EFFECTS OF CONCENTRATE SUPPLEMENTATION ON REPRODUCTION AND LACTATION PERFORMANCE OF F_1-SMALL EAST AFRICAN x NORWEGIAN DOES

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ABSTRACT

Forty-five (12-15) months-old, grazing Small East African (SEA) x Norwegian (N) does (20.7 ± 0.6 kg BW) were used to determine effects of three dietary levels on reproductive and lactation performance for 17 months experiment in Morogoro, Tanzania. The experimental animals were randomly blocked into three dietary treatments (T_{200}, T_{400} and T_{600} which consisted of 200, 400 and 600 g of concentrate diet respectively), with 15 does each. All does were supplied with 800 g of concentrate diet daily after kidding. The does were exposed to three bucks (>75% N-blood) for mating. Each buck was assigned to one of the treatment groups and rotated after every three days. Body weight and condition scores of the does increased (P<0.001) with the increasing levels of concentrate diet. At birth, both single and twin kids born in diet T_{600} (3.47 and 2.51 kg) were heavier (P<0.05) versus T_{400} (3.07 and 2.13 kg) and T_{200} (2.46 and 1.92 kg). There was no significance differences (P>0.05) among kids at weaning in all dietary treatments. Milk yield were significantly higher (P<0.001) for does fed diet T_{600} (1.72 L/d) versus diet T_{400} (1.44 L/d) and T_{200} (1.10 L/d) throughout the lactation. Does fed diet T_{600} were superior for most of the milk component analyzed compared to those fed diets T_{200} and T_{400}. Based on the results obtained, it was concluded that supplementation of does during pregnancy and throughout lactation, positively improves reproductive and lactation performance of the does.

Key words: Does; kids; body weight change; dietary concentrate level; milk yield; milk component; crossbred (Small East African x Norwegian) does

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DECLARATION

I, Innocent Thomas do hereby declare to Norwegian University of Life Science that, this Thesis is my original work and that it has never been submitted for a degree award in any other University.

Signature………

Date……13/12/2010

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LIST OF SYMBOLS AND ABREVIATIONS

ANOVA	Analysis of variance
ADG	Average daily gain
BW	Body weight
BCS	Body condition score
CP	Crude protein
D	day
DM	Dry matter
g	gramme
INVDMD	In vivo dry matter digestibility
INVOMD	In vitro dry matter digestibility
kg	kilogramme
L	Litre
LBW	Live body weight
ME	Metabolizable energy
MJ	Mega joules
N	Norwegian
NDF	Neutral detergent fibre
NFE	Nitrogen-free extract
N-blood	Norwegian blood
SEA	Small East African goats
SEA x N	crosses between Small East African and Norwegian goats
SNF	Solid not fat
TS	Total solids

CHAPTER ONE

1.1 Background information

Small-scale farmers dominate the agriculture in Tanzania with the average farm size between 0.9 and 3.0 hectares. Different cereals (i.e. maize, wheat, barley, paddy rice, sorghum) and other crops are produced from these farms for food. In additional to farming, livestock production is also one of the most important agriculture activities in Tanzania since it provides 30 % of the agricultural gross domestic product (GDP) (Official online gateway of the United Republic of Tanzania, 2008).

Small ruminant production constitutes an important part of agricultural activity in Tanzania and most of the livestock products are for the domestic market. This mean, the dairy industry needs further development to meet the demands of both domestic and export markets. One of the limiting factors which hinder dairy industry development in tropics is low productivity partly due to slow growth rate which is mainly attributed to breed type (SEA goat).

Most goats in Tanzania are indigenous, of which they are kept mainly for meat production. The indigenous goat breed (SEA) is characterized by better tropical environment adaptability and low productivity performance (milk and meat). The latter is associated with many factors mainly breed, inadequate nutrition and poor management in general (Bosman *et al*., 1997; Kosgey *et al*., 2006). Efforts to improve productivity of these animals through crossbreeding have been started in different parts of the country especially in mountainous areas, where pure breed dairy goats (i.e. N breed), have been introduced. However, Eik *et al*., (2008) reported high mortality rate of kids and low milk yield from the crossbreed dairy does over a ten months lactation period.

1.2 Introduction

Reproductive performance is one of the main determinants of productivity of goats and entails measurements that can be expressed as the kidding rate, weaning rate, kidding interval, live weight of kids born or weaned and the length of the reproductive cycle. In many parts of the tropic regions, the traditional goat production system is characterized by random mating, mating of does at early age, high mortality rates, low body weights, low growth rates of kids and poor reproductive efficiency of does (Sebei *et al*., 2004; Kosgey *et al.*, 2006; Chikagwa-Malunga and Banda, 2006). In Tanzania, efforts to improve management of the kids to ensure survival and subsequent sufficient performance have been taken.

To improve performance of the cross breed, it requires high quality feedstuffs which are difficult to obtain from pasture alone (Serradilla, 2001; Berhane and Eik, 2006). Normally, in a pasture-based farming system, energy is usually the most limiting nutrient for milk production of dairy goats (Chilliard *et al*., 2003; Macedo *et al*., 2002; Morand-Fehr, 2005). In the dry season, in particular, the quality of feeds is low that does lose weight and body conditions in addition to low birth weight of the kids born and reduction in milk production (Ben Salem and Smith, 2008). For example, forage diets often cannot meet the nutritional needs of high producing animals, such as lactating does, especially those nursing triplets and kids with the genetic potential for rapid growth. For this reason, supplements are often provided to enable livestock to reach their genetic potential for milk production and growth (Schoenian, 2009).

However, the level of dietary supplementation to dairy goats show variable responses due to differences in genotypes (Macedo *et al*., 2002; Morand-Fehr, 2005), type and amount of diet (Goetsch *et al*., 2002) and physiological state of the animal (Chilliard *et al*., 2003). Besides, nutrient requirements vary with genetic selection and crossbreeding (Luo *et al*., 2004; Kirkland and Gordon, 1999). Nutrients' demand of grazing crossbred dairy goats (SEA x N) on productive and reproductive performance in responses to levels of diet in Tanzania, have not been extensively studied. However, feeding practices of SEA x N dairy goats have been studied; proper feeding during gestation and lactation periods of these dairy goats is unclear. The objectives of this study were (1) to assess reproductive and lactation performance of SEA x N dairy goats fed varying levels of concentrate diet and (2) to study the birth weight and growth performance of the kids born to SEA x N does fed different levels of concentrate diet.

1.3 Hypothesis

H_o: Increasing levels of concentrate diet supplementation doesn't improve productivity performance of dairy goats ($\mu_1 = \mu_2 = \mu_3$)

H_a: Increasing levels of concentrate diet supplementation improve productivity performance of dairy goats ($\mu_1 < \mu_2 < \mu_3$)

CHAPTER TWO

LITERATURE REVIEW

2.1 Factors affecting reproductive performance of dairy goats

2.1.1 Nutrition

Productivity of goats is fostered by the efficient utilization of nutrients which is possible with an adequate supply of energy. Energy requirements are determined by age, body size, physiological state, environmental factors, hair growth, muscular activity and relationships with other nutrients (Acero *et al.,* 2008). Weather conditions such as temperature, humidity and sunshine may increase or decrease energy needs depending upon the location of the region. Stress of any kind may increase energy requirements as well.

Nutrition is considered to be an important factor affecting reproductive performance in dairy goats. Reproduction increases the animal requirement for nutrients. The nutrient supply to animals can influence their reproductive processes i.e. onset of ovarian cyclicity. Moreover, nutrient requirements for reproduction vary considerably from one phase of the reproductive cycle to another. Dairy goats often experience reproductive problems associated with nutritional deficiencies (Orkov, 1999). For this case, animals having the highest nutritional requirements should have access to high quality browse and supplement diet so as to meet energy requirement for maintenance and production.

Poor nutrition affects breeding performance. A study on factors limiting productivity of dairy goats by Mellado *et al*., (2003) found that kids born with low birth weight below 2.7 kg were less likely to conceive when they became adults compared to kids born with heavier weights. Low birth weight reduce pre-weaning daily gains, large parity groups 2-5 and older goats have high risk for abortion.

A common practice in females of different species of dairy animals is to prepare them for the breeding season by flushing. Flushing is the practice of providing extra energy and/or protein to breeding does prior to the breeding season and for the first several weeks of the breeding season. In goats, this practice consists of an increase in the level of energy offered from prior to introduction of the buck until approximately 21 ds thereafter (Luginbuhl *et al.*, 1998). Several studies in small ruminants have shown that with flushing, ovulation and fetal implantation in the uterus are improved (Kusina *et al*., 2001; Acero *et al.*, 2008). The increased weight gain that the does experience may translate into higher fertility and ovulation rates, though many factors will determine the female's response to flushing. Thin does respond best to flushing (Schoenian, 2009). Failure in reproduction, low weaning rate and low growth rate will result if does are too thin while over fat does can suffer pregnancy toxemia.

