Assessment on Morphometric Characteristics Measurements and Population of Boer Goats in Perlis using Linear Regression Model

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DECLARATION

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ABSTRACT

In Malaysia, the demand of meat consumption by the consumers has been exceeding the amount of livestock production for meat yield purposes. However, there is only little information about the total population of goat available in each area and state such Perlis itself. There is also no proper guidance on morphometric measurements aside from livestock body score scheme that can determine the health condition of goats based on their own breeds. The objectives of this study are to identify the population of Boer goats in Perlis and to estimate the relationship of the morphometric characteristics of goat by using linear regression model. Cluster sampling method is applied by choosing 150 goats from different farms located in Kangar, Arau and Padang Besar, Perlis as the targeted sample for this study. The data collection is done by measuring the morphometric parameters in purebred and crossbred Boer goats. The complete data is then analyzed and modeled with linear regression by using Statistical Package for Social Science (SPSS). This study is proven to have higher live body weight value in male goats when comparing to females. Moreover, this study showed that there is a significant relationship between live body weight with body measurements in Boer goats that could lead to more meat yield with Boer goat population in Perlis, Malaysia.

Keywords: *Morphometric characteristics, linear regression model, Boer goat, live body weight, body measurements*

ABSTRAK

Di Malaysia, permintaan untuk konsumsi daging oleh pelanggan telah melebihi daripada bilangan pengeluaran ternakan yang bertujuan untuk hasil daging. Walaupun begitu, hanya ada sedikit informasi mengenai jumlah populasi kambing yang ada di setiap kawasan dan negeri seperti di Perlis sendiri. Tidak ada juga panduan ukuran morfometrik yang betul selain daraipada skema skor badan ternakan yang boleh menentukan keadaan kesihatan kambing berdasarkan baka masing-masing. Objektif kajian ini adalah untuk menentukan populasi kambing Boer di dalam Perlis and menganggar hubungan di antara ciri-ciri morfometrik kambing dengan menggunakan model regresi linear. Kaedah pensampelan kelompok telah digunakan dengan memilih 150 ekor kambing dari ladang-ladang ternakan berbeza yang bertempat di Kangar, Arau dan Padang Besar, Perlis sebagai sasaran sampel untuk kajian ini. Pengumpulan data disiapkan dengan mengukur sebilangan parameter morfometrik dalam kambing Boer baka tulen dan kacukan. Data lengkap kemudiannya dianalisis dan dimodelkan dengan regresi linear menggunakan Statistical Package for Social Science (SPSS). Kaji selidik ini membuktikan ianya mempunyai nilai berat badan hidup yang lebih tinggi dalam kambing jantan apabila dibandingkan dengan betina. Tambahan pula, kajian ini menunjukkan bahawa hubungan yang ketara di antara berat badan hidup dengan ukuran badan kambing Boer yang boleh membawa kepada lebih banyak hasil daging menggunakan populasi kambing Boer di Perlis, Malaysia.

Kata kunci: *Ciri-ciri morfometrik, model regresi linear, kambing Boer, berat badan hidup, ukuran-ukuran badan*

LIST OF FIGURES

LIST OF TABLES

LIST OF SYMBOLS

		Page
%	Percentage	2
y	Response or dependent variable	15
x	Single regressor or independent variable	15
$þ_0$	Intercept of y value when x is 0	16
$þ_1$	Regression coefficient	16
e	Error or value of variation for regression coefficient	16
Y_j	Dependent variable for live body weight	22
X_1	independent variables NC for male	22
X_1, X_2 and X_3	Independent variables PG, CG and CC for female	22

LIST OF ABBREVIATIONS

		Page
LBW	Live Body Weight	3
MM	Morphometric measurements	5
kg	kilogram	4
MT	Metric ton	9
SPSS	Statistical Package for Social Science	17
N	North	18
E	East	18
BL	Body length	19
CG	Chest girth	19
WH	Wither height	19
CD	Chest depth	20
PL	Paunch length	20
CC	Cannon circumference	20
HEL	Head length	20

PG	Paunch girth	20
PH	Paunch height	20
NC	Neck circumference	20

CHAPTER 1

INTRODUCTION

1.1 Research Background

Livestock industry has been one of the important emerging industries that promotes agricultural development in Malaysia. The reason is because it caters to the local population with supplies of meat, milk and dairy products as well as vast job employment. This also includes goat industry as one of the livestock industries which contributes to the livestock development. According to Food and Agriculture Organization of the United Nations (2021), the world ovine meat production statistics in 2020 is 16.2 million with the highest number in Asia (9.8 million), followed by Africa (3.6 million), Europe (1.2 million), Oceania (1.1 million), South America (0.3 million), Central America (0.1 million), and Northern America (0.09 million). Ever since Covid-19 outbreaks started, trading livestock business from oversea has become more difficult. On the other hand, this problem has opened up new opportunities to the locals and

smallholder farmers in engaging with goat raising, either doing it as a side income or main job. Now, it has become one of major contributors to Malaysia rural economy.

There are several goat breeds that are primarily raised for meat purpose in Malaysia, including the indigenous goat Katjang and exotic breeds such as Jamnapari, Boer and Savanna. Malaysia also has crossbreed meat-type goats for enhancing meat yield like Boer-Katjang. Other than for daily consumption, the market demand of goats in Malaysia also focuses on for Muslim religion festive season such as *Korban* and *Akikah*. In Perlis, many farmers choose Boer goats (Figure 1.1) or Crossed Boer goats for their meat goat farming. Boer goat is a meat goat with a larger frame that has developed some adaptations to the region where it is raised. Domestic market in Perlis have more demand on meats of Boer goat compared to other types of goat meat. This is because the locals prefer the Boer goat meat as they are meatier. Boer goat has the dressing percentage of 50-57%, while other breeds of goat will dress out probably less than 45% (Vincent, 2018).

Figure 1.1: Boer goat (Source: Britannica, 2018)

Meat-type goat need to be known its live body weight (LBW) as it is an important economic trait in deciding the amount of feed intake for the animal and determining drug dosages. However, not all farmers in rural area could afford in procuring weighing scales to weight their animals due to their lack finance and the field conditions in rural farms. Therefore, farmers can use an alternative to solve these problems by using body measurements to estimate the goat body weight. According to Habib et al. (2019) and Waheed et al. (2020), some studies showed a strong connection between body measurement and goat body weight. Apart from that, weighing the weight of animal itself is not really accurate and less effective. This is because some farmers commit fraud by giving food or drink more than necessary to increase the body weight livestock before they are being sold to the market.

The aim in this study is to identify the Boer goat population in Perlis. In gaining information on morphometric characteristics of goat, linear regression model is used for the research. The model is chosen because it can determine the relationship between body measurements with the growth of Boer goats.

1.2 Problem Statement

Perlis, known as the smallest region located at furthest north of Malaysia, also has a number of goat farms being run at different locations such as Kangar, Arau, and Padang Besar, Perlis. The most population of goat breed that serve for meat purpose in Perlis farms is Boer goat. However, there is no availability of study publications on the

morphometric traits of Boer goats in Perlis region. Ab Jalal (2018) found that the demand of meat by consumers in Malaysia, including Perlis residents, has always shows higher growth rate compared to supplying the meat (Table 1.1). By conducting this study, the information of goat population in Perlis could give contribution to the market and also to the world as the total goat population in one region is a part of managing livestock production and meat consumption in Malaysia.

*e = estimated

Table 1.1: Per capita consumption of meat in Malaysia (kg).

