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CULTURE AND ANIMAL HUSBANDRY: AN INVESTIGATION INTO THE TRADITIONAL METHODS AND CULTURAL CONSTRAINTS OF GOAT PRODUCTION AND MANAGEMENT AMONG THE PEOPLE OF THE MUHANGA DISTRICT OF RWANDA

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ABSTRACT

The purpose of this study was to analyze effects of culture on goat production and management in Rwanda. Because the goat serves significant cultural, social, and economic functions in Rwanda, this study aimed to generate methods consisting of traditional and modern approaches to maximize goat production. To this end, a brief review of animal husbandry of the goat, followed by a literature review on the goat in Rwanda is included. First-hand cultural perspectives were collected by the author during two trips to Rwanda, at which time goat herders were interviewed. This work culminated in a list of conclusions and recommendations for goat production in Rwanda. In general, there are many constraints facing Rwandan goat herders stemming from previous ethnic conflict, climate change, failure of knowledge dissemination, and lack of financial capital, especially for women. Improved goat production can be achieved through investment in medications and feeds designed for small ruminants, such as goats, more effective knowledge dissemination, gender equality in agriculture, and increased availability of veterinary services. It is hoped that the Rwandan government and others involved will be able to utilize the recommendations presented at the end of this report.

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Chapter 1

Introduction

Purpose of the Study

The purpose of the study is to examine the impact of culture on animal husbandry. Specifically, it focuses on the production and management of goats in Rwanda. The objective is to suggest new methods of goat production to combine with existing traditional cultural practices in efforts to increase goat production in Rwanda, while maintaining the welfare of both goats as well as the health of the people of Rwanda's Muhanga District.

The Problem

Goat production is one of the animal husbandry branches that is economically important in both Africa and the West. However, in Africa, the goat is not only an economically important commodity, but it holds a great cultural significance as well as it bestows higher social status to the owner. There have been several studies conducted concerning goat production in Rwanda, but very few have focused on combining the cultural production methods with a scientifically based approach as a means of increasing goat production. This study aims to combine both traditional cultural methods with new scientific approaches in attempts at maximizing goat production, particularly among the goat herders of the Muhanga District of Rwanda.

Background to the Problem

It is estimated that goats were domesticated between 10,000 and 11,000 years ago during the Neolithic Era. The increase in meat, milk, leather, and fiber attributed to the domestication of the goat gave way to the "Neolithic Revolution" (Fernandez, Hughes, Vigne, Helmer, Hodgins, Miquel, Hanni, Luikart & Taberlet, 2006). Numerous sites have been accredited with being the first to practice goat management, such as Pakistan's Indus Basin, areas of Turkey, and parts of Israel. It is now believed that much of this domestication occurred simultaneously and involved several different breeds of goats, including the Bezoar and Markhor breeds, which are thought to be the original ancestors of many of the breeds known today (Khan, Iqbal & Mustafa, 2003). Recent mitochondrial DNA analysis has revealed that the Neolithic farmers responsible for the domestication began transporting small herds of goats into Europe, an area where the goat remains a popular commodity to this day (Fernandez et al., 2006).

Recently, there has been an estimation of over 300 breeds of goats, 100 of which are most popularly used for their products of mohair, milk, and meat. Many of the breeds known today have originated from Africa, such as the Boer goat, which is well-circulated around the world today (Gall, 1996). Certain meat goat breeds, such as the Small East African goat, are popular in Rwanda.

In the Western world, including the United States, goat management and production practices vary widely, seeing as there are many new goat industries into which farmers can enter. For instance, there are the traditional facets for meat, milk, and mohair production, but there are now also new outlets emerging, such as pet goats and goat milk soap (goatmilkstuff.com/Soaps, 2012). For Example, in the United States, demand for goat products has been on the rise. Between 2002 and 2007, the United States Department of Agriculture documented a 30%

increase in terms of sheep, goats, and sheep/goat product sales (Overview of the United States Sheep and Goat Industry NASS, 2011). Specifically, the increase in goat production and sales is attributed to the nation-wide increase in the number of ethnic groups that consume goat meat as one of their major protein sources (NASS, 2011). These groups also rely on the goat as the centerpiece for holidays such as the Islamic New Year, the beginning of Ramadan, Passover, Rosh Hashanah, and Chanukah (Jones, 2007). Indeed, goat herders have seen a sharp rise in sales around these times of the year. Despite the increase in sales, the sheep and goat industry revenue only comprises 0.2% of the nation's total sale of agricultural products (NASS, 2011). In the United States, the average market age for goats is under one year.

The 4-H program, a youth development program concerned with establishing a background of science, citizenship, and healthy living among today's youth, with a particular emphasis on agricultural animal production, is a well-established program in the United States and serves as another major market for goat sales. Each year, 4-H members can choose to raise a goat for auction. Other organizations support the goat-showing industry either for sport or marketing purposes (Smith, 2012). Goat registries enhance the lucrative nature of goat production by adding value to pure-bred goats. Such seedstock industries include the American Dairy Goat Association, the Myotonic Goat Registry, the American Boer Goat Association, and many others (adga.org; myotonicgoatregistry.net, 2012; abga.org, 2012). These registries are founded on the principle of preserving the integrity and breeding standards of their respective breeds. Although there exists a vast number of goat sub-industries in the United States, the majority of goat production is for the purpose of meat. For instance, in 2010, there were an estimated 152,000 goat production practices in operation, out of which 128,000 were for meat production (NASS, 2011). On average, there are 20 goats to each of these operations (NASS,

2011). United States goat production differs from that in Africa, due to the notable sector for mohair and specialty goat industries in the U.S.

In African countries, especially Rwanda, the goat is a culturally popular commodity. This statement is attested by the fact that in 2007, there were 10.8 goats per every 100 people in Rwanda, compared to only 0.8 goats per every 100 people in the United States (http://kids.fao.org/glipha/, 2013). The large proportion of goats compared to the general population is not a characteristic of Rwanda alone, but rather all of Africa.

Overall, the livestock industry comprises 8.8% of the total GDP of Rwanda, and there are about 1,270,973 goats that help contribute to this industry (minagri.gov.rw, 2013). In Gitarama (the city nearest to the Muhanga District) alone, there are 144,375 goats (Butera & Rutagwenda, 2004). The main areas of goat production in Rwanda are in the districts surrounding Kigali, Kibuye, and Buyumba (minagri.gov.rw, 2013). Currently, the Ministry of Agriculture and Animal Resources is implementing a program to improve the goat production in these areas by importing high-yielding foreign breeds of goat (minagri.gov.rw, 2013). Similar practices have seen success in Kenya and Burundi.

The reasons behind the practicality of goat management over other livestock endeavors are many. Goats are very efficient animals and are capable of converting the low quality pastures and forages that populate the African brush into valuable products, such as meat, mohair, and milk (Khan et al., 2003). In essence, the goat is capable of being sustained on less than ideal grazing conditions, which makes it a prime candidate for farmers in Africa who experience frequent drought due to environmental conditions (Khan et al., 2003). Compared to cattle, Boer goats have lower energy requirements, and can thus be managed on less feed than would cattle (Khan et al., 2003). Furthermore, goats provide quick investment returns, since

they can be bred as young as seven months of age, and well-growing kids can be sold as yearlings (American Dairy Goat Association; Khan et al., 2003). Goats are particularly well suited for Rwandan production, because the preferred environment of the goat is in drier tropical areas (Khan et al., 2003). However, goats can thrive in many climates due to their superb adaptability, which makes them even more appealing to African farmers of today, who may be facing unexpected climatic changes (Khan et al., 2003).

The Ministry of Agriculture and Agricultural Resources of Rwanda has identified an extensive list of constraints to goat production in the country. Some of these challenges include, lack of veterinarians and veterinary services, low-performing local breeds, lack of financial resources, poor nutrition, prevalence of disease, weak organizational capacity of goat herders, and a shortage in the amount of available farmland (Butera et al., 2004).

Historical practices of Rwandan pastoralists, hunters, and farmers have contributed many of the problems faced by Rwandan herders today. Rwandan goat herders do their best to mediate these problems by modifying some of the traditional practices previously held. For example, the decrease in land availability has led some farmers to permanently stable their animals, rather than allow them to graze freely (Rwamasirabo, 1990). This is just one of the many adaptations made by modern-day Rwandan pastoralists.

Hypothesis

The combination of scientific methods, with traditional cultural techniques of goat production, will provide a more efficient approach to goat management in the Muhanga District of Rwanda than current cultural methods alone.

Significance of the Study

The significance of the study is two-fold. First, the study will add to the existing corpus of knowledge concerning goat production and management, particularly information on its production and management in Rwanda. Secondly, it will benefit numerous groups, including the goat herders of the Muhanga District, the Rwandan Government, Western goat production specialists, university students in both Africa and in Western societies, animal activist groups, and foreign aid organizations, such as the World Bank, the International Monetary Fund, and the Food and Agricultural Organization.

Data Collection

Data collection for this study included library resources, such as books, journals, newspapers, and Internet sources. Additionally, the author conducted field research in Rwanda which involved personal observations of goat management techniques in the Muhanga District of Rwanda, interviews with goat herders of the District, as well as a review of government information on goat herding published online by the Rwandan Ministry of Agriculture and Animal Resources.

The author chose the Muhanga District of Rwanda for the study after her initial experience there during the summer of 2012. She recognized the great importance livestock holds in the lives of the people of the Muhanga District where she discovered that cattle seemed to predominate in certain regions, but she was more interested in learning about the smaller-scale farmers of the District who did not have enough land for cattle. Their alternative was to raise goats. Hence, the idea for this study was born.