Though literature is scanty on the effects of supplementary feeding of pregnant goats based on intra-uterine growth pattern, it has been observed that nutrient diversion to foetus and other associated tissues is extremely small before sixty ds of gestation. In mid pregnancy, the nutrient requirements of foetus are still low, but placenta must grow at this time and if growth of the placental tissue is restricted by low plane of nutrition, it will be unable to adequately nourish the foetus in the final stage of pregnancy and consequently birth weight will be reduced (Abd *et al*., 2005).

The rapid growth rate of foetal during the final six weeks of pregnancy imposes a metabolic challenge to the doe, which is met by the mobilization of maternal body tissue (Akusu *et al*., 2000). This may result in weight loss of doe, if the dietary supply of nutrients is inadequate. Feeding during pregnancy may lead to reproductive wastage resulting from either abortion or neonatal death due to low birth weight resulting from malnutrition of pregnant does (Abd *et al*., 2005). On the other hand, overfeeding may result on dystocia due to absolute foetal oversize as a result of high level of feeding throughout gestation.

2.1.2 Body condition of the doe

Body condition at mating is achieved over a longer period i.e. the period between one reproductive cycle and the next. This has a greater effect on ovulation rate and barrenness than flushing. Body condition score (BCS) is a function of mainly nutrition; therefore concentrate feeding will raise body condition score. Does supplemented with concentrates will have good body condition score than those which are not supplemented. Weight of does at kidding influence kids birth weights positively (Zahradeen *et al.*, 2008). Kids from does with good body conditions tended to be superior in weight during all stages of life. Very low BCS leads to low birth weight which is associated with increased neonatal mortality while too high BCS leads to high birth weight with increased complicated labour and maternal death (Rafiq *et al*., 2007). Young does and does with small weight at mating will have small kids. As in all placental mammals, the maternal uterine space has a finite capacity to gestate offspring, and as litter size increases individual birth weights decline. Male kids have higher birth weights than female kids which is the influence of sex of the kid. In addition, maternal BSC prior to conception had a significant effect on birth outcome.

2.1.3 Maternal effect

The maternal effect refers to the effect of animal's dam influencing individual's performance during gestation and nursing. Such effects arise from the ability of the mother to produce milk needed for growth and other maternal behavior (Maniatis and Pollott, 2002). Maternal environment include age of the dam, breed, pelvic dimension and nutrition. Goats supplemented with concentrates will give birth to heavier kids and will produce more milk which will enhance high growth rate of kids. The weight gain of suckling kids is closely associated with the level of milk intake during the early stages of the milk feeding period and declines with declining milk production.

Early growth is influenced by the genotype of the animal, and also by the maternal environment. These maternal effects reflect the dam's milk production and mothering ability. Maternal effects are especially important in early life, and also may have carry-over effects later in life. Good mothering ability increase performance of the kids in terms of improved birth and weaning weights, survival rates of kids at various ages of life and early attainment of puberty. It also improve reproductive make-up of kids at commencement of reproduction, substantial improvement in milk yield in kids that grow to does in their first and subsequent parities, increase immunity and minimal incidence of diseases and pests among kids, as well as meat/protein production at an early stage of life which increase income to the farmer (Zahraddeen *et al*., 2008). Body weights used in performance testing are often recorded at a relatively early age. Studies on traits measured at an early age in farm animals have shown that both direct and maternal influences are important for animal growth (Maghsoudi *et al*., 2009).

According to Kinne (2002) small sized does are most likely to have small (underweight) kids and sometimes abortion or dystocia may occur and the kid may die. Most abortions occur in response to stress between 90 and 110 ds of gestation, which is critical stage of rapid fetal development. Under nutrition during the critical stage of rapid fetal development, and competition for nutrients between fetal and maternal organisms, appear to be one explanation.

2.2 Factors affecting milk yield and composition

Some factors such as feeding, physiological state, hormones, parity, breed, stage of lactation, litter size, season of kidding, age of does at parturition and the combined effect parity-year-season of kidding are known to be the factors affecting milk yield and its composition (Milerski and Mares, 2001).

2.2.1 Feeding

Productivity of goats is fostered by the efficient utilization of nutrients which is possible with an adequate supply of energy (Morand-Fehr *et al*., 2000)**.** Energy requirements are affected by age, body size, physiological state, environmental factors, hair growth, muscular activity and relationships with other nutrients. Weather conditions such as temperature and humidity may increase or decrease energy needs (NRC, 1981).

Improved feed during pregnancy increases milk production of animals. This is because, good body conditions of the animal during late pregnancy has positive effects on early lactation milk yield (Morand-Fehr *et al*., 2000). During the early months after kidding, the doe has the tendency to mobilize body tissues for maintenance and production if they consume less dry matter feeds (Tovar-Luna *et al*., 2010).

Average daily milk yield, peak yield, time of peak yield, persistency, fat and protein content of the milk, depends on the quantity and quality of feed eaten by the animal (Salama *et al*., 2005). Before and after parturition, feeding of good quality forages favourably affects the onset of lactation. In the middle of lactation and especially at the end of lactation, maintenance of milk production at a high level requires a slightly higher supply of concentrates than that necessary to meet the requirements for energy.

2.2.2 Physiological state and hormones

The mechanism by which pregnancy influences milk yield is not fully understood, but it is believed to be caused by the hormones released during pregnancy, most probably estrogen (Bormann *et al*., 2002). The administration of estrogen causes mammary gland regression with a significant decline in milk yield in lactating goats (Brotherstone *et al*., 2004). In addition to estrogen, placental lactogen peaks during the last third of pregnancy, may influence mammogenesis and lactogenesis, and alter the maternal metabolism to accommodate the growth and development of the fetus (Akers, 2002).

Lactose is the major osmotic regulator of milk, and there is a strong positive correlation which exists between lactose synthesis and milk yield. Salama *et al*., 2005 found that, the number of secretory cells in the udder of goats decreased as lactation advanced, but cell activity remained unchanged.

2.2.3 Parity and breed

As the parity increases from the first to the third, there is a rapid increase in milk yield and the milk production increases at a decreasing rate up to fifth parity (Hansen *et al*., 2006). During the first kidding, does have low body weights which contribute to low daily milk yield. As the number of parity increases, the animal is attaining maturity and energy competition between growth and milk synthesis is reduced hence high milk yield (Mellado *et al*., 2003).

Daily milk yield of dairy goats has been reported from different breeds ranging from local, crosses and exotic breeds under tropics condition (Berhane and Eik, 2006; Peacock, 2008). Breed of the dairy goats has effect on milk yield. Temperate breeds give more milk than tropical does, while crosses are intermediate in milk yields (Kendall *et al*., 2006). Genetic differences among the dairy goat breeds affects ash and fat content of the milk (Schmidely *et al*., 2002), where as the tropical breeds give higher percentage fat than temperate breeds. Milk from the tropical breeds has higher total solids, mainly due to higher fat and protein contents. The concentration of these nutrients is associated with the relative small amount of milk produced (Abd *et al*., 2005).

2.2.4 Stage of lactation

Milk yield varies according to the stage of lactation. Goats are more persistent milkers than cattle. They reach their peak milk yields during the 8^{th} to 12^{th} week after kidding. On the 5^{th} month of lactation, the milk yield decreases slowly and thereafter yields remains fairly constant (Salama *et al*., 2005). Antunac *et al.,* (2001), reported that in the first lactation goats produce small amount of milk per day and milk yield increased progressively with the parity until the third lactation. Milk from the early stage of lactation normally contained high milk components. Fat, protein and lactose contents are high at the beginning of lactation, drop during peak milk yield and then increase slowly until the doe dries off. Within the extended lactation, dairy goats increase their daily yield when their levels of nutrition increase (Salama *et al*., 2005). Milk production is also influenced by milking practice. For example, milking twice a d may yield up to 40 % more milk than milking once a d (Salama *et al*., 2003).

2.2.5 Litter size

Litter size has been reported to have an effect on the lactation performance of an animal. Litter size increases with age and is more related to the weight of the doe at conception than age (Sangare and Pandey, 2000). Does with twins produce more milk than does with single. The high milk yield in does with twins is caused by high lactogenic activities during prepartum stage which cause greater development of mammary gland potential for milk synthesis and hence high milk yield during early postpartum. Sangare and Pandey (2000), working with local Sahelian goats found that does with twin kids produced significantly more milk than the does with singles and milk yield declines rapidly. Further, reports by other workers (Browning *et al.*, 1995; Milerski and Mares, 2001), show lower milk production in does with single litters while does with three and more kids produce more milk and that goats with single litters produce milk with highest protein and lower fat contents.

