INITIAL TRENDS IN THE KENTUCKY BUCK TEST PROGRAM

A Thesis
Presented to
the Faculty of the College of Science and Technology
Morehead State University

In Partial Fulfillment
of the Requirements for the Degree
Master of Science

by
Robert S. Kelly
April 20, 2012
Accepted by the faculty of the College of Science and Technology,
Morehead State University, in partial fulfillment of the requirements for the
Master of Science degree.

[Signature]
Director of Thesis

Master's Committee: 

Rebecca Miculinich, Ph.D., Committee Chair
Tammy Platt, Ph.D., Committee Member
Joyce Stubbs, Ph.D., Committee Member
Judith Willard, Ph.D., Committee Member

April 30, 2012
Date
INTIAL TRENDS IN THE KENTUCKY BUCK TEST PROGRAM

Robert S. Kelly, M.S.
Morehead State University, 2012

Director of Thesis: [Signature]

ABSTRACT

In the United States, meat goat production has continued to increase along with the consumer demand for goat meat. As a result, U.S. meat goat producers are moving towards selection for improved growth and carcass traits. As a result of the increased demand for quality seedstock, the Kentucky Buck Test Program (KBTP) was initiated by the Kentucky Department of Agriculture and the Kentucky Goat Producers Association in 2005. 150 bucks from 63 different producers completed the test from the years 2005 to 2010. Greater than 90% of the bucks placed on test were registered fullblood Boer, with the remaining 10% originating from meat-breed crosses. Bucks were acclimated 14 days to feed and environment then placed on test at Western Kentucky University Farm in Bowling Green, KY. An initial weight was
taken at the beginning of the test period (ONTEST), then followed by serial weights taken at day 28 (D28), day 56 (D56) and day 84 (OFFTEST). An adjusted average daily gain (ADG) for the entire test period was calculated. ADG calculations were also made for 3 phases of the testing period: Phase 1; ONTEST to D28, Phase 2; D28 to D56, and Phase 3, D56 to OFFTEST. In addition, for the test years 2007-2010, real-time ultrasound measurements of loin eye area (LEA) and back fat (BF) at the 12th rib were recorded via real-time ultrasonography. A statistical analysis to evaluate differences in ADG, BF and LEA among the test years and breed groups was completed using the PROC GLM and PROC CORR procedures in SAS (SAS Inst., Inc. Cary, NC). Results indicate that ADG for bucks that completed the KBTP increased significantly (P<0.05) between the test year 2005 (.20 kg/day) and the test year 2010 (.28 kg/day). Phase 1 of the test showed the largest ADG compared to Phase 2 and Phase 3. No significant difference (P>0.05) was found between breed groups, but numerically, fullblood Boer had the highest ADG LSMEANS of 0.255 kg/d. Although LEA LSMEANS increased numerically each year of the test, no significant difference (P>0.05) was detected for LEA between the test years. The Boer cross-bred breed had significantly higher (P>0.05) LEA LSMEANS compared to the other breeds tested. BF was significantly (P<.001) higher in the years 2009 and 2010 compared to the first year BF was measured (2007); however, no significant differences (P>0.05) for BF were found between breeds. As expected, the correlation between ADG and BF and BF and LEA was significant (P<0.001). Results indicated that bucks tested in the KBTP have improved over time, for growth and carcass traits.
Additionally, breed differences were found. Results indicate that further investigation is warranted in a larger population over a longer period of time to verify trait differences.

Accepted by:

Rebecca Migulinich, Ph.D., Committee Chair

Tammy Platt, Ph.D., Committee Member

Joyce Stubbs, Ph.D., Committee Member

Judith Willard, Ph.D., Committee Member
Acknowledgements

The author would like to thank his committee, Dr. Rebecca Miculinich, Dr. Judith Willard, Dr. Joyce Stubbs, and Dr. Tammy Platt, for their support, guidance, and assistance through his academic career. Each of the committee members has contributed to the academic success, and personal development that I have made. The author would like to thank his chairperson, Dr. Rebecca Miculinich for her unsurpassed support, advice, and friendship that has allowed him to grow as a professional and as a person.

In addition to committee members, the author expresses gratitude to those producers who have placed animals on the Kentucky Buck Test Program. The producers are the everyday people who really can make changes in the meat goat industry from a production standpoint. Dr. Troy Wistuba has also been a large component of this project and without his knowledge, guidance and collection of carcass data this project would not be possible. Tess Caudill with the Kentucky Department of Agriculture and members of the Kentucky Goat Producers Association are also acknowledged for the time and effort put into the assessment and management of the animals that have participated in the Kentucky Buck Test Program.

The author wishes to also thank his friends for always standing behind him. You all have been an essential part in helping with the success and progress that has
been made for me professionally and personally. MaryJo Moncheski, fellow alumnus from Morehead State University, without the late night thesis chats and friendship I don’t know how I would have survived without a major breakdown. James “JJ” Jones, your drive as a person and your friendship has been of great value. Alan and Pam Motta, thank you for the guidance and opportunities that you have provided for me in the goat industry.

Finally, the author wishes to thank his family for their unconditional support. My mother and father, Bobby and Shari Kelly, I don’t know where I would be without the unconditional love and guidance for which you both have provided. My grandparents, Bobby and Gloria Kelly, who have always supported my dreams and have always been supportive of me. As well as, my sister, Kayla, who has also been a great support in my life. Without the foundations, support and love that you all given, none of this would have been possible. Thank you.
TABLE OF CONTENTS

<table>
<thead>
<tr>
<th>CHAPTER</th>
<th>PAGE</th>
</tr>
</thead>
<tbody>
<tr>
<td>I. LITERATURE REVIEW</td>
<td>1</td>
</tr>
<tr>
<td>1.1 Introduction</td>
<td>1</td>
</tr>
<tr>
<td>1.2 World Statistic Information</td>
<td>1</td>
</tr>
<tr>
<td>1.3 United States Statistical Information</td>
<td>2</td>
</tr>
<tr>
<td>1.3.1 Population Change</td>
<td>2</td>
</tr>
<tr>
<td>1.3.2 Population of Goats</td>
<td>3</td>
</tr>
<tr>
<td>1.3.3 Commercial Harvest and Importation of Goat Meat</td>
<td>4</td>
</tr>
<tr>
<td>1.4 Effects of Meat Goat Breeds in the United States</td>
<td>5</td>
</tr>
<tr>
<td>1.4.1 Boer</td>
<td>6</td>
</tr>
<tr>
<td>1.4.2 Kiko</td>
<td>7</td>
</tr>
<tr>
<td>1.4.3 Spanish</td>
<td>7</td>
</tr>
<tr>
<td>1.5 Buck Performance Tests as a Means of Selection</td>
<td>8</td>
</tr>
<tr>
<td>1.6 Growth Traits as a Measurement of Selection</td>
<td>9</td>
</tr>
<tr>
<td>1.6.1 Reasons for Selecting Growth Traits</td>
<td>10</td>
</tr>
<tr>
<td>1.6.2 Feedstuffs and Breed Effect on Kid Weights</td>
<td>10</td>
</tr>
<tr>
<td>1.6.3 Breeding and Weaning Time Effects on Kid Weights</td>
<td>11</td>
</tr>
<tr>
<td>1.6.4 Breed Differences for Average Daily Gains on Different Diets</td>
<td>11</td>
</tr>
<tr>
<td>1.7 Use of Real-Time Ultrasound Measurements as a Selection Tool</td>
<td>12</td>
</tr>
<tr>
<td>1.8 Meat Goat Carcass Composition as a Means of Selection</td>
<td>14</td>
</tr>
<tr>
<td>1.9 Summary</td>
<td>16</td>
</tr>
</tbody>
</table>
II. MATERIALS AND METHODS