Research Questions

The following questions guided the data collection for the research project:

1. What are the various goat production methods in the Western World?
2. What are the historical and cultural backgrounds of Rwanda and the Muhanga District?
3. What are the goat production methods in Rwanda?
4. What are the major constraints of goat production in the Muhanga District?
5. What is the significance of the goat in the Rwandan culture?

The next section presents the literature review on animal husbandry and culture.

Chapter 2

Animal Husbandry of the Goat

Introduction

This chapter discusses the history and development of animal husbandry as well as the modern definition of the term. It is an attempt to trace the historical development of this science and show its impact on animal care today. The discussion focuses mainly on the animal management of the goat both in the U.S. and across the globe.

Definition

In its simplest form, animal husbandry is "a branch of agriculture concerned with the production and care of domestic animals" ("Animal Husbandry"). Despite this simplistic definition, animal husbandry is influenced by a wide range of factors including reproduction, animal nutrition, housing, and health care. In this study, animal husbandry is used to refer to the methods involved in livestock production.

Animal Husbandry of the Goat

The domestication of the goat, which marked the beginnings of animal husbandry in early human settlements, occurred around 11,000 BC, and it is considered only second to that of the

dog which also occurred between 18,000 and 32,000 years ago (Payne & Wilson, 1999; Thalmann, Shapiro, Cui, Schuenemann, Sawyer, Greenfield, Germonpré, Sablin, López-Giráldez, Domingo-Roura, Napierala, Uerpmann, Loponte, Acosta, Giemsch, Schmitz, Worthington, Buikstra, Druzhkova, Graphodatsky, Ovodov, Wahlberg, Freedman, Schweizer, Koepfli, Leonard, Meyer, Krause, Pääbo, Green & Wayne, 2013). Domestication of the goat also introduced alteration of the species to suit human needs and environmental conditions. For example, certain species, such as the Boer goat, were developed to serve as meat breeds, while others, like the Nubian and Saanen, were bred for their milking capabilities. **Table 1** exemplifies the intended purposes for a sampling of goat breeds.

Table 1 Goat Breeds and Intended Uses

Goat Breed	Intended Use
Alpine	Milk
American Cashmere	Fiber
Anglo-Nubian (Nubian)	All-purpose
Barbari	Meat
Boer	Meat
British Alpine	Milk
Kiko	Meat
LaMancha	Milk
Myotonic	Meat
Nigerian Dwarf	Milk
Pygmy	Recreation
Saanen	Milk

Adapted from: ansi.okstate.edu, 1995

Still others were also bred and managed for their ability to survive in tropical environments. These included the West African Dwarf and the Small East African breeds, which were raised for their meat, and the Galla, which was also raised for both meat and milk (Payne et al., 1999). Additionally, temperament was key in terms of goat selection. Hence, only well-behaved goats were selected to propagate the breeds for the next generation.

Goat animal husbandry includes the implementation of selection and breeding programs, nutrition, housing, and health care. Goats may be bred as young as 2 months; however a majority of tropical goats that are not subjected to a controlled breeding program often conceive around the age of 7 months and give birth about the age of 12 months (Payne et al., 1999). Although there are disadvantages in regards to breeding doe kids, benefits often outweigh risks with goats being bred as doe kids having higher lifetime productivity rates than those bred as yearlings (eblex.org.uk, 2010).

Nutrition is a key aspect of animal husbandry as it is essential for overall health and optimal reproductive and production performance of the animals. In contrast to sheep and cattle, goats are classified as selective browsers, referring to their preference for fruits, flowers, leaves, and twigs as opposed to grasses and herbs. A goat provided with only low quality forages will not thrive due to their reduced body size and fast rate of passage of food compared to cattle, thus limiting the amount of nutrients they are able to extract from available forage. Despite goats possessing a preference for concentrates, they have been documented to adapt to the ever-changing availability of feeds and forages in tropical environments (T. Ott, Sheep and Goat Production and Management Course Notes, March 2013).

In contrast to some livestock production systems in the West, goats are best managed under free-ranging conditions. However, they are also known to have an elevated sensitivity to parasitic infestations compared to sheep, which positions them at a greater risk for infection under enclosed management systems. Such systems also increase the risk of respiratory diseases spreading throughout the flock. In order to prevent such disease from ruining the flock, it has been suggested that special attention must be paid to the design, temperature, ventilation, and lighting of the housing unit (Toussaint, 1997). A well-designed goat handling facility includes handling pens, isolation pens, kidding pens, and, if applicable, a milking shed or slaughter room (Peacock, 1996).

Modern Technologies and Trends

Modern times have brought new concepts into the field of animal husbandry. New aspects include organic animal production systems as well as improvements to livestock health care. Still other technologies, such as artificial insemination have focused on the improvement of breeding practices of goats and other livestock animals.

Organic Agricultural Production

In the Western world, an increased consumer interest in animal welfare has led to the development of "organic agriculture." The term "organic" was officially defined by the Organic Foods Production Act (OFPA) under the 1990 U.S. Farm Bill. The Act encompasses many components of the food system from production to processing and handling. Specifically, and in regards to livestock production systems, organic farming entails "using rotational grazing and

mixed forage pastures for livestock operations and alternative health care for animal wellbeing" without the use of antibiotics (sare.org, 2003).

Since its inception, there have been advocates and dissenters of organic agriculture. Many animal welfare groups are proponents of organic implementation on the grounds that organic legislation forbids the use of steroids and use of antibiotics as growth promoters in animals. However, the latter point also is a cause of concern, seeing as the forbiddance of antibiotic use also serves as a violation of animal welfare, if the animal is ill. According to organic legislation in the United States, animals that are injured or sick must be treated with the appropriate medications, but are not allowed to be sold under an organic label (ams.usda.gov).

Health Care Practices

The practice of deworming (i.e. the use of anthelmintics) has been applied since approximately 170 AD, when the Greek physician Claudius Galënus first used vegetable extracts for anti-parasitic treatments in humans (Waller, Bernes, Thamsborg, Sukura, Richter, Ingebrigtsen, & Höglund, 2001). Since then, the field of animal husbandry has witnessed the application of this technology to animals and the expansion of known anthelmintics. It was not until the early 20th century when large-scale deworming programs were practiced (Bundy, Walson & Watkins, 2013). Unfortunately, many of the early anti-parasitic approaches, included blood-letting and the administration of toxic mercury or animal offal, were not effective as they harmed the animal in the process of killing the parasites (Robert, 2013).

Thiabendazole, of the anthelmintic class benzimidazoles, was the first modern anthelmintic to be introduced in 1961. Although thiabendazole is no longer on the market, other

drugs within the same class, such as oxfendazole, fenbendazole, and albendazole, are still being utilized to treat parasitic infestations in livestock today. The two additional modern classes of anthelmintics are nicotinic agonists, which include imidazothiaoles and tetrahydropyrimidines, and macrocyclic lactones (Schoenian, 2010).

With the introduction of modern anthelmintics has come the parasite resistance to these anthelmintics. This resistance is the result of over-application of a single class of anthelmintics and the sole reliance on anthelmintics alone in parasite-prevention and control strategies. Resistant parasitic species are particularly prevalent in small ruminants found in the tropics where many farmers are limited in their deworming options (Krecek & Waller, 2006). In order to combat this growing resistance, livestock researchers and veterinarians are advocating an integrated approach to parasite management. This multifaceted system includes the use of anthelmintics in addition to practices, such as rotational grazing, which have been shown to significantly reduce parasite loads in livestock herds. Rotational grazing involves the movement of animals between sub-divided pastures after being grazed for a relatively short period of time and then left fallow for a longer period of time. The length of grazing and non-grazing periods of a pasture differs with the type of production system (Barger, 1999). By rotating animals between pastures, the larvae from parasite eggs deposited during the grazing period do not have the opportunity to re-infect the animal, since the animal will have been moved off that pasture before larval maturity. So effective are such rotational grazing practices, the parasite load of a pasture can be reduced by half without even the application of a single anthelmintic (Waller, 1997).

The American Sheep Industry Association, however, cautions that in cases where anthelmintics are needed to further reduce parasitic infestations, they should be applied sparingly. The Association offers five steps shown to decrease and/or prevent drug resistance:

1. Dose according to body weight and use the full recommended dose, which is approximately 1.2 to 1.5 times the suggested dose for sheep
2. Dose new animals before introducing them to the pasture
3. Apply a dewormer until resistance develops
4. Check for resistance annually
5. Use an integrated approach to parasite management (2002).

Vaccinations and Prophylactic Treatment

The dawn of vaccinations began in 1796 when Edward Jenner developed a vaccine providing immunity against small pox (historyofvaccines.org). Since then, there has been the development of thousands of vaccinations for both human and animal use.

Although there are less veterinary medications available on the market for small ruminants than there are for large ruminants, there are many vaccines that exist to combat disease in sheep and goats (Kerr, 2007). For example, contagious caprine pleuropneumonia, brucellosis, peste des petits ruminants, enterotoxemia, anthrax, and foot and mouth disease are just some of the diseases that can be effectively prevented through vaccination. Specifically, the vaccine available for contagious caprine pleuropneumonia is produced in France, Turkey, and Kenya, with a heat-tolerant vaccine now available on the market. This latter point is especially important to goat herders of Africa that may lack refrigeration but may live in extreme heat conditions (Peacock, 1996).