2.2.6 Season of kidding, age and weight

Season and year of kidding affects daily, monthly and total lactation milk yields. Normally, goats kidding on wet season have low milk yield due to the low dry matter intake, reduced grazing time and prevalence of diseases, especially worm infestation and foot rot (Mourad, 1992; Hoste *et al*., 2005). Also season of kidding has the most consistence effect on lactation curve.

Milk yield increases with age up to five years. As the age of the animal increases, the hormonal status of the animal body, metabolic activity, secretory cells and nutrient intakes which are used in the milk synthesis increase too (Carnicella *et al*., 2008; Hansen *et al*., 2006). Birth weight is strongly correlated with kid survival, growth rate and adult size and also with kid viability.

CHAPTER THREE

3. Materials and methods

3.1 Location and management of experimental animals

The study was carried out from June 2008 to November 2009 at Magadu research farm of Sokoine University of Agriculture, Morogoro, Tanzania. The area is located between latitude 6^o 85' South and longitude 37^o 64' East and at an elevation of 568 m above sea level. Annually, the area receives 800 – 950 mm of rainfall. Seasons were grouped according to weather pattern: season 1, July to September (dry season); season 2, February to May (wet season).

Forty five (12-15) months-old, grazing SEA x N does were allotted into three dietary treatments (T_{200}, T_{400} and T_{600} which consisted of 200, 400 and 600 g of concentrate respectively). Each treatment consisted of 15 does. The does were exposed to bucks for mating where three bucks (above 75% N-blood) were used. Each buck was assigned to one of the treatment groups. Mating took place for two months when the does attained 20 kg live body weight. All animals were screened for gastro-intestinal worms after every three months and Ivomectin were used for treatment and control of the gastro-intestinal and ecto-parasites.

3.2 Feeds and feeding

The concentrate on offer was composed of maize bran (70 %), sunflower seed cake (28 %) and minerals (2 %) with a chemical composition as shown in Table 1. The animals were subjected to a preliminary feeding period of one month during which they received 200 g of concentrate per doe per d. Dietary treatments T_{200}, T_{400} and T_{600} were provided with 200, 400 and 600 g of concentrate/doe/d respectively from mating to kidding. After kidding, the level of concentrate for the kidded does was increased gradually to 800 g/doe/d; i.e. 400 g/doe in the morning and 400 g/doe in the evening. All does grazed pastures (*Leucaena leucocephala, Panicum maximum, Pennisetum purpureum, Tripsacum laxum, Guatemala grass, Solanum incunum, Heteropogon contortus, Hyparrhenia rufa and Cynodon spp*) during the day for about six hours and were housed at night and free access to water.

Table 1: Chemical composition of the experimental concentrate feed

Chemical composition	Concentrate feed
Dry matter (g/kg)	910
Crude protein (g/kg DM)	173
Ether extract (g/kg DM)	134
Ash (g/kg DM)	52
Neutral detergent fibre (g/kg DM)	391
Acid detergent fibre (g/kg DM)	223
Crude fibre (g/kg DM)	146
In vitro dry matter digestibility (g/kg DM)	546
In vitro organic matter digestibility(g/kg DM)	546
Nitrogen free extract	405
Metabolisable energy (MJ/kg DM)	12.6

3.2.1 Methods of analysis

Dry matter (DM) was determined according to AOAC, (2000); Ash, Crude protein (N Kjeldahl x 6.25) (CP) and Crude fibre (CF) contents were determined according to Weende method: Association Francaise de Normalisation (AFNOR, 1981); Acid and neutral detergent fibres (ADF and NDF) were determined by the method described by van Soest *et al* (1991); In vitro dry matter digestibility (IVDMD) was determined according to Tilley and Terry (1963); In vivo organic matter digestibility was determined according to Steg *et al*. (1987); Nitrogen content was determined using the Kjedahl method (AOAC, 2000); Metabolisable energy (MJ/kg DM) was determined according to the Weende Analyses System (1984).

3.3 Data collection

Live body weight (kg) was taken monthly before mating and thereafter for the does, throughout the experiment at the same interval. The weighing was conducted before feeding. Body condition score on a rating scale from 1 very thin; 5 obese (Spahr 2004), was also taken throughout the experiment.

Mating started on 28th August 2008 and ended 28th October 2008. Bucks were rotated after every three days for all groups. The does kidded from 22nd January to 15th February 2009. Live body weight (kg) for does and kids was taken within 24 hours after kidding then every four weeks for kids, up to weaning. Hand milking method was used to milk the does. During pre-weaning period does were milked once per day (evenings) whereby the kids were allowed to stay with their mothers during the night until weaning (90-days). Thereafter, does were milked twice a day (morning and evening) during post-weaning period and daily milk yield (L) were recorded. Milk samples were collected twice per month until the end of lactation period and analyzed separately.

The samples were collected after thorough mixing of milk in clean bottles and brought to the Laboratory for chemical analysis at the Department of Animal Science and Production. Crude protein content was analyzed using the Kjeldahl method as a reference (N x 6.38) according to International Dairy Federation Standards (IDF, 1993). The Gerber method (IDF, 1993) was used as the reference for milk fat content, and total solids were determined by oven drying (IDF, 1982). All these methods adhere to the International Dairy Federation standards and all measurements were made in duplicate. The results obtained were averaged to get the monthly value.

3.4 Chemical analysis and calculation

Reproduction parameters were calculated as follows: Conception rates (%) = number of does conceived per number of does mated x 100; litter size = number of kids per doe kidded; survival rate of kids (%) = number of kids alive at weaning per number of kids born x 100; twining rate (%) = number of does kidded multiples per total number of does kidded x 100; Pre weaning daily gain was calculated by using the following formula;

$$\frac{\text{Weaning weight} - \text{birth weight}}{\text{90 days}}$$

3.5 Data analysis

Data were analyzed using GLM procedures of (SAS Institute Inc. 2003). Dietary treatments and month of lactation were independent factors, parameters including monthly live body weight changes (LBW) and body condition scores (BCS), litter size, milk yield and milk composition were dependent factors. Each individual animal served as an experimental unit for all the parameters. Since there was variation in initial live weight of does within the diet group, some of the traits (e.g. body weight changes and body condition score) were corrected by taking their initials and age of the doe as a covariate. For milk composition, milk yield on the test day were taken as a covariate. Means of the various parameters were separated by the least squares means at 5% level of significance. The following two models were used:

Model 1 for doe's weight and body condition score

$Y_{ij} = \mu + T_i + e_{ij}$

Where: Y_{ij} = weights or body condition scores at different stages

μ = Overall mean

T_i = Effect of treatment (T_1, T_2 and T_3)

E_{ij} = Residual effect associated with the animal of the i^{th} treatment

Model 2 for kids' birth weights, pre-weaning average daily gain and weaning weights

$Y_{ijkl} = \mu + T_i + S_j + B_k + (TS)_{ij} + (TB)_{ik} + e_{ijkl}$

Where: Y_{ijkl} = Birth weight, pre weaning daily gain, weaning weight

T_i = Effect of treatment (T_1, T_2 and T_3)

S_j = Effect of sex (1= male, 2 = female)

B_k = Effect of birth type (1 = single, 2 = twins)

$(TS)_{ij}$ and $(TB)_{ik}$ = interaction between sex and birth type, and between birth type and treatment respectively

E_{ijkl} = Residual effect

Model 3 for milk yield and milk components

$Y_{ij} = \mu + T_i + e_{ij}$

Where: Y_{ij} = milk yield or milk components at different stages of lactation

μ = Overall mean

T_i = Effect of treatment (T_1, T_2 and T_3)

E_{ij} = Residual effect associated with the animal of the i^{th} treatment

CHAPTER FOUR

4. Results and Discussion

4.1 Results

The effect of different diets on body weight changes and condition scores of the does are presented in Table 2. At the start of experiment, does in all diets had similar (P>0.05) body weights and condition scores. One month before kidding and the period of kidding, does in diet T_{600} had significantly higher (P<0.001) body weight and body score than does in diets T_{200} and T_{400}. From kidding to weaning, does in diet T_{600} maintain higher (P<0.001) body weight than those in diets T_{200} and T_{400}.

Table 2: Least squares means (±SE) for weight gain and body condition score of SEA x Norwegian does supplemented three different levels of concentrate.