2.1 Population

  2.1.1 Breeds Tested

2.2 Growth Trait Measurements

2.3 Carcass Trait Measurements

2.4 Statistical Analysis

2.5 Limitations

III. RESULTS

3.1 On Test and Off Test Weights

3.2 Average Daily Gain

  3.2.1 Overall Average Daily Gain

  3.2.2 Average Daily Gain by Phases

  3.2.3 Average Daily Gain by Breed

    3.2.3.1 Overall Average Daily Gain by Breed

    3.2.3.2 Average Daily Gain for Breeds by Phases

3.3 Carcass Traits

  3.3.1 Loin Eye Area

  3.3.2 Backfat

3.4 Correlations

IV. Summary and Conclusions
LIST OF TABLES

<table>
<thead>
<tr>
<th>TABLE</th>
<th>PAGE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Table 2.1: Breed classification of bucks tested in the Kentucky Buck Test Program.</td>
<td>20</td>
</tr>
<tr>
<td>Table 3.1: On test weight mean, minimum, and maximum by test year for bucks that have completed the Kentucky Buck Test Program.</td>
<td>24</td>
</tr>
<tr>
<td>Table 3.2: Off test weight mean, minimum, and maximum by test year for bucks that have completed the Kentucky Buck Test program.</td>
<td>24</td>
</tr>
<tr>
<td>Table 3.3: Overall average daily gain (ADG) least square means (LSMEANS) of the bucks that completed the Kentucky Buck Test Program by year.</td>
<td>25</td>
</tr>
<tr>
<td>Table 3.4: Phase 1 (on test to day 28) average daily gain (ADG) least square means (LSMEASNS) by year of bucks completing the Kentucky Buck Test Program.</td>
<td>27</td>
</tr>
<tr>
<td>Table 3.5: Phase 2 (day 28 to day 56) average daily gains (ADG) Least square means (LSMEANS) by year of bucks completing the Kentucky Buck Test Program.</td>
<td>28</td>
</tr>
<tr>
<td>Table 3.6: Phase 3 (day 56 to off test) average daily gains (ADG) Least square means (LSMEANS) by year of bucks completing the Kentucky Buck Test Program.</td>
<td>29</td>
</tr>
</tbody>
</table>
Table 3.7: Overall average daily gain (ADG) least square means (LSMEANS) by breed of buck completing the Kentucky Buck Test Program

Table 3.8: Phase 1 (on test to day 24) average daily gain (ADG) least square means (LSMEANS) by breed of buck completing the Kentucky Buck Test Program.

Table 3.9: Phase 2 (day 24 to day 56) average daily gain (ADG) least square means (LSMEANS) by breed of buck completing the Kentucky Buck Test Program.

Table 3.10: Phase 3 (day 56 to off test) average daily gain (ADG) least square means (LSMEANS) by breed of buck completing the Kentucky Buck Test Program.

Table 3.11: Loin eye area (LEA) least square means (LSMEANS) of bucks that completed the Kentucky Buck Test Program by year.

Table 3.12: Loin eye area (LEA) least square means (LSMEANS) by breed of buck completing the Kentucky Buck Test Program.

Table 3.13: Backfat (BF) least square means (LSMEANS) of the bucks that completed the Kentucky Buck Test Program by year.
Table 3.14:
Backfat (BF) least square means (LSMEANS) by breed of buck completing the Kentucky Buck Test Program.

Table 3.15:
Correlations of loin eye area (LEA), backfat (BF), and average daily gain (ADG), for bucks that completed the Kentucky Buck Test Program.
## LIST OF FIGURES

<table>
<thead>
<tr>
<th>FIGURE</th>
<th>PAGE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Figure 1.1: Total inventory of goats reported by classification of use in the United States from January 1, 1989 to January 2011.</td>
<td>4</td>
</tr>
<tr>
<td>Figure 1.2: Number of goats reported for commercial harvest in the United States from 1988 to 2010.</td>
<td>5</td>
</tr>
<tr>
<td>Figure 2.1: Bucks tested in the Kentucky Buck Test Program by year.</td>
<td>19</td>
</tr>
<tr>
<td>Figure 3.1: Initial trend of average daily gain (ADG) least square means (LSMEANS), of bucks completing the Kentucky Buck Test Program over the test years. ADG LSMEANS with identical letters do not differ at (P&gt;0.05).</td>
<td>26</td>
</tr>
<tr>
<td>Figure 3.2: Initial trend loin eye area (LEA) least square means (LSMEANS) of bucks evaluated in the Kentucky Buck Test program for LEA LSMEANS, from 2007 to 2010.</td>
<td>34</td>
</tr>
<tr>
<td>Figure 3.3: Initial trend of backfat (BF) least square means (LSMEANS) of bucks evaluated in the Kentucky Buck Test Program for BF, from 2007 to 2010.</td>
<td>37</td>
</tr>
</tbody>
</table>
Chapter 1

LITERATURE REVIEW

1.1 Introduction

The meat goat is one of the most prevalent and rapidly growing livestock industries in the world today. World statistics and production data in the United States demonstrate the direction of the meat goat industry and the growth that has accrued (FAOSTAT, 2011). In the United States, breeds such as Boer, Spanish, and Kiko, have been used to provide insight into current industry trends and status. These insights are established by evaluating performance and carcass traits of the aforementioned breeds. Selection tools implemented by other livestock industries such as average daily gain calculations and carcass measurements via real-time ultrasound may be able to give goat producers an efficient and cost effective tool for selection practices. Overall, taking into account factors such as population growth, demand of goat meat and new selection tools, that can lead the meat goat industry into prominent food production in the future, could be significant in advancing the meat goat industry.

1.2 World Statistic Information

The world of food animal agriculture is ever changing, as are the animals and the products that are being produced. Meat goat production is becoming prevalent in today’s agricultural industry. Aziz (2010) states that the total number of goats in the world has increased by 146% since 1990. In 2008, the world goat population was
reported at 861.9 million animals; a remarkable increase since 1990 when only 509.1 million goats were reported (FAOSTAT, 2011). Included in the number of goats reported were approximately 500 different breeds worldwide (Thompson, 2006).

The increased population of goats worldwide has subsequently increased the amount of goat meat produced. The continents of Asia and Africa were home to the top ten producers of goat meat. China was ranked number one in goat meat production with 1.8 million tons, followed by India with 558,551 tons produced in 2008 (FAOSTAT, 2011). However in 2008, Australia and France were the top exporters of goat meat with 17,528 tons and 2,531 tons respectively (FAOSTAT, 2011).

1.3 United States Statistical Information

1.3.1 Population Changes

What role does the United States play in goat production? For many reasons the United States goat industry has drastically changed over the past 20 years. The elimination of the mohair subsidy in 1995 was a major contributing factor to this change (Glimp, 1995). Secondly, new meat breeds, such as the Boer and Kiko, have been imported into the United States (Sahlu et al., 2009). In 1987, the total goat population in the United States was 2.2 million, and 1.7 million of those were used for mohair production (USDA, 1994). By 1997, this number dropped to 829,000 goats that were used for mohair production; which was over a 50% decline (USDA, 2004).
1.3.2 Population of goats

Goat numbers increased in the United States to 3 million in 2011. Therefore, 2.47 million of those were classified as meat and other type. Dairy goats totaled 360,000, while mohair goats totaled 172,000, of the 3 million goats reported in 2011 (NASS, 2011). The aforementioned population of meat goats consisted of 2 million breeding animals and replacement kids. Of those, 1.49 million were over a year of age, and 366,000 were under a year of age. The total kid crop for the year was 1.91 million (NASS, 2011). In 2006, goat inventory was listed at 2.89 million, with 2.33 million classified as all meat and other goats, which did not include Angora (mohair) and milk goats. The population of meat goats consisted of 1.91 million animals used for breeding and replacement purposes as shown in Figure 1.1. No data was available until 2005 for dairy and meat goats. The total kid crop reported for 2006 was 1.48 million (NASS, 2011). An increase in production levels was seen between the years 2006 and 2011 as shown in Figure 1.1. The kid crop has increased as the number of breeding animals that producers used for meat production purposes has increased.
1.3.3 Commercial Harvest and Importation of Goat Meat

