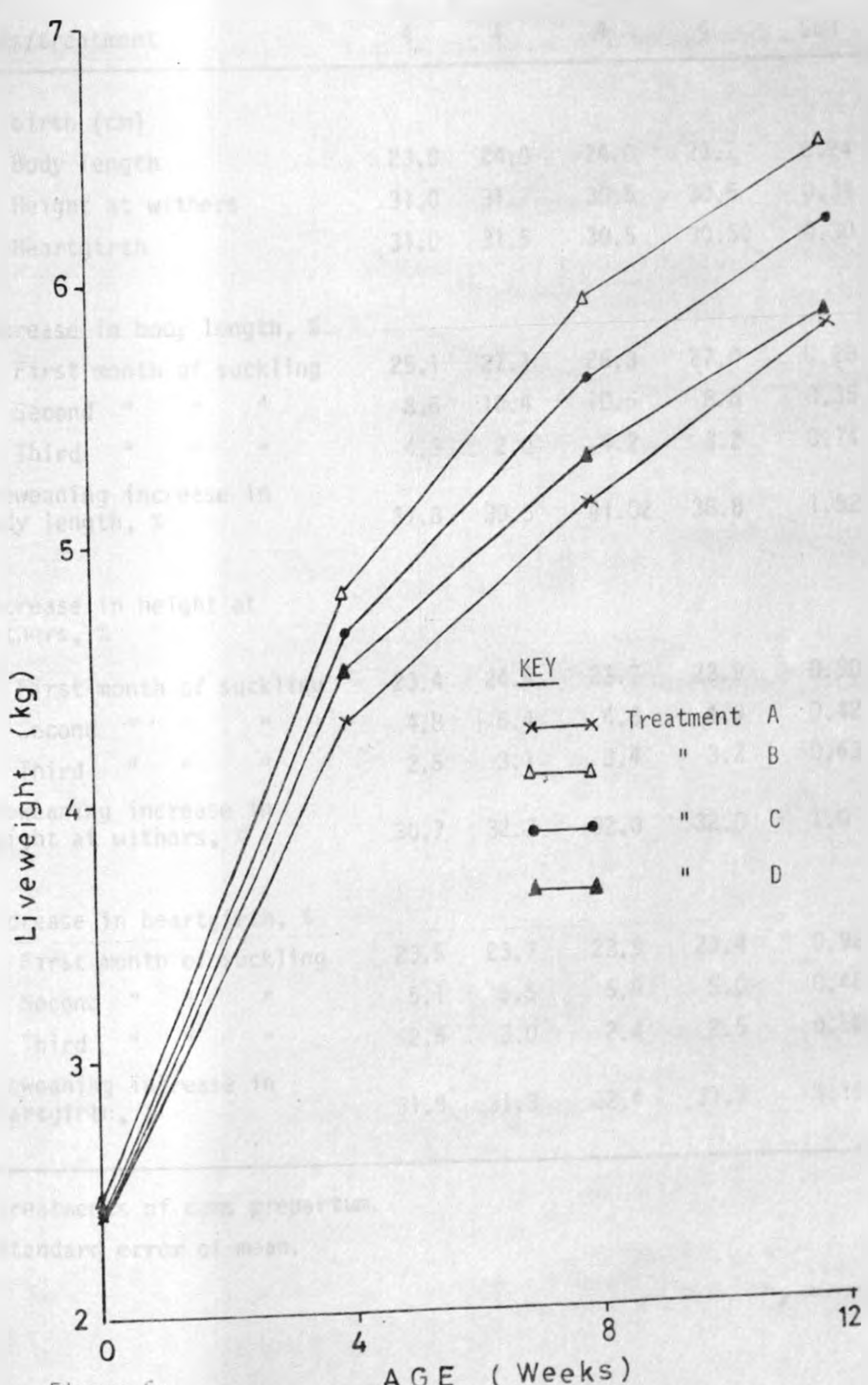


Figure 6:

Table 14: Body measurements of kids from does steamed-up using different levels of concentrate for various periods

	Treatments[1]				
	A	B	C	D	
Kids/treatment	4	4	4	4	SEM[2]
At birth (cm)					
Body length	23.0	24.0	24.0	23.2	0.24
Height at withers	31.0	31.7	30.5	30.5	0.34
Heartgirth	31.0	31.5	30.5	30.50	0.30
Increase in body length, %					
First month of suckling	25.1	27.1	26.3	27.0	0.28
Second " " "	8.6	10.4	10.5	8.6	0.35
Third " " "	4.3	2.0	4.2	3.2	0.74
Preweaning increase in body length, %	37.8	39.5	41.02	38.8	1.52
Increase in height at withers, %					
First month of suckling	23.4	24.4	23.7	23.9	0.90
Second " " "	4.8	5.4	4.8	4.9	0.42
Third " " "	2.5	3.1	3.4	3.2	0.63
Preweaning increase in height at withers, %	30.7	32.7	32.0	32.0	1.0
Increase in heartgirth, %					
First month of suckling	23.5	23.7	23.9	23.4	0.96
Second " " "	5.1	5.5	5.9	5.0	0.48
Third " " "	2.5	3.0	2.4	2.5	0.58
Preweaning increase in heartgirth, %	31.9	31.3	32.4	31.7	1.19

[1]Treatments of dams prepartum.

[2]Standard error of mean.

measurements of kids were highest during the first month and lowest during the third month of suckling. Highest changes were observed on body length while changes in height at withers and heartgirth were almost similar. Overall, kids from the control group had the lowest increase in body length; while kids from does on treatment C had highest increase in body length. Kids from does on treatment C and D had the biggest and smallest increase in heartgirth, respectively.

4.5 Effect of postpartum supplementation on performance of Small East African goats

4.5.1 Performance of does

Data on the performance of does supplemented during a twelve-week lactation period using the following levels of concentrate: 0, 0.25; 0.50 and 0.75 kg per doe per day is shown in Table 15 and Figure 7.