Reproductive Advances

Artificial insemination describes the act of the semen collection from a sire and the introduction of this semen into the reproductive tract of a corresponding dam through mechanical means (Althouse, 2008). The first act of artificial insemination (AI) in animals was performed by Lazzaro Spallanzani in 1784; however, it was not until the late 19th century when efforts to improve AI techniques in livestock reproduction were underway in Russia (Foote, 2002). Artificial insemination techniques saw great advances, with higher conception rates being achieved, and widespread application during the 1940s, particularly in dairy cattle (Foote, 1999). Today, artificial insemination is utilized in a large number of livestock species, as well as in dogs and cats (Linde-Forsberg, 1995; Tsutsui, 2006).

Goats are no exception to the worldwide increase in AI application. In South Africa alone, 50, 592 frozen semen samples from sheep and goats are produced each year. Although there is still improvement to be made in terms of AI conception rates, the application of AI technologies in the goat industry has many advantages. For instance, AI can aid in the reduction of sexually-transmitted diseases, such as bluetongue; eliminate the need to maintain a buck on the property; and increase genetic progress and potential of the herd (Althouse, 2008).

U.S. Goat Production

In the United States, a majority of goat farmers reside in the western portion of the country. The top six states in terms of income from goat sales are Texas, Colorado, California, Iowa, South Dakota, and Wyoming.

The most recent goat inventory (as of January 1, 2013) performed by the United States Department of Agriculture (USDA) reveals a decrease of 2% in total goat numbers from 2012, resulting in a total goat population of 2.81 million head. Consequently, the number of kids born in 2012 also dropped, as well as the number of goats currently in breeding status. On a more promising note, the number of market goats and kids is up 1% from the previous year, totaling 490,000 (Sheep and Goats, 2013).

There are many similarities between Rwandan and U.S. goat production techniques. For instance, animals are generally penned or tied in both countries; however, the reasoning behind this practice differs. In Rwanda, the government has installed a "no wandering law" that applies to all livestock, preventing them from being free range (National Agriculture Survey, 2010). In the United States, livestock are contained, but for the reason of conservation and preservation of streams and the prevention of neighboring property damage. The treading of livestock into water creates erosion, thus, by fencing off streams and preventing access to natural bodies of water, the water systems are maintained (agcensus.usda.gov, Conservation and Agriculture Practices).

As in Rwanda, a majority of United States goat herders are men. According to the most recent United States Department of Agriculture Census, only 26.1% of sheep and goat producers are women. Amazingly, this percentage strongly mimics the percentage of female farm heads in the Muhanga District of Rwanda (26.3%) (National Agriculture Survey, 2010). Although women goat herders are still a minority in the U.S., their numbers are up by 4% since the previous census conducted in 2002 (agcensus.usda.gov, Sheep and Goat Farming).

Regardless of the location, local predators always serve as a threat to livestock. While in Rwanda, white-backed vultures, eagles, and domestic dogs are the major threats to goat populations, in the United States, coyotes are the number one menace, followed by eagles, dogs,

and foxes, destroying $3.4 million dollars' worth of goats and their products. U.S. goat herders take a variety of combined approaches to protect their herd from predators. Such practices include fencing, guard dogs, livestock guardian animals (horses, donkeys, and llamas), goat sheds, herding, night penning, and fright tactics. So prevalent are predators that U.S. goat herders spent a total of $1.0 million to protect their herds (Sheep and Goats Predator Loss).

The United States goat market shares a comparable distribution to the goat market in Rwanda. Meat goats dominate the market accounting for roughly 82.4% of the U.S. goat population. Of the 2,816,000 goats in the U.S., 360,000 of them are utilized for milk (12.7% of the market). The remaining 136,000 goats are sheared for their angora hair (Sheep and Goats, 2013).

Just as Rwandan farmers struggle with parasites, goat farmers in the United States are in a constant battle with parasitic infestation. However, the manner in which farmers in the two respective countries deal with parasites differs. Formerly, U.S. scientists and animal specialists encouraged a set schedule of deworming with the rotation of different dewormers with each session (T. Ott, Sheep and Goat Production and Management Course Notes, March 2013). Recently, however, this suggestion has drastically changed with farmers being urged to deworm their animals on a more selective basis and only around times of parturition. Furthermore, the same dewormer should be utilized until it ceases to provide 95% effectiveness against internal parasites (Sheep Production Handbook, 2003).

Despite the many similarities shared between Rwandan and U.S. goat farms, there are also quite a few differences. The first one of these differences is size. The United States is not nearly as densely populated as Rwanda, with only 33.7 people per square kilometer on average (census.gov). This is in contrast to the population density of 416 people per square kilometer in

Rwanda (Featured Indicators). Obviously, this leads to dissimilarities in farm size. Farms in the United States are drastically larger than that in Rwanda, with the average U.S. farm being 418 acres (169 hectares) and the average Rwandan farm being less than 0.8 hectares (agcensus.usda.gov, Farm Numbers; National Agriculture Survey, 2010). As a result, farmers in each country have the capacity to produce dramatically different amounts of crops and livestock.

Although some demographic characteristics are the same, there are differences in the age of farmers in Rwanda and the United States. The average age of all farmers in the U.S. is 57, while the average age of new farmers is 48. The latter age more closely resembles the average age of farmers in the Southern Province of Rwanda, 46 (National Agriculture Survey, 2010). However, this similarity may be skewed based on the discrepancy in life expectancy in each country. According to the CDC, the average life expectancy in the United States is 72.7 (cdc.gov), whereas the average life expectancy in Rwanda is nearly 20 years lesser at 55 (unicef.org).

An additional difference between United States goat production and Rwandan goat production is the number of individuals who rely on livestock farming as their primary income. A majority of U.S. farmers (55%) derive most of their income from an alternative source other than farming (agcensus.usda.gov, Farm Numbers). Specifically, 64.2% of sheep and goat herders in the United States hold an alternative primary occupation besides sheep and goat production (agcensus.usda.gov, Sheep and Goat Farming). The statistics are nearly reversed when it comes to farmers in Rwanda where 56.3% of Rwandan farmers do *not* pursue other forms of income besides agriculture.

There is not as great of a percentage of the U.S. population involved in agriculture as there is in Rwanda. Nearly 85% of families in Rwanda practice some form of agriculture, while

only 2% of the U.S. population participates in farming (National Agriculture Survey, 2010; epa.gov). These percentages are the result of the types of farming practiced by respective populations around the globe. In Rwanda, as in much of Africa, farming is primarily subsistence, with a majority of the products being used for self-consumption rather than profit. This is the opposite case in America where agricultural products are largely supplied for the country's consumer market.

Based upon goat herder interviews conducted by the researcher in Rwanda, it became apparent that most of the goat herders in the Muhanga District of the country do not spend a great portion of their income, if any, on feed (Personal interview, 2013). On the other hand, in the United States, livestock feed encompasses the greatest expense, costing sheep and goat farmers a total of $238.5 million (or nearly 25% of all production expenses) (agcensus.usda.gov, Sheep and Goat Farming).

American goat herders also face difficulties not necessarily experienced by Rwandan goat herders. For example, the Endangered Species Act of 1973 has resulted in the introduction of natural predators to goats, such as the Gray Wolf, and in the restriction of land for pasture grazing. During the wolf hunting season of 2013-2014, which spans from August 30 to March 31, the state of Idaho aimed to reduce the number of wolves to the lowest volume possible without causing a relisting of the Gray Wolf on the endangered species list (Maughan, 2013). In December of 2013, the Idaho Department of Fish and Game even hired a professional trapper to eliminate two Gray Wolf populations to protect wild animals, such as elk and deer, as well as domestic ones (Barker 2013). Such restrictions on hunting do not yet exist in Rwanda.

Conclusion

Since the domestication of the goat in 11,000 BC, animal husbandry has evolved dramatically in terms of animal production and management. Recently, organic agriculture has come into popularity, impacting the practices of goat herders in addition to other livestock herders. This method remains controversial as researchers seek to determine the true environmental and health benefits of organic production systems. In terms of health care, practices involving anthelmintics are changing as more and more parasites become resistant to the dewormers currently available on the market.

Goat production in the United States bears several similarities to Rwandan goat production, while also maintaining some distinct differences. In both countries, goat herders battle predator threats and parasitic infestations. Conversely, the most American goat herders have a greater amount of land available for grazing, and thus should not experience the same overcrowding issues witnessed in Rwanda. Similarly, a smaller proportion of the U.S. population consists of goat herders compared to that in Rwanda. Despite these differences, the main goal remains to produce healthy, viable goats capable of providing the goat herder with a decent income to maintain an optimal quality of life.

The next section will discuss the culture and goat animal husbandry in Rwanda.

Chapter 3

Culture and Animal Husbandry in Rwanda

Introduction

This chapter discusses culture and goat production and management in Rwanda, focusing on how culture influences the practice. The topics discussed include a brief history of Rwanda, Rwanda under Belgian colonial rule, Rwandan Independence, and culture and goat production.

Rwanda: A Brief History

Rwanda is a landlocked country in Southern Africa bordered by Burundi, Tanzania, Uganda, and the Democratic Republic of Congo (DRC). The country spans approximately 26,000 square kilometers, with land comprising 24,668 square kilometers (cia.gov). The population of Rwanda is about 12 million people, comprising the Twa, the Tutsi, and the Hutu, with the latter forming the largest group and the Twa being the minority (Twagilimana, 1998). It is believed that all three ethnic groups were present in Rwanda by 900 AD, but the Twa group was the first to arrive in the region, followed by the Hutu, and finally the Tutsi.