Product	1993	2003	2010	2015	2016	2017[e]
Beef	3.65	5.06	6.42	8.1	7.7	7.8
Mutton	0.48	0.75	0.82	1.4	14	1.5
Pork	10.1	7.83	8.87	7.3	7.1	7.1
Poultry	28.06	37.7	48.75	57.1	61.2	59.4

(Source: Department of Veterinary Services, Malaysia, 2018)

Morphometric refers to the study or concept on quantitative description and analysis of form which comprises both the size and shape of an organism. It is important to study about the morphometric characteristics of the goat as they could be an alternative in determining the LBW of goats without weighing the goats at the farm. Abd-Allah et al. (2019) said that measuring heart girth, also known as chest girth, is the most practical method to estimate the LBW of goats when the measuring equipment for weighing is not available or inaccessible. In addition to that, several studies conducted showed a strong connection on goat body weight with body measurements, which was a positive and

significant relationship between live body weight and morphometric measurements (MM) consisting body length, wither height and heart girth in Boer goats (Habib et al.,2019 and Waheed et al., 2020). When the result exhibited high correlation coefficients between LBW and MM, it is proven that using either of the variables or combination for estimation could predict LBW in Boer goats.

Goat from different breeds may have variation of body weights as each breed also has different body sizes and measurements. For instance, Katjang goats have smaller body size than other meat type goats, hence it is more convincible to measure morphometric traits of goats based on their own breed. Furthermore, there were also problems ensued where the data of weighing animal only is less effective, inaccurate and does not show a definite result. Dakhlan et al. (2020) reported that few farmers altered their livestock body weight before they are sold at the market by feeding or giving more drink more than their usual feeding regimen. Due to this misconduct, calculating the measurement of morphometric traits in goats would support more evidence in determining whether those livestock are growing in a healthy condition or not.

Hence, this study is aimed towards Boer goat population raised at farms in Kangar, Arau, and Padang Besar, Perlis. This study could benefit the researchers and producers in estimating the morphometric characteristics of goat by using linear regression model. This study could also help the government to achieve the objective of National Agro Food Policy (2011-2020) which to achieve self-sufficiency in agro-food production including livestock.

1.3 Hypothesis

H_o: There is no difference between the goat morphometric measurements between male and female.

H_a: There is difference between the goat morphometric measurements between male and female.

1.4 Scope of the Study

In this research, the population of Boer goats in Perlis is the main focus on the scope of study. The study is also focusing on the morphometric characteristics of goats and body measurements were used as independent variables. Whereas the live body weight of Boer goats was used as dependent variable. The purebred and crossbred Boer goats that are raised in farms at Kangar, Arau, and Padang Besar, Perlis were selected for the samples for the study.

1.5 Significance of the Study

In this study, the morphometric characteristics of goat are highlighted. The significant of this study includes of observing the data of meat goat population from specific breeds such as Boer that are available in Malaysia. This study could also assist researchers from own country or other countries to develop more findings on meat goat population of the world. This could also help the market to set the target for upcoming production by evaluating the past sale with current information.

This study could also help the locals to know the location of goat farms in Kangar, Arau, and Padang Besar when they want to buy goats directly from the farms for daily consumption or for Muslim religion festive. For producers, this study could assist them in measuring the morphometric traits of meat-type goat at their own farms to know the body weight of the goats before they are sold. In addition to this, there are also people who raise goats as pets so this study could help them to know the goat pet's body weight when managing the goat healthcare, such as how much amount of feed or medicine dosage to give.

Furthermore, this research could help to satisfy the policy objective in Malaysian Development Plan and the National Agricultural Policy (2011-2020), which livestock is also considered as agro-food commodities in providing sufficient local agro-food for agriculture performance.

1.6 Research Objectives

1) To identify the population of Boer goats in Perlis.
2) To estimate the relationship of the morphometric characteristics of goat using linear regression model.

CHAPTER 2

LITERATURE REVIEW

2.1 Goat Industry Development in Malaysia

Malaysia considered goat as one of the significant industries in the agro-food subsector because it can provide nutrition to people with its supply of meat and milk. In order to achieve self-sufficiency, Malaysian government has planned out many initiatives in increasing the local production of mutton and this would help to lessen the dependency of imported meats from foreign countries. Malaysia goat industry is relatively small compared to other countries as the current number of goat and sheep population in Malaysia is around 572000 animals. These ovine could supply around 4600 MT of mutton a year, but the number had not reach the number of mutton consumption in Malaysia, which is around 40388 MT a year (Marini et al., 2018). Even in 2017, goat industry in Malaysia achieved RM175.55 million, which the total in dollar value is $42.81 million. To handle this situation, Malaysia get some import of around 51150 live goats and sheep, and 34984 MT of mutton. The stocks were mainly imported from Australia, New Zealand, South Africa and India. The data gathered from FAOSTAT (Table 2.1) showed the amount of production, producing animals/slaughtered, and yield/carcass weight from 2017 to 2019.

Table 2.1: Data of production, producing animals/slaughtered and yield/carcass weight.

Domain Code	Domain	Area Code	Area	Element Code	Element	Item Code	Item	Year Code	Year	Unit	Value	Flag	Flag Description
QL	Livestock Primary	131	Malaysia	5320	Producing Animals/Slaughtered	1017	Meat, goat	2017	2017	Head	67667	Im	FAO data based on imputation methodology
QL	Livestock Primary	131	Malaysia	5320	Producing Animals/Slaughtered	1017	Meat, goat	2018	2018	Head	79735		Official data
QL	Livestock Primary	131	Malaysia	5320	Producing Animals/Slaughtered	1017	Meat, goat	2019	2019	Head	80945		Official data
QL	Livestock Primary	131	Malaysia	5417	Yield/Carcass Weight	1017	Meat, goat	2017	2017	hg/An	350	Fc	Calculated data
QL	Livestock Primary	131	Malaysia	5417	Yield/Carcass Weight	1017	Meat, goat	2018	2018	hg/An	320	Fc	Calculated data
QL	Livestock Primary	131	Malaysia	5417	Yield/Carcass Weight	1017	Meat, goat	2019	2019	hg/An	312	Fc	Calculated data
QL	Livestock Primary	131	Malaysia	5510	Production	1017	Meat, goat	2017	2017	tonnes	2368		Official data
QL	Livestock Primary	131	Malaysia	5510	Production	1017	Meat, goat	2018	2018	tonnes	2554		Official data
QL	Livestock Primary	131	Malaysia	5510	Production	1017	Meat, goat	2019	2019	tonnes	2527		Official data

(Source: FAO, 2021)

2.2 Characteristics of Goat

2.2.1 Taxonomy and Classification

The scientific name of goats is *Capra aegagrus hircus*. They are members belong to the phylum *Cordata*, the class *Mammalia*, the order *Artodacyala*, the *Bovidae* family (hollow-horned), the subfamily *Caprinae*, the genus *Capra*, and the *hircus* species. Many fossils and molecular remains of historic animals in report resemble the goats in this century. For instance, it is found that the today's goat has a common ancestor that lived during the late Miocene 11 million years ago and it was originated in an alpine region of Asia or Mediterranean. The fossil and molecular remains at Pikermi in Greece and Maragheh in Iran is of a proto-goat called Pachytragus crassicornus that has been roughly lived 8.2 million years ago. The latest fossil reported in the book written by Weaver (2020) was in 2006, which the founding is the bones of first true goat *Capra dalii* that lived near Dmanisi in Georgia back in 1.77 million years ago. It is believed that the site was where the oldest human settled outside of Africa as the bones of *Capra dalii* were found alongside *Homo erectus georgius*. This latter of both species of bones indicate that they were involved in hunting. However, there is only little information about the evolution occurred from *Capra dalii* to the variety of wild species today.