Postpartum supplementation of does had no significant (P> 0.05) effect on weight changes of lactating does. Irrespective of level of postpartum supplementation weight loss was highest and lowest during the first and last four weeks of lactation, respectively. Overall, does on treatment E had the highest rate of weight loss while does on treatment F and H had the lowest rate of weight loss.

4.5.2 Weight gain of kids

Supplementation of lactating does had a significant (P< 0.05) effect on average daily gain (ADG) of kids up to four weeks of age (Table 16). Average daily gains of kids from all treatment groups were significantly (P< 0.05) different from each other during the same period. Growth rates of kids were not affected (P> 0.05) by level of supplementation of does after the fourth week of age.

Table 15: Effect of postpartum supplementation on performance of does

	Treatments				
	E	F	G	H	
Does/treatment	3	3	3	3	
Concentrate/doe/day, kg	0	0.25	0.50	0.75	SEM[1]
Liveweight of does, kg					
One day postpartum	29.17	27.30	29.67	30.83	0.52
4 weeks "	26.83	26.17	27.83	29.50	0.41
8 " "	26.33	25.67	27.33	29.17	0.51
12 " "	25.83	25.50	27.0	29.0	0.52
Average daily weight loss, g					
0-4 weeks postpartum	83.33	41.67	65.48	47.62	6.57
5-8 " "	17.86	17.86	17.86	11.90	5.95
9-12 " "	17.86	5.95	11.90	5.95	4.04
Overall average daily weight loss, g	39.68	21.82	31.75	21.82	2.48
Weight loss during lactation, kg	3.33	1.83	2.67	1.83	0.21

[1]Standard error of mean.

Figure 7: Liveweight of does supplemented during lactation using different levels of concentrate.

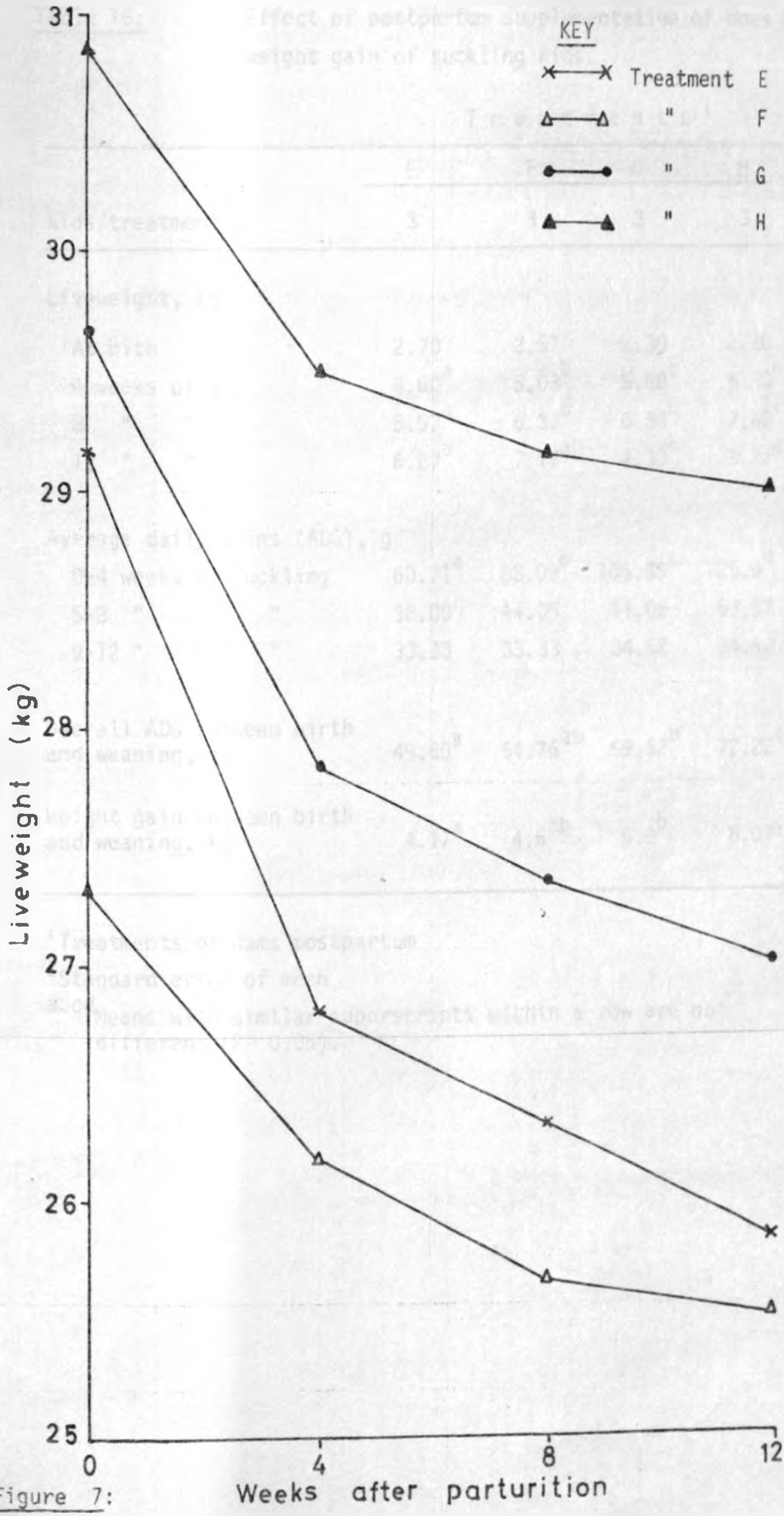

KEY
Treatment E
" F
" G
" H
31
30
29
28
27
26
25
Liveweight (kg)
0
4
8
12
Weeks after parturition

Figure 7:

Table 16: Effect of postpartum supplementation of does on weight gain of suckling kids.

