MILK YIELD AND LINEAR BODY MEASUREMENT OF DAIRY GOAT AT EARLY LACTATION

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ABSTRACT

Studies were conducted to evaluate the milk yield and linear body measurements of Saanen dairy goat at early lactation stage (0 until 9 weeks postpartum). A total of 10 Saanen were chosen randomly among the early lactating group as experimental units. The parameters for linear body measurement were body weight (BW), circumference of heart girth (HG) and body length (BL). Study was conducted by collecting the data weekly. A one-way analysis of variance (ANOVA) was used to determine BWT, HG, BL and Yield with the General Linear Model (GLM) procedure of SAS 9.3. Pearson's correlation Coefficients between parameters measured were determined using the CORR procedure in SAS. The level of significant level used to determine the differences between treatment is $P<0.05$. There was significant difference on milk yield ($P<0.05$) between weekly collected data. However, most of the parameters measured were not differed significantly ($P>0.05$) between the weeks in lactation. The peak milk yield ($P<0.05$) was recorded at week 6 postpartum with mean yield 2.75 litre. The average milk yield, BWT, BL and HG of Saanen dairy goat at early lactation was determined as 2.33 litre, 42.65 kg, 78.21 and 79.32 cm respectively. There is correlation ($P<0.05$) between BL and all parameters measured. The strength of correlation was determine based on the coefficient of correlation (r value). There is a strong correlation observed between BWT and HG ($r=0.80$), while there is also correlation between BL with BWT ($r=0.75$), HG ($r=0.50$) and yield ($r=0.05$). The most favourable regression equation established is when BL and HG is considered together, with coefficient of determination up to 75% and the equation is derived as: BWT = -94.200 + (BL*1.561) + (HG*2.844).

Keywords: Saanen, dairy goat, milk yield, body weight, body linear measurement, heart girth, body length

HASIL SUSU DAN UKURAN BADAN LINEAR KAMBING TENUSU DI LAKTASI AWAL

ABSTRAK

Satu kajian telahpun dibuat untuk mengkaji hasil susu dan ukuran berat badan linear kambing tenusu primipara baka Saanen pada peringkat laktasi awal (0 hingga 9 minggu laktasi). Sebanyak 10 ekor kambing tenusu primipara baka Saanen dalam peringkat laktasi awal dipilih secara rawak. Parameter untuk ukuran badan linear adalah berat badan (BWT), lingkaran dada (HG), dan panjang tubuh (BL). Kajian ini telah dilakukan dengan merekod data pada setiap minggu. Analisis ANOVA satu hala digunakan untuk menentukan BWT, HG, BL dan Yield berdasarkan prosedur General Linear Model (GLM) SAS 9.3. Analisis *Pearson's correlation Coefficient* antara parameter yang diukur ditentukan menggunakan prosedur CORR dalam SAS. Tahap signifikan yang digunakan untuk menentukan perbezaan antara rawatan ialah $P < 0.05$. Terdapat perbezaan bererti pada hasil susu ($P < 0.05$) yang diperolehi. Walau bagaimanapun, kebanyakan parameter yang diukur tidak mempunyai perbezaan ($P > 0.05$) antara data mingguan. Laktasi puncak ($P < 0.05$) dicatatkan pada minggu pasca 6 dengan min hasil susu 2.75 liter. Purata hasil susu, BWT, BL dan HG dari kambing tenusu Saanen pada laktasi awal masing-masing ditentukan sebanyak 2.33 liter, 42.65 kg, 78.21 dan 79.32 cm. Terdapat korelasi ($P<0.05$) diatara BL dengan semua parameter yang diukur. Kekuatan korelasi ditentukan berdasarkan korelasi koefisien (value r). Terdapat korelasi yang kuat antara BWT dan HG ($r=0.80$), manakala terdapat juga korelasi antara BL dengan BWT ($r=0.75$), HG ($r=0.50$) dan hasil susu ($r=0.05$). Persamaan regresi yang memuaskan untuk menentukan berat badan kambing tenusu primipara baka Saanen adalah ketika BL dan HG dianggap bersama, dengan koefisien korelasi hingga 75%. Maka persamaan yang diperolehi adalah seperti berikut: BWT = -94.200 + (BL * 1.561) + (HG * 2.844).