	Diet			
Parameters	T_{200}	T_{400}	T_{600}	Significance
Number of does per treatment	14	15	14	
Body weight				
Start of experiment (Kg)	20.7 ± 0.6	20.2 ± 0.6	21.2 ± 0.5	NS
1 month before kidding (Kg)	28.7 ± 0.5[b]	29.7 ± 0.4[b]	31.6 ± 0.4[a]	***
At kidding (Kg)	23.6 ± 0.5[c]	25.6 ± 0.5[b]	27.9 ± 0.5[a]	***
At weaning (Kg)	22.3 ± 0.5[c]	24.8 ± 0.5[b]	27.1 ± 0.5[a]	***
Body condition score				
At mating	2.4 ± 0.1	2.4 ± 0.1	2.2 ± 0.1	NS
1 month before kidding	3.9 ± 0.1[b]	4.2 ± 0.1[a]	4.2 ± 0.1[a]	***
At kidding	2.6 ± 0.1[b]	2.8 ± 0.1[b]	3.3 ± 0.1[a]	***
At weaning	2.2 ± 0.1[c]	2.7 ± 0.1[b]	3.4 ± 0.1[a]	***

Within rows, least squares means with a common superscript are not significantly different (P>0.05). Significance: NS, not significant, *P<0.05, **P<0.01, ***P<0.001.

Reproductive traits of does fed different diets are presented in Table 3. Although not tested statistically, trends for most parameters (i.e. survival rate, litter size and twinning rate) showed increase with increasing level of concentrate diet while the total number of deaths was lower in diet T_{600} compared to diets T_{200} and T_{400}.

Table 3: Effect of concentrate supplementation on reproductive parameters in SEA x Norwegian does

Parameters	Diet T_{200}	T_{400}	T_{600}
No. of does per treatment	14	15	14
Conception rate	1	1	1
Percentage born alive	100	100	100
Birth weight of kids (Kg)	2.5	2.7	2.9
Survival rate (%)	71.4	76.9	96.3
Litter size	1.5	1.9	2.3
Twining rate (%)	50	60	64

Data presented here are not statistically analyzed. Survival rate = Percentage of kids alive/kids born; Twining rate = Number of twins births/Total kidding; Conception rate = No. of does kidded/No. of does mated.

Body weight changes of kids from birth to weaning are given in Table 4. Both single and twin kids born in diet T_{600} were significantly heavier ($P<0.05$) than those born in diets T_{200} and T_{400}. Female kids in diet T_{600} were born heavier ($P<0.05$) than those in diets T_{200} and T_{400}. However, at weaning no significantly difference ($P>0.05$) was observed on neither birth type nor sex.

Table 4: Least squares means (±SE) for body weight changes of kids born to SEA x Norwegian does subjected to three different levels of concentrate diets.

Parameters	Trait	Diet T_{200}	T_{400}	T_{600}	S.E.M	Significance
Birth Weight (Kg)	Single	2.46^{c}	3.07^{b}	3.47^{a}	0.1	*
	Twins	1.92^{c}	2.13^{b}	2.51^{a}	0.1	*
	Male	2.43^{b}	2.62^{b}	3.06^{a}	0.1	*
	Female	1.96^{c}	2.58^{b}	2.91^{a}	0.1	*
ADG 0-3 months old (g/d)	Single	103.8	107.5	109.3	3.5	NS
	Twins	93.1	102.9	107.7	2.6	NS
	Male	101.8	112.7	113.8	2.9	NS
	Female	95.1	97.7	103.2	3.8	NS
Weight at weaning (Kg)	Single	11.8	12.8	13.3	0.3	NS
	Twins	10.4	11.4	12.2	0.2	NS
	Male	11.6	12.8	13.4	0.2	NS
	Female	10.6	11.4	12.2	0.3	NS

Within rows, least squares means with a common superscript are not significantly different ($P>0.05$). Significance: NS, not significant, *$P<0.05$, **$P<0.01$, ***$P<0.001$. ADG = Average daily weight gain; S.E.M = Standard error of means.

Effects of sex and birth type on birth weight and growth performance of kids to weaning are presented in Table 5. Male kids were born significantly heavier (P<0.001) than female kids and they maintain their superiority until weaning. Kids born twins had significantly lower (P<0.01) birth weight among dietary treatments compared to singles. Generally, kids born to does fed diet T_{600} were heavier (P<0.001) at birth and weighed more at weaning than those born in diets T_{200} and T_{400} (Fig 1).

Table 5: Least squares means (±SE) for body weight weights of kids at birth, pre-weaning daily gains and at weaning.

		Variable					
		Birth weight (kg)		Pre weaning daily gain (g)		Weaning weight (kg)	
Factor		n	LSMean	n	LSMean	n	LSMean
Overal mean		74	2.4 ± 0.03	65	104 ± 1.19	65	11.9 ± 0.11
Sex	Males	35	2.7 ± 0.04[a]	32	109 ± 1.65[a]	32	12.5 ± 0.15[a]
	Female	39	2.5 ± 0.04[b]	33	98 ± 1.88[b]	33	11.4 ± 0.17[b]
	Significance		***		***		***
Birth type	Singles	18	3.0 ± 0.05[a]	17	107 ± 2.05[a]	17	12.6 ± 0.18[a]
	Twins	56	2.2 ± 0.04[b]	48	101 ± 1.54[b]	48	11.3 ± 0.14[b]
	Significance		***		*		***
Treatment	T_1	21	2.2 ± 0.06[c]	16	98 ± 2.32[c]	16	11.1 ± 0.21[c]
	T_2	26	2.6 ± 0.06[b]	23	105 ± 2.28[b]	23	12.1 ± 0.20[b]
	T_3	27	3.0 ± 0.05[a]	26	108 ± 2.00[a]	26	12.7 ± 0.18[a]
	Significance		***		**		***

Within column, least squares means with a common superscript are not significantly different (P>0.05). Significance: *P<0.05, **P<0.01, ***P<0.001.

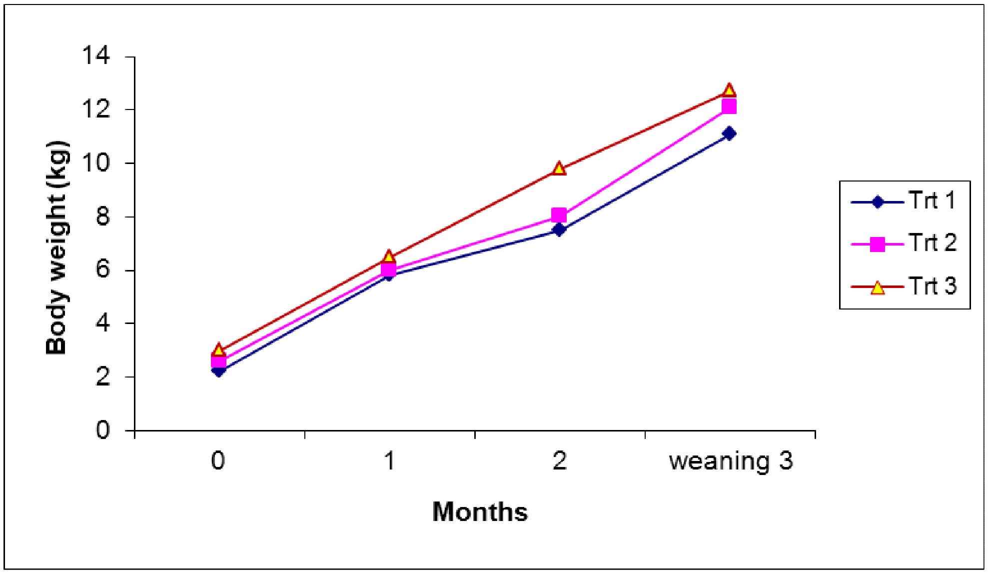

Fig. 1: Body weight changes of kids born to SEA x Norwegian does subjected to three different levels of concentrate supplementation

Milk yield and milk composition are reported in Table 6. Milk yield were significantly ($P<0.001$) influenced by the level of concentrate diet. Does fed diet T_{600} produced higher ($P<0.001$) amount of milk (1.72 L/d) compared to those fed diets T_{200} (1.10 L/d) and T_{400} (1.44 L/d). There was a marked increase in daily milk yield during the initial stage of lactation up to 8 weeks of lactation where all animals attained their peak milk yield, followed by a gradual decline (Fig. 1). The milk yield was significantly affected by week of lactation ($P<0.001$) and the lactation curve had an asymmetrical peak 8 weeks postpartum and the milk yield at peak lactation was 2.2 L/d (T_{600}), 2.04 L/d (T_{400}) and 1.61 L/d (T_{200}).

Table 6: Least square means (±SE) for milk production and milk components of SEA x Norwegian does fed three different levels of concentrate.

Parameters	Diet			Significance
	T_{200}	T_{400}	T_{600}	
No. of does per treatment	14	15	14	
Milk yield (L/d)				
Average daily yield	1.10 ± 0.008^c	1.44 ± 0.007^b	1.72 ± 0.008^a	***
Total milk yield per lactation	216.75 ± 15.85^c	285.16 ± 13.84^b	340.23 ± 15.29^a	***
Milk components (%)				
Fat	3.46 ± 0.04^c	3.86 ± 0.04^b	4.13 ± 0.04^a	***
Protein	2.81 ± 0.05^b	3.24 ± 0.05^a	3.37 ± 0.05^a	***
Solid not fat	9.57 ± 0.15^c	11.87 ± 0.14^b	13.63 ± 0.15^a	***
Total solids	14.09 ± 0.21^c	17.06 ± 0.20^b	18.41 ± 0.21^a	***

Within rows, least squares means with a common superscript are not significantly different (P>0.05). Significance: NS, not significant, *P<0.05, **P<0.01, ***P<0.001.