Seven hundred seventy nine thousand goats were reported for commercial harvest in the United States for the year of 2010. An increase was seen from the number of goats commercially harvested in 2006, with 749,000 animals reported (NASS, 2011). There was an increase in commercially harvested goats from 1988 to 2010 (Figure 1.2). In 2009, the United States ranked first for importation of goat meat with a reported total of 11,707 tons, and a value of $37.96 million. Compared to 1999, 3,233 tons of goat meat with a value of $8.48 million was reported to be imported by the United States (FAOSTAT, 2011). To date, the United States importation of goat meat has continued to grow because the demand for goat meat outweighs the current production levels in the United States (USDA, 2011; FAOSTAT, 2011).
Research in the goat industry has not grown as rapidly as meat goat production levels (Sahlu et al., 2009). However, there has been some progress made for improvement of milk and meat production. Research data gave the producers a better indication on economically feasible ways to meet the demands of the consumers in the United States, as well as, the world.

1.4 Meat Goat Breeds in the United States

Each individual meat goat breed based on genetic contributions and can have an impact on production levels and practices. Differences in breed selection can affect performance, hardiness, growth rates, and carcass composition. Using evaluation techniques, such as central buck test programs, gave a better understanding of what each breed may contribute to the meat goat industry. Many producers have been
using cross-bred goats in commercial operations due to the added production rates. The three main breeds that have been used for meat production are Spanish, the improved Boer, and Kiko (Browning and Leite-Browning, 2011).

1.4.1 Boer

The Boer meat goat breed is an improved indigenous breed that originated in South Africa. The Boer has some influences of European, Angora, and Indian goat breeds, and was imported into the United States in the early 1990’s (Oklahoma State, 2011). Blackburn (1995), mentioned that the Boer goat breed stimulated the highest level of interest and has had the most influence of any other breed on production levels in the United States meat goat industry. One of the many possibilities is that this is currently the main breed in South Africa for meat goat production. The Boer was the first meat goat breed placed on a performance testing scheme in 1970, and has been the only breed to be regularly a part of a performance test (Luginbuhl, 2000). The Boer was also noted for having higher levels of lean meat, as well as, higher growth rates compared to the goats that were being used for meat production at the time of importation into the United States (Casey and Van Niekerk, 1988; Van Niekerk and Casey, 1988).

In addition to superior carcass traits the Boer also has advantage in reproductive performance. Malan (2000) reported the Boer breed as one of the few goat breeds that can bred year round because of their fertility and breeding capacity. Fecundity rate has been reported to be 210% and a weaning rate of 149%. The mature
doe of the Boer breed weighs between 70-80 kg, while the buck average weight is 100-120 kg. The average kid weight for 120 days is 29 kg. The breeds’ conception rate is an average of 90%, with a kidding percentage of 189% (Malan, 2000).

1.4.2 Kiko

The Kiko, also a meat goat breed, originated from New Zealand, and was selected for the improved weight and performance traits demonstrated by its ancestors. Kiko’s were imported into the United States in the early 1990’s, approximately the same time that the Boer breed was imported. The Kiko was developed as a composite breed made up feral goats crossed with dairy bucks of the Nubian, Toggenburg, and Saanen breeds. The first known date for establishment of the Kiko breed was in 1986, when producers closed the original development herd (Oklahoma State University, 2011). According to the International Kiko Association, this breed was selected for its maternal traits, parasite resistance, as well as its lean carcass characteristics. Limited performance data has been reported on Kikos compared to the other breeds used in the United States.

1.4.3 Spanish

The Spanish breed was the first known meat goat to be imported into the states of Texas and Oklahoma in the early 1540’s. Most of the first Spanish goats brought over by the Europeans escaped and were allowed to run freely. This may have contributed to their feral nature, making them a hardier breed, in terms of
nutritional and reproduction maintenance, when compared to the Boer and Kiko. Thompson (2006), reported the mature Spanish doe weight between 29-45 kg, while the mature buck can range from 54-99 kg. Kidding rates of the Spanish breed were approximately 150%, with the average gain of 0.09-0.1 kg/d.

1.5 Buck Performance Test as a Means of Selection

Buck performance tests have gained popularity with producers over the past ten years. While buck performance test vary in different aspects, buck performance tests were similar to that of bull tests used for evaluating cattle (Pennsylvania Department of Agriculture). The purpose of previous buck tests was to evaluate performance traits of bucks and compare the animals placed on test. Different testing programs have various requirements for bucks to be entered for testing, as well, as different testing protocol strategies for the bucks on test.

The Pennsylvania Buck Test fed a standard ration to each of the bucks on the trial. Each buck was penned individually to reduce competition for feed between animals on the trial. These bucks were evaluated for breeding soundness, muscle and carcass traits via real-time ultrasound, as well as, average daily gains (Pennsylvania Department of Agriculture). Methods utilized were similar to the buck performance test in Kentucky, except that the Kentucky bucks were grouped into 3 different pens based on the individual buck’s weight upon enrollment in the trial (Kentucky Goat Producers Association).
The Oklahoma Buck Test program was forage based trial. This test was similar to those previously mentioned in that it tests the average daily gains of the bucks in the program. The Oklahoma trial differed from the Kentucky buck test, in that it also took into account fecal egg counts for parasite resistance and pasture fed bucks on test (Kerr Center for Sustainable Agriculture).

Overall, centralized buck test programs are valuable to the producer as an unbiased evaluation of their animals, compared to other bucks of certain breeds can take place. Based upon the test differences in yearly buck test trials, the producer can select which trial best fits their operation for a more accurate evaluation. In addition information accumulated through centralized buck test programs has the potential to lead to advanced quantitative genetic selection tools.

1.6 Growth Traits as a Measurement of Selection

Growth performance is currently an important factor to evaluate and gain precedence for selection of breeding stock. Considerations must be made in selection decisions for accelerated daily gains and improved feed efficiency (Blackburn, 1995). Growth feed efficiency is a major component all producers should select for as it provides maximum returns, minimum investment and efficient use of resources (Browning and Letie-Browning 2011). Knowledge of performance data would help predict production of goat meat. Development of selection tools that use scientific data would allow a producer to select for traits that best fit their market and preference, and in addition allow for better sustainability.
1.6.1 Breed Effect on Birth Weight

Birth weights are currently utilized in selection for meat goats. In a completed diallel study by Browning and Leite-Browning, (2011), kids sired by Boer bucks had higher birth weights when bred to Kiko and Spanish dams. This was not observed when they were bred to Boer dams. Goonewarde et al., (1998) also noted in a study comparing Boer and Alpine sired kids that the Boer sired kids had a 9% higher average birth weight, relative to the Alpine sired kids. 3.8 kg higher birth weights were observed for Boer-Saanen cross kids when compared to Spanish-Feral, Boer-Angora, and Feral-Feral cross kids. This may indicate that the Boer breed may have a positive impact as a terminal breed and work positively in a crossbreeding system.