Kata kunci: Saanen, kambing tenusu, hasil susu, berat badan, ukuran badan linear, berat badan, lingkaran dada, panjang tubuh

TABLE OF CONTENT

LIST OF TABLES

LIST OF FIGURES

LIST OF SYMBOLS, UNITS AND ABBREVIATIONS

%	Percentage
°C	Degree of Celsius
"E	East
"N	North
ANOVA	Analysis of Variance
BCS	Body Condition Score
BL	Body length
BWT	Body weight
Cm	Centimetre
CORR	Pearson correlation coefficient
DHIR	Dairy Herd Improvement Registry
DIM	Day in milk
F2	Second filial generation
F3	Third filial generation
g	Gram
g per day	Gram per day
GLM	General Linear Model
HG	Heart girth
ID	Identification
Inc.	Incorporated
kg	Kilogram
LID	Local Indian Breed
Mil. litres	Million litres
mm	Millimetre
N/A	Not available
NEB	Negative Energy Balance
R^2	Coefficient of (Multiple) Determination
SAS	Statistical Analysis System
USA	United States of America
Yield	Milk yield

LIST OF FORMULAE

CHAPTER 1

INTRODUCTION

1.1 Introduction

Milk is an important source for dairy product such as fluid milk, milk powder, cheese, yogurt, butter, and ice cream. Milk can be very important in providing good source of protein, vitamin, calcium and dairy is fattening. Milk products are becoming more popular to Malaysian consumers. According to a study conducted by Boniface and Wendy (2012), Malaysian consumers have increased their consumption of dairy product. This will continue to increase as it is because Malaysian are now aware and conscious about their health.

Milk is produced by the mammary gland of a mammal. The process of producing milk is called lactation. Lactation occur after the animal gone to the process of giving birth, parturition. Other than dairy cattle, dairy goat are also reared for milk production. Goats milk are usually referred to as homogenised goat milk which is because of the small milk fat globules, having less curd yields and weaker cured firmness which together help in the digestion. Goat milk have higher level of essential amino acids compared to cow milk (Posati and Orr, 1976).

Goat are known to be the earliest livestock to be domesticated. The number of goat populations are 921 million with total of 570 breeds available. More than 30 indigenous breeds are found in developing countries and 15 of them are found in Asia. Asia have the largest population of goats which is 60 % (556 million), followed by Africa having 311 million of goats, India, China and Pakistan consisting of 35.2 %, 29.3 % and 12.0 % of goat's population respectively. Altogether, they share 77 % of the goat's population and 42 % of breed share.

In Asia, there are 146 indigenous breed that could be identify. From this number, there are only 13 breeds that belongs to the dairy goat. However, all of these breeds are low-medium milkers. Apart from that, many of the 'improved breeds' which can produce higher milk yield are introduce into Asia which include Alpine, Anglo-Nubian, Saanen, Tonggenburg and Boer. From crossing the improved breeds with the indigenous breeds, there are many variable results of crossbreeds. For example, crossbreeding up to F2-F3 generation has improve the productivity of Anglo-Nubian in Malaysia.

In 2014, the number of goat has increased up to 5 % which is 434, 202 in 2013 to 455, 727 in 2014 (Department of Statistics Malaysia, 2015). In peninsular Malaysia, up until 2014 there are only 8,195 heads of dairy goats reported (Shanmugavelu, 2014). Malaysia do not have any local breed for dairy goat and the production is relatively low in the Malaysia livestock sector. Furthermore, there are official national goat milk production statistics. Based on the Country Report - Malaysia 2013/2014, the average milk yield ranges from 1 to 5 litre per head daily, depends on the type of breeds, farm size and the production system.

