BINDURA UNIVERSITY OF SCIENCE EDUCATION

FACULTY OF AGRICULTURE AND ENVIRONMENTAL SCIENCE

A comparative study on the growth performance of crossbred goats (Mashona-Boer and Mashona-Kalahari red) at Bindura University Farm

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DECLARATION

I, Madziyo Melline, declare that this project is my own work and all other sources used were cited. I declare that this thesis has never been submitted to any university or an academic institution.

Madziyo Melline……. Date 30 June 2022

Supervisor(s)' declaration:

Date: 30 June 2022

Dr P Chatikobo

I certify that I have checked this Research Project and I am satisfied that it conforms to The Department of Animal Science Guidelines for Project Preparation and Presentation. I therefore, authorize the student to submit this dissertation for marking.

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ABSTRACT

The objectives of the study were to compare the birth weights and growth performance of Mashona x Boer and Mashona x Kalahari Red (KR) F1 crosses from birth up to weaning. The birth weight and fortnightly weights of 62 F1 crosses, broken down as 31 Mashona x Boer and 31 Mashona x KR were monitored over the period January to June 2022. The goats were exposed to the same management, housing, feeding, and general husbandry practices at Bindura University of Science Education (BUSE) Goat Breeding Centre at Shamva. The mean birth weight of Mashona x Boer F1 crosses was (3.081 ± 0.6 Kgs) which was significantly higher ($P<0.05$) than that of Mashona x Kalahari Red F1 crosses (2.68 ± 0.9 Kgs). The weaning weights followed a similar trend to birth weights. It was concluded that both Red Kalahari and Boer goats cross breeding can improve the growth performance of Mashona breed. This study confirms the superiority of exotic goat breeds that were specifically selected for meat production over our indigenous unimproved Mashona goats for birth weight and growth performance and it also confirms the superiority of indigenous unimproved Mashona breeds on hardiness and adaptive traits. These results will likely lead to massive crossbreeding by smallholder farmers aiming to upgrade the quality of their goats. If this is done indiscriminately, this will lead to loss of valuable indigenous goat genetics.

DEDICATION

I dedicate this project to my parents? Mr. and Mrs. Madziyo who stood by me until the completion of this research study

ACKNOWLEDGEMENTS

I would like to convey my very great appreciation to the Almighty God for guiding and strengthening me throughout my study. My profound gratitude also goes to my supervisor Dr P Chatikobo, Department of Animal Science in the Faculty of Agriculture and Environmental Science, Chairperson Mr. Kunaka, all lecturers and Animal Science department staff for their kind support and guidance. My sincere appreciation goes to Bindura University of Science Education for giving me the opportunity to do my research study on their goats at Bindura University of Science Education farm. Lastly, would also want to convey my sincere gratitude towards my family for all the sacrifice they made for me to reach this far.

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1. Introduction

In Zimbabwe, the goat- *Capra hircus*, population is around 4.3 million. Small-holder farmers own the vast majority (97%) of the nation's goat herd (Ndlovu *et al*., 2020). All agro-ecological zones include goats, and they are suitable for practically all types of livestock production systems, from intense to highly extensive (Wilson, 2012). In Zimbabwe, breeds such Matebele goats, Mashona goats, Boer goats, and Kalahari goats are frequently raised. The sturdy, prolific Mashona and Matabele goats are native (Christopher *et al*., 2020).

Goats are essential in the livelihoods of small-scale farmers in developing countries because they provide food and nutrition security (meat and milk), and are a source of income and employment to the farmers, agricultural workers, and others involved in the value chain (Adam *et al*., 2010). Goats have been found to contribute towards food security especially in low income earners who keep them (Chikura, 2019). The main reason is that goats multiply quickly and thus their population allows for sustainable and constant food supply. Because of their small size, goats consume less feed relative to large ruminants and thrive under marginal agro-ecological conditions and drought years. Goat skins are used to create mats, drums and other useful tools in the socio-cultural activities of most rural Zimbabweans (Mapani, 2016). Other products from goats can be added value and become a better source of income, like the milk is used to create cheese and other milk-based products like ice-cream (Wilson, 2012). There has also been an increase in the exportation value of goats to Asian countries (Chikura, 2019). This exportation of goats makes them a viable business with a ready foreign market; thus, the goats have become contributors towards the national output and gross domestic product.

In semi-arid areas, goats have a comparative advantage over cattle due to the fact goats are more resistant to droughts and are affected by a few diseases (Nair *et al*., 2021), which makes goat producers resilient to droughts and other natural disasters. Goats can use a diversity of plants, and have a higher reproductive rate that enables them to increase rapidly, hence, they are critical for rapid recovery of livelihoods after droughts, earthquakes or floods. According to Sibanda (2005), goat farming has distinct advantages over other livestock in terms of economics and management due to the goat's lower initial investment, low input needs, higher rate of reproduction, early sexual maturity, and simplicity of marketing.

Although indigenous unimproved Mashona goats are highly prolific, have a high tolerance in diseases and can also adapt to various climatic environments, these goats have a slow growth rate, small mature weight, and low carcass weights. The slow growth rate and low body and carcass weights results in increased costs of production as these goats have to be kept for a long time before they mature, meanwhile consuming more feed, and other overhead costs. Small carcass weight (9-12kgs) also militates against market access (Kusina, 2020). Goat producers need to upgrade their indigenous unimproved goats in order to raise animals with improved growth rates and carcass weights while maintaining and sustaining hardness as reflected by resistance to diseases, ability to tolerate poor nutrition and surviving prolonged periods of feed scarcity such as droughts. Improving growth rate and maturity of Mashona goats can be done by crossing breeding of Mashona goats with Boer goats and the Kalahari Red

Crossbreeding between Mashona and Matabele breeds have been on-going for many years (Manyanga, 2017) as the goats are cheaper and easier to find. For commercial use, the crossing of exotic breeds like the Boer and the Kalahari Reds is gaining momentum but there is a dearth of information on the performance of the F1 crosses between these exotic breeds and the indigenous unimproved genotypes. There is no performance recording and no performance data in the smallholder farming areas. Lack of performance data is a problem in designing breeding programmes as one need to know the baseline situation.