1.6.2 Feedstuffs and Breed Effect on Kid Weights

The amount of feedstuffs available for consumption by the goat impacted growth performance. This was demonstrated by Blackburn (1995), who utilized a computer simulated of factors affecting feedstuffs and environment. He compared the amount of forage available in two different locations to determine how availability of forage affected Spanish and Boer does raising kids. When forage conditions were not limited the Boer breed performed at a higher rate with higher weaning and sale weights of kids relative to the Spanish breed. However, when forage conditions were limited, the Spanish breed showed higher sale weights of kids. Johnson et al., (2010), also found that goats placed on a grain diet reached harvest weight in a shorter time period compared to goats placed on a forage diet; thus requiring fewer days on feed.
1.6.3 Breeding and Weaning Time Effects on Kid Weights

Breeding and weaning times periods can also affect production levels. In a year-round breeding program, with an unlimited amount of forage, Boer does were able to produce 5.1 kg higher sale weights of kids compared to Spanish does. However, when forage was limited and breeding season was changed to a fall setting only, the Spanish doe out-performed the Boer doe (Blackburn, 1995). In a complete diallel study of Boer, Kiko, and Spanish breeds, kids born in the month of March had higher average daily gains, but lighter birth weights compared to kids born in the month of May (Browning and Leite-Browning, 2011). Zhang et al., (2009), found that there was a seasonal effect on weaning weights of kids when evaluating the Boer breed, as well. Kids born from December to February were found to have higher average daily gains when compared to kids born in March and April. By finding the most ideal time of year to kid for a particular breed, the producer can increase average daily gains.

1.6.4 Breed Differences for Average Daily Gains on Different Diets

The use of different diets for meat goats effected average daily gain of the different breeds and crosses. Ngwa et al., (2009) implemented a feeding trail using $\frac{3}{4}$ Boer- $\frac{1}{4}$ Spanish and fullblood Spanish wethers and evaluated two different feeding methods, that the Boer cross had higher average daily gains on a grain concentrated diet compared to the Spanish breed. Spanish and the $\frac{3}{4}$ Boer- $\frac{1}{4}$ Spanish that were fed a grass hay diet, performed at the same level, as no significant differences in average
daily gains were reported. Prieto et al., (2000), also noted that the Boer cross had higher average daily gains when compared to ¾ Boer-¼ Spanish and 100% Spanish wethers. When wethers were fed a 50% or 75% concentrate diet, the Boer was found to have higher average daily gains, compared to the Spanish, Alpine and Angora breeds. The first phase of that trial had average daily gains of 90 g, 59 g, 59 g, 49 g, for the Boer, Alpine, Angora, and Spanish breeds respectively. In phase two of the trial, the average daily gains decreased to 82 g for the Boer, 63 g for Angora, 58 g for the Alpine, and 25 g per a day for the Spanish.

1.7 Use of Real-time Ultrasound Measurements as a Selection Tool

Real-time ultrasound has been used for many years in livestock animals as a predictor of carcass traits and will continue to play an important role in live animal evaluation (Stanford et al., 1995). According to Stouffer (2004), ultrasound technique can play an important role for its use in providing an accurate and objective evaluation of the live-animal carcass. This technology allowed the producer to efficiently evaluate their breeding stock so that they could select for traits of economic importance such as backfat and loin eye area. Evaluating carcass characteristics of breeding stock used will allow them to develop educated selection practices for replacement; resulting in the superiority of replacement stock and increasing the probability of passing desired traits to subsequent offspring.

Stanford et al., (1995), found that real-time ultrasound has been used in other livestock industries, such as pork, beef and sheep, for selection purposes. Traits that
were evaluated included increased muscling and fat coverage. Looking at ultrasound predictions in feedlot steers, Smith et al., (1992), found that there was a high positive correlation ($r=0.81$) between real-time ultrasound and the loin eye measurements taken at harvest. Since real-time ultrasound is currently used in other livestock species for genetic predictions and to improve selection accuracy and therefore is a viable evaluation tool for the meat goat industry as well.

One of the first known studies using real-time ultrasound as a predictive tool for carcass data on goats was completed on Alpine dairy goats. This study found that the best correlation between harvest measurements and pre-harvest real-time ultrasound predictions were at the 12th rib of the carcass, where depth of the longissimus muscle was measured. The correlation of real-time ultrasound to actual carcass measurements was found to be 0.62, which is comparable to correlations found in cattle and sheep. Real-time ultrasound correlations have been reported to be 0.60 to 0.76 in cattle, and 0.62 to 0.79 in sheep (Stanford et al., 1995).

Teixeria et al., (2008) compared seven different locations on the goat carcass using real-time ultrasonography to measure the amount of fat. The indication was made that the best relationships between in-vivo measurements and the carcass measurement ($r=0.94$) was at the sternum and the point between the third and fourth sternebrae. It was found that the best correlation coefficients ($r=.084$) for muscle depth were found for the measurements taken between the third and fourth lumbar vertebrae, 2 cm from the middle of the vertebral column, as well. Peres et al., (2010) confirmed that ultrasound measurements were simple and reliable to measure for goat
fat thickness evaluation. Finding the best correlations for fat and muscle depth on the
carcass at harvest and live evaluation accuracy of real-time ultrasound can be
improved for its maximum potential as a prediction and selection tool.

1.8 Meat Goat Carcass Composition as a Means of Selection

Carcass data collection on the different breeds, as well as the feeding and
environmental factors, can give insight into the quality and quantity of meat products
being produced. Consumers demand a quality product in terms of lean value and
eating quality. Producers should strive towards a uniform product, as well as, animals
that can produce those products under different operating conditions.

Blackburn (1995) noted that the Boer breed’s uniform body conformation
could aid in the development of a grading standard for meat goats. Three selection
grades are used by the USDA for live evaluation of meat goats at livestock sale barns.
This system evaluated goats on visual appraisal of muscle, with Selection 1 being the
heaviest muscled and Selection 3 the lightest muscled. Selection 1 described by goats
having thick muscle over the entire body, having big forearms, a full loin, and
moderate thickness in the shoulder, as well as visually tracking wide. Selection 2
described goats as having an average conformation of muscle, while Selection 3 goats
have inferior muscling and are thin (Harris, 2002).

Another factor that had been taken into account when looking at the goat
carcass was the cutability or the amount of product that was usable by the consumer.
Boer cross-bred kids, when compared to Spanish bred kids, have shown to have
heavier muscling for the following: shoulder, breast, rack, loin, leg, shank, and flank. Numerical scores of leg and quality confirmation were higher for the Boer crossbreds when compared to the Spanish bred kids (Cameron et al., 2001). Dhanda et al. (2003), found that kids from a Boer-Feral cross had larger loin eye area when compared to offspring of Boer-Angora, Boer-Saanen, Saanen-Feral, Feral-Feral, Saanen-Angora, and Saanen-Feral crosses.

Carcass length impacted the amount of meat that was available for consumption, which affects the overall value of the carcass (Oman et al., 2000). It was found that the Boer-Saanen and Saanen-Feral cross kids have a longer carcass length compared to Boer-Feral, Boer-Angora, Feral-Feral, Saanen-Angora, Boer-Spanish crosses (Dhanda et al., 2003). Oman et al. (2000) confirmed that Boer-Spanish cross and Spanish goats have longer carcass length relative to the Angora breed.

Backfat was another characteristic evaluated at harvest. Backfat depth can have an impact on the amount of product from the carcass that can be used by the consumer (Johnson et al., 2010). Boer-Spanish cross and Spanish kids a higher percentage of lean meat when compared to Spanish-Angora cross and Angora kids (Oman et al., 2000). Goonewardene et al., (1994) also found that fat coverage in the Boer-Spanish cross was lower when compared to the Alpine-Spanish and the Boer-Alpine cross.

There has been much debate on the efficient methods to economically feed meat goats. Oman et al. (1999) indicated that goats fed an 80% concentrate diet
compared to goats fed a forage diet have differences for carcass traits. Heavier live weights and hot carcass weights for Boer-Spanish cross and the Spanish breed fed a grain diet were found. The Boer-Spanish cross had a higher marbling score, larger loin eye area, and more desirable flank streaking score. Johnson et al., (2010) confirmed that goats fed a grain concentrate diet compared to goats on a forage based diet, had a heavier average hot carcass weight (19.94 kg) for grain fed than for forage based (17.39 kg). It took 211 days for the grain-fed kids to reach harvest weight while 246 days were needed to feed the kids on a forage diet to reach the desired harvest weight. Dressing percentage in this study was not statistically different but found numerically different, where the grain-fed goats had a higher dressing percentage of 49.90 and the kids forage-fed had a dressing percentage of 49.60.