Despite the devastation imparted by the 1994 genocide, Rwanda's economy has attained pre-1994 levels and is continuing to grow. As of 2012, the country's gross domestic product (GDP) reached $15.02 billion, with an annual growth rate of 7-8% over the past 9 years. According to the CIA, $1.871 billion was spent by the Rwandan government on imports in 2012, a value bypassing the $1.565 billion spent in 2011 (cia.gov). Due to the limited natural resources in Rwanda's possession (those primarily being wolframite, columbite-tantalite, and cassiterite),

the largest sector of the import share is that of mineral and chemical fertilizers. This is followed by aircraft/space craft vehicles, petroleum, raw sugarcane, and medicaments (Yager, 2011). In turn, Rwanda exported products, namely coffee, tin and niobium ores, and tea, valued at $512 million in 2012 (cia.gov; Simoes). These imports and exports were facilitated by Rwanda's major trading partners. Rwanda imports over 30% of its products from the bordering countries of Kenya and Uganda; this is followed by the UAE, China, India, Tanzania, Belgium, and Canada. Likewise, Kenya imports the greatest share of Rwanda's export products. The Democratic Republic of Congo, China, Malaysia, the United States, and Switzerland constitute the remaining major export recipients (cia.gov). Provided the disproportionate amounts spent on imports compared to funds generated from exports, in addition to hefty loan payments to foreign countries, Rwanda maintains an external debt of $799 million (USD), while also balancing an internal debt of $486 million (USD) (imf.org).

Although Rwanda's economy is improving, 44% of its citizens live below the poverty line. Unfortunately, there is no current data on unemployment rates in Rwanda. As of 2002, the rural unemployment rate was estimated to be 14% (Meyers, Bledowski, Christensen, Hauner, Di Bella & Rother, 2004). More recently, a study conducted by the African Development Bank cited that 42% of Rwanda's youth are either underemployed or unemployed. This is a startling fact, given 40% of Rwanda's population is comprised of youth. The study linked the high unemployment rates to a lack of jobs and economic growth, particularly in rural areas (African Economic Outlook Rwanda, 2012).

Ethnic strife between the Hutu and the Tutsi began early in Rwanda's history, around 1500 AD, when the latter declared themselves the ruling class of the society (Twagilimana, 1998). The remainder of the social ladder was dependent upon the number of cattle a family

owned—the more cattle, the higher the status. As a result, most families abstained from the consumption of beef in order to preserve their wealth; thus, cows were utilized primarily for their milk and reproductive capabilities (Rwamasirabo, 1990). Inevitably, the Tutsi comprised the majority of the upper class since they owned the most cattle. The Hutus were primarily agriculturalists, while the Twa sustained themselves on a hunter-gatherer lifestyle (Rwamasirabo, 1990). While social identification of individuals designated Tutsi, Hutu, and Twa lineages, citizens of the Rwandan state were also recognized as being members of cross-lineage clans. In other words, one clan may have contained members of both Tutsi and Hutu lineages (Newbury, 1978).

Prior to discrimination between the Hutus and Tutsis, the Twa were segregated from the remainder of society. Their marriages to non-Twa were forbidden and their livestock-raising practices relegated, demoting the Twa to the lowest social class with the least amount of cattle (i.e. zero head of cattle). Not only were physical attributes a basis for discrimination, but behavior and even dietary habits differentiated the classes of early Rwandan societies (Taylor, 2005).

Before 1865, land ownership was based on a lineage system, thus immigrants who had no established lineage in Rwanda served as clients to those residents who owned land, creating a patron-client system (Newbury, 1978). However, as the ruling class, the Tutsi established their own monarchy in 1865, with King Rwabugiri serving as the first monarch of the country. Upon his ascension to the throne in 1865, King Rwabugiri enacted several changes to the land ownership qualifications, creating social class differentiation (Newbury, 1978). Livestock ownership therefore, led to greater social and ethnic divides, and it was also during this time when local chiefs became in charge of land distribution, providing a stark contrast to the

previously held land-lineage system. Also during his reign, Rwabugiri began the practice of collecting a cow from well-to-do cattle herders, thus adding to the wealth and power of the monarchy.

Ethnic rivalries and political instabilities in more recent years have prevented the entire potential effectiveness of government policies and agricultural assistance from being felt around the country (André, 1998). The increase in population both in the past and present has culminated in a decrease in cultivated land availability, which was somewhat staved off by the massive killings of Tutsi cattle herders during the genocide of 1994.

Rwanda under Belgian Colonial Rule

Like the rest of the African continent, Rwanda has been plagued by the legacies left by European colonization. Initially, the Germans took hold of Rwanda from King Rwabugiri; German rule ended in 1916 (Twagilimana, 1998).

At the end of World War I, the League of Nations granted Belgium administrative control of the country. Under Belgian rule, social status became increasingly more defined, and ranchers with a greater number of livestock wielded extensive political power (Rwamasirabo, 1990).

Adding to the ethnic differentiation, the Belgians conducted census in 1933, which classified each individual in Rwanda as Tutsi, Hutu, or Twa. Later, these classifications would pervade themselves through the distribution of identification cards. The Belgians justified their class identification practices behind the curtain that they must protect the depressed "Hutu masses," citing the agriculturally well-to-do and politically powerful Tutsis as being a threat to Hutu social justice (Melvern, 2009). However, this claim by the Belgians was entirely false,

since the *Belgian* government itself was the one that unleased mass terror on the Hutus through routine persecutions that were carried out by Tutsi government officials (libcom.org).

The Rwandan monarch's power was greatly diminished following the inception of Belgian rule and was completely weakened when Tutsi King Mutara Rudahigwa died in 1959 (Melvern, 2009). This year marked the beginning of a long road of extreme ethnic violence between the Hutu and Tutsi groups, and which was just coming to fruition during the reign of King Rwabugiri (Rwamasirabo, 1990). It was at this time when the Belgian administration imposed military rule, with the appointment of the Special Military Resident Guy Logiest. Logiest was quick to favor Hutus and denounce Tutsis within the Rwandan administration, thus turning the Hutus against the Tutsis (Melvern, 2009).

Belgian rule ended in 1961, when Rwanda was granted independence; however, the ethnic tensions were far from over (libcom.org).

Independence and the 1994 Genocide

The Hutu party was successful in winning the 1961 presidential elections, and almost immediately, military troops were sent out to purge the country of Tutsi. After twelve years of violence, General Habyarimana established an authoritarian government that further segregated the nation between Hutu and Tutsi ethnic lines (libcom.org). The following decades were marked by increased Tutsi persecution, numerous revolts and military coups, and widespread violence throughout the country.

In 1992, the French served a great presence in Rwanda, as their soldiers used the identification card system to target Tutsis for arrest at road checkpoints (Melvern, 2009). Thus,

events from the colonial and post-colonial periods contributed to the 1994 holocaust that killed nearly one million Rwandans, most of them being Tutsis (McKay & Loveridge, 2005).

Even before the start of the genocide, the Food and Agriculture Organization (FAO) had announced that the political turmoil was leading to massive famines in the southern province of the country. Not only were militant forces and famine responsible for the loss of life during the genocide, but hundreds of thousands of individuals died due to inadequate medical care, which, according to the FAO, began to collapse in 1992 (Melvern, 2009). Needless-to-say, the 1994 genocide had massive impacts on Rwandan food security and livestock production—thousands of animals were killed in the countrywide slaughter, and the resulting lack of able-bodied workers left farms unattended (McKay et al., 2005).

Today, Rwanda remains one of the poorest countries in the world and has the greatest population density among African countries. With a population estimate of about 10,537,222 people spread over less than 25,000 square miles, the population density is approximately 416 people per square kilometer, an increase from 321 people per square kilometer in 2002 (Population and Housing Census, 2012). This correlates to a farm size of about 0.83 hectares per family or 2.05 acres (Clay, Byiringiro, Kangasniemi, Reardon, Sibomana, & Umwananya, 1995). The amount of land per person is expected to decrease with the CIA's estimates of a population growth rate of 2.7% (cia.gov). It is for this reason that land availability is becoming one of the primary challenges faced by farmers and livestock producers in the country.

Goat Herding in Rwanda

Throughout Rwanda, goats are seen as a means of income, sustenance, and a key component of rituals and customs. The majority of the goat population in Rwanda belongs to poor, rural farmers that practice a low-input system. Due to their unsurpassed adaptability, the goat is ideal for this type of system, which has served rural goat herders for centuries (Boyazoglu, Hatziminaoglou & Morandfehr, (2005). In fact, the goat was the staple of Hutu diets during the early colonial period. In more recent times, goats are used as a food source by all Rwandans and even serve in customary social events. For example, a goat is often given to a husband and wife upon the birth of their first child (Taylor, 1988). Although cattle tend to dominate livestock populations in the highlands, goats are often managed by women in addition to their gardens (U.S. Congress Office of Technology Assessment, 1988). The fact that Rwandan women have been integrated into the process of raising goats since their domestication attests to the importance of cultural goat production methods in the maintenance of gender equality.

Furthermore, goats in Rwanda serve functional purposes. Manure from these animals can be used as both a biofuel and as a fertilizer, practices that have been held by herders for generations (Riethmuller, 2003).

Due to the importance of the goat and livestock as a whole, the Rwandan government has established progressive programs for the betterment of livestock rearing. One such project is the Agricultural Information and Communication Center (CICA), whose objective is "to regularly collect, product, process, adapt, store, and disseminate agricultural information" (http://www.minagri.gov.rw/index.php?id=574). The Center's most recent achievement was the production of over 10,000 copies of extension materials by the end of 2012.

The Livestock Infrastructure Support Program implemented by the Rwandan Ministry of Agriculture and Animal Resources was launched in 2011 and will continue to function through 2015. The intention of this program is to increase market accessibility of rural Rwandan livestock herders through infrastructural improvements with loans from the African Development Bank (afdb.org).