	Treatments[1]				
	E	F	G	H	
Kids/treatment	3	3	3	3	SEM[2]
Liveweight, kg					
At bith	2.70	2.57	2.30	2.20	0.09
4 weeks of age	4.60[a]	5.03[b]	5.60[c]	5.90[c]	0.11
8 " " "	5.57[a]	6.33[b]	6.50[b]	7.40[c]	0.13
12 " " "	6.87[a]	7.17[ab]	7.30[b]	8.27[c]	0.11
Average daily gains (ADG), g					
0-4 weeks of suckling	60.71[a]	88.09[b]	105.95[c]	125.0[d]	2.85
5-8 " " "	38.09	44.05	44.05	53.57	3.65
9-12 " " "	33.33	33.33	34.52	34.52	3.19
Overall ADG between birth and weaning, g	49.60[a]	54.76[ab]	59.52[b]	72.22[c]	1.89
Weight gain between birth and weaning, kg	4.17[a]	4.6[ab]	5.0[b]	6.07[c]	0.17

[1]Treatments of dams postpartum

[2]Standard error of mean

[abcd]Means with similar superscripts within a row are not different ($P > 0.05$).

However, kids from treatment group H had the highest ADG between the fifth and eighth week of suckling, while kids from the control group had the lowest ADG. Between the ninth and twelfth week kids from treatment groups E and F; and G and H had similar ADG. Kids from does on treatments, E, F and G had lower ($P < 0.05$) preweaning ADG and weaning weights than kids from does on treatment H (Figure 8). However, preweaning ADG and weaning weights of kids from does on treatments E and F and F and G were not different ($P > 0.05$).

4.5.3 Changes in body measurements of kids

Body measurements of kids from does supplemented during lactation is shown in Table 17.

Postpartum supplementation of lactating does had a significant ($P < 0.05$) effect on changes in heartgirth of kids during the first month and between birth and three months of suckling. During the first month, increase in heartgirth of kids from all treatments groups were significantly ($P < 0.05$) different from each other. Kids from supplemented does had higher ($P < 0.05$) overall increase in heartgirth than kids from the control group. However, differences between increases in heartgirth of kids from does on treatments F and G; and G and H were not significant ($P > 0.05$).

Figure 8: Liveweight of kids from does supplemented during lactation using different levels of concentrate.

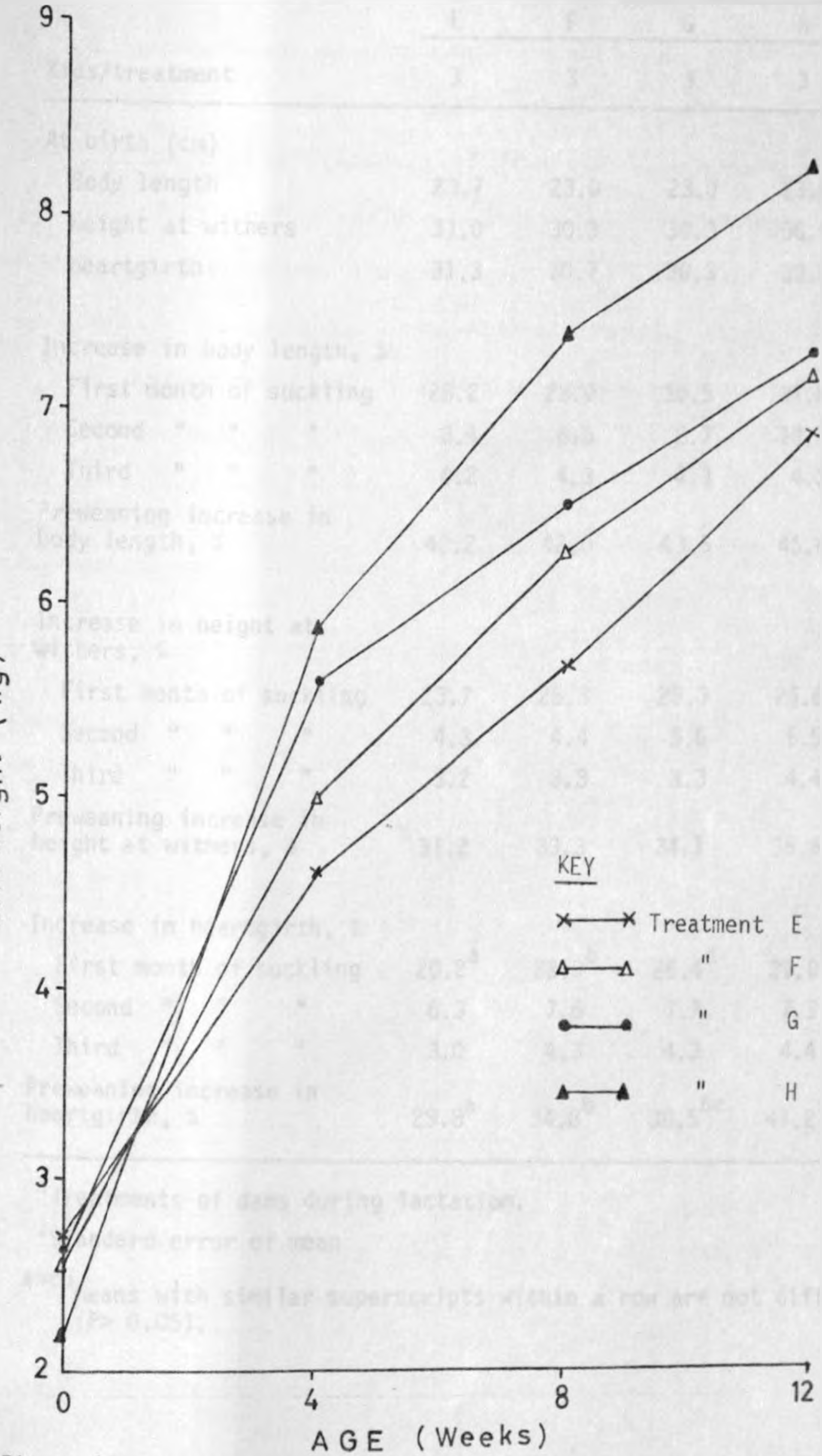


Figure 8:

Table 17: Body measurements of kids from does differentially supplemented during lactation

	Treatments[1]				
	E	F	G	H	
Kids/treatment	3	3	3	3	SEM[2]
At birth (cm)					
Body length	23.7	23.0	23.0	23.0	0.74
Height at withers	31.0	30.3	30.3	30.0	0.30
Heartgirth	31.3	30.7	30.3	30.0	0.43
Increase in body length, %					
First month of suckling	28.2	29.0	30.5	31.8	0.64
Second " " "	8.4	8.6	8.7	10.2	0.95
Third " " "	4.2	4.3	4.3	4.3	0.05
Preweaning increase in body length, %	40.2	42.0	43.5	46.4	0.73
Increase in height at withers, %					
First month of suckling	23.7	25.3	25.3	25.6	0.39
Second " " "	4.3	4.4	5.6	5.5	0.56
Third " " "	3.2	3.3	3.3	4.4	0.28
Preweaning increase in height at withers, %	31.2	33.3	34.1	35.6	0.67
Increase in heartgirth, %					
First month of suckling	20.2^{a}	22.9^{b}	26.4^{c}	29.0^{d}	0.67
Second " " "	6.3	7.6	7.7	7.9	0.72
Third " " "	3.0	4.3	4.3	4.4	0.80
Preweaning increase in heartgirth, %	29.8^{a}	34.8^{b}	38.5^{bc}	41.2^{c}	1.36

[1]Treatments of dams during lactation.

[2]Standard error of mean

[abcd]Means with similar superscripts within a row are not different ($P > 0.05$).

Postpartum supplementation had no significant (P> 0.05) effect on increase in either body length or height at withers. Irrespective of level of postpartum supplementation of dams, greatest changes were observed during the first month of suckling on all body measurements for all kids; while least increases were realised in the third month. Increase in body length was greatest, while that in height at withers was least. Overall, kids from does on treatment H had highest increases in all body measurements whereas kids from the control had lowest increases in all body measurements.

4.6 Simple correlations relating bodyweight (kg) heartgirth, height at withers and body length (cm) of growing lambs and kids at various stages of growth

Simple correlations relating bodyweight, heartgirth, height at withers and body length of growing lambs and kids throughout the suckling period are shown in Tables 18 and 19, respectively.

All correlations relating bodyweight to body measurements of lambs and kids were high and significant ($P < 0.01$). Body development parameters were highly ($P < 0.01$) correlated to each other.

Correlations relating bodyweight to other body measurements at various stages of growth were high and significant ($P < 0.01$). At any one stage of growth, heartgirth was highly correlated to body weight (Tables 20 and 21). Correlation coefficients tended to improve towards weaning age. Between birth and weaning correlation coefficients between liveweight and heartgirth increased from 0.82 to 0.88; and from 0.68 to 0.71 for lambs and kids, respectively. Correlation coefficients of liveweight and height at withers; and liveweight and body length varied from 0.71 to 0.84 and 0.62 to 0.79, respectively, for lambs. For kids correlation coefficients of liveweight and height at withers varied from 0.65 to 0.67; whereas that of liveweight and bodylength increased from 0.58 to 0.62 during the same period.

Table 18: Simple correlations relating body weight (kg) heartgirth, height at withers and body length (cm) of growing lambs

Parameters	BWT	HG	HW	BL
Body weight (BWT)	1.0			
Heartgirth (HG)	0.97**	1.0		
Height at withers (HW)	0.94**	0.96**	1.0	
Body length (BL)	0.91**	0.94**	0.93**	1.0

**P< 0.01.

Table 19: Simple correlations relating body weight (kg), heartgirth, height at withers and body length (cm) of growing kids

Parameters	BWT	HG	HW	BL
Body weight (BWT)	1.0			
Heartgirth (HG)	0.96**	1.0		
Height at withers (HW)	0.95**	0.96**	1.0	
Body length (BL)	0.91**	0.96**	0.95**	1.0

**P < 0.01.

Table 20: Simple correlations relating body weight (kg) to heartgirth, height at withers and body length (cm) of lambs at various stages of growth.

Stage of growth (in weeks)	At birth	4 weeks	8 weeks	12 weeks
Heartgirth	0.82**	0.86**	0.87**	0.88**
Height at withers	0.71**	0.82**	0.82**	0.84**
Body length	0.62**	0.67**	0.69**	0.79**

** $P < 0.01$.

Table 21: Simple correlations relating body weight (kg) heartgirth, height at withers and body length (cm) of kids at various stages of growth.

Stage of growth (in weeks)	At birth	4 weeks	8 weeks	12 weeks
Heartgirth	0.68**	0.70**	0.71**	0.71**
Height at withers	0.65**	0.65**	0.66**	0.67**
Body length	0.58**	0.62**	0.62**	0.62**

**P< 0.01.

5. DISCUSSION

Steaming-up increased weight gain of ewes significantly but had no effect on weight gain of does prepartum. Increased weight gain prepartum due to steaming-up of ewes was consistent with the findings of Wallace (1948); Thomson and Thomson (1949); Coop (1950); Papadopoulos and Robinson (1957); Peart (1967); Butterworth and Blore (1969); Black et al. (1979). Pregnant ewes on the highest plane of nutrition gained most weight prepartum. Tisser, Theriez Molenat (1976) feeding Limousin ewes six weeks prepartum on a basal diet of hay and soybean meal plus silage ad libitum showed that ewes consuming maximum amounts of silage gained most weight. It is, therefore, probable in this study that feeding ewes on high amounts of concentrate improved utilisation of the low quality forage grazed through increased digestibility and higher voluntary intake by the pregnant ewes (Blaxter, Wainman and Wilson, 1961; Elliott 1967b) which was reflected in higher weight gains.