Percentage fat, protein, solids not fat and total solids were significantly (P<0.001) influenced by the level of concentrate diet. Animals fed diet T_{600} were superior for most of the milk component analyzed compared to those fed diets T_{200} and T_{400}. During the early stage of lactation, milk contained high fat and total solids which then decreased gradually towards the end of lactation.

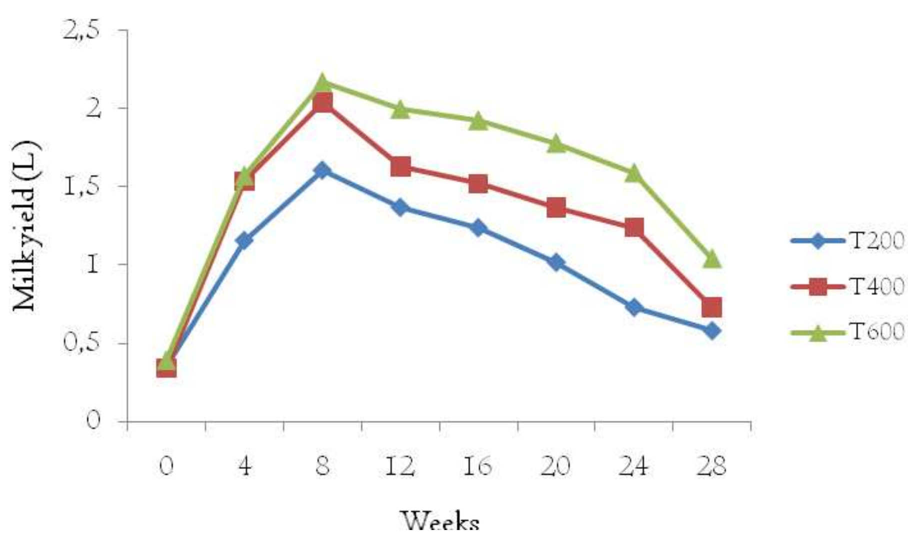

Fig.2: Milk yield of SEA x N does in the first lactation subjected to three different levels of concentrate supplementation.

4.2 Discussion

4.2.1 Body weight and condition score

This study has shown that, different levels of dietary treatment fed to does from mating to kidding had a marked effect on does weights and condition scores. During mating, there was no significance different on body weight and body condition scores among does because the dietary effect was not manifested. Few months after mating, does received diet T_{600} start to gain more weight compared to those in diets T_{200} and T_{400}. The reason for gradual weight gain in diets T_{200} and T_{400} could be associated with the high energy requirement to support foetus development. The higher body weight of all does observed at one month before kidding could be associated with the interaction between the level of supplementation and the number of fetuses (Ivey *et al*., 2000).

At kidding and during early lactation, does received diet T_{200} lose more weight compared to those in diets T_{600} and T_{400}, and the effect endure until weaning. This is in agreement with Rastogi *et al.* (2006), who reported higher weight loss of the pregnant does fed 200 g of concentrates during lactation compared to those fed 400 g and 600 g of concentrates. Similarly, Acero *et al.* (2008) reported weight loss for nannies supplemented with lower energy level diet. Weight loss in does is normally related to the mobilization of body reserves (protein and fat) and labile protein stored during the dry period to maintain milk production throughout lactation (Morand-Fehr, 2005). The decrease in body weight after kidding and during the early lactation as a result of mobilization of body reserves was also reported by Eknæs *et al*., (2006) and Ngwa *et al*., (2009).

4.2.2 Effect of body weight on reproductive performance

Body weight at mating time affect ovulation rate and litter size at the following kidding. Flushing improves ovulation and foetal implantation in the uterus (Acero *et al*., 2008). The increased weight of does during flushing may be translated into higher fertility and ovulation rates, though many factors may determine the female's response to flushing

(Schoenian, 2009). The increased body weight of does as a result of increased level of dietary supplementation influence kid's birth weights (Gardner *et al.*, 2007), survival rate (Akingbade *et al*., 2001) and twinning rate (Kusina *et al*., 2001). However, Sibanda *et al*. (1999), indicating that litter size may be controlled more by genetic, rather than nutritional factors. Zahradeen *et al*., (2008), observes the higher daily weight gain of kids from does with good body condition score which is different from the present study.

4.2.3 Birth weight and weight gain of the kids

The average birth weight of kids in the present study might be attributed to the dietary treatments (Malau-Aduli *et al.* 2004); since it was revealed that, the higher the levels of concentrate diet, the higher the kids' birth weights. The differences in birth weight between kids born could be the results of maternal nutrition (high and low nutrients available for the foetus). Rastogi *et al.* (2006) reported low birth weight of the kids from the Gravid does group supplemented with low level of concentrate during pregnancy compared to high and medium level of concentrate supplementation groups. Similarly, Akingbade *et al.*, (2001) found the relationship between body weight of the South African indigenous does during pregnancy and the development of the foetus. This is because the live weight of pregnant does during gestation affects the amount of available energy for foetal growth (Isaacs *et al*., 1991). However, size and health status of a doe may be another important factor, which may affect birth weight of kids (Hossain *et al.*, 2003).

In this study, the significantly differences observed in sex and birth type of the kids at birth, is in agreement with that reported by Eik *et al*., (2008) on purebred N and their crosses at Mgeta. Male kids weighed significantly more than females kids at birth and all along until weaning. This is in agreement with an earlier study by Nkungu *et al*. 1995 who observed that N x SEA male kids were superior to their female counterparts at all stages of growth up to 12 months. The growth superiority of male kids has been attributed to the presence of androgens, which play a role in growth (Elabid, 2008). Likewise, kids born single were significantly heavier than their twin counterparts. This could be attributed to the weight advantage to competition for martenal nutrients and the less inter-uterine space in cases where does carry two or more foetuses as compared to one (Zahraddeen *et al*., 2008).

Generally, the availability of enough milk from the dams results to faster pre-weaning weight gain and infested the effect of birth weight on both sex and birth type between dietary treatments (Alexandre *et al*., 2002). The highest ADG values of 93.1-113.8 g/d reported in this study are justifiable given the fact that, the kids were born during the wet season where, naturally grazed pasture were plenty and they were given concentrate feed during pre-weaning in additional to suckling enough milk from their mothers. In additional, ADG of single male, single female, twin male and twin female kids differed non-significantly in terms of daily weight gain from birth to 100 days of age (Adama and Arowolo, 2002; Supakorn and Pralomkarn 2009). During weaning, kids in all dietary treatments loss weight as a result of weaning stress (Memiši *et al*., 2009).

The overall pre-weaning growth rate was higher (109 g/day and 105 g/day) in kids born to does fed diets T_{600} and T_{400} respectively than those born from does supplied with diet T_{200} of concentrate (99 g/day). This is because heavier kids are stronger and robust than others, therefore they eat more. In additional to this, body requirements are higher in heavier kids than in lighter kids because animals feed according to their body weights and sizes. Therefore, they were probably eating more and hence grow faster. The does' body condition scores had pronounced effect on daily weight gain of kids at the various age intervals. Zahradeen *et al*. (2008) also found that kids from does with good body condition score had significantly higher daily weight gain at various ages than those with lower body scores. For instance, kids from does with body condition scores 3 and 4 were superior ($P<0.05$) to kids from does with body condition score of 2 at birth to 30, 31- 60 and 91-120 days of age. Also Reynolds (1990) found that, supplementation significantly increased kid growth rate to weaning.

The higher growth rate and body weight of male kids at weaning could also be attributed to their birth weight. This is because they were born heavier than females and hence they grew faster and attained higher weaning weights compared to females even though they belongs to the same level of dietary treatment. Islam *et al.* (2009) observed the higher body weight values of kids at weaning for both sexes in does supplemented with concentrates than non supplemented does.

4.2.4 Milk yield and components

In spite of weight loss in does, higher average daily milk yield and peak yield were observed on does received diet T_{600} followed by those in diet T_{400} and diet T_{200}. Generally, the average daily milk yield obtain in this study was a bit higher compared to that (1.0 L/d for purebred N goats, 0.9 and 0.7 L/d for the 75% and 50% N goats, respectively) reported by Eik *et al*., (2008) at Mgeta. However, in the present study, animals were in the first parity with low body weight and still growing. These contributed to the lower milk yield observed throughout the lactation, since there is a correlation between body weight and milk yield (Adewumi and Olorunnisomo, 2009; Ezekwe and Machebe, 2005). Normally, milk yield increases with advancing lactations (age). Milk production is largely affected by a combination of factors, namely, the use of improved breeds selected for milk production (Malau-Aduli *et al.* 2004), a favourable nutritional environment and improved management practices (Buckley *et al*., 2003). Alexandre *et al.* (2002) reported an efficient response to supplementation of the Creole does (0.45 kg supplemented does produced 0.5 kg more milk).