Livestock inspection facilities have also been established by the Rwandan government to ensure safety and quality of animal products. The Rwanda Agriculture and Livestock Inspection and Certification Services provide quality inspection of plant and animal products destined for trade. The program upholds the health and safety standards of the WTO and the International Plant Protection Program (minagri.gov.rw).

As the year 2020 approaches, so does the initial deadline of Rwanda's Vision 2020. Ultimately, this project, instituted in 2000, achieve middle-income status by 2020. One way in which this is planned to be accomplished is through movement away from subsistence farming (minecofin.gov.rw). According to a performance summary released in 2011, the agricultural goals are "on-watch," which is the middle category between "on-track" and "off-track." Agricultural population and production are on-track, yet the Ministry of Finance and Economic Planning claims that per capita growth rate within the agricultural sector must increase to obtain the 2020 target of a 12% growth rate within the industry sector (Vision 2020 Progress and Way Forward).

Despite the goat's amazing adaptability and the Rwandan's reliance on the goat for centuries, goat herding in Rwanda does not come without challenges. A 1983 conference conducted by the FAO compiled some of the latest research on small ruminant production and management in Africa. The overall consensus of the conference sessions was that while

Rwanda's farmers are restricted in terms of space for livestock production, at present, the genetic competitiveness of local Rwandan goats is quite low. The fact that most goats (as with other livestock species) are raised under "low-resource conditions" does not maximize the limited genetic potential (U.S. Congress Office of Technology Assessment, 1988). Solutions for these and other constraints are addressed in the final chapter of this paper.

Goat Herding Problems in Rwanda

Problems faced by Rwandan goat herders include diseases and parasites, predator threats, water availability, food and nutritional quality. These problems are compounded by the financial constraints facing many rural famers.

Diseases and Parasites

Rwandan goat herders, like other goat managers around the world, are plagued by the effects of high worm populations among their goats. Parasitic infections result in decreased growth rates and increased numbers of stillborn kids. Worms are especially detrimental to Rwandan farmers who lack the resources necessary to treat worm infestations among their herd (researchintouse.com).

Symptoms of parasitic infection include edema of the submandibular area, known as bottle jaw, diarrhea, weight loss, rough hair coat, decreased production, abortions, slowed growth rate, and possibly death (Peacock. 1996).

Parasitic trypanosomes are often vector-transmitted with the most notorious vector being the tse-tse fly; however, other fly species, such as those comprising the family of horse flies,

have been shown to transmit the parasite as well. Like many livestock parasites, trypanosomes present a human health issue in that can it readily spread to humans, resulting in African sleeping sickness (WHO). It is estimated that approximately 70 million individuals are at risk of contraction of the disease; however, most of the reported cases have originated from the Democratic Republic of Congo (WHO). Due to the geographic location of Rwanda, with respect to the DRC, this places those residing in the country under threat of parasitic trypanosome infections. Although there have been no reported cases of African sleeping sickness in Rwanda within the last ten years, this is most likely a skewed perspective due to complications in epidemiological data collection and hindered surveillance efforts (WHO). Human contraction of African sleeping sickness initially results in fever and bodily aches, which then progress to incoordination, other neurological changes, and changes in sleep patterns.

Many ticks serve as vectors of parasitic anaplasma species (Lew-Tabor, 2015). *Anaplasma marginale* and *A. ovis* have both been recovered from goats (Kuttler, 1984). This parasite infects the red blood cells of the host, causing them to be targeted by the immune system, resulting in severe anemia (Kocan, De La Fuente, Guglielmone, & Melendez, 2003). Traditionally, antibiotics, such as oxytetracyline, have been used to treat anaplasmic infections; yet, it has been recently discovered that animals treated with multiple rounds of antibiotic, still retain DNA fragments of the infectious agent (ufl.edu). As a result, prevention via inoculation with an attenuated vaccine is recommended.

Another tick-vectored parasite falls under the species *Theileria*. *Theileria lestoquardi* is the species of concern among goat herders; however, *T. separata* is another species that is capable of infecting goats (cfsph.iastate.edu). In particular, *T. lestoquardi* infections result in tropical theileriosis, which is characterized by loss of appetite and subsequent weight loss,

swollen lymph nodes, and anemia (merckmanuals.com). Unfortunately, this parasite leads to high mortality rates within goat herds (cfsph.iastate.edu). Even if an animal does recover from tropical theileriosis, it is typically afflicted with an inadequate and suppressed immune system due to the destruction of white blood cells by the infecting agent (merckmanuals.com). Currently, much research is underway in Germany and elsewhere in order to provide a better means of theileriosis detection (Mousa, 2010).

Eimeria is a coccidian protozoan species that is an inhabitant of the intestines of animals. As such, the most detrimental side effects of coccidian infections are malnutrition and weight loss resulting from decreased nutrient absorption via the gut mucosa (ars.usda.gov). Live vaccines and prophylactic coccidiostats are available on the market to prevent the contraction and spread of *Eimeria* spp. (ars.usda.gov).

A prevalent disease of sub-Saharan Africa, the Rift Valley fever (RVF), a disease spread by a mosquito-borne virus, is responsible for high mortality rates among goat herds, especially those with a large number of kids (cfsph.iastate.edu; fao.org). It is also linked to staggering abortion rates, with the WHO reporting rates as high as 100% among susceptible breeds. The FAO does note that indigenous African breeds are more immune to the disease, thereby suffering from an abortion rate of no more than 30% should the herd be infected with RVF (fao.org). The cause of death from this disease is typically hemorrhaging of internal organs.

Contagious caprine pleuropneumonia (CCPP) is another disease common among goats in Rwanda. The primary symptom of CCPP is dyspnea, but paralysis may result in the later stages of the disease (fao.org). According to the FAO, an entire herd could contract CCPP (100% morbidity), with 80% of the herd mates dying (80% mortality; Rurangirwa & McGuire, 1994). According to Rurangirwa et al. (1994), dihydrostreptomycin sulphate can be utilized in the

treatment of goats suffering from CCPP (nih.gov). Not only does diydrostreptomycin sulphate cure the animal of the internal infection, but it also eliminates the mycoplasma DNA of the causative agent from the animal's system, inhibiting the previously infected animal from serving as a carrier for the disease, hence preventing the spread to other herd mates (nih.gov).

Although a disease of all goats, mastitis is primarily found in dairy goats. Most commonly, mastitis results from infestation of *Staphylococcus aureus*. The disease is characterized by a red, inflamed udder. Not only does mastitis decrease milk yield, but it also serves as a human health concern due to the increased somatic cell content and bacterial contamination of milk from an infected udder (Haenlein, 2002). For example, studies have found methicillin resistant *S. aureus* in bovine milk extracted from udders suffering from mastitis (Holmes & Zadoks, 2011). Because higher somatic cell counts are associated with udder infection, countries such as the United States, have set limits on the somatic cell content of milk (Sheep Handbook). Interestingly, there is a genetic component to the somatic cell content of milk, suggesting that selection methods can be established to reduce udder infection, thereby reducing somatic cell content.

Peste des petits ruminants (PPR), which has been deemed "the most destructive viral disease affecting small ruminant animals" by the Rwanda Agriculture Board, is a disease of small ruminants, including goats, that presents itself by mouth lesions, ophthalmic discharge, and the sudden onset of coughing and diarrhea (rab.gov). It is associated with high mortality rates, upwards of 90% (fao.org). Recently, there have been several outbreaks of PPR in Tanzania, one of the countries bordering Rwanda, posing a threat to Rwandan livestock (rab.gov.rw).

A capripoxvirus is responsible for the disease known as goat pox (fao.org). Like lumpy skin disease in cattle and sheep pox in sheep, goat pox results in the formation of lumps on the

goat's body, especially around the eyes and mouth. The disease is fatal in about half of the reported infections due to the development of papules on the lungs of the infected animal (fao.org).

Although eradicated in the United States, foot and mouth disease (FMD) still ravages much of the underdeveloped world, with Africa being no exception (Rweyemamu, Roeder, Mackay, Sumption, Brownlie, Leforban, Valarcher, Knowles & Saraiva, 2008). In fact, there are six of a possible seven foot and mouth disease sero-types present in Africa, each requiring their own vaccine to convey immunity (Rweyemamu et al., 2008). Lesions, known as vesicles, located on the mouth, hooves, and nose are distinguishing features of the disease. The presence of vesicles between the toes causes lameness and reluctance to walk or stand (fao.org). The most recent foot and mouth disease outbreak in Rwanda occurred in November of 2012 (ProMED-mail). Although the outbreak was generated among cattle herds, FMD is easily passed to other animals, such as sheep and goats. Infected districts in the Eastern Province of the country were subject to quarantine as the rest of the animals in the district were promptly vaccinated. The outbreak was attributed to the illegal transportation of cattle among districts, leading to the renewed efforts to educate the public and farmers on precautionary methods. Prior to this time, Rwanda had remained devoid of foot and mouth disease since 2004 (ProMED-mail).

Predators

Vultures, such as the lappet-faced vulture, the bearded vulture, and the hooded vulture, are a native bird of Africa. Although they are environmentally friendly, scavenging dead, rotting material, thereby reducing the spread of disease, vultures have been known to attack goat kids,

especially while still covered in uterine fluids. Studies performed in Florida have demonstrated that birthing areas are the primary attractors of such predatory birds (Avery & Cummings, 2004). White-necked ravens, a native bird of Rwanda, also pose a threat to young goats.

Water

The climate of Rwanda is marked by two wet seasons spanning from February to April and from November to January, with a dry season from May to October. Much like the rest of Africa, agricultural practices are dictated by the changes in rainfall between the seasons. With the recent climate change conditions the amount of annual rainfall has been unpredictable, making it difficult for farmers to provide adequate water supply for themselves, let alone their livestock and crops (NAPA Rwanda, 2006). During the period 1961-1975, the majority of United States financial aid to Africa was funneled toward the furnishing of water fixtures to farmers and their livestock (usaid.gov).