1.9 Summary

In conclusion, review of published literature on the meat goat industry indicated that production levels are currently continuing to grow around the world. Initial evaluations of carcass, growth and reproductive traits have been made on the breeds of goats that are currently being used in the United States for meat production; however, further research is needed as the meat goat industry continues to grow. The data generated will help producers meet the consumer demands for a uniform and quality product. Future selection practices can be improved by using those tools already in place by other livestock industries such as real-time ultrasound, average
daily gain data, and performance testing of sires. Initial research data shows promise for the use of these technologies in the meat goat industry.
Chapter 2
MATERIALS AND METHODS

2.1 Population

The Kentucky Buck Test was established in 2005, by the Kentucky Department of Agriculture and the Kentucky Goat Producers Association. The test was established as a means to compare potential breeding bucks performance to other breeding bucks that completed the test. The objective of this research was to establish initial trends of growth and carcass traits for bucks that have completed the Kentucky Buck Test Program (KBTP). Data used to establish the initial trends in the KBTP were from the years 2005, 2006, 2007, 2009, and 2010. There was no test conducted for the year 2008. The test was held at the Western Kentucky University farm (WKUF), located in Bowling Green, Kentucky. The goats placed on the test were managed by the Kentucky Goat Producers Association and the Kentucky Department of Agriculture.

The KBTP was open to all producers within the United States. Sixty three producers have chosen to place bucks in the program with approximately 150 bucks completing the test. Figure 2.1 shows the breakdown of bucks that were placed on test each trial year.
Figure 2.1: Bucks tested in the Kentucky Buck Test Program by year.

2.1.1 Breeds

Table 2.1 shows the breed differences for the 135 bucks. Over 90% of the bucks that completed the performance test were 100% fullblood Boer (BOER). Bucks in the percentage category, ranged from 51% to 99% of the Boer breed in their pedigree (%BOER), while 50% Boer Cross (XBOER) was considered to have 50% Boer in their pedigree. Other breeds (OTHER) used in the test originated from various meat breeds, including Spanish and Kiko.
Breed classification of bucks Tested in the Kentucky Buck Test Program.

<table>
<thead>
<tr>
<th>Breed</th>
<th>N</th>
</tr>
</thead>
<tbody>
<tr>
<td>100% Fullblood Boer (BOER)</td>
<td>111</td>
</tr>
<tr>
<td>Percentage Boer (%BOER)</td>
<td>11</td>
</tr>
<tr>
<td>50% Boer Cross (XBOER)</td>
<td>8</td>
</tr>
<tr>
<td>Other (OTHER)</td>
<td>5</td>
</tr>
</tbody>
</table>

Table 2.1: Breed classification of bucks Tested in the Kentucky Buck Test Program.

2.2 Growth Trait Measurements

Growth traits were measured by average daily gains (ADG) during the test period that lasted 84 days. When bucks arrived at WKUF, weights were taken and goats were placed in 3 different pens based upon initial arrival weight to reduce competition for feed. All bucks were fed a standard 16% protein grain ration the entire testing period, and no changes were made to the diet during the duration of the trial. A 14 day acclimation period took place upon arrival to allow for an adjustment to nutrition and management schemes. On-test weight (ONTEST), was taken after the 14 day acclimation period, and the performance test began. Serial weights were taken on day 28 (D28), and day 56 (D56) of the testing program. Day 84 (OFFTEST) was the end of the testing period and a final weight was taken. A simple ADG calculation, OFFTEST- ONTEST/84d, was used to calculate the overall ADG per animal. An evaluation was also completed to see differences between the test years. The overall ADG for each test year was used to establish an initial trend line for the KBTP.
Average daily gains were calculations were also calculated for the different phases of the trial, Phase 1 (PHASE 1) - ONTEST to D28, Phase 2 (PHASE 2) - D28 to D56, and Phase 3 - (PHASE 3) D56 to OFFTEST. The phases were compared to each other to evaluate differences of growth and differences were evaluated at between the test years. Breed differences were evaluated for each of the phases of the trial, to determine at possible differences between the breeds for growth traits.

2.3 Carcass Traits Measurements

Carcass measurements were taken off-test, using real-time ultrasound, and were completed by a certified technician. The use of real-time ultrasonography began in the test year 2007 and data has been collected annually since. Measurements of the loin eye area (LEA) in cm², and backfat (BF) in mm, were taken at the 12th rib, using an ALOKA 500V ultrasound unit. The ALOKA 500V was equipped with a 17.2 cm, 3.5 MHz linear transducer (Aloka Co. LTD. Wallingford, CT). Images were interpreted with the BIA PRO PLUS program from Designer Genes Technologies, Inc. (Harrison, AR). Differences between test years were evaluated for LEA and BF. An initial trend line was established for both carcass traits. Breed comparisons were also made to evaluate at differences in carcass traits between the breeds.

2.4 Statistical Analysis

A statistical analysis was completed using PROC GLM and PROC CORR procedures in SAS, (SAS Inst., Inc. Cary, NC). Using PROC GLM procedures were
used with fixed effects of breed and year. A covariate of ONTEST was used for growth traits, due to the large weight range of animals placed on trial. Also a covariate of OFFTEST was used for carcass traits, as animals are known to differ for these traits at different weights. PROC CORR was used to calculate correlations in the test years for ADG, LEA, and BF.

2.5 Limitations

This was a retrospective study; the data collected from the KBTP was not originally collected for the purpose of the author’s objective. The author recognized that there were limitations to the data that should be considered when reviewing the results and discussion of this study. The following limitations were found in this study: difference in population numbers were found between ONTEST and OFFTEST as not all bucks were reported for having an on-test weight. Those bucks not having complete weight data were not utilized for ADG calculations. Bucks tested in 2009 were not utilized for phase calculations, due to the absence of serial weights. Not all bucks that where placed on test had breed information reported, and those animals with no breed information where not utilized for differences in breed calculations. Lastly, population number differences were also found between the carcass traits. All of the animals that had loin eye area information did not have data for backfat.
Chapter 3

RESULTS AND DISCUSSION

3.1 On Test and Off Test Weights

The average on-test weight (ONTEST) varied between test years. Average weight at on test for all years combined was 35.55 kg, shown in Table 3.1. ONTEST ranged between 17.70 kg and 59.92 kg. The weight range for ONTEST was larger than that of average daily gain (ADG) trials for other livestock species such as cattle (Midland Bull Test, 2012; Pennsylvania Department of Agriculture). However, ONTEST weights were similar to the Pennsylvania buck test program entrance requirements (Pennsylvania Department of Agriculture). Final weights taken on day 84 (OFFTEST), were found to have a large range, with a combined average for all test years of 53.39 kg. OFFTEST ranged between 27.69 kg and 79.45 kg (Table 3.2). The wide range of OFFTEST weights can be attributed to the wide range of ONTEST weights.
<table>
<thead>
<tr>
<th>Test year</th>
<th>*n</th>
<th>Mean kg</th>
<th>STD DV</th>
<th>Minimum kg</th>
<th>Maximum kg</th>
</tr>
</thead>
<tbody>
<tr>
<td>2005</td>
<td>23</td>
<td>40.18</td>
<td>6.5</td>
<td>26.33</td>
<td>54.02</td>
</tr>
<tr>
<td>2006</td>
<td>29</td>
<td>29.58</td>
<td>6.7</td>
<td>17.70</td>
<td>43.58</td>
</tr>
<tr>
<td>2007</td>
<td>32</td>
<td>33.82</td>
<td>9.1</td>
<td>21.73</td>
<td>51.75</td>
</tr>
<tr>
<td>2009</td>
<td>20</td>
<td>37.52</td>
<td>7.7</td>
<td>20.88</td>
<td>49.48</td>
</tr>
<tr>
<td>2010</td>
<td>35</td>
<td>36.66</td>
<td>10.6</td>
<td>18.16</td>
<td>59.92</td>
</tr>
</tbody>
</table>

Table 3.1: ONTEST weight mean, minimum, and maximum by test year for bucks that have completed the Kentucky Buck Test Program. * Indicates the population (n=139) of bucks that had ONTEST weights reported.