1.1 Problem statement

There is little information on the growth performance of F1 crosses between Mashona x Boer goats and Mashona x Kalahari Red goats. Lack of information impacts on the current, on-going and future indigenous goat improvement programmes due to lack of baseline values. Without this information decisions on which is the right breeds and or crosses remain based on guesswork, which can be misleading. The adage goes ‘What can be measured can be improved’, conversely, without proper measurement and documentation of records, it will be difficult to continually improve the growth performance of the indigenous goats in Zimbabwe.

1.2 Objectives of the study

The main objective of this study was to determine the growth performance of Mashona x Boer and Mashona x Kalahari Red F1 crosses. The specific objectives were to compare the birth weights and growth performance of Mashona x Boer and Mashona x Kalahari Red F1 crosses from birth to weaning.

1.3 Hypotheses

H_0- there is no difference in the growth performance of F1 crosses;

H_1- The growth rate of KR x Mashona F1 crosses is higher than that of Boer x Mashona F1 crosses;

2 Literature Review

2.1 The socio-economic importance of goats

Goats around the world are reared for different reason such as for meat production, milk production, as a symbol of wealth, social status lobola, rituals, mohair and for hides (Mhlanga *et al*., 2018). Goats have become a source of income for others in the rural areas. The modern restaurants have taken a turn towards providing the traditional relish in their restaurants. This makes goat meat one of the unique meals which are being provided in fancy restaurants. It is because of this that the goats show their value in a business sense. With higher prices even in the export market, goats have become a competitive advantage for some farmers who seek to export towards Asian countries. The Chinese businessmen in Zimbabwe have favored the Mashona goats and commended their quality as well as taste. This has made them increase their purchase price as well as purchase volumes. Thus, by and by, the production and rearing of goats in Zimbabwe has gained significant economic value over the past years to date.

As if this is not enough, goats have become an attractive source of meat for the areas where rains are falling less and less. During drought seasons and seasons with very little rain, there arise common diseases which affect mostly cattle and chicken. The population of the cattle decreases with the occurrence of such diseases as foot and mouth diseases. Birds are also affected by these dry spells and their mortality increases. This leads to a decrease in the supply of beef and chicken for diet. Goats are drought resistant (Campbell, 2003) and thus gain popularity as a common dish. In areas like Masvingo where naturally less rains fall, there is a high occurrence of goat meat other than cattle and chicken because of the conditions which are incurred in the rearing of animals. Goats become an important part of the nutrition of the family. Goat skin is also a valuable source of leather and raw material for crafts designing. The goat skin creates mats, rags, shoes, drums, clothes, bags and many other accessories which the humans use in their daily lives.

2.2 Goat production in the world

The world has about 1 billion goats. About 90% of the world goats are located in Asia and Africa. Europe has got around 1.8% of goats (FAOSTAT, 2016). In developed country,

production of goats is very high because high number of goats are of genetically selected for massive production. Goats are essential for feeding the population. India, Bangladesh, Pakistan and Sudan are the larger producers of goat milk in the world. China is the country that produces large amounts of goat meat (Skapetas & Bampidis, 2016). The production of goats globally has been an eyeopener for goat production in Zimbabwe. The most productive countries in the world have adopted cross-breeding of goats in search for enhanced performance in the goats. This crossbreeding has led to the discovery of better performing breeds which perform desirably in disease tolerance and growth performance. The Chinese people have made strides in crossbreeding of goats to achieve high carcass yields in these goats with goats which weigh almost the same as cattle after slaughter, ranging in the hundreds of kgs. The global scale of goat production has motivated this study to try and understand why Zimbabwe is not being talked about in the goat production spheres. There appears to be problems in the goat production of Zimbabwe, thus the study sought to find out what could be the main cause of the less information on crossbreeding and goat growth performance.

2.3 Goat production in Zimbabwe

In Zimbabwe goat population 4 million, 97% of the national heard of goats is owned by small holder famers (Matongo, 2021). Goat production forms an integral and essential component of the small holder farming system (Kusina *et al*., 2019). The majority of the goats being bred in zimbabwe are the Mashona goats which form about 60% of the population of goats in the country (Agritex, 2021). The Matabele goats are the second most common goat type and they comprise of around 30% of the goat population in Zimbabwe. They are mainly found in Matabeleland, parts of midlands and Beitbridge areas (Agritex, 2021). The other common types of goats are the Boer and the Kalahari goats, but, these exotic breeds are mainly found in the commercial farming areas.

The major challenges in the rearing and crossbreeding of goats in Zimbabwe include high kid mortality, poor agricultural methods, ignorance of the new commercial goat production system, and economic feasibility. (Maposa, 2018; Katsande, 2019). These challenges are mainly technical and managerial, which imply lack of competitive skills in the smallscale farmers. The growth performance of goats is quite high in Zimbabwe, the climatic conditions are conducive

and the indigenous goats are disease tolerant. Indigenous unimproved goat breeds can be improved by selection and cross-breeding with exotic goats which show enhanced rates of growth (Obwolo, 2003).

2.3.1 The Mashona goats

The conformation of the Mashona goat is that it is a small compact and hardy goat. The goat has short ears and they are held horizontally. The goat usually appears in multiple colors. The goats have tassels or toggles or wattles hanging under the neck. Traditionally the goats with toggles is considered very fertile in Zimbabwe. The males often have a ridge of long hair along the spine, sometimes more or less developed mane. Both females and males are of a small body frame. Both sexes have horns and they have beard sometimes. The mature weights of the Mashona goat range from 25-35 kgs. Kid birth weight is about 2.4 kgs, with a weaning weight ranging from 10 to 12 kgs (Matopos research station, 2003). The fertility is about 67.2% and a litter size from 1.1 to 1.3. Twining rates from range 14% to 30%. The gestation period is about 5 months on average.