Poor nutrition increases mobilization of adipose tissue reserves in early lactation to meet energy requirements of peak milk production (Ngwa *et al*., 2009; Margrete *et al*., 2006). Milk yield during lactation is improved by increasing level of concentrate supplementation in the diet. Though, the ingredients composition of the concentrate diet real matter. The significant ($P<0.001$) higher average daily milk yield and total milk yield per lactation observed in does received diet T_{600}, is the results of higher level of concentrate supplemented to them. This is in agreement with other researchers, Min *et al*., (2005); Greyling *et al.*, (2004); Malau-Aduli *et al.* (2004) and Alexandre *et al*., (2002) who found that milk yield increases with the increased level of concentrate diet.

Milk components depends largely on the volume of milk produced (Greyling *et al*., 2004). The constituents of milk, namely fat, protein and lactose determine the value of the milk (Sanz Sampelayo *et al*., 2007). The composition of milk is a function of several factors, e.g. breed, stage of lactation, climatic condition, diet and season (Shamay *et al*., 2000). In this study, the does received diet T_{600} produced the highest mean milk components, namely, fat, protein, SNF and TS compared to their counterparts in diets T_{200} and T_{400}. Fat content in milk was highest in the first ds after parturition, and then declined until 28th week of lactation. This is in agreement with other findings that, milk production increases with a decrease in milk constituents (Greyling *et al*., 2004; Olafadehan 2010). However it contradicts the earlier findings that reported markedly increase in fat content with the lactation stage. It is possible that frequent milking stimulate synthesis of milk fat within the mammary gland and hence increase the total milk fat content as well as milk production (Negrão *et al*., 2001).

Milk production and composition are more depending on composition of the diet fed to animal, the energy balance and energy reserved of the animal. Morand-Fehr *et al*., (2000) note that, the effect of concentrate diet under grazing condition has little effect on the milk composition, and higher level of energy intake normally increase milk production which containing lower level of fat. Differences in the milk composition of goats have been attributed to factors such as age and plane of nutrition. In this study, fat content was increased with the increase in level of dietary supplementation. This is because animals with a lower production capability (i.e. SEA goats), an increase in energy intake may increase milk production which may contain higher proportions of fat and protein (Hussain *et al*., 1996). The inclusion of Sunflower seed cake in the diet, has also contributed to higher fat content obtained (Chilliard *et al*., 2006). The higher TS obtained during the early lactation, might be due to the highly correlation of the TS yield with milk yield (Gadir and Zubeir, 2005). There is a positive but no significant correlation between TS and other milk constituents i.e. protein, SNF and lactose. This implies that the higher TS observed in this study, was due to the corresponding increase in protein and lactose contents of the milk (Olafadehan 2010).

Conclusion

The result obtained in this experiment indicated that does fed a high concentrate diet level (T_{600}), produced kids with significantly higher birth weight and higher milk yield with higher contents of fat, protein, SNF and TS compared to those fed low levels (T_{200} and T_{400}). The increased levels of concentrate supplementation might increase the availability and proper balance of nutrients to the doe. This in turn resulted to the higher supply of nutrients to the fetus which reflects higher birth weight and increase in milk yield. Therefore with similar grazing and roughages available, does should be supplemented with 500 – 600 g of concentrate diet during gestation and the level should be increased to 800 g during lactation period to obtain higher birth weight of the kids and higher milk yield. However, other factors such as body size, live body weight, health status of doe and environment may affect birth weight and milk yield of the doe. Also economic efficiency of milk production using concentrate supplementation should be considered when deciding levels of concentrate supplementation to feed.

References

Abd El Gadir, M.E., and Ibtisam El Zubeir, E.M., (2005). Production performance of crossbred (Saanen and Nubian) goats in the second kidding under Sudan conditions. *Pakistan Journal of Biological Sci.* 8(5), 734-739.

Acero-Camelo, A., Valencia, E., Rodríguez, A. and Randel, P.F., (2008). Effect of flushing with two energy levels on goat reproductive performance. *Livestock Research for Rural Development. Volume 20, Article No. 136.*

Adama, T.Z. and Arowolo, I.O., (2002). Body weight and body condition of Yankasa lambs and Savanna Brown kids from birth to 100 ds of life. *Journal of Agric. Sci. Techno.* 12, 92-96.

Adewumi, O.O. and Olorunnisomo, O.A., (2009). Milk yield and milk composition of West African dwarf, Yankasa and crossbred sheep in southwest of Nigeria. *Livestock Research for Rural Development. Volume 21, Article No. 42.*

Ahuya, C., Okeyo, A. and Peacock C., (2003). Developmental challenges and opportunities in the goat industry: The Kenyan experience. Small Ruminant Research, Volume 60, 197-206.

Ahuya, C.O., Ojango, J.M.K., Mosi, R.O., Peacocka, C.P., Okeyo, A.M., (2009). Performance of Toggenburg dairy goats in smallholder production systems of the eastern highlands of Kenya. Small Ruminant Res. 83, 7-13.

Akers, R. M., (2002). Lactation and the mammary gland. 1st ed. Iowa State Press, Ames, Iowa.

Akingbade, A.A., Nsahlai, I.V., Bonsi, M.L.K., Morris, C.D., du Toit, L.P., (2001). Reproductive performance of South African indigenous goats inoculated with DHP-degrading rumen bacteria and maintained on *Leucaena leucocephala/*grass mixture and natural pasture. Small Rumin. Res. 39, 73-95.

Akusu, M.O. and Ajala, O.O., (2000). Reproductive performance of West African Dwarf goats in the humid tropical environment of ibadan. *Vol.* 55 (2).

Alexandre, G., Fleury, J., Coppry, O., Archimede, H. and Xandé, A., (2002). Effects of mode of supplementation upon milk and growth performances of suckling Creole goats and their kids reared at pasture in Guadeloupe. *Livestock Research for Rural Development 14(1).*

Antunac, N., Samarzija, D., Havranek, J.L., Pavic, V., Mioc B., (2001). Effects of stage and number of lactation on the chemical composition of goat milk. Czech *Journal of Anim. Sci.*, 46, 548-553.

AOAC (2000). Official Methods of Analysis, Association of Analytical Chemists, Washington, DC.

AOAC.: Official methods of analysis, 14th ed., Association of Official Agricultural Chemist., Washington D.C., 1984.

Association Franoaise de Normalisation, (1981). Cellolose brute, Methode CCE 4eme Directive Norme NF V 03-040 in Aliments des animaux. Mbhodes d'analyse. AFNOR, Paris.

Ayalew, W., King, J.M., Bruns, E., Rischkowsky, B., (2003). Economic evaluation of smallholder subsistence livestock production: lesson from an Ethiopian goat development program. *Journal of Ecological Economics*. *Vol.* 45, 473-485.

Ben Salema, H. and Smith, T., (2008). Feeding strategies to increase small ruminant production in dry environments. Small Ruminant Res. 77,174-194.

Berhane, G. and Eik, L.O., (2006). Effect of vetch (Vicia sativa) hay supplementation on performance of Begait and Abergelle goats in northen Ethiopia. I. Milk yield and composition. Small Rumin. Res. 64, 225-232.

Bormann, J., Wiggans, G. R., Druet, T. and Gengler. N., (2002). Estimating effects of permanent environment, lactation stage, age, and pregnancy on test-day yield. *Journal Dairy Sci.* 85.

Bosman, H. G., Ayantunde, A. A., Steenstra F. A., Udo, H. M. J., (1997). A simulation model to assess productivity of goat production in the Tropics. Agricultural Systems, Vol. 54, No. 4, pp. 539-576.

Brotherstone, S., Thompson, R. and White, I. M. S., (2004). Effects of pregnancy on daily milk yield of Holstein-Friesian dairy cattle. *Livestock Production Sci*. 87, 265- 269.

Browning, R. Jr., Leite-Browning, M.L. and Sahlu, T., (1995). Factors affecting standardized milk and fat yields in Alpine goats. *Small Rumin.Researsch, 18,* 173–178.

Buckley, F., O'Sullivan, K., Mee, J.F., Evans, R.D. and Dillon, P., (2003). Relationships among milk yield, body condition, cow weight and reproduction in Spring-calved Holstein-Friesians. Journal of Dairy Sci. 86:2308–2319.