Land Availability

As previously mentioned, the growing Rwandan population has resulted in less available farmland, with farmers being constricted to an average 0.83 hectares (Clay et al., 1995). The lack of agricultural farmland further compounds the parasite infestations found in many Rwandan livestock herds due to the farmers' inability to practice rotational grazing, which is defined as rotating the use of pasture on a set time-table. One benefit of rotational grazing is a reduction in parasite load on a given plot of land. Insufficient land availability also increases animal density, more quickly leading to land degradation and erosion.

Financial Constraints

Less land available implies reduced agricultural production, and hence a lower household income. Indeed, McKay et al. (2005) reported a decrease in net income among rural poor Rwandans whose lives are dependent upon their agricultural practices and products.

Lack of stable and adequate income among African households has been identified as being one of the major causes of undernourishment of over 200 million Africans. Such malnutrition has led to the reliance upon food aid from foreign countries, which negatively impacts local African farmers, forcing them to be left with crop and livestock surplus and forgone income (ifad.org). Furthermore, the shortcomings of available financial resources greatly impact the country's ability to adapt and mitigate the effects of climate change.

With agriculture comprising 43% of the gross national product in 2002, it remains obvious that an improvement in the economy of Rwanda requires an improvement in the agricultural sector. "With a rate of 60% of the population below poverty line, its adaptive capacity to impacts related to extreme meteorological phenomena is very low" (NAPA Rwanda, 2006). In 2002, the agriculture sector accounted for 43% of GDP and sustains almost 90% of the population. The agricultural economy depends almost exclusively on the quality of the rainy season, which makes the country particularly vulnerable to the climate change (NAPA Rwanda, 2006). The increased frequency of drought periods, floods, landslides and erosion presently observed considerably decreases the country's food availability.

Culture and Goat Herding: Field Research in Rwanda

In the summers of 2013 and 2014, the researcher conducted interviews with a total of thirteen Rwandan goat herders, one Rwandan veterinarian, and two Rwandan veterinary students, all in the Muhanga District of Rwanda. These interviews were conducted on a face-to-face basis on the farms and also within the homes of the participants. The Pennsylvania State Institutional Review Board approved the interview questionnaire and methods before the beginning of the interview. The following questions were asked in sequential order during the interview:

1. How long have you been raising goats?
2. How many goats do you have?
3. Has your family traditionally raised goats?
4. What are some types of management practices you have in place involving your goat herd? Why?
5. What do you feed your goats?
6. What types of predators threaten your herd?
7. How do you deal with predators?
8. Is it often that your goats succumb to disease? Is it treatable?
9. Do you have a vaccination program?
10. What types of parasites do you usually deal with?
11. Do you see goats as a profitable agricultural venture? In your opinion, are goats a better option for the farmers of Rwanda compared to other livestock, such as cattle?
12. Are there markets for goats nearby? Are they easily accessible?
13. Do you sell your goats live or are they pre-slaughtered?
14. What are some problems/constraints you encounter being a goat herder? And how do you plan to fix this?
15. Have you received any assistance from the government for your goat production system? (ex. Livestock Infrastructure Support Program, Agricultural Information and Communication Center, Livestock Inspection and Certification Services)
16. What is the nutritional quality of the grass on your farm?
17. Please explain to me as many possible cultural/traditional Rwandan goat production practices? Why is it important to you? Is it economically/socially valuable?
18. What is one change you would like to see in terms of goat herding?

19. If this change occurs, are you afraid that you may be losing a traditional aspect of Rwandan goat herding?

The responses to each question are reported below.

How long have you been raising goats? Has your family traditionally raised goats? How many goats do you currently have?

According to the resident goat herders and veterinarians of the Muhanga District interviewed, most families have a tradition of raising goats, in addition to other forms of livestock. Sizes of the goat herds ranged from one or two goats to about fifty goats.

What are some types of management practices you have in place involving your goat herd? Why?

The management practices of goats in the Muhanga District are not necessarily steadfast, the reason being that goats are still considered secondary (or as the researcher found, maybe even the least desirable of all livestock). All the goats of the individuals interviewed are managed on pasture. Some goat herders practice a form of semi-intensive grazing in which the goats are brought in at night and allowed outside during the day. This practice, they claimed, was a precaution against predators. It is also considered to be a "mixed system," as opposed to the traditional system of tying or letting goats roam free and the modern system of strict stabling of goats. Interestingly, several of the goat herders who denied using the "traditional system" still tied goats out on pasture, as witnessed by the researcher.

Unlike current recommendations in the United States and Europe, twelve of the thirteen goat herders involved in this study deworm their goats every three months. In the U.S., it is believed that such a strategy increases parasitic resistance to dewormers, which are becoming increasingly difficult to come by in terms of effectiveness. Yet, most of the goat herders

reportedly do not experience problems with parasites or parasitic resistance. One goat herder did follow such recommendations set forth by American veterinarians in that she deworms her goats only before and after pregnancy, thereby decreasing the risk of resistance and increasing refugia (the population of worms that have not been exposed to dewormers and are thus still susceptible).

What do you feed your goats?

As previously mentioned, all of the goat herders primarily feed their goats pasture grass out of convenience. Only three of the thirteen interviewed goat herders supplemented their goats with "special feed" comprised of maize, maize bran, soya, vitamins, and other ingredients; however one goat also herder provided additional nutrients to her goats by offering them water in which beans had been cooked.

What types of predators threaten your herd? How do you deal with predators?

As previously mentioned, predators do serve as a threat to livestock in Rwanda. Primarily, feral cats and dogs create the most devastation among goat herders. As a result, methods of prevention and protection against such animals have become commonplace. For instance, six of the interviewed goat herders constructed fences and roofs to shelter their goats, while another simply kept her goats closer to her house where she could keep closer watch of them, but none of the farmers possessed guard dogs to protect their flocks. One of the herders had a guard dog, and two had designated shepherds to watch over their goats.

Is it often that your goats succumb to disease? When they are sick, how do you treat them?

Although the goat herders did not have much trouble with disease, with only two to three goats falling ill per year, they were unable to name the diseases with which their goats were

stricken. Unfortunately, the veterinarians often fail to explain the diseases the goats are suffering from, leaving the goat herder uneducated as to disease symptoms and causes.

Do you have a vaccination program?

Because this question was asked only during the summer of 2014, the sample population is out of six. Half confirmed a vaccination schedule, while the other half declined.

What types of parasites do you usually deal with?

Some of the parasites the Rwandan goat herders battle include *Taenia* parasites, which are a large genus of flatworms, and ascarids, intestinal roundworms. The customary response from goat herders was that they deworm goats every three months to avoid worms within their herd.

Do you see goats as a profitable agricultural venture? In your opinion, are goats a better option for the farmers of Rwanda compared to other livestock, such as cattle?

Concerning the question, "Do you see goat herding as a profitable agricultural venture?" nine herders said goats *are* a profitable venture, while three felt they were not, and one was unsure as to whether or not goats served as a good investment for the Rwandan people. Interestingly, the type of response received to this question differed based on the area of the Muhanga District in which the goat herder resided and raised their herd. Three individuals who felt goat herding was profitable were further removed from the city of Gitarama, and consequently, closer to the capital, Kigali. Conversely, the herders who did not see goat herding as a worthwhile investment raised their herds closer to Gitarama.

In terms of the rankings of livestock, six of the thirteen herders identified goats as the most profitable with reasons being they are easy to care for, easy to sell, and have more offspring

than cattle. Two herders found cattle to be the most profitable, and one viewed pigs as the most profitable.

On the other hand, the veterinarian and the two pre-veterinary students interviewed identified chickens as the most profitable mode of livestock, followed by cattle, then rabbits and pigs, and finally, sheep and goats. Chickens were placed at the top due to their multi-faceted usage: a farmer can utilize chickens for eggs, meat, and/or manure. Goats were presumed the least profitable due to their high contraction of disease and sensitivity to parasites. Despite the drawbacks of goats, the veterinarian stated that goats are much easier to sell at a market compared to cattle. This was confirmed by many of the goat herders themselves. Most individuals already have a cow, due to the One Cow Per Family Program, and therefore, did not need another one. Furthermore, if someone is selling an older cow, it is usually indicative that the cow no longer produces milk—the only real product of interest to the Rwandan people.

Are there markets for goats nearby? Are they easily accessible? Do you sell your goats live or are they pre-slaughtered?

In terms of marketing, two of the goat herders interviewed raised goats solely for self-consumption, while the remainder sold their goats at markets or to customers that come by their farm. More often than not, farmers rely on customers who come to the farm, because accessibility to transportation and the markets themselves can be problematic for small farmers. One market advantage identified by the farmers is that a higher price can be obtained at markets, since they are mainly populated by restaurant owners, hotel administrators, and cabaret managers—higher end customers willing to pay top dollar for a quality product. When considering the producers who do market their goats, all of them sell their goats live, due to the increased time and cost on their part to sell the goat pre-slaughtered.

What are some problems/constraints you encounter being a goat herder? And how do you plan to fix this?

The personal interviews provided greater insight into the problems and constraints faced by goat herders in the Muhanga District. The problems identified by the respondents included the lack of veterinary expertise and high mortality rates from disease and parasites as being the most significant. According to the respondents, out of the number of veterinarians available, the "good ones" are the most expensive and are mainly stationed in Kigali (which is one hour away from the Muhanga District). This makes the service of such veterinarians impractical in the event of an emergency. These constraints were followed by a lack of genetic potential within the goat population of Rwanda. The goat herder from France noted that French breeds of milk goats are capable of producing between 9 and 10 liters of milk per day, whereas the local Rwandan breed can only supply about ½ of a liter. Additionally, the lack of nutritious grass, and grass/feed in general, was a common problem.