<table>
<thead>
<tr>
<th>Test year</th>
<th>*n</th>
<th>Mean kg</th>
<th>STD DV</th>
<th>Minimum kg</th>
<th>Maximum kg</th>
</tr>
</thead>
<tbody>
<tr>
<td>2005</td>
<td>23</td>
<td>59.65</td>
<td>7.6</td>
<td>41.31</td>
<td>73.09</td>
</tr>
<tr>
<td>2006</td>
<td>29</td>
<td>45.11</td>
<td>8.7</td>
<td>30.87</td>
<td>64.46</td>
</tr>
<tr>
<td>2007</td>
<td>32</td>
<td>53.23</td>
<td>9.6</td>
<td>39.95</td>
<td>73.54</td>
</tr>
<tr>
<td>2009</td>
<td>28</td>
<td>52.25</td>
<td>10.82</td>
<td>27.69</td>
<td>74.00</td>
</tr>
<tr>
<td>2010</td>
<td>35</td>
<td>56.73</td>
<td>10.05</td>
<td>32.68</td>
<td>79.45</td>
</tr>
</tbody>
</table>

Table 3.2: OFFTEST weight mean, minimum, and maximum by test year for bucks that have completed the Kentucky Buck Test Program. * Indicates the population (n=147) of bucks that had OFFTEST weights reported.
3.2 Average Daily Gain

3.2.1 Overall Average Daily Gain

ADG calculated for the 84 day test period (Table 3.3) showed a significant
difference (P<0.05) between the test years, 2005 (0.20 kg/d) and 2010 (0.28 kg/d) for
ADG least square means (LSMEANS). No significant differences (P>0.05) where
found between the test years of 2006, 2007 and 2009; ADG LSMEANS were found
to be 0.24, 0.23, and 0.23 kg/d respectively. An initial trend over the testing period
for ADG demonstrates an upward trend with rates increasing over time (Figure 3.1).
These results were consistent with Gipson et al., (2007), that also demonstrated
increases in ADG in a central buck test over a period of time.

<table>
<thead>
<tr>
<th>Test Year</th>
<th>n</th>
<th>ADG LSMEANS (kg/d)</th>
<th>STD Error</th>
</tr>
</thead>
<tbody>
<tr>
<td>2005</td>
<td>23</td>
<td>0.20&lt;sup&gt;a&lt;/sup&gt;</td>
<td>0.01</td>
</tr>
<tr>
<td>2006</td>
<td>29</td>
<td>0.24&lt;sup&gt;b&lt;/sup&gt;</td>
<td>0.01</td>
</tr>
<tr>
<td>2007</td>
<td>32</td>
<td>0.23&lt;sup&gt;b&lt;/sup&gt;</td>
<td>0.01</td>
</tr>
<tr>
<td>2009</td>
<td>20</td>
<td>0.023&lt;sup&gt;b&lt;/sup&gt;</td>
<td>0.02</td>
</tr>
<tr>
<td>2010</td>
<td>35</td>
<td>0.28&lt;sup&gt;c&lt;/sup&gt;</td>
<td>0.01</td>
</tr>
</tbody>
</table>

Table 3.3: Overall average daily gain (ADG) least square means (LSMEANS) of the
bucks that completed the Kentucky Buck Test Program by year. * Indicates the total
population (n=139) of bucks calculated for ADG per a year. ADG LSMEANS with
identical letters do not differ at (P>0.05).
Figure 3.1: Initial trend of average daily gain (ADG) least square means (LSMEANS), of bucks completing the Kentucky Buck Test Program over the test years 2005 to 2007, 2009 and 2010. ADG LSMEANS with identical letters do not differ at (P>0.05).

3.2.2 Average Daily Gain by Phases

ADG was also calculated for each of the phases of the testing period to evaluate for potential growth differences in the phases. Test year 2009 was not included for phase calculations as no serial weights for that test year were recorded. ONTEST to day 24 (PHASE 1) showed significant differences (P<0.05) between the test years for ADG LSMEANS (Table 3.4). No statistical differences were found between 2005 (0.302 kg/d) and 2007 (0.309 kg/d). 2006 (0.239 kg/d) was significantly different from all the other test years, and 2010 (0.399 kg/d) was significantly different from the other test years. Numerical differences were also found between the test years for phase 1, ranging from 0.239 kg/d in 2006 to 0.399 kg/d in 2010.
<table>
<thead>
<tr>
<th>Test year</th>
<th>*n</th>
<th>ADG LSMEANS kg/d</th>
<th>STD error</th>
</tr>
</thead>
<tbody>
<tr>
<td>2005</td>
<td>23</td>
<td>0.302&lt;sup&gt;a&lt;/sup&gt;</td>
<td>0.03</td>
</tr>
<tr>
<td>2006</td>
<td>29</td>
<td>0.239&lt;sup&gt;b&lt;/sup&gt;</td>
<td>0.02</td>
</tr>
<tr>
<td>2007</td>
<td>32</td>
<td>0.309&lt;sup&gt;a&lt;/sup&gt;</td>
<td>0.02</td>
</tr>
<tr>
<td>2010</td>
<td>35</td>
<td>0.399&lt;sup&gt;c&lt;/sup&gt;</td>
<td>0.03</td>
</tr>
</tbody>
</table>

Table 3.4: Phase 1 (on test to day 28) average daily gain (ADG) least square means (LSMEANS) by year of bucks completing the Kentucky Buck Test Program. *Indicates the total population (n=119) of bucks calculated for phase 1 ADG LSMEANS. Phase 1 ADG LSMEANS with identical letters do not differ at (P>0.05).

In phase 2 of the testing period (day 28 to day 56), significant differences were found (P<0.05) between the test years for ADG LSMEANS (Table 3.5). No statistical differences were found between 2005 (0.217 kg/d) and 2010 (0.186 kg/d); however, both were different from 2006 (0.126 kg/d) and 2007 (0.362 kg/d). Furthermore, 2006 and 2007 were significantly different (P<0.05) from each other. Numerical differences were found for phase 2, ranging from 0.126 kg/d (2006) and 0.362 kg/d (2007).
<table>
<thead>
<tr>
<th>Test year</th>
<th>*n</th>
<th>ADG LSMEANS kg/d</th>
<th>STD error</th>
</tr>
</thead>
<tbody>
<tr>
<td>2005</td>
<td>23</td>
<td>0.217&lt;sup&gt;a&lt;/sup&gt;</td>
<td>0.019</td>
</tr>
<tr>
<td>2006</td>
<td>29</td>
<td>0.126&lt;sup&gt;b&lt;/sup&gt;</td>
<td>0.017</td>
</tr>
<tr>
<td>2007</td>
<td>32</td>
<td>0.362&lt;sup&gt;c&lt;/sup&gt;</td>
<td>0.016</td>
</tr>
<tr>
<td>2010</td>
<td>35</td>
<td>0.186&lt;sup&gt;a&lt;/sup&gt;</td>
<td>0.018</td>
</tr>
</tbody>
</table>

Table 3.5: Phase 2 (day 28 to day 56) average daily gain (ADG) least square means (LSMEANS) by year of bucks completing the Kentucky Buck Test Program. * Indicates the total population (n=119) of bucks calculated phase 2 ADG LSMEANS. Phase 2 ADG LSMEANS with identical letters do not differ at (P>0.05).