Ewes on the control gained least weight prepartum. This could have been due to low quality pasture grazed which contained 2.8-3.8% crude protein. Crude protein content of pasture has been shown to be a critical factor controlling dry matter intake (Bredon and Horrell, 1962; Butterworth, 1961; 1965; Abate, 1978). Levels of dietary crude protein below 10% have been shown to limit intake of tropical grasses (Elliott, 1967a). It has also been shown (Holmes and Jones, 1965) that when digestibility of organic matter of pasture was below 70%, feed quality restricted intake by grazing animal. Mugerwa, Christensen and Ochetim (1973) asserted that when digestibility coefficients of dry matter were below 66%, intake of tropical forages by grazing animals was limited. In this study, digestibility of pasture varied from 25.1 to 33.0%, which might have restricted intake and hence the poor performance of ewes on the control.

Does in this study showed no significant weight gain prepartum due to steaming-up; possibly due to a higher quality diet consumed by these animals. Although the quality of the Themeda triandra pasture grazed was low (2.8-3.8% crude protein and 25.1-33.0% digestible), goats browsed high quality shrubs containing 15.0-19.1% crude protein and were 52.2-66.0% digestible. The high quality browse might have increased pasture utilization hence the similarity in weight gain of all does.

All ewes and does lost weight at parturition. However, ewes that had been subjected to the highest level of prepartum feeding lost most weight. Shevah, Black and Land (1975) reported that pregnant Finn x Dorset ewes steamed-up for six weeks lost weight at lambing. The difference in weight loss between this study and that of Shevah et al.

(1975) could be attributed to breed differences. In addition to the weight of the lamb at birth, weight loss at lambing has been attributed to foetal fluids and membranes which are breed specific (Tribe and Coles, 1966). However, weight loss due to foetal fluids and membranes was not investigated in this study.

Although ewes and does that were steamed-up lost relatively less weight during the entire lactation than those on the control the difference was not significant. McArthur (1980) also observed that full supplementation of pregnant Gaddic ewes prior to lambing reduced weight loss during lactation but the effect was non-significant. When Doreset Horn ewes were fed to make 16 and 6% liveweight gain during the last six weeks of pregnancy, weight changes during lactation were not significantly different (Treacher, 1971). Gonzalez, et al. (1980) reported that liveweight of ewes during lactation were not significantly affected by prepartum level of protein intake.

The highest weight loss occurred during the first four weeks of postpartum for all ewes and does. High weight loss during the first few weeks of lactation has been reported in other studies. Butterworth and Blore (1969) observed that Persian Blackhead ewes steamed-up lost 6.9 to 8.6 kg during the first four weeks and 2.9 to 3.7 kg between the fourth and twelveth week postpartum. In early lactation milk synthesis and production often exceeds appetite (Jordan and Hanke, 1977). This may explain the observed high loss of weight by ewes and does in early lactation.

Steaming-up of pregnant ewes and does had no effect on birthweight of lambs and kids. This finding for sheep was consistent with numerous reports (Coop, 1950; Papadopoulos and Robinson, 1957; Treacher, 1971; Louca et al. 1974; Shevah et al. 1975; McArthur, 1980). However, Wallace (1948); Thomson and Thomson (1949); Adu and Olaloku (1979) using higher planes of nutrition and/or supplementing ewes for longer periods reported that steaming-up had significant influence on lamb birthweights.

Growth rates of lambs and kids were not different between prepartum levels of supplementation of dams. Earlier reports by Coop (1950); Papadopoulos and Robinson (1957); Peart (1967); Maxwell et al. (1979) showed similar findings. This observation, however, contradicted that of Robinson and Forbes (1968); Butterworth and Blore (1969) who reported differences in growth rates of lambs from ewes fed at different planes of nutrition prepartum. Since birthweights of lambs were not different this could have caused, in part, the similar pre-weaning weight gains. Bush and Lewis (1977) reported that birthweights accounted for 20% of the variability in the rate of weight gain of lambs. Other studies on cattle (Singh, Scalles, Smith, and Kessler, 1970; Winks, O'Rourke, Venamore and Tyler, 1978) suggested that birth weights significantly influenced preweaning growth rates of calves.

Steaming-up had no effect on weaning weights of lambs and kids. This concurred with the findings of Sheehan and Lawlor (1972); McArthur (1980) working on sheep. However, Butterworth and Blore (1969) indicated that prepartum level of feeding of ewes affected liveweights of lambs at twelve weeks of age. Liveweights of lambs at any age depended, partly, on their birthweights and growth rates (Spedding, 1970; Bush and Lewis, 1977). This study showed that birthweight and growth rate of lambs and kids were not affected by prepartum supplementation of dams which might have caused similarity in weaning weights.

All ewes and does supplemented postpartum lost most weight during the first four weeks of lactation as had been earlier reported by Thomson and Thomson (1953), Maule and Young (1961) and Jordan and Hanke (1977). However, the overall weight changes of all ewes and does during the twelve weeks of lactation were not significantly different. Barnicoat, Logan and Grant (1949) and Coop (1950) showed that ewes on a high plane of postpartum feeding lost significantly less weight than ewes on a low plane. Supplementary concentrate given to the ewes and does in this study might have been used for milk production and not for weight gain. Langlands (1977) found that the efficiency with which Merino ewes utilized metabolizable energy for milk production and weight gain was 66 and 57%, respectively. Corresponding values for Greyface ewes were 59 and 53%, respectively (Maxwell et al. 1979).