2.3.2 The Matabele goats

Typically, the southern and southernmost regions of Matabeleland Province are where you can find Matabele goats. The Gwanda-Thuli region of Matabeleland is native to the Matebele goat. It resembles many of the goat breeds found in southern Africa and is larger than the majority of tropical goats, with males being about 65 cm at the withers and weighing more than 35 kg. Large-framed and weighing between 30 and 50 kg for does and up to 55 kg for mature males, they are goats. The color of the coat can be any color combination, including black, white, and brown. Their ears are long and drooping (Ndlovu *et al.,* 1993). In general, they get along well with Boer goats during crossbreeding, and the black-coated Matabele goats produce beautiful offspring that resemble Boer goats quite a bit. Due to crossbreeding with imported varieties and the Mashona goat, their huge frame proportions are causing them to spread quickly throughout most of the nation. They produce delicious meat that is favored in prosperous South African markets.

2.3.3 The Boer goats

Boer, South African breed of goat, the most productive meat goat in the world. Millions of Boer goats are raised across southern Africa as well as in Australia and New Zealand, the United States and Canada, the United Kingdom, and elsewhere (Lass, 2002). They are prized for their size (ranging in the hundreds of KGs), rapid weight gain (about 200 grammes per day), carcass quality, hardiness, and docility.

These qualities can be passed on even when Boer bucks are bred to does of other breeds. Boer does are renowned for kidding as often as two times in three years, frequently bearing twins and sometimes triplets. The Boer goats are large, stocky animals with a white body and a red head, brown eyes, lop (downward-hanging) ears, backward-curving horns, and strong, well-placed legs. Adult males often reach 160 kg (350 pounds), and females can weigh as much as 110 kg (about 250 pounds).

2.3.4 The Kalahari red

Kalahari Red goat is a very lovely creature that resembles the Boer goat in appearance. It is a sizable goat breed with a red coat (white or light shades of red are not desirable). The faint red or white hues do not offer as much protection from predators in their native pasture. The Kalahari Red goats exhibit strong defensive herding tendencies as well. Their ears are long and floppy. Their neck region has loose skin. Above their ears, they have somewhat big, sloping horns. Due to the complete pigmentation of their skin, they may forage and gain weight even in the sweltering summer sun. The does' udders and teats are complete and securely attached. To increase hardiness and carcass size, the Kalahari Red goats make a good crossbreed. Typically, bucks are bigger than does.

The Kalahari Red buck weighs in at about 115 kg on average. And the does weigh around 75 kg on average (Ramoroka, 2020). The Kalahari Red has a strong maternal instinct. They take excellent care of their children, who are typically born three times every two years by a doe. Newborn Kalahari Red goat calves are often robust and have a great desire to sucking. The weight of young children often increases by 1.5 kg every week, sometimes even more, as they grow quite quickly. The Kalahari Red goat, however, is a superior breed of meat goat. When keeping goats economically, they can yield maximum profit with the least amount of care and management.

2.4 Goat breeding in Zimbabwe

2.4.1 Natural selection

Natural selection is the approach which stresses on the survival of the fittest approach where animals that survive are the stronger ones which have more dominant and resilient characteristics (Williams,1992). The fast growing, more fertile, more disease resilient and better performing animals find themselves out-surviving their lesser counterparts. This is a very common breeding method in Zimbabwe, it is the most common among small scale farmers who do not involve any technicalities in the growth breeding of the goats. The main advantages of this breeding method are that it is very easy to implement and cheap to implement. The disadvantage is that there are no deliberations on the qualities of the goats. The goats are breeding freely without control thus some undesirable traits can be passed along. There is also risk of in-breeding among the goats.

2.4.2 Cross breeding of goats

Cross breeding can be defined as the process by which two animals of different breed within the same species that have desired characteristics are mated in order to produce offspring that carry desired traits (Shrestha & Fahmy, 2007). Crossbreeding is a mating system whereby it uses crossbreeding to maintain a desirable level of heterosis or breed complementary. Crossbreeding is especially of goats is done with breeds with one or more breeds that have good genetic merit in the performance traits of economic importance like high growth rate. Crossbreeding can also be used to upgrade herd and to create new breeds. In order for crossbreeding to be most effective, it is significant to identify the strengths and weaknesses of various breeds so as to regulate the significance a breed in a crossbreeding program. Crossbreeding should be done looking at several criteria such as merit and availability of the breeds to be used, the expected level of heterosis and the complementary of the available breeds (Shelton, 1986). Advantages of crossbreeding includes generating heterosis and breed complimentality

2.4.2.1 Hybrid vigor

Heterosis or hybrid vigor is one of the major reasons for crossbreeding (Wakchaure *et al*., 2015). In the first cross (F1) maximum heterosis is attained in animals that are not related and where there is wide variation in the trait of importance. In order to attain maximum heterosis, backcrossing should be avoided completely. Backcrossing is defined as the crossing of a hybrid with an animal that is genetically similar to its parent so as to obtain offspring that are genetically closer to that particular animal. Backcrossing has got its demerits for example it has little recombination and undesired genes can be transferred to the new variant if they are closely related with the desired genes.

2.4.2.2 Breed complementary

It is defined as the production of an offspring that have more desirable characteristics by mating breeds that are genetically different from each other but have complementary characteristics (Bett *et al*., 2009). During crossing of breeds, all breeds will contribute to the net merit of the progeny because every breed is known for high growth rate others for disease tolerance. In some breeds, environment plays a role in influencing desirable genes than in others.