In phase 3 of the testing period (day 56 to OFFTEST), significant differences (P<0.04) were found for ADG LSMEANS between test years (Table 3.6). No statistical difference was found between 2005 (0.183 kg/d) and 2006 (0.177 kg/d). However, 2005 and 2006 were significantly different (P<0.04) from 2007 (0.104 kg/d) and 2010 (0.136 kg/d), no statistical difference was found between 2007 and 2010. Numerical differences were found for phase 3 ADG between the test years ranging from 0.104 kg/d (2007) to 0.183 kg/d (2005).
Table 3.6: Phase 3 (day 56 to off test) average daily gain (ADG) least square means (LSMEANS) by year of buck completing the Kentucky Buck Test Program. * Indicates the total population (n=119) of bucks calculated for phase 3 ADG LSMEANS. Phase 3 ADG LSMEANS with identical letters do not differ at (P>0.04).

<table>
<thead>
<tr>
<th>Test year</th>
<th>*n</th>
<th>ADG LSMEANS kg/d</th>
<th>STD error</th>
</tr>
</thead>
<tbody>
<tr>
<td>2005</td>
<td>23</td>
<td>0.183a</td>
<td>0.028</td>
</tr>
<tr>
<td>2006</td>
<td>29</td>
<td>0.177a</td>
<td>0.024</td>
</tr>
<tr>
<td>2007</td>
<td>32</td>
<td>0.104b</td>
<td>0.035</td>
</tr>
<tr>
<td>2010</td>
<td>35</td>
<td>0.136b</td>
<td>0.026</td>
</tr>
</tbody>
</table>

Between the 3 phases, significant differences were found when comparing ADG. Phase 1 had the highest ADG LSMEANS while phase 2 and phase 3 had the lower ADG LSMEANS for all test years. ADG in phase 1 ranged from 0.239 kg/d to 0.399 kg/d, while phase 2 and phase 3 ranged from 0.104 kg/d to 0.217 kg/d.

3.2.3 Average Daily Gain by Breed

3.2.3.1 Overall Average Daily Gain by Breed

Breed comparisons for the different phases of the testing period demonstrated what breed has the most significant impact during a certain growth period. No significant differences (P>0.05) were found when comparing the different breeds’ ADG LSMEANS for the overall testing period (ONTEST to OFFTEST); however numerical differences were found (Table 3.7). Numerical differences were found, including (ranked highest to lowest): Other breeds made up of other meat breeds such as Spanish and Kiko (OTHER) (0.225 kg/d), 100% fullblood Boer (BOER) (0.233
kg/d), the percentage Boer, ranging from 51% to 99% Boer (%BOER) (0.197 kg/d) and the 50% Boer cross (XBOER)(0.194 kg/d).

<table>
<thead>
<tr>
<th>Breed</th>
<th>*n</th>
<th>ADG LSMEANS kg/d</th>
<th>STD error</th>
</tr>
</thead>
<tbody>
<tr>
<td>BOER</td>
<td>111</td>
<td>0.233</td>
<td>0.01</td>
</tr>
<tr>
<td>XBOER</td>
<td>8</td>
<td>0.194</td>
<td>0.02</td>
</tr>
<tr>
<td>%BOER</td>
<td>11</td>
<td>0.197</td>
<td>0.02</td>
</tr>
<tr>
<td>OTHER</td>
<td>5</td>
<td>0.225</td>
<td>0.02</td>
</tr>
</tbody>
</table>

Table 3.7: Overall average daily gain (ADG) least square means (LSMEANS) by breed of buck completing the Kentucky Buck Test Program. * Indicates the total population (n=135) of bucks calculated for breed differences for overall ADG LSMEANS. No significant difference was found (P>0.05) for overall ADG LSMEANS.

3.2.3.2 Average Daily Gain for Breeds by Phases

PHASE 1 of the test did show significant differences (P<0.055) between breeds for ADG LSMEANS (Table 3.8). BOER (0.28 kg/d), %BOER (0.34 kg/d), and OTHER (0.21 kg/d) showed no statistical difference; however, XBOER (0.19 kg/d) was significantly lower for phase 1 ADG LSMEANS. Numerical differences were also found between breeds (ranked highest to lowest): %BOER, BOER, OTHER and XBOER.
Table 3.8: Phase 1 (on test to day 24) average daily gain (ADG) least square means (LSMEANS) by breed of buck completing the Kentucky Buck Test Program. * Indicates the total population (n=115) of bucks calculated for breed differences for phase 1 ADG LSMEANS. ADG LSMEANS with identical letters do no differ at (P>0.055).

Phase 2 ADG LSMEANS showed no significant difference (P>0.05) between breeds (Table 3.9), however numerical differences were found. Numerical differences for Phase 2 ADG LSMEANS for the breed analysis ranged from 0.218 kg/d for XBOER and 0.233 kg/d for %BOER.

Table 3.9: Phase 2 (day 24 to day 56) average daily gain (ADG) least square means (LSMEANS) by breed of buck completing the Kentucky Buck Test Program. * Indicates the total population (n=115) of bucks calculated for breed differences for phase 2 ADG LSMEANS. No significant difference found at (P>0.05)
Phase 3 ADG LSMEANS showed no significant difference (P>0.05) between breeds (Table 3.10), however numerical differences were found. Numerical differences for Phase 3 ADG LSMEANS for breed ranged from 0.105 kg/d for XBOER and 0.181 kg/d for BOER.

<table>
<thead>
<tr>
<th>Breed</th>
<th>*n</th>
<th>ADG LSMEANS kg/d</th>
<th>STD error</th>
</tr>
</thead>
<tbody>
<tr>
<td>BOER</td>
<td>91</td>
<td>0.181</td>
<td>0.01</td>
</tr>
<tr>
<td>XBOER</td>
<td>11</td>
<td>0.105</td>
<td>0.02</td>
</tr>
<tr>
<td>%BOER</td>
<td>8</td>
<td>0.162</td>
<td>0.02</td>
</tr>
<tr>
<td>OTHER</td>
<td>5</td>
<td>0.151</td>
<td>0.05</td>
</tr>
</tbody>
</table>

Table 3.10: Phase 3 (day 56 to off test) average daily gain (ADG) least square means (LSMEANS) by breed of buck completing the Kentucky Buck Test Program. * Indicates the total population (n=115) of bucks calculated for breed differences for phase 3 ADG LSMEANS. No significant difference found at (P>0.05)

Few statistical differences were observed between the breeds for the 3 phases. No significant differences (P>0.05) were found for the overall ADG of the breeds, this is likely due to the lower population of %BOER, XBOER and OTHER that were tested. Gipson et al., (2007) observed breed differences in a central buck test, finding that the Boer breed out-performed the Kiko breed, which was included in the OTHER of this study. With a larger population of each breed represented, statistical differences could be expected and have been observed in other studies (Ngwa et al., 2009; Prieto et al., 2000).

3.3 Carcass Traits
3.3.1 Loin Eye Area

Loin eye area (LEA) taken, via real-time ultrasound on OFFTEST in the years 2007, 2009, and 2010 did not differ statistically (P>0.05). However, numerically loin eye area (LEA) increased each year (Table 3.11). 2007 showed an average LEA LSMEANS of 13.94 cm$^2$, and in the test year 2010 average LSMEANS LEA of 15.15 cm$^2$. The initial trend of LEA, in the KBTP has shown an upward climb (Figure 3.2).