The consumption of goat milk in Malaysian however is showing a slight increment despite the lack of national statistic. This is due to the increase in milk demand in this country due to the increasing population. Other than that, Malaysian are now becoming more educated, they are more concern about their health and choice of beneficial healthy food and increase in society affluence have cause the increase demand on goat milk.

1.2 Justification

Several correlation parameters can be used to estimate the live body weight of dairy goat since it is more practical and less time consuming (Nsoso *et al.*, 2004). Moreover, the estimation of body weight by heart girth and body length was well establishes in lactating dairy goats (Alade *et al.*, 2008). Meanwhile, other has include heart girth, withers height, body length, chest depth and shank circumference in estimation of dairy goat's body weight.

Past study has found out there is a correlation between body weight and milk yield and between body weight and linear body measurement. However, there are still limited reference available for the correlation between linear body measurement and milk

yield. Therefore, this current study can fill the knowledge gap for the correlation between linear body measurement and milk yield for Saanen dairy goat in Malaysia.

Objective

i. To evaluate the body weight, circumference of heart girth, body length and milk yield of dairy goat at early lactation stage.
ii. To determine the correlation of circumference of heart of heart girth, body length and milk yield on body weight of the dairy goat at early lactation stage.

1.3 Hypothesis

H_O: There is no correlation between the live body weight and body linear measurement of dairy goat on the milk production within two months after kidding.

H_A: There is a correlation between the live body weight and linear body measurement of dairy goat on the milk production within two months after kidding.

CHAPTER 2

LITERATURE REVIEW

2.1 Dairy Industry in Malaysia

Dairying was introduced as an agricultural activity in Malaysia since early twenty centuries. Dairy cattle are brought by the immigrants from India. They have brought with them several non-descriptive mixture of Indian cattle breeds, which was then given the name 'Local Indian Breed' (LID). Since then many programme such as introducing pure breeds, upgrading and continuous selection, cross breeding programme and Dairy Development Programme has been establish by many institute, government and non-government including the European Agriculturist, Government Dairy Farm, Department of Agriculture, Department of Veterinary Services and local dairy farm. The purposes of all programmes are to improve the performance and produce high-grade of dairy cattle.

Dairy industry development project in Sabah started in the early 1970's. In the crossbreeding programme, local Zebu cattle were crossbreed with imported Friesian by using the artificial insemination. Later on in 1976, dairy breeding herds were established in Keningau and Tawau. In 1980, Sahiwal-Freshian heifers were introduced from New Zealand. Meanwhile, around the same time, Koperasi Pembangunan Desa uses the pure Friesian breed and venture into highland dairy farming at Mesilau Plateau, Ranau.

The status of the dairy industry in Peninsular Malaysia and Sabah between 1990 to 2010 (Malaysia Livestock Breeding Policy Committee 2013) was shown in Table 2.1 and Table 2.2.

Table 2.1 Status of the dairy industry in Peninsular Malaysia (1990-2010)

Parameter	Year				
	1990	1995	2000	2005	2010
Total Dairy Animals	N/A	N/A	37,854	25,843	34,386
No. of Milking Cows	N/A	N/A	14,635	9,617	12,646
Milk Production (mil. litres)	26.20	31.87	24.42	34.06	67.00
Milk Yield per Cow per lactation (litres)	N/A	N/A	1,669	2,631	2,658
Lactation Length (days)	N/A	N/A	N/A	300	270
Calving Interval (days)	N/A	N/A	N/A	4878	475

Source: Malaysia Livestock Breeding Policy Committee 2013

Table 2.2 Status of the dairy industry in Sabah (1990-2010)

Parameter	Year				
	1990	1995	2000	2005	2010
Total Dairy Animals	1,870	3,140	2,360	3,632	7,180
No. of Milking Cows	1,140	1,740	1,830	2,725	4,204
Milk Production (mil. litres)	2.00	4.89	4.99	7.48	10.40
Milk Yield per Cow per lactation (litres)	1,758	1,905	2,009	2,325	2,470
Lactation Length (days)	272	279	275	282	267
Calving Interval (days)	386	389	402	381	398

Source: Malaysia Livestock Breeding Policy Committee 2013

2.2 Dairy goat

Goats are known to be the earliest animal domesticated. They are known to be able to tolerate to harsh climate change and have high resistance to diseases. This explains why goats flourish well and rapid in most part of the world. Dairy goats are reared for their purpose on milk production. In many developing countries, dairy goats are the primary source of milk for human's consumption. This is because the composition of goat milk is similar to cow milk. Not only that, goat does not need large space requirement and they are able to consume leafy forage or low quality food and covert it to good quality of meat or milk compared to other animals.