2.5 Assessing the productive performance of goats- the measures

The productive performance of goats can be measured by the adaptability to the environment and production condition. Adaptability Of all the production traits, this one is the most significant (Aziz, 2010). If the production environment is detrimental to an animal's capacity for survival and reproduction, the profitability of any meat goat operation may be significantly reduced. The goat has shown to be among the most adaptive domesticated animals. In fact, the goat thrives in a variety of environmental settings all throughout the world. However, domesticated livestock of any species may not always reach its productivity potential when moved from one environment to another. Because natural selection has already lowered the genetic variability, adaptability has a low heritability. As a result, adaptability will react to selection slowly.

The single most significant element affecting the effectiveness of production is reproduction rate. Conception rate, kidding rate, and ability to breed outside of season are reproductive characteristics that are important to a meat goat business.

Goats often have good reproductive rates with no issues with conception rate. Multiple studies have shown that triplets and twins produce higher total weight of kid per doe per year despite having lower birth and weaning weights and slower growth rates (Aziz, 2010). Prolificacy, which is measured as the quantity of offspring born per doe, is a crucial reproductive characteristic. Since they have developed in temperate climates, goats typically reproduce only seasonally, with females going into estrus in the fall and anestrus in the late summer.

The average daily gain prior to weaning and the average daily gain following weaning can be used to divide the growth rate. A strong pre-weaning average daily gain not only illustrates the animal's genetic potential but also the doe's capacity as a mother. Pre-weaning average daily gain is a crucial production characteristic to consider since in some production systems, kids are sold at weaning. In other production methods, young animals are sold as yearlings or older animals, and average daily gain after weaning plays a significant role in output (Dereje *et al.*, 2015).

2.5.1 Factors affecting the birth weight in goat kids

Season of birth in particular may have a significant impact on farm animal output performance. Natural resources (such as water sources, lands, and pastures), biodiversity, and animal health are all impacted by climate change (Thornton, 2010). Climate seasonality is the primary element regulating goat flock productivity in tropical environments. Since goats are raised in harsh environments, environmental elements, including relief and altitude, climate parameters, and climate change, play a significant role in determining the performance and productivity level. This alteration is a result of poor management, seasonal variations in feed availability, and illnesses, including endoparasites. The effects of climate change on pastures and rangelands could include a decline in pasture quality (Field, 2005). Livestock productivity is impacted by the widespread adverse effects on feed quality. The changes in the nutritional environment are mostly responsible for the indirect consequences in reduced or improved birth weight. However, climatic changes would have an impact on the type and quantity of forage produced.

The main obstacle to sustained livestock production in drylands, especially during the dry seasons, is poor animal nutrition (Mnene et al 2004).

2.5.2 Factors affecting kids' growth rate

2.5.2.1 Breed

Growth rate in goats varies considerably among goat breeds. Normally, offspring from large goats have a high growth rate than goats of small breeds (Dhanda *et al*., 2003). Growth rates differ from around 50 g per day for the small breeds such as Mashona goats and Matebele goats and large breeds like Boer goats can gain over 200g per day (McGregor 1985). Larger breeds grow faster and reach marketable weight fast while small breeds like Mashona goats grow slowly and their growth rate is relatively slow. Large breeds are normally not always suited to the harsh environmental conditions of the rangelands. Breeding of small breeds in order to improve their growth is limited due to lack of access to breeds that have superior growth characteristics due to lack of fund and knowledge on how to crossbred them such as the small holder farmers. Other than breed, there are also several factors that can affect growth rate in kids. Goat kid can be from a larger breed, but it can have a slow growth rate due to factors such as nutrition, parity, litter number, dam age and birth weight, diseases and the environment.

2.5.2.2 Nutrition

Nutrition have an impact on the growth of kids before and after birth. Malnutrition in kids have a negative effect on the growth rate of kids. It becomes an effect deficiency of the nutrients lacking in a particular animal starts to show (Widdowson & Lister, 1991). Poor nutrition can make live goats to lose weight at a rate of 1kg per week, (McGregor, 2005). According to McGregor (2005), goat kids require 16% crude protein in order to maximize growth performance. Rations that have more than 16 percent crude protein will then result to losses of nitrogen that will therefore causes rumen degradation.

2.5.2.3 Diseases

Diseases have a negative effect on the growth performance of kids. Diseases have an effect on both large breeds or small breeds. Diseases that normally affect small ruminants includes blue tongue, rift valley fever, pulpy kidney. Most of the diseases manifest in lack of appetite, difficult in movement, drooping ears in some breeds and dull and pale eyes. If the animal losses appetite it therefore means it will not feed that will lead to decrease in weight.

When endoparasites infest animal body they cause diseases like lung and stomach worm, liver fluke (Domke *et al*., 2013). Stomach worm have a negative effect on the growth rate of kids because worms destroy the lining of the stomach, that have an access to the blood stream (Villarroel, 2013). Damage of the stomach lining will therefore cause abdominal pain (colic), anemia and weight loss because animals will not be able to digest feed completely, it will therefore cause stunted growth in goat kids.

2.5.2.4 Litter size

Birth type or litter size have a negative impact on the birth and weaning weight. Single births tend to have high birth and weaning weight than kids born twins and triplets (Das & Sendalo 1990). Body weights of kids decrease with an increasing litter size. Birth weight of single kids is better than multiple because multiple kids will tend to compete for a uterine space and available nutrients (Awemu *et al*., 1999). According to Warmington and Kriton (1990) there is competition of suckling within twins and triplets and the single ones.

2.5.2.5 Housing

In the southern regions of Zimbabwe, goats were housed in unroofed housing systems, which exposed the animals to environmental threats and increased their vulnerability to attack by a range of dieses, according to Magamba (2014). Poor housing and habitat, according to Beffa *et al*. (2004), is the main factor in the production failure of goat farms. Farmers are restricted from keeping large goat flocks by the traditional high storey dwelling design. The sheds are typically crowded and do not have a separate enclosure for kids (Masunda, 2011). It often seemed that such unsanitary living circumstances contributed to an increase in disease incidence (Maphosa, 2001).