<table>
<thead>
<tr>
<th>Test year</th>
<th>*n</th>
<th>LEA LSMEAN cm$^2$</th>
<th>STD Error</th>
</tr>
</thead>
<tbody>
<tr>
<td>2007</td>
<td>32</td>
<td>13.94</td>
<td>0.08</td>
</tr>
<tr>
<td>2009</td>
<td>28</td>
<td>14.45</td>
<td>0.12</td>
</tr>
<tr>
<td>2010</td>
<td>35</td>
<td>15.15</td>
<td>0.11</td>
</tr>
</tbody>
</table>

Table 3.11: Loin eye area (LEA) least square means (LSMEANS) of the bucks that completed the Kentucky Buck Test Program by year. * Indicates the total population (n=95) of buck LEA measured. No significant difference was found at (P>0.05).
Comparison of the different breeds for LEA showed a significant difference (P<0.05) (Table 3.12). BOER (13.82 cm$^2$), %BOER (14.54 cm$^2$), and OTHER (10.36 cm$^2$), were not statistically different from each other. However, XBOER (17.26 cm$^2$) was significantly different from the other breed categories. Numerical differences were also found between breed and ranged from 10.36 cm$^2$ (OTHER) to 17.26 cm$^2$ (XBOER).
Table 3.12: Loin eye area (LEA) least square means (LSMEANS) by breed of buck completing the Kentucky Buck Test Program. * Indicates the total population (n=83) of bucks calculated for breed difference of LEA LSMEANS. LEA LSMEANS with identical letters do no differ at (P>0.05).

<table>
<thead>
<tr>
<th>Breed</th>
<th>*n</th>
<th>LEA LSMEAN cm²</th>
<th>STD error</th>
</tr>
</thead>
<tbody>
<tr>
<td>BOER</td>
<td>71</td>
<td>13.82ᵃ</td>
<td>0.41</td>
</tr>
<tr>
<td>XBOER</td>
<td>4</td>
<td>17.26ᵇ</td>
<td>1.63</td>
</tr>
<tr>
<td>%BOER</td>
<td>5</td>
<td>14.54ᵃ</td>
<td>1.48</td>
</tr>
<tr>
<td>OTHER</td>
<td>3</td>
<td>10.36ᵃ</td>
<td>1.80</td>
</tr>
</tbody>
</table>

Initial evaluation of LEA, has showed a numerical increase over the time period that LEA measurements have were taken. Others have also observed an increase in LEA over a period of time in a central buck test (Gipson et al., 2007). Boer influenced bucks also showed a larger LEA LSMEANS compared to OTHER, however it was not significantly different. Gipson et al., (2007) found breed differences over a longer time span in a central buck test. With a longer time period and a larger population of bucks evaluated, LEA would be expected to increase as Gipson et al., (2007) reported an increase over a longer time span with a larger population.
3.3.2 Backfat

BF was found to be significantly different (P<0.001) between the test years 2009 (5.45 mm) and 2010 (5.23 mm) compared to the test year 2007 (3.01 mm) (Table 3.13). The initial trend line for BF (Figure 3.3) of the KBTP increased over the test years since carcass evaluations via real-time ultrasound have been implemented as part of the program.

<table>
<thead>
<tr>
<th>Test year</th>
<th>*n</th>
<th>BF LSMEAN mm</th>
<th>STD Error</th>
</tr>
</thead>
<tbody>
<tr>
<td>2007</td>
<td>32</td>
<td>3.01&lt;sup&gt;a&lt;/sup&gt;</td>
<td>0.22</td>
</tr>
<tr>
<td>2009</td>
<td>28</td>
<td>5.45&lt;sup&gt;b&lt;/sup&gt;</td>
<td>0.35</td>
</tr>
<tr>
<td>2010</td>
<td>35</td>
<td>5.23&lt;sup&gt;b&lt;/sup&gt;</td>
<td>0.32</td>
</tr>
</tbody>
</table>

Table 3.13: Backfat (BF) least square means (LSMEANS) of the bucks that completed the Kentucky Buck Test Program by year. * Indicates the total population (n=95) of buck BF measured. BF LSMEASN with identical letters do not differ at (P>0.05)
Figure 3.3: Initial trend of Backfat (BF) least square means (LSMEANS) of bucks evaluated in the Kentucky Buck Test Program for BF, from 2007 to 2010.

Differences in the breeds were not significant (P>0.05), however the breeds did have numerical differences (Table 3.14). XBOER, had the highest average BF with 5.18mm, and the %BOER had the lowest average BF with 4.06 mm.
An increase of BF has been seen over the test years, with an upward trend.

Increased BF over the years raises concerns for the lean value of goat meat, if this trend continues to increase.

### 3.4 Correlations

Correlations between BF and LEA were significant, with a positive correlation of 0.41. The positive correlation is opposite of what has been found in other species such as pigs (Jesse et al., 1983). ADG also had a positive correlation of 0.26 with BF. However the correlation of LEA and ADG (0.06) was found not to be significant in this study (Table 3.15), ADG and LEA have shown to have a positive correlation in other studies (Gipson et al., 2007; Smith et al., 1992). Correlation discrepancies in this study compared to others are likely due to low population
numbers, as previous work had larger population numbers (Gipson et al., 2007; Smith et al., 1992).

<table>
<thead>
<tr>
<th></th>
<th>LEA</th>
<th>BF</th>
<th>ADG</th>
</tr>
</thead>
<tbody>
<tr>
<td>LEA</td>
<td>-</td>
<td>0.41*</td>
<td>0.06</td>
</tr>
<tr>
<td>BF</td>
<td>0.41*</td>
<td>-</td>
<td>0.26*</td>
</tr>
<tr>
<td>ADG</td>
<td>0.06</td>
<td>0.26*</td>
<td>-</td>
</tr>
</tbody>
</table>

Table 3.15: Correlations of loin eye area (LEA), backfat (BF) and average daily gain (ADG), for bucks that completed the Kentucky Buck Test Program. * Indicates a significant correlation.
Chapter 4
SUMMARY AND CONCLUSIONS

Results from this study indicate that the bucks placed on the Kentucky Buck Test Program (KBTP) increased average daily gains (ADG) since the beginning of the program. These results are consistent with those presented by Gipson et al. (2007) that found ADG increased in the central buck test program at Langston University from 1999 to 2006. Initial trends are ideally evaluated over a 10 year time period, however evaluation of the 6 year testing period, did show ADG increased. ADG can be used by producers as it is a simple calculation that has impacts on growth rates.

When comparing breed differences for ADG, there no significant differences, however in PHASE1, there was a difference found in the breeds with the BOER and %BOER being higher performing. This could be due to the different weight on which the bucks were placed on trial and other studies have indicated that a percentage Boer and Boer cross can have a positive impact on ADG (Ngwa et al., 2009, Prieto et al., 2000). One hundred eleven of the ~150 goats placed in the KBTP have been of the BOER breed, causing an uneven distribution of breeds represented. This could explain the higher ADG for the Boer influenced groups. However, this could indicate that the Boer breed has a positive impact on terminal goat production.

Backfat (BF) significantly increased over the 3 years that carcass data was collected and had an upward initial trend. Goats are unlike other livestock species in that they deposit fat from the inside out. Goat meat is known for its lean characteristics and the increase of BF over the 3 year span may raise some concerns
about the overall lean value trend of the goats placed in the KBTP. Loin eye area (LEA) showed an upward trend numerically but was not significant, over the testing period. Others have found over a longer time period and with a larger population of bucks in a central buck test, that LEA had significantly increased (Gipson et al., 2007).

Expansion of trend lines for the KBTP is warranted, with a larger population of bucks and breeds needed. However, initial results have indicated improvements of bucks placed in the KBTP, for growth and carcass traits. Producers using selection tools such as ADG and real-time ultrasound for carcass traits, have the potential to improve their seedstock for these important traits.

The initial trends that have been established for the KBTP gives a baseline for future research and provides a snapshot of where the bucks in the Kentucky region currently stand for growth and carcass traits. This can give producers a starting point for selection of growth and carcass traits that can be used for their breeding bucks, compared to the other bucks of the Kentucky region. Continued data collection and evaluation of growth and carcass traits could lead to the creation of sire selection indices, which would progress selection practices in the meat goat industry.
References