Two of the goat herders interviewed did not report any problems, because they had only been raising goats for several months.

Have you received any assistance from the government for your goat production system?

None of the goat herders had received financial assistance from the government for their goat production systems. In fact, many of the herders prided themselves on "us[ing] their own knowledge" to raise their goats. Only the French goat herder was aware of the governmental programs previously listed, due to the fact that he had access to technologies, such as a computer and cell phone, devices lacking in the rural poor communities.

What is the nutritional quality of grass on your farm?

The general consensus to this question was that the nutritional quality was poor and there was a lack of grass in general to sufficiently feed their goats.

Please explain to me as many possible cultural/traditional Rwandan goat production practices? Why is it important to you? Is it economically/socially valuable?

While goats are no longer necessarily tied to social status as they were in previous times, they still provide a social incentive, seeing as many of the herders shared meat or live goats with neighbors to "strengthen community ties." In terms of economic value, goat herders are quite profitable based on the rapid reproduction and high fertility levels of goats as a breed.

Respondents' Suggestions

What is one change you would like to see, in terms of goat herding?

The goat herders made several suggestions regarding the improvement of goat production in the country.

First, they suggested that due to the high mortality rates among goat herds, the government should consider introducing improved diagnostics and greater accessibility to diagnostic laboratories to benefit the goat herding business. This, they said, would allow for more appropriate treatment of disease, with the hope of reduced morbidity and mortality rates among the goats.

Second, in addition to the need for increased genetic potential among the goat population of Rwanda, one goat herder felt that more accessible artificial insemination technology would

drastically improve reproduction efforts, allowing for more rapid genetic progress. This would also satisfy the suggestion of several herders who desired better access to "good male goats."

Third, since all of the goat herders manage their goats on pasture, they suggested that increased land availability to goat herders would be beneficial. This would enable the farmers to practice rotational grazing, thereby reducing the parasite load among their herd. Rotational grazing provides further benefits by allowing the grass enough time to regrow between grazing periods, hence providing the goats with a more nutritious meal when grazed. Not only would larger plots of land improve grazing practices, but it would also grant farmers adequate space to build goat houses to protect their goats from predators and inclement weather.

Fourth, the respondents agreed that the government should establish a program making milking goats more accessible; however, the reasoning behind this recommendation differed between the goat herders. The French goat herder felt that goat milk transformed into yogurt is the only manner in which an individual can make a profit from raising goats. It is noteworthy that he was in charge of a creamery operation that produces yogurt for retail sale in Kigali. Yet, another goat herder identified goat milk as being a homeopathic cure for malnutrition among children. Currently, milk goats *are* present in Rwanda, but they are located at great distances from the Muhanga District.

Fifth, it was suggested that more effective strategies of knowledge dissemination on the topic of goat herding should be introduced to goat herders in the country.

Goat herders must be capable of obtaining loans to invest in their business. Such loans would allow them to purchase more goats at one time, thereby allowing them to fill larger purchase orders. Additionally, this practice would help the Rwandan goat production as a whole,

by establishing connections with international aid organizations, such as the World Food Program and the Food and Agriculture Organization.

Finally, despite the numerous governmental programs discussed in the earlier in this chapter designed to aid farmers and livestock owners in their business ventures, very few goat herders had knowledge of such assistance programs. The government, they argued, should therefore, make it a priority to better inform goat herders to allow them to take advantage of such programs. It is for this reason, the researcher argues that greater effort must be applied to more effectively disseminate information on goat production and improvements in technology.

The following question was asked only during the summer of 2014, so the total sample size was six.

If this change occurred, are you afraid that you may be losing a traditional aspect of Rwandan goat herding?

Most of the herders were not as much concerned with losing traditional Rwandan goat herding practices as they were with making a profit. They agreed that a herder should utilize whatever system that allows them to make the most profit.

Conclusion

This chapter provided and discussed the historical events which have contributed to the state of agriculture in Rwanda today, particularly examining the impacts of colonial rule and the 1994 genocide. As a result of these historical factors, along with other compounding factors of the modern world, such as climate change and pressures of a growing population, farmers in Rwanda, especially goat herders, face a variety of challenges, such as parasitic infestation, lack

of veterinary expertise, and monetary constraints. The Rwandan goat herders interviewed for this study offered suggestions ranging from improved breeding techniques to greater loan-lending capacity of banks to aid in the improvement of goat production in Rwanda.

The next chapter presents the summary, conclusions, and recommendations of the study.

Chapter 4

Summary, Conclusions, and Recommendations

Introduction

This chapter presents the summary, conclusions and recommendations of the study, regarding culture and goat production in Rwanda, specifically in the Muhanga District of the country.

Summary

The purpose of the study was to examine the impact of culture on animal husbandry. Specifically, it focused on the production and management of goats in Rwanda. The objective was to suggest new methods of goat production to combine with the existing traditional cultural practices in efforts to increase goat production in the country, while maintaining the welfare of both the goats as well as the health of Rwandans, especially those of the Muhanga District. Goat production is one of the branches of animal husbandry that is economically important in both Africa and the West. However, in Africa, the goat is not only an economically important commodity, but it also holds great cultural significance as well. For example, goat ownership in Rwanda symbolizes wealth and high social status, especially in the Muhanga District. There have been several studies conducted concerning goat production in Rwanda, but very few have focused on combining the cultural production methods with a scientifically based approach as a means of increasing goat production in the country (Wilson et al., 1988; Knights et al., 1997; Lebbie et al., 2004). This study aimed to combine both traditional cultural methods with new

scientific approaches in an attempt to maximize goat production, particularly among the goat herders of the Muhanga District of Rwanda.

Hypothesis

The findings of the study confirmed our original hypothesis, which posited that the combination of scientific methods, with traditional cultural techniques of goat production, would provide a more efficient approach to goat management in the Muhanga District of Rwanda than current cultural methods alone.

Methodology

Data collection for the study included library resources, such as books, journal articles, newspaper articles, and Internet sources. In addition, the author conducted field research in the Muhanga District of Rwanda which focused on personal observations and interviews, as well as review of published articles by the Rwandan Ministry of Agriculture and Animal Products

As stated in Chapter 1, the author chose the Muhanga District of Rwanda for the study after her initial experience there during the summer of 2012. She recognized the great importance livestock holds in the lives of the people of the Muhanga District where she discovered that cattle seemed to predominate in certain regions, but she was more interested in learning about the smaller-scale farmers of the District who did not have enough land for cattle. Their alternative was to raise goats. Hence, the idea for this study came into being.

Conclusions

The following conclusions were drawn from the findings of the study:

1. Animal husbandry, in general, continues to evolve in response to new environmental concerns, including climate change and new methods of agricultural practices. An example of the new agricultural methods of farming is the current practice of organic agriculture, which is greatly impacting goat herding through its non-use of antibiotics and dewormers and prohibition of genetic engineering (Schoenian, 2012; Ronchi, 2003). The latter prevents development of species that may be resistant to certain diseases, while the former results in increased parasitic infestation risks (Ronchi, 2003; Bellon, 2014 page 149).

2. A major concern facing goat herders, both in Africa and the West, is that more parasites which affect goats are increasingly becoming resistant to the de-wormers currently available on the market making it impossible to cure goats from certain parasitic diseases, such as those caused by intestinal roundworms. For example, the study found this problem to exist both in the US and Rwanda.

3. Western goat herders, for example, those in the US, appear to have more grazing land for their herds than the goat herders in Africa, especially those in Rwanda. In Africa, this problem has resulted in serious overcrowding of goats on small plots of land, which has led to over-grazing and depletion of feeding resources and also has caused diseases among the herds.

4. One similarity discovered, regarding goat production both in Africa and the West, was that a smaller proportion of the population in both regions was engaged in the goat production industry. This was found true of the US and Rwanda.

5. Wars, such as ethnic and civil wars, severely impact the livestock of the countries involved. For example, it was discovered that the Rwandan genocide of 1994 severely impacted the country's social, economic and political structures. This problem was especially felt in the agriculture sector as almost a million Rwandans were killed while thousands also fled the country, thus adversely impacting the country's food production including livestock production and management, especially goats. Because goats already comprised a smaller proportion of the livestock sector, destruction of goat herds and fleeing of goat herders during the genocide made it more difficult for the goat industry to rebound in the post-conflict resolution.

6. The interview responses revealed that Rwandan goat herders faced several constraints. These constraints included lack of veterinary experts, insufficient genetic diversity, and inadequate nutrition for their goat herds. The result was goat deaths from unknown causes, limitations in genetic potential of goat herds, and overall suboptimal performance results. For example, nutritional inadequacy has the potential to decrease reproduction, growth, and milk yield (Dunn, 1992).

7. Women goat herders were found to lack significant financial and professional support despite their heavy involvement in the goat herding industry in Rwanda. This indicated

some gender biases in the country which appeared to favor male goat herders over female goat herders.

8. Within the Muhanga District, it was discovered that dissemination of government livestock programs, such as the Agricultural Information and Communication Center and the Support Project to the Strategic Plan for Agricultural Transformation, and also literature and general veterinary information was at a deficit as most of the interviewed goat herders had not heard of any government assistance programs.

Recommendations

The following recommendations were drawn from the conclusions of the study, regarding goat production and management, especially in Rwanda:

1. More commercially-available medication, specifically approved for small ruminants, such as goats, is needed to improve treatment of said animals. It is suggested that pharmaceutical companies in the West and Africa collaborate with corresponding governments to pursue economically sound research and development programs to increase the number of available medications for treating small ruminant diseases and improving their overall health.