Unlike in kids, growth rates of lambs from supplemented ewes were not different during the first four weeks of suckling. However, between the fifth and eighth week of suckling, ADG of lambs from all treatment groups were different from each other. Barnicoat *et al*. (1949) noted that during the first few weeks of birth the correlation coefficients between milk consumed and gain in liveweight were irregular because both ewes and lambs were in the process of settling down to the imposed experimental conditions. Wallace (1948) reported that only about 38% of total milk yield was produced by ewes in the first month of lactation. Tribe and Coles (1966) asserted that during the first three weeks of suckling, all lambs consumed roughly the same amounts of milk which would explain the similarity in weight gain reported in this study for the first four weeks.

Growth rates of kids were all significantly different from each other during the first four weeks of suckling. Unlike lambs, kids may have adjusted fast to the environment (Barnicoat, *et al*. 1949). Therefore they may have been able to suckle most of the milk produced by the dams. Since the dams were supplemented at different levels their milk production must have been different; hence the observed differences in growth rates of their kids. Maule and Young (1961) showed similar response in growth rates of lambs from Merino ewes subjected to different planes of nutrition during lactation.

A summplementation level of 0.25 kg concentrate per ewe per day promoted similar growth rates of lambs as supplementation levels of 0.50 and 0.75 kg concentrate per ewe per day during the first four weeks of suckling. However, higher levels (0.50 and 0.75 kg concentrate per ewe per day) of supplementation were required between the fifth and eighth week of lactation for sustained growth of lambs. Other workers have reported similar findings. Moule and Young (1961) noted that milk production of ewes that were inadequately fed during the whole or later part of lactation was rapidly reduced; and the duration of lactation was shortened. Peart (1970) observed that restricted feeding of ewes in early lactation followed by *ad libitum* feeding did not improve milk production of ewes. When Jordan and Hanke (1977) reduced the energy intake of ewes in late lactation, growth of their lambs was slackened. The observed low growth rates of lambs from ewes supplemented at a rate of 0.25 kg per day during the late stages of lactation, might have been due to similar phenomenon. The low level of supplementation might have been inadequate for stimulating energy intake required for high milk production and sustained lactation.

From the results of this study, it appears, therefore, that for a sustained high milk production ewes should be supplemented with high (0.50 kg concentrate per ewe per day) level of concentrate throughout lactation.

Growth rates of kids were not affected by level of supplementation of dams between the fifth and eighth week postpartum. It has been observed that Small East African goats are poor milkers (Devendra, 1978). Therefore, kids might have depended more on grazing and browsing after the fourth week of age than on milk produced by dams.

Between the ninth and twelfth week of age, growth rates were lowest probably because lambs obtained most of their sustenance from grass due to reduced milk production of dams (Barnicoat et al. 1949).

Overall preweaning growth rates of lambs from supplemented ewes were higher than those of lambs from unsupplemented ewes. This finding concurred with that of Coop (1950) and Papadopoulos and Robinson (1957). High postpartum plane of feeding of ewes might have enhanced milk production which was reflected in superior growth rates of lambs. This was observed in earlier studies (Wallace 1948; Barnicoat et al. 1949; Coop, 1950 and Maule and Young, 1961). Kids from does supplemented with 0.75 kg concentrate per doe per day had the highest preweaning growth rates. Their preweaning growth rate of 72.22 g per day, was similar to the recorded 72.0 g per day, in Kenya (Sheep and Goat Development Project, 1975a). It would appear that a supplementary level of 0.75 kg concentrate per doe per day is necessary to enhance goat productivity in range areas of Kenya. However, there is need to do a cost-benefit analysis.

similar trends. Wanderstock and Salisbury (1946); Mannin and Williams (1950) and Ross (1958) concluded that the most significant single measure for estimating weight in beef cattle was heartgirth. Branton and Salisbary (1946) studied the relationship between heartgirth measurements and body weight of Holstein and Guernsey bulls. Correlation coefficients between heartgirth and body weight were 0.98, 0.95 and 0.96 for all bulls, Holstein and Guernsey bull, respectively. Bonsma and Neser (1951) found that the correlation between chestgirth and weight was 0.95 for bush veld cattle.

6. CONCLUSIONS

Within the limits of the experimental conditions and procedures employed, the results of this study lead to the following conclusions:-

1. Steaming-up increased ($P < 0.05$) weight gain of ewes prepartum; but had no effect ($P > 0.05$) on weight changes during the subsequent lactation. Birthweight, preweaning rate of weight gain, body development and weaning weights of lambs were not affected ($P > 0.05$) by steaming-up of dams.

2. Steaming-up had no effect ($P > 0.05$) on the performance of does pre- and postpartum and that of their kids.

3. Weight changes of ewes differentially supplemented during lactation were not different ($P > 0.05$). However, lamb and kid growth and body development were improved ($P < 0.05$) by postpartum supplementation of dams especially in the first four weeks of age.

4. Weight changes of lactating does were not affected ($P > 0.05$) by level of postpartum supplementation.

In general, steaming-up was not necessary for improving sheep and goat performance under Kenyan range conditions. However, postpartum supplementation of ewes and does at a rate not less than 0.50 kg concentrate per day was deemed necessary in enhancing lamb and kid performance through increased milk production of the dams.

7. SCOPE FOR FURTHER STUDY

The following six topics should be investigated in order to improve sheep and goat productivity from Kenyan rangelands.