In Zimbabwe, it has been estimated that inadequate housing is to blame for more than half of all kids' death (Chikura, 2009). The inadequate housing provided little to no protection from the wind, the cold, the rain, and the dirt. Shumba (2003) attributed the main cause of subpar goat housing constructions to ignorance of the negative impacts of unsuitable housing for goats. Inadequate housing contributed to the incidence of illnesses like pneumonia, foot rot, and intestinal parasites. Lameness is brought on by foot rot, claims Obwolo (2003).

These illnesses are characterized by uncomfortable swelling legs and diminished foraging capacity in the affected animals. As a result, the animals' physical condition declines and their susceptibility to other illnesses increases. To lower pre-weaning kid mortality, better housing for goats as well as preventative medicine and better feeding have been found to be effective (Matika and Sibanda, 1997; Mtenga *et al*., 2004). The employment of modern management tools to regulate the atmosphere in kennel-style tropical housing for goats has become crucial in order to run viable goat farms.

2.5.2.6 General husbandry

The most common type of animal husbandry in Zimbabwe is the traditional animal husbandry. In this system, the farmers take the animals to communal grazing lands and let them feed on grass and shrubs which grow in a communally selected grazing area. For goat farming, the majority of farmers used strategies including free roaming, herding, and confinement. The community goats interbreed as a single flock because there is no mating regulation in the free-ranging system. During the dry season, when the crops have been harvested and the rangeland feed quality is poor in nutrients, this system is prevalent in rural and communal areas (Maphosa, 2001). Early in the morning, the goats are let out to feed without any limitations. According to Kusina (2000), goats are more vulnerable to predators in this arrangement since they would travel vast distances by themselves in quest of food.

Farmers sometimes employ tethering. Goats' movement is regulated in this feeding arrangement. According to the farmers, this is mostly done to stop them from straying and harming nearby crops. As a result, goats are tethered or pinned to a 3 m rope by the roadway, in crop alleys, or on shared rangelands. The goats are only given water when they are moved, which is typically at night when they are put back in their shelter. The farmers chose tethering even though they had some training in goat production, which exposed them to several production systems and their benefits and drawbacks. This allowed them to focus on other farm tasks rather than having to worry about caring for the goats. Animals that are aggressive can be restrained overnight by being tethered. (Gizaw *et al*., 2010).

Tethering enables labor to be saved for other farm tasks, particularly cropping, in mixed crop and livestock farming systems. Tethering, according to certain research, caused goats to lose bodily condition. Additionally, breeding animals receive reduced exposure for mating, which lowers the

does' reproductive efficiency. According to Chikura (1999), a high frequency of vegetation degradation has been seen in regions where tethering is practiced, primarily as a result of overgrazing brought on by the excessive use of tethering spots. This would leave areas of the earth naked, which would eventually cause soil erosion when the rains came.

3 Methodology

3.1 Study site

The study was conducted at Bindura University of Science Education Farm located in Mashonaland central under Shamva District . In Shamva, it is humid and mostly cloud during wet season. In the dry season it is warm. The temperature ranges from 11ºC to 28ºC. Shamva area is found in Agro-ecological region IV. It is characterized by rainfall ranging from 450 -650 mm per annum. Figure 1 below shows the map of the site where the project was conducted.

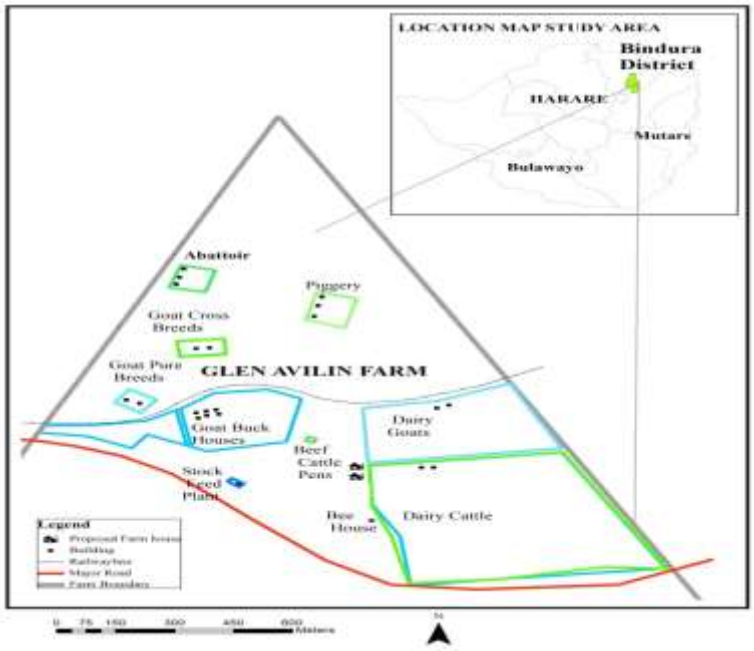

Figure 1: Location of Bindura University Farm

3.2 Experimental Animals

There is an on -going project taking place at Goat Genetics and Artificial Insemination Centre at Bindura University of Science Education. It started February 2020 whereby the centre had 203 local breeds (does), 15 bucks (pure breed Boer) and 13 bucks of pure breed The Kalahari Red. The Kalahari Red and Boer bucks were crossed with the local breed (Mashona goats) to produce

kids that were used in this research project. A total number of 62 kids were selected, 31 kids from crossbreed of Mashona x Boer and 31 kids from Mashona x Kalahari Red.