Carnicella, D., Dario, M., Ayres, M. C. C., Laudadio, V., Dario, C., (2008). The effect of diet, parity, year and number of kids on milk yield and milk composition in Maltese goat. Small Ruminant Research 77, 71–74.

Chikagwa-Malunga, S.K. and Banda, J.W., (2006). Productivity and survivability of goats in smallholder crop/livestock farming systems in Malawi. *Livestock Research for Rural Development* 18, 1: 2006.

Chilliard, Y., Ferlay, A., Rouel, J., Lamberet, G., (2003). A review of nutritional and physiological factors affecting goat milk lipid synthesis and lipolysis. J. Dairy Sci. 86, 1751–1770.

Chilliard, Y., Rouel, J., Ferlay, A., Bernard, L., Gaborit, P., Raynal-Ljutovac, K., Lauret, A., Leroux, C., (2006). Optimising goats milk and cheese fatty acid composition: effects of genotype, feeding factors and dairy technology. In: Willians, C., Buttriss, J. (Eds.). "Improving the fat content of foods" Woodhead Publishing Ltd. pp. 281-312.

Eik, L.O., Kifaro, G.C., Kiango, S.M., Nordhagen, Ø.M., Safari, J., Mtenga, L.A., (2008). Productivity of goats and their contribution to household food security in high potential areas of East Africa: A case of Mgeta, Tanzania. *African Journal of Food, Agriculture, Nutrition and Development Vol. 8, No. 3 (2008)* pp. 278-290.

Eknæs, M., Kolstad, K., Volden, H., Hove, K., (2006). Change in body reserves and milk quality throughout lactation in dairy goats. Small Ruminant Research, Volume 63, 1-11.

Elabid, K.E., (2008). Various factors affecting birth weight of Sudanese Nubian goat kids. Research Journal of Agriculture and Biological Sciences, 4 (6): 700-703.

Ezekwe, A.G. and Machebe, N., (2005). Milk composition of Muturu cattle under the semi-intensive system of management. Nigerian Journal of Animal Production 32(2): 287-292.

Gardner, D.S., Buttery, P.J., Daniel, Z. and Symonds, M.E., (2007). Factors affecting birth weight in sheep: maternal environment. Reproduction, 133(1):297-307.

Goetsch, A.L., Detweiler, G., Sahlu, T., (2002). A note on the effects of preweaning concentrate supplementation on performance of meat goats. J. Appl. Anim. Res. 21, 25–34.

Greyling, J.P.C., Mmbengwa, V.M., Schwalbach, L.M.J., Muller, T., (2004). Comparative milk production potential of Indigenous and Boer goats under two feeding systems in South Africa. *Small Ruminant Research*, *Volume 55, 97-105*.

Hansen, S., Therkildsen, M., Byrne, D.V., (2006). Effects of a compensatory growth strategy on sensory and physical properties of meat from young bulls. Meat Science 74, 628–643.

Hossain, M.E., Shahjalal, M., Khan, M.J., Hasanat, M.S., (2003). Effect of dietary energy supplementation on feed intake, growth and reproductive performance of goats under grazing condition. *Pakistan Journal of Nutrition* 2 (3): 159- 163.

Hoste, H., Torres-Acosta, J.F., Paolini, V., Aguilar-Caballero, A., Etter, E., Lefrileux, Y., Chartier, C., Broqua, C., (2005). Interactions between nutrition and gastrointestinal infections with parasitic nematodes in goats. Small Ruminant Research 60, 141–151.

Hussain, Q., Havrevoll, Ø., Eik, L.O., (1996). Effect of type of roughage on feed intake, milk yield and body condition of pregnant goats. Small Ruminant Res. 22, 131-139.

IDF Standard 152 (1991) International Dairy Federation, Brussels, Belgium

IDF Standard 20B (1993) International Dairy Federation, Brussels, Belgium

IDF Standard 21A, 152 (1982) International Dairy Federation, Brussels, Belgium

Isaacs, K.L., Owens, J.L., Little John, R.P., Johnstone, P.D., Fennessy, P.F., (1991). Influence of maternal live weight on reproductive performance and wool production of heterozygous Booroola Merino x Coopworth (FecB, Fec+) and Merino x Coopworth ewes. N. Zeal. Jornal of Agric. Res. 34, 55-67.

Ivey, D.S., Owens, F.N., Sahlu, T., The, T.H., Dawson, L.J., Campbell, G.A., Goetsch, A.L., (2000). Influence of the number of fetuses and levels of CP and ME in gestation and lactation supplements on performance of Spanish does and kids during suckling and post-weaning. Small Ruminant Res. 35, 123-132.

Kabir, F., Sultana, M.S., Shahjalal, M., Khan, M.J., Alam, M.Z., (2004). Effect of protein supplementation on growth performance in female goats and sheep under grazing condition. Pakistan Journal of Nutrition. 3, 237-239.

Kendall, P.E., Nielsen, P.P., Webster, J.R., Verkerk, G.A., Littlejohn, R.P., Matthews, L.R., (2009). The effects of providing shade to lactating dairy cows in a temperate climate. Livestock Science 103, 148–157.

Kinne, M., (2002). Neonatal mortality in kids. http//www.kinne.net/neomort.htm.

Kirkland, R.M. and Gordon, F.J., (1999). The metabolisable energy requirement for maintenance and the efficiency of use of metabolisable energy for lactation and tissue gain in dairy cows offered a straw/concentrate ration. *Livestock Production Science* 61: 23-31.

Kosgey, I.S., Baker, R.L., Udo, H.M.J., van Arendonk, J.A.M., (2006). Successes and failures of small ruminant breeding programs in the tropics: a review. *Small Rumin. Res.* 61: 13–28.

Kusiluka, L.J.M., Kambarage, D.M., Harrison, L.J.S., Daborn, C.J., Matthewman, R.W., (1998). Causes of morbidity and mortality in goats in Morogoro district, Tanzania: The influence of management. Small Rumin. Res. 29, 167–172.

Kusina, N.T., Chinuwo, T., Hamudikuwanda, H., Ndlovu, L.R. And Muzanenhamo, S., (2001). Effect of different dietary energy level intakes on efficiency of oestus synchronization and fertility of Mashona goats. Ruminant Res. 39, 283-288.

Luginbuhl, M., Poore, J.M.H., Mueller, J.P., Green, T., (1998). *Breeding and kidding Management in the Goat Herd.* NCSU Department of Animal Science.

Luo, J., Goetsch, A.L., Nsahlai, I.V., Sahlu, T., Ferrell, C.L., Owens, F.N., Galyean, M.L., Moore, J.E., Johnson, Z.B., (2004). Prediction of metabolizable energy and protein requirements for maintenance, gain and fiber growth of Angora goats. Small Rumin. Res. 53, 231–252.

Macedo, V.P., Damasceno, J.C., Santos, G.T., Martins, E.N., Macedo, F.A.F., Canto, M.W., (2002). Effect of supplementation level with concentrate on performance of the crossbred Saanen dairy goats in two production systems. Revista Brasileira de Zootecnia 31, 460-466.

Maghsoudi, A., Vaez Torshizi, R., Safi Jahanshahi, A., (2009). Estimates of (co)variance components for productive and composite reproductive traits in Iranian Cashmere goats. Livestock Science 126, 162–167.

Malau-Aduli, B.S., Eduvie, L., Lakpini, C., Malau-Aduli, A.E.O., (2004). Crop-residue supplementation of pregnant does influences birth weight and weight gains of kids, daily milk yield but not the progesterone profile of Red Sokoto goats. Reproduction and nutrition development. 44, 111-121.

Maniatis, N., Pollott, G.E., (2002). Maternal effects on weight and ultrasonically measured traits of lambs in a small closed Suffolk flock. Small Rumin. Res. 45, 235–246.

Mellado, M., Valdéz, R., García, J., López, R., Rodríguez, A., (2003). Factors affecting the reproductive performance of goats under intensive conditions in a hot arid environment. Small Ruminant Research , Volume 63 , Issue 1 – 2 , pp. 110 – 118.

Memiši, N., Žujović, M., Tomić, Z., Petrović, M.P., (2009). The effect of time of weaning on body mass and gain of kids. Biotechnology in Animal Husbandry 25, 993-998.

Milerski, M., Mares, V., (2001). Analysis of systematic factors affecting milk production in dairy goat. Acta Univ. Agric. Et Silvic. Mendel. Brun (Brno), *1*, 43–50.

Min, B.R., Hart, S.P., Sahlu, T., Satter, L.D., (2005). The effect of diets on milk production and composition and on lactation curves in pastured dairy goats. *Journal of Dairy Science, Volume 88, 2604-2615.*

Morand-Fehr, P., (2005). Recent developments in goat nutrition and application. Small Rumin Res. 60, 25-43.