2.2.2 General Knowledge of Goat

Male goats are called bucks or bucklings, while female goats are called does. Sometimes, female goats that are less than a year old are called does. Young goats are being called as kids. Goats are known to be well-adapter in any types of environments, especially in hot environments. This is because they have small size of body frame and their ratio of body surface area to body weight is high. Their body also has the ability in conserving their body water and limiting subcutaneous fat cover. Another reason of them being well in hot environments is because they have hairy coats that are good traits for surviving at desert-like conditions. Goats prefer to forage on a wider range of plants compared to other small ruminants that need specific foraging. In addition to that, goats have a high number of feed efficiency in converting feed sources into milk and meat compared to other ruminant species (Darcan and Silanikove, 2018).

2.2.3 Boer Meat Goat

The Boer breed has some common traits which are red on head and a portion of the neck, and a white body. Boer breed was originated from Africa in the early 1900s, giving its other name as South African goat and Africander. At that time African ranchers began breeding goats specifically for the purpose of meat production. The Boer goats in Africa today has approximately reach 5 million goats and 1.6 million from the total are

the improved types. These goats are known for high growth and fertility rates; hence they were imported into Australia and New Zealand in the late 1980s. From these two countries, in 1993 the breed was then imported into the United States. For Malaysia, Boer goats were brought in during early 2000. Azwan et al. (2018) has stated that along with Boer goats, other meat-purpose breeds like Anglo Nubian, Jamnapari, Savanna, Kalahari Red and others have majorized the goat population in Malaysia. Many farmers prefer to raise Boer goats because they can grow fast and will produce desirable carcasses that can satisfy consumers' demand. These Boer goats also have a very high fertility rates than other goat breeds. The weight of an adult male Boer is about 110-135 kg, while the weight for an adult female Boer is around 90-100 kg.

2.3 Morphometric Characteristics of Goat

2.3.1 Live Body Weight

Live body weight (LBW) or live weight defines as the body weight of a living animal before it is slaughtered and the body is then prepared as a carcass. Approximately, the carcass or hanging weight has value about 44-47% of the live weight. The body mass of livestock has been always using live weight for their daily performance like feeding, breathing, and urinating. Moreover, a research (Abd-Allah et al., 2019) showed that estimating live weights had been helping the farmers in the matter of feeding, the time of breeding, amount of dosage for medications and vaccination. If the livestock are weighed regularly, the farmers will know better when they need to increase or lessen the feed

intake of the animals. This also helps the farmers in preparing new diet or additional nutrients as the animals grow up. In choosing optimal time for breeding, the farmers need to know the health of the herd and their weight. Procuring the weight data beforehand will help to prevent any problems in the future. Identifying body weight of animal could also assist farmers in monitoring the health condition of animals. Hill (2018) wrote that sudden weight loss can be a symptom to serious disease or health complication.

2.3.2 Body Measurements

All animal species have various size of body and their size will keep growing when they become older. The body size also depends on their own growth rates and feed consumption. This is also applied to animals from the same species but with different breeds. The important morphometric measurement considered from both sexes and ages are body weight, body length, chest girth, and wither height. Several studies showed that the measurements of body length and chest girth are reliable in estimating live weight. Moreover, chest girth is also a good predictor for live weight of Bengal goats especially in males. There was also a positive result on correlation among the body weight, body length, chest girth and wither height (Khandoker et al., 2017). Other measurements also include chest depth, paunch length, cannon circumference, and head length. A study (Abd-Allah et al, 2019) stated that paunch girth, paunch height and neck circumference are used as morphological characteristics for the Boer goats. Figure 2.1 shows the scheme

of body measurement in Katjang goats that include body length, wither height, chest girth, chest depth, rump height, cannon circumference, chest width and rump width.

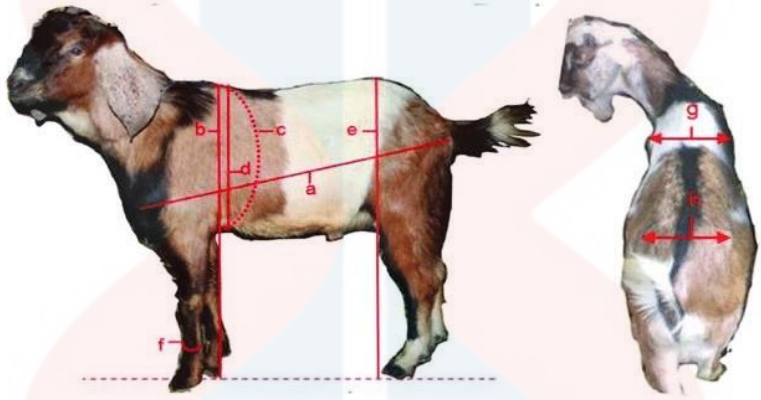

Figure 2.1: The body measurement scheme in Katjang goats consisting body length (a), wither height (b), chest girth (c), chest depth (d), rump height (e), cannon circumference (f), chest width (g) and rump width (h) (Source: Depison, D., 2020)

2.3.3 Modelling with Linear Regression

Linear regression is the relationship between two quantitative variables which the models fit a linear equation to the compiled data. The variables use in the models are one dependent variable and another variable is independent that can be one or more variables. Simple linear models are regressed with a straight line, which is the response y when it has a relationship with single regressor x (Bevans R., 2020). The regression estimated will show how one dependent variable will be changed when one or more independent

variables changes. Simple linear regression is used to observe the two variables relating to each other, and how the dependent variable result when independent variable is at a certain point. As a parametric test, this simple linear regression will make assumptions about the data. The first assumption is homogeneity of variance, which the independent variable does not change predicted error size. Next is independence of observations; the datasets were collected by using statistically valid sampling methods (McCombes S., 2019). The third assumption is normality which the data has a normal distribution and last but not least is the relationship between the independent and dependent variable is linear. Simple regression aims to predict an outcome variable from a single predictor variable whereby multiple regression aims to predict an outcome from several predictors. The formula below shows a simple linear regression formula.

$$_{y} = þ_0 + þ_1 X + e \quad (2.1)$$

y is the dependent variable of (y) predicted for any independent variable (x) given. $þ_0$ is the intercept where y predicted when x is 0. $þ_1$ is the regression coefficient where the y change is expected to the increase x increase. x is the independent variable which expected variable influencing y. e is the estimate error or value of variation in estimated regression coefficient.

CHAPTER 3

METHODOLOGY

3.1 Materials and Apparatus

This study was conducted at five goat farms at few areas in three areas of Perlis which were Gunung Medan and Mata Ayer, Kangar, Arau, and Bukit Cabang,and Taman Singgahsana, Padang Besar. Materials or targeted group that were used in this research were 150 Boer goats from different sex and ages that are raised in different farms located at Kangar, Arau, and Padang Besar, Perlis. Apparatus that was used to measure the independent variables are flexible cloth measuring tape, measuring stick, weighing scale and Statistical Package for Social Science (SPSS).

3.2 Methods

3.2.1 Research Design

To obtain the information on the measurements of morphometric characteristics in goats at the farm, linear regression model design was used. Dependent variable for this research is live body weight of goats, while the independent variables are body measurements of goats. The collected data was analyzed by using Statistical Package for Social Science (SPSS) to insert the data and analysis of dependent and independent variables.

3.2.2 Sampling Method

For this study, cluster sampling was applied. The population target was among crossbred Boer goats that are raised for meat purpose within Perlis area in Malaysia. The group samples that were selected are 150 Boer goats which the sample size was determined according to male and female sex. Five farms that breed Boer goats for meat purpose in Perlis were assessed and the location of the farms are shown in Figure 3. The two farms in Kangar is located at Gunung Medan with latitude 6°24'04.4"N and longitude 100°11'41.6"E, while the farm at Mata Ayer is at latitude 6°28'23.4"N and longitude

100°18’14.6”E. One farm in Arau is at Jalan Kolam Air where the latitude at 6°26’11.6”N and longitude at. 100°16’18.4”E Other two farms in Padang Besar is at Bukit Cabang located at latitude 6°36’18.9”N and longitude 100°15’40.4’E, and at Taman Singgahsana located at latitude 6°39’05.9”N and longitude 100°19’03.1”E.