3.3 Data Collection

The weight of Mashona x Boer kids and Mashona x Kalahari Red where measured after every two weeks from birth up to weaning stage and the reading was recorded. The kids were weighed few minutes after birth. Weighing was done using a digital scale, before weighing the digital scale was put on zero so as to obtain accurate results. Kids were weighed one by one Weighing was done during the morning before the goats are released for feeding to their so as to avoid missing weighing other kids.

3.4 Data Analysis

The growth performance of Mashona x Boer and Mashona x Kalahari Red F_1 crosses were analysed using RStudio (R4.1.0). Tukey-HSD was used for the means comparison test and separation of means. $p<0.05$ representing the significance effect. The data was first in excel. In order to test the reliability, normality and homoscedasticity of the data, The Cronbach's Alpha test was used for reliability, the Shapiro-Wilk test for normality, and the heteroscedasticity test in RStudio

4 Results

4.1 Birth weights

On Average, the birth mass of Mashona x Boer F1 cross is found to be 3.081 kgs with a standard deviation of 0.9686. The minimum recorded birth mass was 1.2 kgs and the maximum was 5.1 kgs. The median birth mass was 3.2 kgs. On the other hand, the Mashona x Kalahari Red F1 cross has a mean weight of 2.681 kgs at birth, with a standard deviation of 0.9866 kgs, a minimum of 1 kg and a maximum of 5 kgs. The median birth mass is 2.5 kgs for the Mashona x Kalahari Red crosses. The table below puts these figures into statistical perspective:

Table 1: Average birth weight of Mashona x Boer and Mashona x KR F1 crossbred kids

Birth weight	N	Mean	s.dev	Min	median	Max
Kalahari Red	31	2.681 kgs	0.9866 kgs	1 kg	2.5 kgs	5 kgs
Boer	31	3.081 kgs	0.9686	1.2 kgs	3.2 kgs	5.1 kgs

The results show that the Mashona-Boer crosses are better performing than the Mashona-Red Kalahari crosses. The average of the Boer crosses is above 3 kgs and out performs the Red Kalahari crosses by almost half a kg. This is a significant weight considering that this is the birth weight.

A normal distribution of the birth weights with a kurtosis to the right, being positively skewed. This indicates that the majority of the kids have an average weight at birth at around 2.5-3 kgs. The diagram below illustrates this finding.

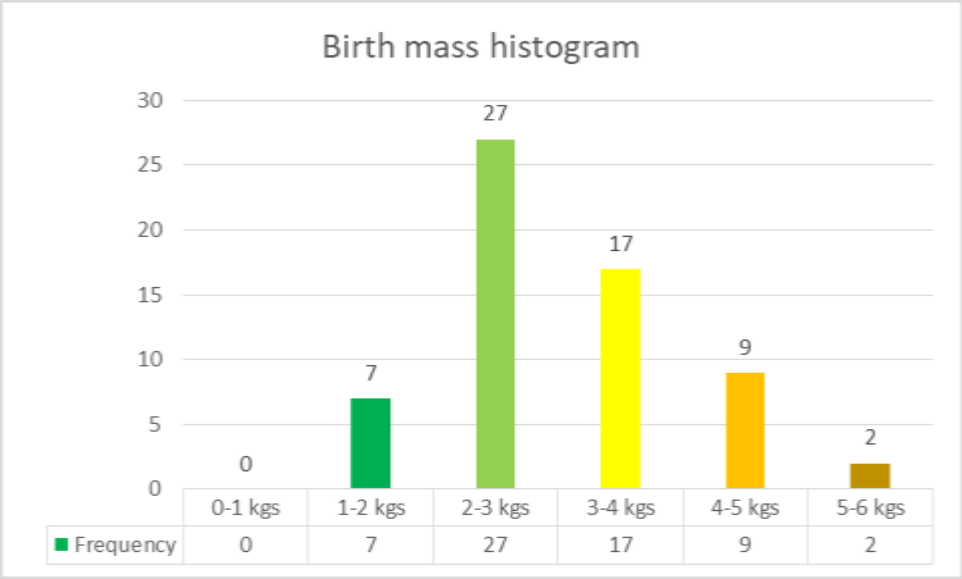

Fig 4.2: Histogram of birth weight of Boer x Mashona and KR x Mashona F1 crossbred kids

4.2 Age at weaning

The average age at for both crosses was 129 days. The standard deviation of both crosses is the same at 8.3 days. The minimum age at weaning experienced in the Kalahari Red crosses was 106 days, which is 4 days ahead of the Boer crosses which have a minimum of 110 days. The median days are 132 days for Kalahari Red crosses and 131 days for the Boer crosses. The maximum number of days at weaning is experienced in the Boer crosses which take 147 days while the Kalahari Red crosses take 141 days. The statistics can be further elaborated by the below table:

Table 2. Age (days)at weaning of the kids by breed of sire.

Age at weaning (days)	N	Mean	s.dev	Min	median	Max
Kalahari Red	31	129	8.3114	106	132	141
Boer	31	129	8.3338	110	131	147

The results show that there are similarities in the age at weaning of both crosses. The Red Kalahari are slightly better performing among the two crosses with the least weaning days. However, the difference is negligible since it falls within a short space of time, with 4 days difference between the two crosses.

The age at weaning follows a normal distribution with a skewness to the negative side. This shows that the majority of the kids are weaned between 120 and 140 days. The diagram below shows the data presentation of the age at weaning of the kids.