Morand-Fehr, P., Boutonnet, J.P., Devendra, C., Dubeuf, J.P., Haenlein, G.F.W., Holst, P., Mowlem, J., Capote, J., (2004). Strategy for goat farming in the 21st century. Small Ruminant Res. 51, 175-183.

Morand-Fehr, P., Sanz Sampelayo, M.R., Fedele, Y.V., Le Frileux, Y., Eknaes, M., Schmidely, Ph., Giger Reverding, S., Bas, P., Rubino, R., Havrevoll, Ø., Sauvant, D., (2000). Effect of feeding on the quality of goat milk and cheeses. In: Proceedings of the Seventh International Conference on Goats, Tours, France, Tome I, pp. 53-58.

Mourad, M. (1992). Effect of mounth of kidding, parity and Litter size on milk yield of Alpine goats in Egypt. Small Rumin. Res. 8, 41– 46.

National Research Council (NRC) (1981). Nutrient Requirements of Goats: Angora, dairy and meats goats in temperate and tropical countries. National Academy Press, Washington D.C. pp. 250.

Negrão, J.A., Marnet, P.G., Labussiére, J., (2001). Effect of milking frequency on oxytocin release and milk production in dairy ewes. Small Ruminant Res. 39, 181-187.

Ngwa, A.T., Dawson, L.J., Puchala, R., Detweiler, G., Merkel, R.C., Wang, Z., Tesfai, K., Sahlu, T., Ferrell, C.L., Goetsch, A.L., (2009). Effect of stage of lactation and dietary forage level on body composition of Alpine dairy goats. *Journal of Dairy Science, Volume 92, 3374-3385.*

Nkungu, D.R., Kifaro, G.C., Mtenga, L.A., (1995). Performance of dairy goats, in Mgeta, Morogoro, Tanzania. S*rnet Newsletter*. 28: 3-8.

Nordhagen, Ø.M., (2004). Studies on productivity of dairy and meat goats in high potential areas of East Africa. A case study of Mgeta, Tanzania. MSc. - thesis, Norwegian University of Life Sciences, Norway, pp. 30 -50.

Official online gateway of the United Republic of Tanzania (2008). *National information by topics*. Available at: http://www.tanzania.go.tz/index2E.html.

Okeyo, A.M., (2000). The role of crossbreeding in the development of a dual purpose goat for small-holder production systems in Kenya**.** *In Proc. Workshop on Dairy goat Research & Production in Kenya: 20 Years on-Which way?, Held at The Garden Hotel, Machakos, Kenya, 11-12, October, 2000.*

Olafadehan, O.A., (2010). Early lactation milk yield and interrelationships between milk constituents of free grazing prepartum supplemented Bunaji Cows. Research Journal of Animal and Veterinary Sciences, 5: 1-5.

Orkov, E. R., (1999). Supplement strategies for ruminants and management of feeding to maximize utilization of roughages. *Preventive Veterinary Medicine*, 38, 179-185.

Peacock, C., (2005). Improving Goat Production in the Tropics. Oxfam/Farm Africa Publ., Oxford,U.K., pp. 386.

Peacock, C., (2008). Dairy goat development in East Africa: A replicable model for smallholders. Small Ruminant Research 77, 225–238.

Rafiq, M. Mumtaz, S., Akhtar, N. and Khan, M. F. (2007). *Effect of strategic supplementation with multinutrient urea molasses blocks on body weight and body condition score of Lohi sheep owened by tenants of Pakistan.* Livestock Production Research Institute, Okara Pakistan. Small Rumin. Res. 7(2-3):200-208.

Rastogi, A., Dutta, N. and Sharma, K., (2006). Effect of strategically supplemented pregnancy allowance on nutrient utilization and reproductive performance of goats. *Livestock Research for Rural Development. Volume 18, Article No. 159*.

Reynolds, L. (1990) *Effect of browse supplementation on production of West Africa dwarf goats.* International Livestock Centre for Africa, Ibadan Nigeria.

Safari, J., Mtenga, L.A., Eik, L.O., Sundstøl, F., Johnsen, F.H., (2008). Analysis of three goat production systems and their contribution to food security in semiarid areas of Morogoro, Tanzania. *Livestock Research for Rural Development. Volume 20, Article No. 74.*

Salama, A. A. K., Caja, G., Such, X., Casals, R. and Albanell, E., (2005). Effect of Pregnancy and Extended Lactation on Milk Production in Dairy Goats Milked Once Daily. *Journal of Dairy Sci*. 88, 3894-3904.

Salama, A. A. K., Such, X., Caja, G., Rovai, M., Casals, R., Albanell, E., Marı´n, M. P., Martı´, A., (2003). Effects of Once Versus Twice Daily Milking Throughout

Lactation on Milk Yield and Milk Composition in Dairy Goats. J. Dairy Sci. 86, 1673–1680.

Salim, H.M., Shahjalal, M., Tareque, A.M.M., Kabir, F., (2002). Effects of concentrate supplementation on growth and reproductive performance of female sheep and goats under grazing condition. Pakistan Journal of Nutrition 1(4): 191-193.

Sangare, M. and Pandey, V. S., (2000). Food intake, milk production and growth of kids of local, multipurpose goats grazing on dry season natural Sahelian rangeland in Mali. *British Social of Animal Sci.* 71, 165- 173.

Sanz Samplelayo, M.R., Fernández, J.R., Ramos, E., Hermoso, R., Gil Extremera, F., Boza, J., (2006). Effect of providing a polyunsaturated fatty acid-rich protected fat to lactating goats on growth and body composition of suckling goat kids. Anim. Sci. 82, 337-344.

SAS, 2003. SAS User's Guide (Release 9.1). Statistical Analysis Systems Inst., Cary, NC.

Schmidely, Ph., F. Meschy, J. Tessier, and D. Sauvant. (2002). Lactation response and nitrogen, calcium, and phosphorus utilization of dairy goats differing by the genotype for casein in milk, and fed diets varying in crude protein concentration. *Journal of Dairy Sci*. 85, 2299–2307.

Schoenian, S., (2009). An introduction to feeding small ruminants. Small Ruminant Info Series. www.sheepandgoat.com/articles/graintruth.html.

Sebei, P.J., McCrindle, C.M.E., Webb, E.C., (2004). Factors influencing weaning percentages of indigenous goats. *South African J. of Anim. Sci.*, 34 (Supplement 1) http://www.sasas.co.za/sajas.html.

Semakula, J., Mutetikka, D., Kugonza, D.R., Mpairwe, D., (2010). Comparison of Breeding Systems by Smallholder Goat Keepers in the Humid, Sub-Humid and Semi Arid Ecological Zones of Uganda. Agriculture Journal. 5, 89-97.

Serradilla, J.M., (2001). Use of high yielding goat breeds for milk production. Livestock Production Science 71, 59–73.

Shamay, A., Mabjeesh, S.J., Shapiro, F., Silanikove, N., (2000). Adrenocorticotrophic hormone and dexamethasone failed to affect milk yield in dairy goats: comparative aspects. Small Rumin. Res. 38, 255–259.

Sibanda, L.M., Ndlovu, L.R., Bryant, M.J., (1999). Effects of a low plane nutrition during pregnancy and lactation on the performance of Matebele does and their kids. Small Rumin Res. 32, 243-250.

Spahr, L., (2004). Body condition scoring in meat goats. Penn State College of Agricultural Sciences. Cooperative Extension in Bedford County. Available online at http://bedford.extension.psu.edu/agriculture/goat/Body%20Condition%20Scoring.htm.

Steg, A., J. M. van der Merwe, B. Smits and Hindle, V. A., (1987). Prediction of the digestibility of feedstuffs: recent developments. Annual report, ID-DLO, The Netherlands.

Supakorn, C. and Pralomkarn, W., (2009). Pre-Weaning Growth of Goats for Meat Raised on a Commercial Farm in Southern Thailand. *Thai Journal of Agricultural Science. 42,13-1*.

Tilley, J. M. A. and Terry, R. A. (1963). A two stage technique for the in vitro digestion of forages. Journal of British Grassland Society 18:104-111.

Tovar-Luna, I., Puchala, R., Sahlu, T., Freetly, H. C., Goetsch, A. L., (2010). Effects of stage of lactation and level of feed intake on energy utilization by Alpine dairy goats. J. Dairy Sci. 93, 4829–4837.

van Soest P. J., Robertson, J. B. and Lewis, B. A., (1991). Methods for dietary fibre, neutral detergent fibre and non-starch polysaccharides in relation to animal nutrition. J. Dairy Sci. 74, 3583-3597.

Zahraddeen, D., Butswat, I.S.R., Mbap, S.T., (2008). Evaluation of some factors influencing growth performance of local goats in Nigeria. *African Journal of Food Agriculture Nutrition and Development. Volume 8, No. 4, pp. 464-479.*