Goats have many benefits compared to cow. This is because the goat milk has better digestibility and cause less allergic compared to cow milk. According to a study by

Ambrosoli *et al.* (1988), guinea pigs that is fed with goat milk that has less or no α-s-1-casein, but has α-s-2-casein has less curd yield, longer rennet coagulation time, more heat lability and weaker curd firmness, in which can also be used to explain the benefits in digestibility in the human digestive tract.

Dairy goats are smaller in size compared to a cow which is about one-sixth the size of a cow. This makes them easy to be handle and transported in a car. In addition, goats are more efficient than cows as because it takes less feed for a dairy goat to produce a gallon of milk. Other than that, the dairy goats have longer productive life which is about 8 to 10 years compared to an average cows which can only serve 4 to 6 years (Curtis, 2011).

The goat's milk is the milk of the first domesticated animals consumed by humankind. A good dairy goat can produce 2.7 to 5.4 kg of milk a day for 305 days of lactation which is about 5 times less produced by a good dairy cow (Curtis, 2011). Furthermore, a low producing goat will give about 1.8 litres of milk a day up to six months.

Goat milk have higher proportion of butterfat, minerals and Vitamin A, Vitamin B and riboflavin (Vitamin B2) (Hayam *et al.,* 2014). The high proportion of butterfat gives goat milk more energy value per unit volume. One unit of fat is equal to 2.5 more energy than 1 unit of carbohydrate. The minerals content which is found to be high in goat milk includes calcium, phosphorus, chlorine, magnesium and potassium. Other than that, goat milk able to treat stomach ulcers due to the its high buffer capacity. Another speciality of the goat milk is the finer particle size of the curd which makes the goat milk to be more easily digested by human.

2.2.1 Dairy Goat Breeds

Malaysia does not have any local dairy goat breed. The dairy goat breeds that are imported includes, Saanen, Alpine, Toggenberg and Shami (Damascus) goat. In Sarawak, a total of 115 dairy goats have been imported by the Agriculture Department in 2009 (Malaysia Livestock Breeding Policy Committee, 2013). The dairy goat breeds including the Saanen, Anglo Nubian, British Alpine, Toggenberg and the Australian Brown breeds which is to meet the request from the local dairy goat producers. The various representative production data for various goat diary breeds is shown in Table 2.3.

Table 2.3 Milk Production by dairy goat breed (2003 DHIR data).

Breed	Milk Production (kg/ lactation)		Milk fat (%)	Milk Protein (%)
	Average	Range		
Alphine	1028	358-2481	3.4	2.9
LaMancha	953	336-1960	4.0	3.2
Nubian	826	254-1937	4.9	3.7
Oberhasli	973	422-2018	3.9	2.9
Saanen	1169	277-2490	3.3	2.9
Tonggenburg	959	426-1987	3.2	2.7

Note: Individual doe data not adjusted for age (275- to 305-day record)

Source: Robert *et al.*, 2017

https://extension.psu.edu/downloadable/download/sample/sample_id/524/

Anglo Nubian is an all-purpose goat that is use for meat and hide production. This breed was a result from crossing breeds of Nubian and English goat (Anonymous, 2017b.). Although it does not have the length of lactation or the quality of milk produced by Swiss breeds, it produces milk that is high in butterfat content. The goat is able to breed out of season and therefore – they are desirable to many tropical countries.