1. Evaluation of nutritive value of browse plants found in range areas of Kenya.

2. Effect of creep feeding of lambs and kids on their pre-weaning growth rates, weaning and mature weights.

3. Seasonal variation of pasture quality and quantity in range areas.

4. Forage intake and digestibility by sheep and goats grazed on range.

5. Utilisation of energy and protein for pregnancy and lactation by sheep and goats.

6. The influence of early postnatal level of feeding on the life time productivity of sheep and goats.

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A P P E N D I C E S

Table A.1: Effect of steaming-up on weight changes of ewes

	Min.	Mean	Max.	F-Static
Initial liveweight, kg	30.0	35.5	43.0	0.09
Weight gain prepartum, kg	-1.5	1.82	4.50	6.54*
Average daily gain (ADG), g	-11.36	48.83	93.02	5.64*
Liveweight, kg				
One day prepartum	31.0	37.22	45.0	0.36
One day postpartum	26.5	33.04	41.5	0.06
Weight loss at lambing, kg	2.0	4.29	7.0	5.59*
Liveweight, kg				
4 weeks postpartum	26.0	30.46	36.0	0.75
8 " "	25.5	28.71	33.0	0.74
12 " "	25.0	27.90	32.0	0.27
Weight loss during lactation, g/day				
0-4 weeks postpartum	0	94.34	250.0	3.01
5-8 " "	0	62.50	178.57	1.94
9-12 " "	0	28.87	+53.57	0.51
Overall loss, g/day	17.86	61.41	113.095	0.36
Weight loss during lactation, kg	1.5	5.16	9.5	0.36

* (P< 0.05).

Table A.2: Effect of steaming-up on weight gain of lambs

	Min.	Mean	Max.	F-Stat.[1]
Liveweight, kg				
At birth	2.50	3.07	4.0	0.25
4 weeks of age	4.10	6.24	8.20	0.27
8 " " "	4.70	6.98	9.0	0.93
12 " " "	6.1	7.93	10.3	1.41
Average daily gain (ADG), g				
0-4 weeks of suckling	57.14	113.17	167.86	0.51
5-8 " " "	0	26.82	53.71	2.21
9-12 " " "	0	34.28	71.43	0.55
Overall ADG, g	38.09	57.88	86.90	1.93
Weight gain between birth and weaning, kg	3.20	4.86	7.30	2.05

[1]All F-values non-significant ($P > 0.05$).

Table A.3: Body measurements of lambs from ewes steamed-up using different levels of concentrate for various periods

	Min.	Mean	Max	F-Stat.[1]
At birth (cm)				
Body length	29.0	31.2	33.0	0.17
Height at withers	34.0	37.5	40.0	0.05
Heartgirth	34.0	37.5	40.0	0.18
Increase in body length, %				
First month of suckling	12.5	21.4	25.8	0.06
Second " " "	3.1	7.3	12.9	0.55
Third " " "	0	1.3	3.2	0.14
Preweaning increase in body length, %	21.9	29.8	35.5	0.67
Increase in height at withers, %				
First month of suckling	13.5	17.75	24.3	0.07
Second " " "	2.6	4.8	7.9	0.62
Third " " "	0	2.8	5.4	0.08
Preweaning increase in height at withers, %	19.4	25.4	29.7	0.64
Increase in heart girth, %				
First month of suckling	10.0	17.6	26.5	0.29
Second " " "	0	6.8	10.5	1.32
Third " " "	0	3.2	8.1	0.13
Preweaning increase in heartgirth, %	21	27.6	39.5	0.76

[1]F-values all non-significant ($P > 0.05$).

Table A.4: Effect of postpartum supplementation on body weight changes of ewes

	Min.	Mean.	Max.	F-Stat.
Liveweight of ewes, kg				
One day after lambing	26.0	32.56	40.5	0.95
4 weeks postpartum	24.50	30.27	40.0	2.03
8 " "	22.50	29.52	37.0	3.11*
12 " "	22.0	28.60	38.5	2.08
Weight loss during lactation, g/day				
0-4 weeks postpartum	17.86	81.84	196.43	1.17
5-8 " "	0	26.79	107.14	0.51
9-12 " "	0	29.76	+ 53.57	0.79
Overall loss, g/day	17.86	47.12	89.29	1.14
Weight loss during lactation, kg	1.50	3.96	7.50	1.14

* (P< 0.05).

Table A.5: Effect of postpartum supplementation of ewes on weight gain of lambs

	Min.	Mean	Max.	F-Stat.
Liveweight of lambs, kg				
At birth	2.5	3.11	4.0	0.33
4 weeks of age	5.0	6.82	8.6	8.0*
8 " " "	5.6	9.48	12.7	23.93*
12 " " "	6.4	11.54	16.0	23.79*
Average daily gain (ADG), g				
0-4 weeks of suckling	71.43	132.59	185.71	10.81*
5-8 " " "	21.43	94.94	128.57	37.86*
9-12 " " "	14.29	76.19	139.29	3.65*
Overall ADG, g	40.48	100.33	154.48	25.46*
Weight gain between birth and weaning, kg	3.0	8.43	13.0	25.39*

*(P< 0.05).

Table A.6: Body measurements of lambs from ewes supplemented during lactation using different levels of concentrate

	Min.	Mean	Max.	F-Stat.
At birth (cm)				
Body length	30.0	31.4	33.0	0.41
Height at withers	35.0	37.5	40.0	0.61
Heartgirth	35.0	37.4	40.0	0.17
Increase in body length, %				
First month of suckling	12.5	23.1	26.7	1.0
Second " " "	3.0	6.9	19.3	0.60
Third " " "	0	2.2	6.4	0.61
Preweaning increase in body length, %	21.9	32.3	41.9	3.61*
Increase in height at withers, %				
First month of suckling	10.5	21.1	25.7	3.26*
Second " " "	2.6	10.9	18.9	1.96
Third " " "	0	3.6	5.7	1.0
Preweaning increase in height at withers, %	15.4	35.9	48.1	5.38*
Increase in heartgirth, %				
First month of suckling	7.7	23.2	32.4	4.22*
Second " " "	2.7	12.4	19.4	3.42*
Third " " "	0	6.4	11.1	2.40
Preweaning increase in heartgirth, %	17.9	40.8	58.3	10.81*