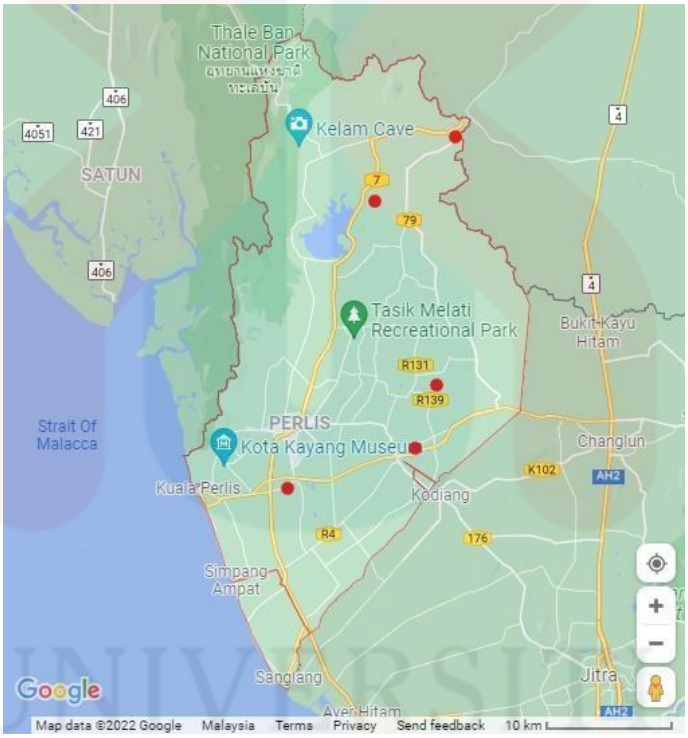

Figure 3.1: Map location of Boer goat farms in Perlis (Source: Google Map, 2022)

The regression analysis was used to estimate the relationship between morphometric characteristics of Boer goats in Kangar, Arau, and Padang Besar, Perlis. The goat morphometric parameters that were measured from both sexes were including live body weight (LBW), body length (BL), chest girth (CG), wither height (WH), chest

depth (CD), paunch length (PL), cannon circumference (CC), head length (HEL), paunch girth (PG), paunch height (PH) and neck circumference (NC).

3.2.3 Data Collection

The data was collected in semi-structured data collection sheets on assessing the morphometric characterizations of goats. The morphometric parameters in goat was then modelled for linear regression analysis by using Statistical Package for Social Science (SPSS) for Windows Package Version 22.0 (Khandoker, M. A. M. Y., 2016). The important morphometric parameters considered from both sexes were including live body weight, body length, chest girth, and wither height. The data collection of parameters was then extended to chest depth, paunch length, cannon circumference, and head length. A study stated that paunch girth, paunch height and neck circumference are used as morphological characteristics for the Boer goats (Abd-Allah et al., 2019).

Goats that were used for observing the morphometric traits were from both sexes with different ages. Each measurement of sampled goat was observed and recorded carefully. The live body weight (LBW) of goat from all classes was taken by using weighing scale in kilogram (kg) one by one and the data was recorded at 2.00 p.m. in the evening, as the monsoon season made the weather became unpredictable. Body length (BL) was the distance from the base of ear to the base of tail. Chest girth (CG) was measured as circumferential measure around the chest behind the front legs and withers.

Wither height (WH) was measured as vertical distance from the top of withers to the ground. Chest depth (CD) was measured as vertical distance from the sternum to withers, paunch length (PL) was the distance between the front and rear legs, cannon circumference (CC) was measured from the left mid metacarpus, and head length (HEL) was the distance measured from the nodule of horn to the upper lip of animal. Paunch girth (PG) was measured as the body circumference after the abdomen before the hind legs, paunch height (PH) was the distance from the surface of a platform to the paunch of the animal and neck circumference (NC) was the circumference of the neck at the midpoint.

3.2.4 Data Analysis

After the data was collected, Statistical Package for Social Science (SPSS) for Windows Package Version 22.0 was used to analyze the data and achieve the objectives of this study. SPSS was used to analyze the dependent variable and independent variables. Analysis that was used in this study is regression analysis in order to answer the objectives of this study.

3.3 Statistical Analysis

Statistical analysis for body weight and morphometric measurements of the goats was done by using Statistical Package for Social Science (SPSS). The collected data was classified according to the sex. Average means and mode of Boer goat morphological traits were compared based on their sex by using Independent T-test. Pearson's coefficient of correlation was measured between the goat body weight and morphometric measurements. Linear body measurements were regressed on body weight to develop simple linear, multiple linear and quadratic regression equations that can calculate the body weight of goats. Live body weight was regressed on morphometric measurements by using stepwise multiple linear regression analysis. The coefficient of determination (R^2) was used to estimate the accuracy of prediction equations between live body weights and morphometric measurements. For the fixed effect of sex and age, separate prediction equations were developed. The multiple linear regression equation to fit standardize of live body weight and the factor scores equations were expressed below.

$Y_j = þ_0\ X_0 + þ_1\ X_1 + e_j$……..for male. (3.1)

$Y_j = þ_0\ X_0 + þ_1\ X_1 + þ_2\ X_2 + þ_3\ X_3 + þ_4 X_4 + e_j$ ..... for female.

Where: Y_j = the dependent variable (live body weight); β_0 = the intercept; X_1 is the independent variables NC for male; X_1, X_2 and X_3 are the independent variables PG, CG and CC for female; β_1 , β_2 and β_3 are the regression coefficient of these variable; and e_j = the residual error.

CHAPTER 4

RESULT AND DISCUSSION

4.1 Descriptive Statistics of Live Body Weight (kg) and Body Measurements (cm) of Boer Goats Based on Sex

The least square means in Table 4.1 states the live body weight (LBW) and morphometric measurements (MM) of Boer goats, which include body length (BL), chest girth (CG), wither height (WH), chest depth (CD), paunch length (PL), cannon circumference (CC), head length (HEL), paunch girth (PG), paunch height (PH) and neck circumference (NC). The obtained results proven to have numerical mean difference among male and female in all measurement assessed for morphometric traits. The value for coefficient of variation (CV) in body measurements varied from 8.9 % to 17.7 %, showing an occurrence of moderate variation in the goat morphometric measurements. LBW had the highest coefficient of variation which is 44.3 % when compared to other body measurements, be it the sex affecting the morphometric characteristics. Whereby,

all targeted goats from different farms in the study have different groups of age and they also influenced the different value of each goat morphometric measurements. The result is in accord with the report by Abd-Allah (2019), which the CV of Boer goat in Egypt has morphometric measurements that are ranged from 4.55 % to 34.41 %, showing the homogeneity between morphometric traits in the study.

Table 4.1: Statistical description of live body weight (kg) and body measurements (cm) of Boer goats.

Traits	Minimum	Maximum	Sum	Mean	Std. Error	Std. Deviation	Variance	Coefficient of Variation Mean Centered
LBW	3.4	78.2	4974.2	33.161	1.1997	14.6933	215.892	44.3%
BL	45	94	10544	70.29	0 .921	11.280	127.229	16.0%
CG	42	97	10438	69.59	0.771	9.449	89.278	13.6%
WH	43	83	9277	61.85	0.574	7.024	49.339	11.4%
CD	15	31	3610	24.07	0.224	2.741	7.512	11.4%
PL	24	59	6588	43.92	0.444	5.439	29.577	12.4%
CC	8	11	1384	9.23	0.067	0.820	0.673	8.9%
HEL	12	24	2893	19.29	0.176	2.159	4.662	11.2%
PG	5	130	12291	81.94	1.184	14.495	210.110	17.7%
PH	22	45	4869	32.46	0.334	4.092	16.747	12.6%
NC	20	43	4648	30.99	0.369	4.521	20.443	14.6%

Live body weight (LBW), body length (BL), chest girth (CG), wither height (WH), chest depth (CD), paunch length (PL), cannon circumference (CC), head length (HEL), paunch girth (PG), paunch height (PH) and neck circumference (NC).