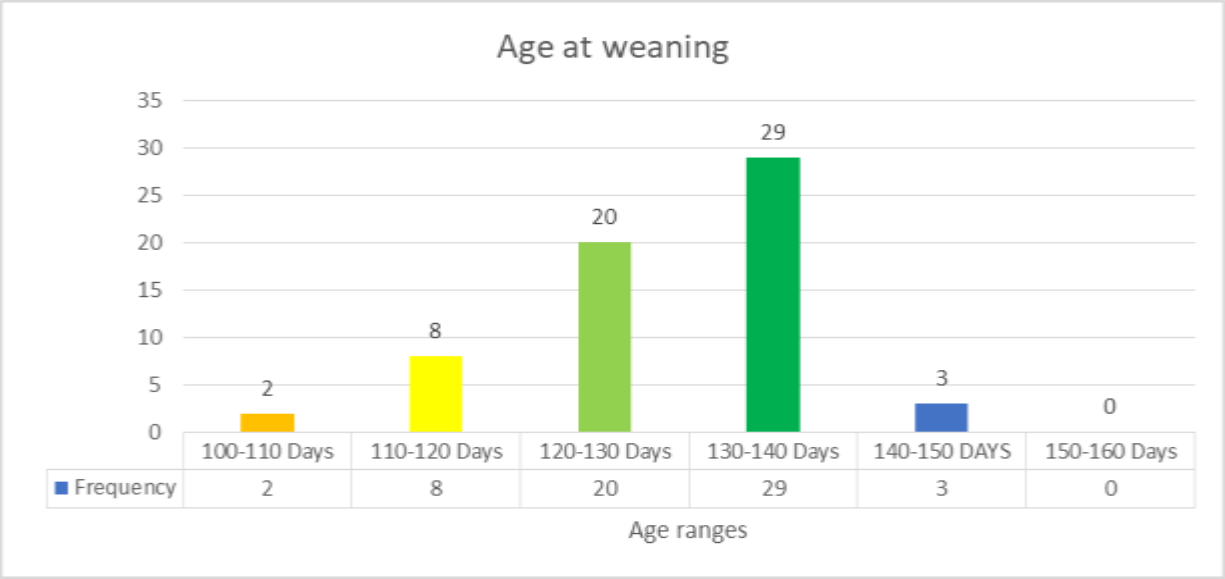

Fig 4.1. Histogram of age at weaning of Mashona x Boer and Mashona x Red Kalahari F1 crosses

4.3 Weaning weight

The average weaning weight of the Mashona x Boer F1 crosses was found to be 13.180 kgs, with a standard deviation of 3.071 kgs. The minimum weight recorded was 7.5 kgs and a median of 14, with a maximum of 19.5 kgs. The found that the Mashona x Kalahari Red F1 cross has a mean of 12.577 kgs with a standard deviation of 2.998 kgs. The minimum recorded weight was 8 kgs, median of 12 kgs and a maximum of 12 kgs. The researcher found that, at weaning, the Mashona x Kalahari Red crosses outperformed the Mashona x Boer crosses. This is shown in the table below:

Table 3: Descriptive statistics of the weaning mass of Mashona-Boer F1 crosses and Mashona-Red Kalahari F1 crosses

Weaning Weight (Kgs)	N	Mean	s.dev	Min	median	Max
Kalahari Red	31	12.577	2.998	8	12	20
Boer	31	13.180	3.071	7.5	14	19.5

The distribution of weaning mass overall follows a normal distribution with the majority of the kids weighing between 10 kgs and 16 kgs at weaning. This is shown in the histogram below.

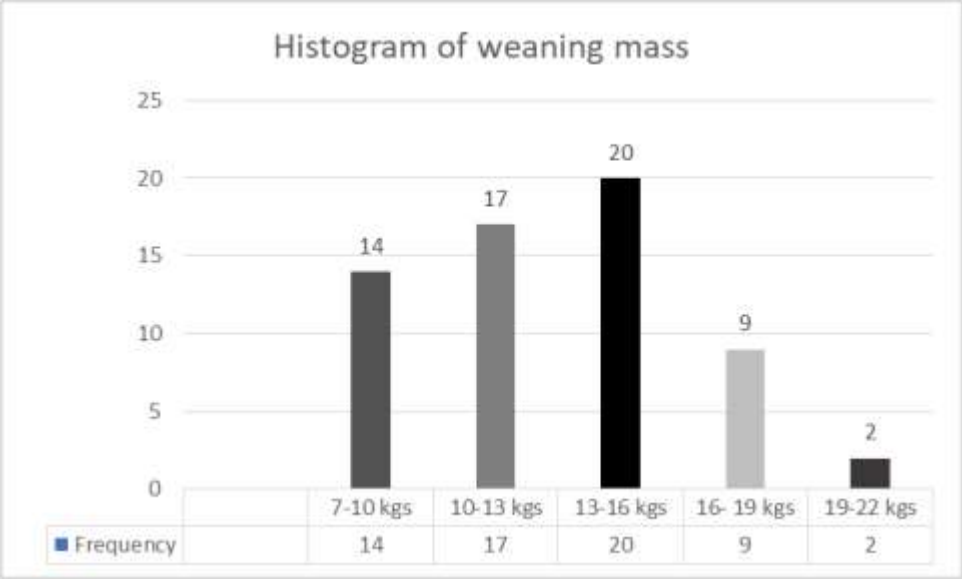

Fig 4.3. Histogram of weaning mass for the Mashona-Boer cross and the Mashona-Red Kalahari crosses.

5 Discussion

5.1 Birth weights

From the results obtained, the average birth masses of the kids on the Mashona x Boer F1 crosses had a mean weight of 3.081 kgs and Mashona x Kalahari Red crosses had a mean weight of 2.681 kgs that is the Boer crosses perform better than Kalahari Red crosses at birth. Therefore, the researcher notes that the crosses perform better than the pure Mashona breed because the average mass of the Mashona kids is found to be 2.4 kgs by Sikosana & Senda (2007). The current findings of the average mean of the birth mass of the Boer crosses are different to what was documented by Deribe *et al*., (2015) on the growth performance of crossbred goats (Boer x central highland) that is 2.6 kgs. The current results show that Kalahari Red crosses have a high average birth mass of 2.681 kgs compared to the average birth mass of the pure Red Kalahari goats which was documented by Omotosho *et al*., (2020), the average birth mass was 2.30kgs.