*($P < 0.05$)

Table A.7: Effect of steaming-up on weight changes of does

	Min.	Mean	Max.	F-Stat.[1]
Initial liveweight, kg	21.0	30.59	38.0	1.10
Average daily gain (ADG), g	16.67	34.23	54.05	2.73
Liveweight of does, kg				
One day prepartum	21.50	31.62	38.5	1.50
One day postpartum	20.0	28.29	34.0	0.56
Weight loss at kidding, kg	1.50	3.53	6.0	1.94
Liveweight of does, kg				
4 weeks postpartum	20.0	26.62	31.50	1.97
8 " "	20.5	25.44	30.50	1.91
12 " "	20.0	24.94	29.50	2.23
Weight loss, during lactation, g/day				
0-4 weeks postpartum	0	52.46	178.57	0.19
5-8 " "	71.43	40.18	+17.06	0.98
9-12 " "	0	22.32	+17.86	0.28
Overall loss, g/day	0	36.83	11.90	0.72
Weight loss during lactation, kg	0	3.16	8.5	0.73

[1]All F-values non-significant (P> 0.05).

Table A.8: Effect of steaming-up on weight gain of kids

	Min.	Mean	Max.	F-Stat.[1]
Liveweight, kg				
At birth	2.0	2.4	3.0	0.03
Four weeks of age	3.8	4.57	5.4	0.64
Eight " " "	4.7	5.46	6.4	1.34
Twelve " " "	5.0	6.04	7.0	0.81
Average daily gain (ADG), g				
0-4 weeks of suckling	60.71	77.45	103.57	1.50
5-8 " " "	17.86	31.70	42.86	0.85
9-12 " " "	10.71	19.42	28.57	0.10
Overall ADG between birth and weaning, g	33.09	43.38	50.0	1.87
Weight gain between birth and weaning, kg	2.8	3.60	4.0	1.87

[1]All F-values non-significant (P> 0.05).

Table A.9: Body measurements of kids from does steamed-up using different levels of concentrate for various periods

	Min.	Mean	Max.	F-Stat.[1]
At birth (cm)				
Body length	22.0	23.0	25.0	0.87
Height at withers	29.0	30.9	32.0	0.34
Heartgirth	28.0	30.4	34.0	0.90
Increase in body length, %				
First month of suckling	20.8	26.4	36.4	0.12
Second " " "	4.2	9.5	13.0	0.48
Third " " "	0	3.4	8.7	0.54
Preweaning increase in body length, %	30.4	39.3	47.8	0.19
Increase in height at withers, %				
First month of suckling	18.3	23.9	31.0	0.06
Second " " "	3.2	5.0	6.4	0.42
Third " " "	0	3.0	6.9	0.63
Preweaning increase in height at withers, %	25.8	31.9	36.7	0.23
Increase in heartgirth, %				
First month of suckling	21.9	23.6	30.0	0.02
Second " " "	3.1	5.3	7.1	0.18
Third " " "	0	2.6	5.9	0.06
Preweaning increase in heartgirth, %	25.8	31.8	36.7	0.04

[1]F-values all non-significant ($P > 0.05$).

Table A.10: Effect of postpartum supplementation on weight changes of lactating does

	Min.	Mean	Max	F-Stat.[1]
Liveweight of does, kg				
One day after parturition	26.0	29.25	31.5	1.98
4 weeks postpartum	25.0	27.83	29.5	3.15
8 " "	23.5	27.12	29.5	2.26
12 " "	23.0	26.83	29.5	2.34
Weight loss during lactation, g/day				
0-4 Weeks postpartum	35.71	59.52	125.0	2.05
5-8 " "	0	16.37	35.71	0.06
9-12 " "	0	10.42	35.71	0.61
Overall ADG, g/day	11.90	28.77	47.62	3.04
Weight loss during lactation, kg	1.0	2.42	4.0	3.04

[1]All F-values non significant (P >0.05).

Table A.11: Effect of postpartum supplementation weight gain of suckling kids.

	Min.	Mean	Max.	F-Stat.
Liveweight of kids, kg				
At birth	2.0	2.44	2.9	1.68
4 weeks of age	4.20	5.20	6.4	5.69*
8 " " "	5.20	6.47	8.1	6.99*
12 " " "	6.4	7.40	9.0	7.33*
Average daily gain (ADG), g				
0-4 weeks of suckling	50.0	94.94	128.57	22.94*
5-8 " " "	21.43	44.94	60.71	0.46
9-12 " " "	21.43	33.93	46.29	0.01
Overall, ADG, g	42.86	59.03	78.57	6.90*
Weight gain between birth and weaning, kg	3.60	4.96	6.60	5.89*

*P< 0.05.

Table A.12: Body measurements of kids from does supplemented during lactation using different levels of concentrate

	Min.	Mean	Max.	F-Stat.
At birth (cm)				
Body length	22.0	23.2	24.0	0.05
Height at withers	29.0	30.4	32.0	0.48
Heartgirth	28.0	30.6	32.0	0.43
Increase in body length, %				
First month of suckling	25.0	29.9	33.3	1.54
Second " " "	4.5	9.0	13.6	0.18
Third " " "	4.2	4.3	4.5	0.47
Preweaning increase in body length, %	37.5	43.2	50.0	2.70
Increase in height at withers, %				
First week of suckling	21.9	25.0	27.6	0.45
Second " " "	3.1	4.95	6.9	0.38
Third " " "	3.1	3.50	6.7	1.09
Preweaning increase in height at withers, %	28.1	33.8	36.7	1.82
Increase in heartgirth, %				
First month of suckling	18.7	24.6	30.0	8.37*
Second month of suckling	3.3	7.38	10.7	0.26
Third month of suckling	0	4.06	6.9	0.11
Preweaning increase in heart-girth, %	28.1	36.1	43.3	4.49*

*(P< 0.05)