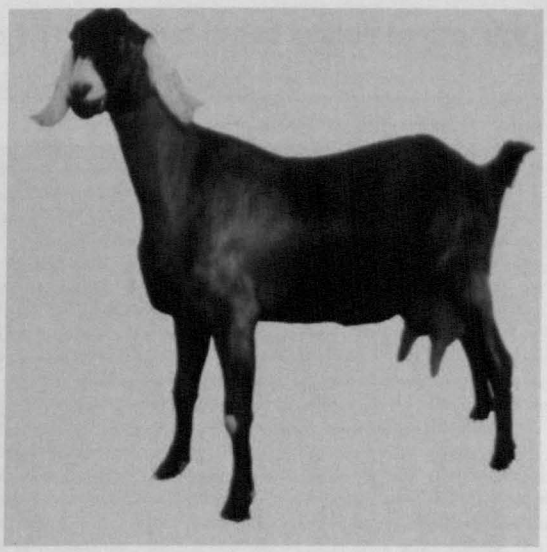

Figure 2.1 Anglo Nubian goat

Source: FarmCradle 2016 http://farmcradle.com/15-different-types-of-goats-breeds/

Saanen are is one of the heavy milk producer that can produce up to 1169 kg of milk per lactation (Robert *et al.*, 2017), originating from Saanen Valley of Switaerland. The buck and doe weight about 70-90 kg and 60-70 respectively (Anonymous, 2017a.). Moreover, in the United State, this breed is one of the best due to their consistency in producing large amount of milk in accordance to their sturdiness, easy to manage and also easy to adapt to tolerate environmental changes.

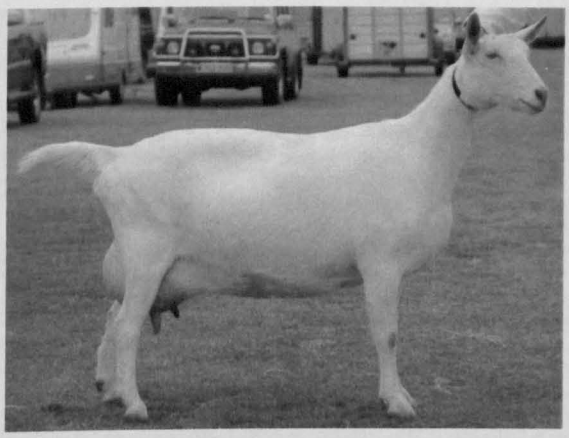

Figure 2.2 Saanen goat

Source: FarmCradle 2016 http://farmcradle.com/15-different-types-of-goats-breeds/

The British Alpine highly active breed which is suited to open grazing management system. They were originated from Switzerland and are available in almost all countries of Europe (Anonymous, 2017b.) This type of breed is able to produce good milk production with better average butterfat and solid-not-fat.

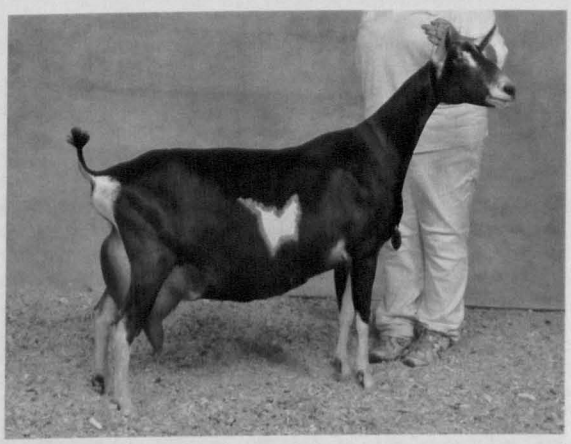

Figure 2.3 British Alpine goat

Source: Steve Pope 2017 http://adga.org/adga-national-show-alpine-champions-2017/

Tonggenburg goat is originally from the Obertoggenburg, Switzerland, in which where the purity of this breed was strictly regulated. It is known to be the oldest known dairy breed of goat. This type of breed is popular in both small farm operations and commercial dairies because of its excellent milk production. due to their excellent milk production, Tonggenburg goats are used as dairy goat breeder of India, Malaysia, Philippine, Venezuela, South Africa and many more (Anonymous, 2017b.)