The findings from this study show that the Mashona x Kalahari Red crosses perform better than the Mashona breed, this confirms the findings by Deribe et al., (2015) who noted that crossing the Red Kalahari with indigenous Zimbabwean goat breeds often leads to above average growth performance. Assertions by Sikosana & Senda (2007) also revealed that there is a higher growth rate in crossing the Matebele goats and the Red Kalahari goats. They found the Matebele x Kalahari Red cross to better perform in terms of birth and weaning weight than the Matebele x Boer crosses. This is different with the findings by this study which show that on average the Boer crosses are performing better than the Kalahari Red crosses.

The average birth weight of pure Boer goats was 3.16 kg as documented by Manirakiza *et al*., (2020) which is a bit higher than 3.081kgs. Difference in birth weight might be due to litter size because litter size has a negative impact on the birth and weaning weight. Single births tend to have high birth and weaning weight than kids born twins and triplets (Das & Sendalo 1990), difference conversion, breed and environment. The crossing led to a reduction in the average birth weight of the kids. Another reason can be attributed to the genetics of the Mashona goat which has an average birth weight way lower than the Boer.

5.2 Weaning weights

On the weaning weights the Mashona x Boer F1 crosses have a mean weight of 13.78 kgs and a maximum of 19.5 kgs at weaning. The Mashona x Kalahari Red F1 crosses have a mean of 12.58 kgs and a maximum of 20 kgs. The Mashona x Boer F1 performed well than Mashona x Kalahari Red F1 crosses at weaning mass. Thus, the researcher is of the opinion that the Mashona x Boer F1 cross is a better performer in terms of weaning weight than the Mashona x Kalahari Red F1 cross. The reason can be inferred scientifically to the growth capacity of the bucks used in the study. The Boer bucks outgrow the Kalahari Red bucks and thus, genetically, the kids will maintain this growth pattern. Studies by the Matopos research station (2003) revealed that the pure Mashona breed averages at around 10-12 kgs in weight. Thus, the crossbreeding of the goats is a boost towards the growth rate and weights of the Mashona goats.

The Boer pure breed has an average weaning weight of 26 kgs (Ramoroka, 2020), and the Kalahari Red pure breed has an average weaning weight of 24 kgs (Ramoroka, 2020). This indicates that the Red Kalahari goat outperforms the Boer on weaning mass. The Mashona x Boer F1 cross and the Mashona x Kalahari Red F1 crosses also reflect materially that the Mashona x Boer cross outperforms the Mashona x Kalahari Red cross on weaning weights. Thus, the results are of the same opinion as the findings in the study by Ramoroka (2020), who found that the Mashona-Boer F1 cross is outperform the Mashona x Red Kalahari F1 cross. Similarly, the other studies have also found that the Matebele x Kalahari Red cross outperforms the Matebele x Boer cross (Sikosana Senda, 2007). This furthers the understanding that the Red Kalahari is a good breed to cross should one seek to improve weights in the goats. Other studies have found that the Mashona goat average weight at weaning is around 10-12 kgs (Matopos research station, 2003), that is Mashona x Boer F1 crosses and Mashona x Kalahari Red performed better than pure Mashona breed in terms of weaning mass. The pure Mashona breed has a very low weaning weight compared to the other breeds in this study.

Thus, there is a significant improvement in the weaning weight of the Mashona pure breed should they be crossed with the Boer or Kalahari Red breed. The improvement is increased in the Mashona-Red Kalahari crosses than the Mashona-Boer crosses. The Boer crosses performed better than Kalahari Red crosses on weaning weights because it might be due the Boer have good

maternal instincts that is it nurtures and rarely neglects their young one. Thus, the Boer mothers will ensure healthy growth of the kids.

5.3 Growth performance of F1 crosses

The found that the growth performance of all the kids under this study followed a normal distribution. The majority were surrounding the mean and the growth behaviour was positively skewed both at birth weights and weaning weights. The finds this to be a satisfactory finding because naturally growth patterns should follow a normal distribution. The same results were found by Manirakiza et al., (2020) in their study. This finding leads the researcher to believe that despite the differences in average performance of the Mashona x Boer F1 crosses and the Mashona x Kalahari Red F1 crosses, the two cross breeds have similar growth traits with the majority of the kids performing about the average of the birth and weaning masses. Therefore, the researcher finds that, although the Mashona x Boer crosses perform better than the Mashona x Kalahari Red crosses, their differences are not very significant to the extent that one might completely discourage the Mashona x Kalahari Red F1 crossing.

6 Conclusion and recommendations

6.1 Conclusion

From this study it can be concluded that Mashona x Boer F1 crosses have a high average birth mass and high average weaning weights than Mashona x Kalahari Red F1 crosses. The both crosses on this research have shown an improvement on the birth weight and weaning weight comparing with the weights of the pure Mashona goats breed. Since this study is the first to document the growth performance of the Kalahari Red and Boer- Mashona x Boer F1 crosses from birth to weaning stage, therefore it will help farmers and any other individual in the breeding programs of the Mashona goat breed. Weaning age of the kids should range from 120 to 140 days so as to avoid diseases, reduced weight and death to the weaners.

6.2 Recommendations

recommends all farms from semi-arid and arid tropical to adopt crossbreeding of Mashona goat breed with exotic breeds like Boer goat breed and the Kalahari Red breed. Crossbreeding will help in the improvement of growth performance of the Mashona goats breed. Improvement of the growth performance means there will be an increase in carcass weight and an increase in market prices, this will enable farmers to better their living standards. The researcher also recommends other researchers and other farmers that are into breeding of Mashona goat breed to document their finding so as to help other farmers. Further research must be done on the growth performance of Boer and their F1 crosses and the Red Kalahari and their F1 crosses.

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