In Table 4.2, some measurements on morphometric traits of Boer goats for males were lower than in females. LBW, BL, CG, WH, CD, PL, HEL, and PG, in male goats had lower numbers than the females. While, the higher number in males compared to females were CC, PH, and NC. This result is dissimilar when referred to other researches due to the different number group of goats based on sex, which the total number of goats from five farms in Perlis that being assessed in this study were 51 males and 99 females. Female goats were bred in farm more than the males because the farmers focused on breeding more kids until they are three to five months years old for meat purpose and taking care of both sex of goats until they are two years old going to three, which is the maturity age for *Korban* and *Akikah* purpose. Both male and female goats have a numerical mean difference, but did not have significant difference ($P < 0.05$) value in all MM. For example, the average LBW of male goats was not significantly lower than the females. Female goats recorded higher mean PG (32.15) compared to male, which in parallel with the study by Abd-Allah, S. (2019), which the female Shami goats in Egypt have higher mean PG of 33.46 than the males.

Table 4.2: Statistical description of live body weight (kg) and body measurements (cm) of Boer goats based on sex.

Groups	N	Statistic	LBW	BL	CG	WH	CD	PL	CC	HEL	PG	PH	NC
Male	51	Mean	28.87	67.55	67.45	60.59	23.69	43.29	9.45	18.80	77.55	33.06	33.18
		Std. Error	0.96	1.00	0.87	0.74	0.39	0.74	0.11	0.24	1.25	0.57	0.62
Female	99	Mean	35.38	71.71	70.69	62.49	24.26	44.24	9.11	19.54	84.20	32.15	29.86
		Std. Error	1.71	1.28	1.07	0.78	0.27	0.55	0.08	0.23	1.63	0.41	0.42

Live body weight (LBW), body length (BL), chest girth (CG), wither height (WH), chest depth (CD), paunch length (PL), cannon circumference (CC), head length (HEL), paunch girth (PG), paunch height (PH) and neck circumference (NC).

28

4.2 Correlation Coefficients between Live Body Weight (kg) and Body Measurements (cm) of Boer Goats

The correlation coefficients were estimated among the live body weight and the body measurements in the Table 4.3 for the male and female Boer goats. Using the Pearson's coefficients of correlation, a high, positive and significant ($P < 0.01$) correlates between live body weight and body measurements. The range for correlation coefficients was varied from 0.303 to 0.899 among live body weight and morphometric measurements. Both male and female goats showed high and significant ($P < 0.01$) and the highest value of positive correlation ($P < 0.01$) was recorded for the male is between LBW and CG (0.899) and the female is between LBW and BL (0.883). For lowest estimation, the results showed correlation of LBW in male with PH ($r= 0.585$) and in female with PG ($r= 0.486$).

Table 4.3: Correlation coefficients among live body weight (kg) and body measurements (cm) of Boer goats.

Traits	Sex	LBW	BL	CG	WH	CD	PL	CC	HEL	PG	PH	NC
LBW	Male	1	0.849**	0.899**	0.821**	0.744**	0.612**	0.645**	0.651**	0.739**	0.585**	0.771**
	Female	1	0.883**	0.826**	0.842**	0.785**	0.551**	0.677**	0.688**	0.486**	0.511**	0.690**
BL	Male	0.849**	1	0.595**	0.673**	0.661**	0.416**	0.528**	0.475**	0.554**	0.572**	0.551**
	Female	0.883**	1	0.750**	0.845**	0.840**	0.664**	0.788**	0.693**	0.521**	0.563**	0.597**
CG	Male	0.899**	0.595**	1	0.762**	0.689**	0.636**	0.592**	0.749**	0.783**	0.474**	0.780**
	Female	0.826**	0.750**	1	0.762**	0.688**	0.527**	0.559**	0.631**	0.391**	0.455**	0.616**
WH	Male	0.821**	0.673**	0.762**	1	0.824**	0.378**	0.603**	0.469**	0.643**	0.730**	0.641**
	Female	0.842**	0.845**	0.762**	1	0.846**	0.658**	0.707**	0.728**	0.494**	0.653**	0.685**
CD	Male	0.744**	0.661**	0.689**	0.824**	1	0.389**	0.699**	0.541**	0.727**	0.602**	0.634**
	Female	0.785**	0.840**	0.688**	0.846**	1	0.730**	0.745**	0.748**	0.544**	0.571**	0.669**
PL	Male	0.612**	0.416**	0.636**	0.378**	0.389**	1	0.464**	0.554**	0.494**	0.194**	0.568**
	Female	0.551**	0.664**	0.527**	0.658**	0.730**	1	0.666**	0.676**	0.479**	0.461**	0.492**
CC	Male	0.645**	0.528**	0.592**	0.603**	0.699**	0.464**	1	0.627**	0.712**	0.593**	0.701**
	Female	0.677**	0.788**	0.559**	0.707**	0.745**	0.666**	1	0.570**	0.474**	0.533**	0.546**
HEL	Male	0.651**	0.475**	0.749**	0.469**	0.541**	0.554**	0.627**	1	0.760**	0.439**	0.726**
	Female	0.688**	0.693**	0.631**	0.728**	0.748**	0.676**	0.570**	1	0.508**	0.429**	0.607**
PG	Male	0.739**	0.554**	0.783**	0.643**	0.727**	0.494**	0.712**	0.760**	1	0.490**	0.635**
	Female	0.486**	0.521**	0.391**	0.494**	0.544**	0.479**	0.474**	0.508**	1	0.303**	0.480**
PH	Male	0.585**	0.572**	0.474**	0.730**	0.602**	0.194**	0.593**	0.439**	0.490**	1	0.651**
	Female	0.511**	0.563**	0.455**	0.653**	0.571**	0.461**	0.533**	0.429**	0.303**	1	0.570**
NC	Male	0.771**	0.551**	0.780**	0.641**	0.634**	0.568**	0.701**	0.726**	0.635**	0.651**	1
	Female	0.690**	0.597**	0.616**	0.685**	0.669**	0.492**	0.546**	0.607**	0.480**	0.570**	1

**. Correlation is significant at the 0.01 level (2-tailed).

Live body weight (LBW), body length (BL), chest girth (CG), wither height (WH), chest depth (CD), paunch length (PL), cannon circumference (CC), head length (HEL), paunch girth (PG), paunch height (PH) and neck circumference (NC).

30

4.3 Prediction of Live Body Weight (kg) from Body Measurements (cm) of Boer Goats

To obtain the best prediction equations, Stepwise regression analysis was applied to measure the live body weight from linear and circumference morphometric measurements of the goats. As been shown in Table 4.4, equations for live body weight were different since they were based on measurements from different body parts. The best prediction equations according to R^2 were -66.170 + 0.821 BL + 0.494 CG + 0.777 NC – 0.350 PL. When predicting live body weight of Boer goats, the value LBW are influenced by independent variables. Since this study has different size of data set according to sex of goats, the independent variables counted were five body measurements including body length, chest girth, paunch length, head length, and neck circumference. From the calculated result, the male goat had the highest correlation determined between LBW and CG, BL, HEL, and NC with R^2 (0.969). Predicted values for female were determined between LBW and BL, CG, NC, and PL with R^2 (0.865).