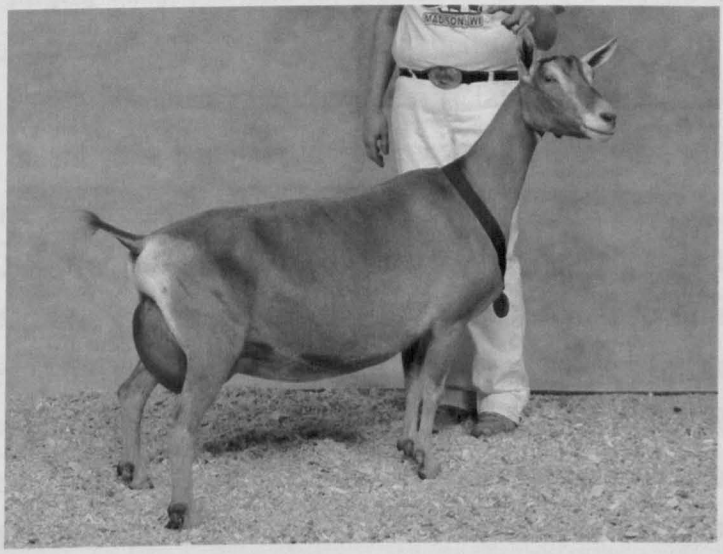

Figure 2.4 Toggenburg goat

Source: Steve Pope 2017 http://adga.org/adga-national-show-toggenburg-champions-2017/

Australian Brown breed developed in Australia since 1990 and then officially recognized as a breed in 2006. It is well known for its long lactating period and ease of milking.

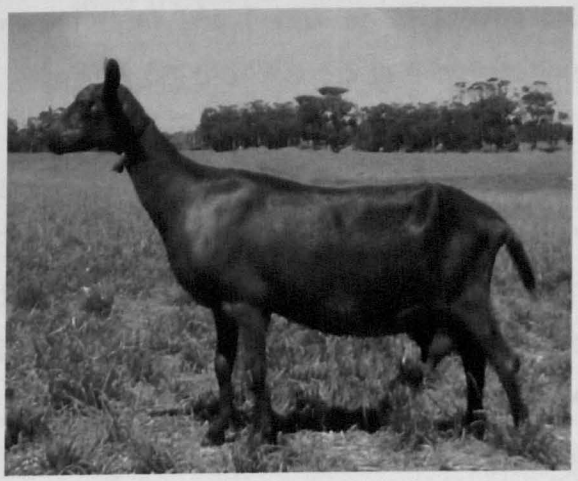

Figure 2.5 Australian Brown goat

Source: http://bib.ge/goat/open.php?id=912

2.3 Factor Influencing Milk Yield

2.3.1 Stages of Lactation

Lactation is the process of producing milk by the mammary gland of the mammalian species. This process occurs after parturition which is defined as the process of giving birth, and the period of lactation is between one parturition and the next. Lactation cycle is split into four stages, early mid and late lactation and the dry period. Nsahlai, *et al.* (2004) divide the lactation stage into: early lactation (week 1 until 10 postpartum), mid lactation (week 11 until 20 postpartum), and late lactations (week 20 and above). Based on one study on Baladi dairy goats by El-Tarabanya and Roushdya (2016), the stage of lactation was divided into three stages; Early (DIM less than 80 days), Mid (DIM 80-140 days) and Late (DIM over 140 days). Another most important phase in the lactation cycle is the dry period. Irene (2004) stated that dry period or late pregnancy is important because it determine the gain success of herd and many aspects of the health program. Therefore, the pregnant doe should have a 40 to 60 days dry period for them to regain the condition lost during lactation and achieve a certain body score as preparation before they enter the early lactation. In an ideal world, does must achieve kidding rate 3 times within two years. In a nutshell, lactation stage is one of the many factors that can influence the production of milk (Ibeawuchi and Dangut, 1996).