Table 4.4: Regression equations developed to estimate weight from body measurements (cm) of Boer goats

Groups	Model	R	R^2	Adjusted R^2	Std. Error of the Estimate	Change Statistics		
						R^2 Change	F Change	Sig. F Change
Male	1	0.899[a]	0.809	0.805	3.0413	0.809	207.659	0.000
	2	0.980[b]	0.961	0.960	1.3828	0.152	189.017	0.000
	3	0.982[c]	0.965	0.962	1.3383	0.003	4.248	0.045
	4	0.984[d]	0.969	0.966	1.2628	0.005	6.792	0.012
	Model Summary					Prediction equations		
	a. Predictors: (Constant), CG					LBW= -38.660 + 1.001 CG		
	b. Predictors: (Constant), CG, BL					LBW= -48.646 + 0.679 CG + 0.469 BL		
	c. Predictors: (Constant), CG, BL, HEL					LBW= -47.050 + 0.748 CG + 0.473 BL - 0.345 HEL		
	d. Predictors: (Constant), CG, BL, HEL, NC					LBW= -45.218 + 0.687 CG + 0.459 BL - 0.493 HEL + 0.181 NC		
Female	1	0.883[a]	0.780	0.778	8.0180	0.780	344.250	0.000
	2	0.917[b]	0.841	0.838	6.8496	0.061	36.916	0.000
	3	0.927[c]	0.859	0.854	6.4983	0.017	11.660	0.001
	4	0.930[d]	0.865	0.860	6.3719	0.007	4.806	0.031
	Model Summary					Prediction equations		
	a. Predictors: (Constant), BL					LBW= -49.410 + 1.182 BL		
	b. Predictors: (Constant), BL, CG					LBW= -64.857 + 0.807 BL + 0.599 CG		
	c. Predictors: (Constant), BL, CG, NC					LBW= -73.375 + 0.736 BL + 0.492 CG + 0.710 NC		
	d. Predictors: (Constant), BL, CG, NC, PL					LBW= -66.170 + 0.821 BL + 0.494 CG + 0.777 NC - 0.350 PL		

Dependent Variable: LBW Live body weight (LBW), body length (BL), chest girth (CG), wither height (WH), chest depth (CD), paunch length (PL), cannon circumference (CC), head length (HEL), paunch girth (PG), paunch height (PH) and neck circumference (NC).

32

4.4 Predicted Live Body Weight (kg) of Boer Goats from Body Measurements (cm)

As summarised in Table 4.5, this study had used the best-fitted regression models to calculate the measured and predicted live body weight. In male, PLBW achieved by using CG, BL, HEL, and NC measurements which gave an adjusted R^2 value of 0.966 to MLBW. While in female, PLBW were estimated by using BL, CG, NC, and PL measurements which gave an adjusted R^2 value of 0.854 to MLBW. Many researchers had been applying this predictive value of linear body measurement to determine LBW in the study for Boer and Shami goats (Abd-Allah et al., 2020), and for Ettawa goats (Chinchilla-Vargas J., 2018, and Dakhlan A., 2020). From past studies, chest girth is proven to be the easiest parameter to use in predicting live weight of the goats for both sexes as it was used in many reports. Therefore, using these models to predict live body weight of goats is valid when there are high values of adjusted R^2 between PLBW and MLBW.

Table 4.5: Measured and predicted live body weight (kg)of Boer goats in Perlis

Groups	Prediction Equations	Adjusted R^2	MLBW, kg	PLBW, kg	Residual
Male	LBW= -38.660 + 1.001 CG	0.805	28.87	28.86	0.01
	LBW= -48.646 + 0.679 CG + 0.469 BL	0.960		28.83	0.04
	LBW= -47.050 + 0.748 CG + 0.473 BL - 0.345 HEL	0.962		28.87	0.00
	LBW= -45.218 + 0.687 CG + 0.459 BL - 0.493 HEL + 0.181 NC	0.966		28.86	0.01
Female	LBW= -49.410 + 1.182 BL	0.778	35.38	35.35	0.03
	LBW= -64.857 + 0.807 BL + 0.599 CG	0.838		35.36	0.02
	LBW= -73.375 + 0.736 BL + 0.492 CG + 0.710 NC	0.854		35.38	0.00
	LBW= -66.170 + 0.821 BL + 0.494 CG + 0.777 NC - 0.350 PL	0.860		35.34	0.04

LBW: Live body weight, MLBW: Measured live body weight, PLBW: Predicted live body weight, body length (BL), chest girth (CG), paunch length (PL), head length (HEL), and neck circumference (NC).

34

CHAPTER 5

CONCLUSION

5.1 Conclusion

This study was carried out to determine the assessment on morphometric characteristics measurements and population of Boer goats in Perlis by using linear regression model. Based on previous study, the live body weight of goats in this study has the highest coefficient of variation value compared to other morphometric measurements. The hypothesis of this study is acceptable as it had proven the difference of morphometric characteristics between male and female goats. However, this study showed the live body weight of male Boer goats had lower value than the females because of the different size of data set. Lastly, this study showed that there is a positive significant relationship between live body weight with body measurements in Boer goats that could lead to more meat yield with Boer goat population in Perlis, Malaysia.

5.2 Recommendation

Some recommendations can be done for future study. Age can be added as one of the variables in order to reduce the measurement gap between different ages. Besides that, feeding regimes could also be taken into consideration. This is because different types of feeding regimes may affect the morphometric measurements of goats. Lastly, geographic location of the farm also could be included in the variables. Similarly, different geographic farm may affect the morphometric measurements of goats. Hence, by knowing the geographic farm location, further information regarding goat growth can be discussed in more detail.

REFERENCES

Abd-Allah, S., Salman, F., Shoukry, M., Abd-El Rahman, H., Mohamed, M., & Abedo,A.(2019). Study of some morphological characteristics of boer goat raised in egypt. *Adv. Anim. Vet. Sci*, *7*(10), 888-897.

Abd-Allah, S., Abd-El Rahman, H. H., Shoukry, M. M., Mohamed, M. I., Salman, F. M., & Abedo, A. A. (2019). Some body measurements as a management tool for Shami goats raised in subtropical areas in Egypt. *Bulletin of the National Research Centre*, *43*(1), 1-6.

Alemayehu, K., & Kebede, D. (2017). Evaluation of morphometric and reproductive traits of indigenous dairy goat types in North Western Amhara, Ethiopia. *Iranian Journal of Applied Animal Science*, *7*(1), 45-51.

Bakar, A. M. A., Ab Jalal, I. B., Rosali, M. H., & Abd Wahab, M. H. (2018). Manipulating of Katjang Goat Genetic Material for Sustainable Goat Industry in Malaysia. Retrieved May 01, 2021, from Food and Fertilizer Technology Center for the Asian and Pacific Region website: https://ap.fftc.org.tw/article/1364

Bevans, R., (2020). Simple linear regression: an easy introduction & examples. Retrieved May 01, 2021, from Scribbr website: https://www.scribbr.com/statistics/simple linear-regression/

Britannica, T. Editors of Encyclopaedia (2018). Boer breed of goat. Retrieved May 01, 2021, from the Encyclopedia Britannica website: https://www.britannica.com/animal/Boer-breed-of-goat

Chinchilla-Vargas, J., Woodward-Greene, M. J., Van Tassell, C. P., Wandui Masiga, C., & Rothschild, M. F. (2018). Predicting live weight of rural African goats using body measurements. *Livestock Research for Rural Development*, *30*(7), 123.

Dakhlan, A., Hamdani, M., & Sulastri, S. (2020). Regression Models and Correlation Analysis for Predicting Body Weight of Female Ettawa Grade Goat using its Body Measurements. *Advances in Animal and Veterinary Sciences*, *8*(11), 1142-1146.

Darcan, N. K., & Silanikove, N. (2018). The advantages of goats for future adaptation to climate change: A conceptual overview. *Small Ruminant Research*, *163*, 34-38.

Dardak, R. A. (2019). Malaysia's Agrofood Policy (NAP 2011-2020): performance and new direction. *FFTC agricultural policy platform*, 1-13.

Depison, D., Putra, W. P., Gushairiyanto, G., Alwi, Y., & Suryani, H. (2020). Morphometric characterization of Kacang goats raised in lowland and highland areas of Jambi Province, Indonesia. *Journal of Advanced Veterinary and Animal Research*, *7*(4), 734.

FAO. (2020). Publication card: Meat Market Review – Overview of global market developments in 2019. Retrieved May 01, 2021, from the FFTC agricultural policy platform website: http://www.fao.org/publications/card/en/c/CA8819EN

Hill, K. (2018). 5 important reasons why you must weigh your livestock regularly. Retrieved May 1, 2021, from the BNP Media website: https://www.provisioneronline.com/articles/106701-important-reasons-why you-must-weigh-your-livestock-regularly

Khandoker, M. A. M. Y., Syafiee, M., & Rahman, M. S. R. (2016). Morphometric characterization of Katjang goat of Malaysia. *Bangladesh Journal of Animal Science*, *45*(3), 17-24.

Manirakiza, J., Hatungumukama, G., Besbes, B., & Detilleux, J. (2020). Characteristics of smallholders' goat production systems and effect of Boer crossbreeding on body measurements of goats in Burundi. *Pastoralism*, *10*(1), 2.

McCombes, S. (2019). Sampling methods: types and techniques explained. Retrieved May 01, 2021, from Scribbr website: https://www.scribbr.com/methodology/sampling-methods/

Sarma, L., Nahardeka, N., Goswami, R. N., Aziz, A., Zaman, G., Das, A., & Akhtar, F. (2019). Non-genetic factors affecting pre-weaning growth and morphometric traits in Assam Hill goat. *Veterinary world*, *12*(8), 1327.

Vincent, B. (2018). *Farming meat goats: breeding, production and marketing*. Australia: Commonwealth Scientific and Industrial Research Organisation (CSIRO) Publishing. 36-43.

Weaver, S. (2020). *The Goat*. New Jersey: Princeton University Press. 14-15.

APPENDIX A

Figure A.1: Body length measurement

Figure A.2: Paunch length measurement

Figure A.3: Ladang Kambing Gunung Medan location signboard in Kangar

Figure A.4: Chest girth measurement

Figure A.5: Bandar Arau Dairy House location signboard in Arau

Figure A.6: Chest depth measurement

Figure A.7: Ladang Ternakan Manja location signboard in Kangar

Figure A.8: Cannon circumference measurement

Figure A.9: Padang Besar Farm location signboard in Padang Besar

Figure A.10: Paunch height measurement

APPENDIX B

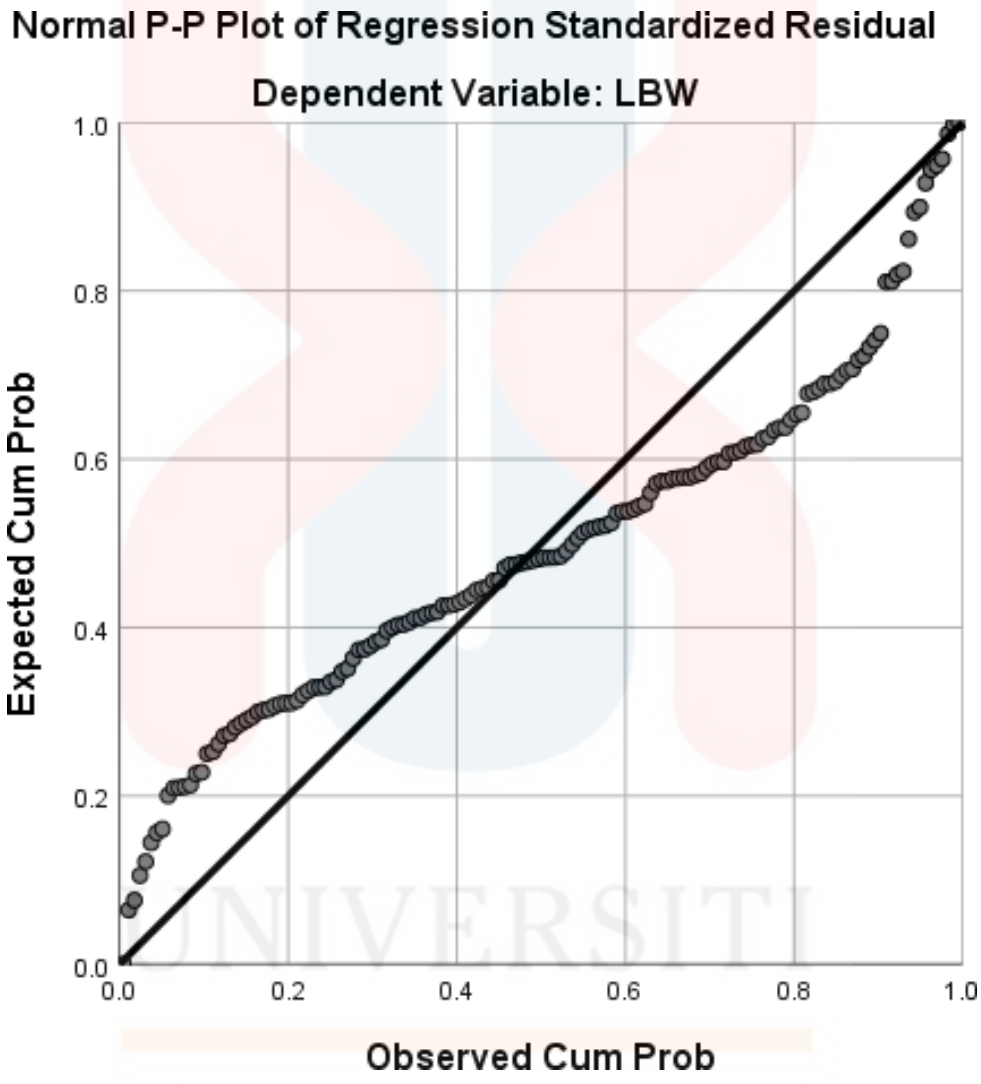

Figure A.11: Normal P-plot of regression standardized residual in both goat sexes