Early lactation

Generally, the milk yield of the dairy goat will peak from four to six weeks (Robert *et al.*, 2017) after kidding however the feed intake will not peak until later. However, Hart (2008), Gadir and Zubeir (2005) and Louca *et al.* (1975) said that, the peak milk production is between weeks 3 to 8, 5 to 7 and 5 to 6 of lactation, respectively. The rate of decline in milk yield after kidding is known as persistency. High lactating does will have high the peak milk production as well as high persistency.

The number of blood vessels in the mammary gland during pregnancy increases gradually as the gland preparation for abundant milk production (Yasugi *et al.*, 1989; Matsumoto *et al.*, 1992; Djonov *et al.*, 2001). At the establishment of lactation, the blood vessels in the mammary gland are maintained and slowly regress with advancing lactation and involution. As a result, the change in milk yield are associated with the changes in blood flow to the mammary gland (Prosser *et al.*, 1996). However, even though the mammary blood flow and milk yield are closely associated, they are not always causally

linked as because other limiting factor involved can have an influenced on the milk yield (Prosser *et al.*, 1994; Lacasse and Prosser, 2003).

At the early lactation stage, the dairy goat will experience negative energy balance and variable degree of lipolysis in fatty tissue, increasing levels of free fatty acids that have a negative effect on the palatability traits of milk (Strzałkowska *et al.*, 2009). Due to the genetic potential, the does are in a state of negative energy balance in early to mid-lactation. The negative energy balance is when the body reserves, which are the fat and protein, have to be used to make up for the lack of the energy in the doe. After the milk production has decreased to 60 to 80 % of the peak, the energy from the animal's nutrient will meet the does demand. The relationship between feed intake, body weight, and milk production in lactating doe is illustrated in Figure 2.5.

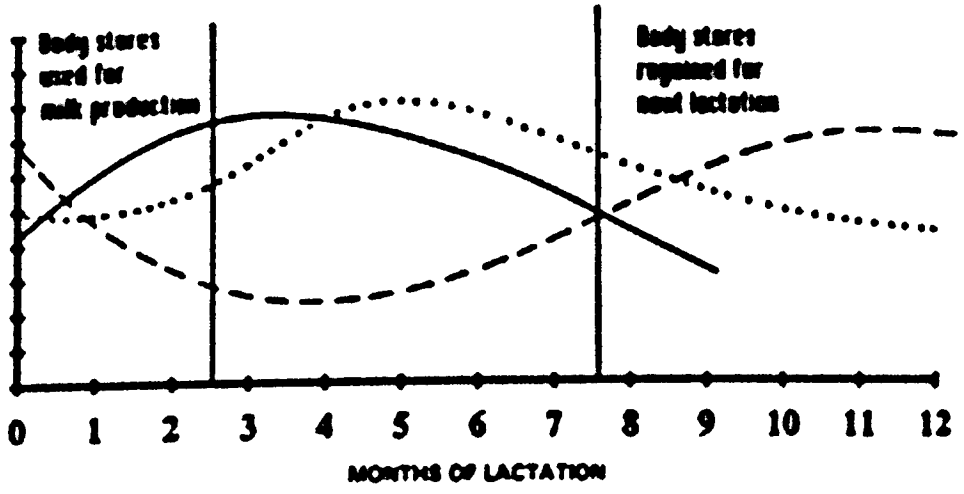

Figure 2.6 Relationships of milk yield (–), body weight (- - -) and feed intake (. . .) of lactating goats.

Source: EXtention.org 2012 http://articles.extension.org:80/pages/31784/goat-early-lactation

2.3.2 Gestation

In pregnant does, the gestation period can be divided into three stages: Day 0 to 50; 50 to 100; and more than 100 (Sahlu and Goetsch, 1998). From Day 0 up to 100 of gestation, the foetuses is develop and additional nutrient above needed to be given for lactation, maintaining body weight, activity and growth. There is a significant decrease in milk production towards the end of the lactation period. According to Salama *et al.* (2005), pregnancy causes the milk yield to reduce from week 10 after conceiving onward.

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