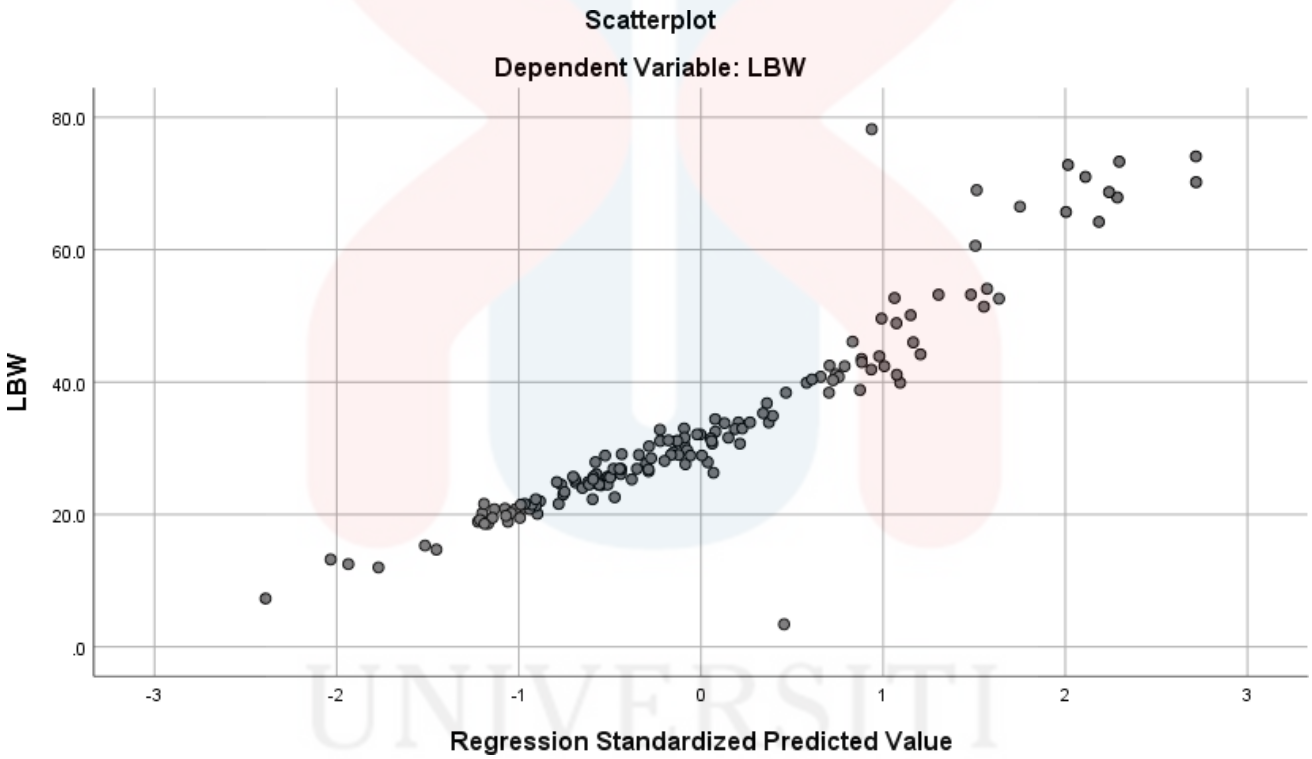

Figure A.12: Scatterplot of regression standardized predicted value in both goat sexes

45

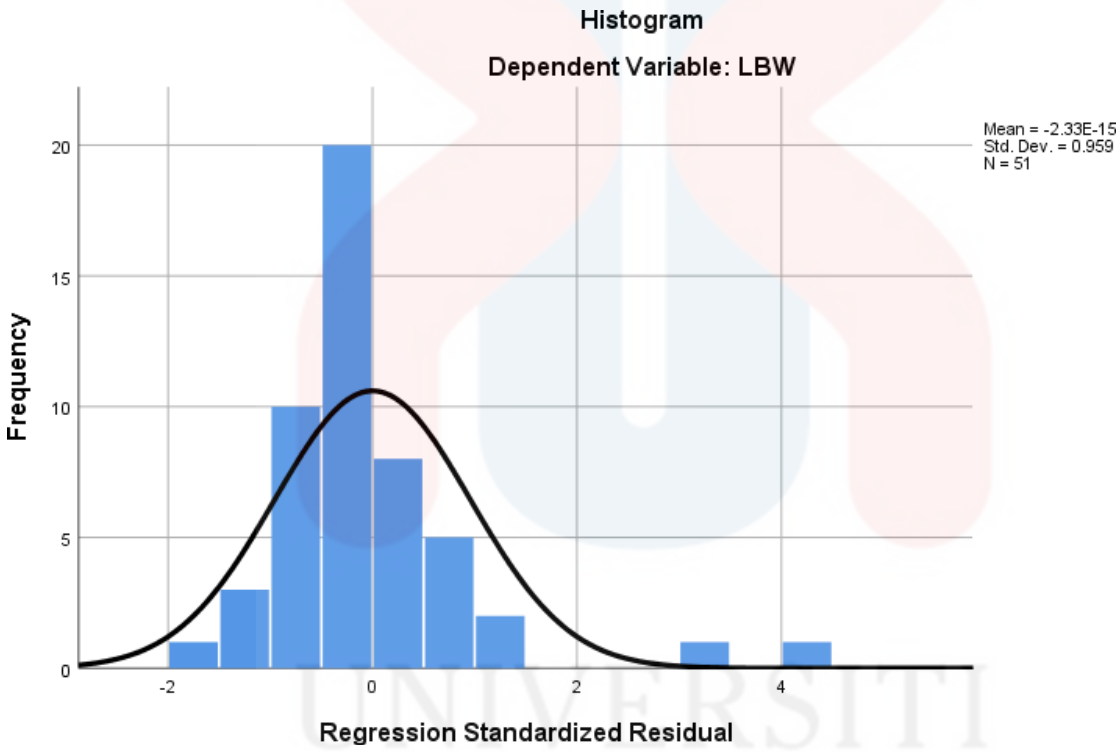

Figure A.13: Histogram of regression standardized residual in male goats

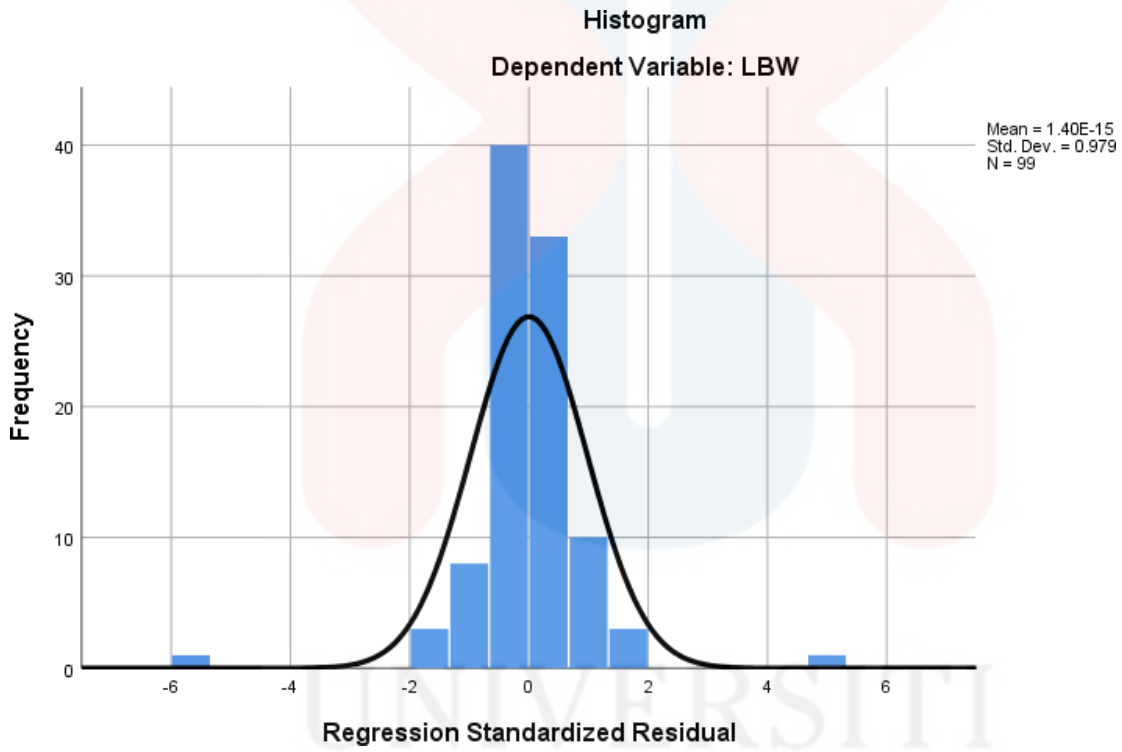

Figure A.14: Histogram of regression standardized residual in female goats