2. The Rwandan government should employ a more effective knowledge dissemination mechanisms to extend modern goat production techniques to the rural areas of the

country. This may be accomplished through the hiring of community workers in rural regions who would be trained in the skills of these programs. These workers could then share the knowledge with their neighbors in order to improve the overall production of goats in the community.

3. Research into goat health and nutrition, particularly in Rwanda, must be pursued to improve goat production in the country. The Rwandan government should invest in storage facilities that allow goat herders to better store supplement feeds (millet, sweet potato peels, maize) into the dry season. Examples of storage methods include traditional cooking fire ashes or more modern actellic dust, pit silos, plastic storage containers, and hermetic bags, such as the ones produced by Purdue University (purdue.edu Robinson, 2012).

4. For goat production to be maximized, it is important for experts to study and understand the cultural practices of societies and combine them with modern, scientific approaches so that newly implemented techniques may be sustained.

5. Population planning and more finite land ownership regulations in Rwanda may help increase the grazing areas available to goat herders, thereby decreasing the incidence of disease. The current land ownership laws in Rwanda provide only small plots of land to families. These plots are inadequate to sustain the production of large herds of goats or other livestock.

6. Women goat herders play significant roles in the industry and hence must be empowered through cooperatives and governmental agencies. This will provide further support to the preservation of the traditional goat herding methods of Rwanda, since women have preserved traditional methods of goat herding to a greater extent than men.

7. Goat herders and researchers both in Africa and the West must establish consistent recommendations for deworming goats and design integrated methods of parasite management to reduce the economic impact of parasite infestation among goat herds.

8. The Rwandan Government needs to allocate adequate funds to train more veterinarians to increase the healthcare provided to livestock throughout the country, especially those in the rural areas.

9. Simple spreadsheets (see Appendix B) may be used in order to increase the nutrition and overall health of goat herds. The tables in Appendix B were constructed based on the "Indigenous Breed" classification from the 2007 US National Research Council *Nutrient Requirements of Small Ruminants*. The compilation of feedstuffs includes those commonly found in Rwanda, often as residual scraps from human meals. These include banana peels, coconut meal, dried cassava scraps, various sorghum meals soybean meal, pineapple hay, sweet potato leaves, stems and roots, and corncob meal. Banana peels, coconut meal, and cassava are all classified as fermentable fiber sources, which are key to proper digestion in ruminant animals, such as goats. These products increase the health of the bacterial population within these animals that function in the breakdown and

nutrient extraction of feeds. Cassava foliage also adds protein, which often serves as a limiting factor in animals maintained on indigenous grasses. Studies have shown that ruminants on elephant grass diets achieve greater average daily gains when supplemented with cassava forage (Smith, 1988). Sorghum, soybean, and corncob meal are considered concentrates, which provide the animal with a more readily-available source of energy compared to byproduct feeds, such as banana peels. Sweet potato vines have been promoted by experts as an excellent crude protein source; additionally, they are high in moisture, which diminishes the need for supplementation of free water (Tolera, Merkel, Goetsch, Sahlu, & Negesse, 2000).

Implications for Further Study

1. The challenges facing Rwandan goat herders in the Muhanga District.
2. The perspectives of Rwandan goat herders on modern approaches to goat production.
3. Effective implementation strategies for successful government livestock programs in rural and remote areas of Rwanda.

Appendix A

Maps of Rwanda

Figure 1 Political map of Africa with red arrow pointing to Rwanda (worldatlas.com).

Figure 2 Political map o fRwanda displaying the districts of the country. The white arrow points to the Muhanga District, the focus of this study (commons.wikimedia.org).

Figure 3 Geo-political map of Rwanda (Chossudovsky, 2014).

Appendix B

Example Spreadsheet Nutrition Table

Kids (kg/day)

Growth	As Fed	DMI (kg)	TDN (kg/d)	NDF (kg/d)	CP @20% (g/d)	Ca (g/day)	P (g/day)	Salt (g/day)	Cu (mg/kg)	Se (mg/day)	Zn (mg/day)	Vit A (RE/d)	Vit E (IU/d)
Coconut Meal	**0.00**	0.00	0.00	0.00	0.0	0.00	0.00	0.00	0.00	0.00	0.00	0.0	0.0
Corn	**1.00**	0.88	0.80	0.09	88.0	0.18	2.55	0.22	1.98	0.00	0.00	0.0	0.0
Soybean Hulls	**0.00**	0.00	0.00	0.00	0.0	0.00	0.00	0.00	0.00	0.00	0.00	0.0	0.0
Sorghum Sudan Hay	**0.00**	0.00	0.00	0.00	0.0	0.00	0.00	0.00	0.00	0.00	0.00	0.0	0.0
Pineapple Forage Silage	**0.00**	0.00	0.00	0.00	0.0	0.00	0.00	0.00	0.00	0.00	0.00	0.0	0.0
Corn Cobs Ground	**0.50**	0.45	0.23	0.39	12.6	54.00	18.00	0.90	3.15	0.04	2.25	540.0	0.0
Total nutrients supplied	**1.50**	1.33	**1.03**	**0.48**	**100.6**	**54.18**	**20.55**	**1.12**	**5.13**	**0.04**	**2.25**	**540.0**	**0.0**
Nutrients required	10.00	**0.38**	**0.33**	**0.10**	**69**	**2.2**	**1.10**	**1.0**	**9.5**	**0.46**	**10**	**1000**	**100**
Difference		**0.95**	**0.70**	**0.38**	**31.60**	**51.98**	**19.45**	**0.15**	**(4.37)**	**(0.42)**	**(7.75)**	**(460.0)**	**(100.00)**
Dietary Concentration		**88.7%**	**77.1%**	**36.1%**	**7.6%**	**4.07%**	**1.55%**	**0.08%**	**3.86**	**0.03**	**1.69**	**406.0**	**0.0**
%BW or Ratios		**13.3%**		**4.8%**		**2.64**							

Does, Bucks, Castrated Males (kg/day)

Maintenance	As Fed	DMI (kg)	TDN (kg/d)	NDF (kg/d)	CP @20% (g/d)	Ca (g/day)	P (g/day)	Salt (g/day)	Cu (mg/kg)	Se (mg/day)	Zn (mg/day)	Vit A (RE/d)	Vit E (IU/d)
Coconut Meal	**0.00**	0.00	0.00	0.00	0.0	0.00	0.00	0.00	0.00	0.00	0.00	0.0	0.0
Corn	**0.50**	0.44	0.40	0.04	44.0	0.09	1.28	0.11	0.99	0.00	0.00	0.0	0.0
Soybean Hulls	**1.00**	0.91	0.73	0.60	111.0	4.82	1.64	0.68	16.20	0.13	43.68	0.0	3.4
Sorghum Sudan Hay	**1.00**	0.91	0.51	0.60	102.8	4.64	2.82	0.46	28.57	0.00	34.58	0.0	0.0
Pineapple Forage Silage	**0.25**	0.09	0.06	0.05	7.6	0.44	0.16	0.14	1.02	0.00	4.52	0.0	0.0
Corn Cobs Ground	**0.00**	0.00	0.00	0.00	0.0	0.00	0.00	0.00	0.00	0.00	0.00	0.0	0.0
Total nutrients supplied	**2.75**	**2.35**	**1.69**	**1.30**	**265.5**	**9.99**	**5.90**	**1.39**	**46.78**	**0.13**	**82.78**	**0.0**	**3.4**
Nutrients required	50.00	**1.68**	**0.89**	**0.80**	**112**	**2.8**	**2.4**	**3.75**	**33.60**	**0.18**	**24.0**	**2512**	**424**
Difference		**0.67**	**0.80**	**0.50**	**153.46**	**7.19**	**3.50**	**(2.36)**	**13.18**	**(0.05)**	**58.78**	**(2512.0)**	**(420.6)**
Dietary Concentrations		**85.6%**	**72.0%**	**55.3%**	**11.3%**	**0.42%**	**0.25%**	**0.06%**	**19.9**	**0.1**	**35.2**	**0**	**1.4**
%BW or Ratios		**4.7%**		**2.6%**		**1.69**							

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Education

B.S., Veterinary and Biomedical Sciences, 2015, The Pennsylvania State University, University Park, PA

B.A., African Studies, 2015, The Pennsylvania State University, University Park, PA

Honors and Awards

- Gamma Sigma Delta Honor Society, The Pennsylvania State University College of Agricultural Sciences, 2014
- Evan Pugh Scholar Award, The Pennsylvania State University, 2014
- Student Indigenous Knowledge Research Award, Majorie G. Whiting Endowment for the Advancement of Indigenous Knowledge at Penn State, 2014
- Summer Undergraduate Discovery Grant, The Pennsylvania State University, 2014
- Undergraduate International Research Competitive Grant, The Pennsylvania State University Office of International Programs, 2014
- President Sparks Award, The Pennsylvania State University, 2013
- Phi Kappa Phi Honor Society, 2013
- The Dickerson Family Fund Award, The Pennsylvania State University College of Liberal Arts, 2013
- President's Freshman Award, The Pennsylvania State University, 2012

Association Memberships/Activities

Pennsylvania Veterinary Medical Association

Professional Experience

Research Interests

I have a broad interest in the epidemiology of emerging infectious diseases among wildlife populations, specifically emerging viral diseases within wild populations of nonhuman primates.

Professional Presentations

"Rwandan Goat Production," The Interinstitutional Consortium for Indigenous Knowledge, The Pennsylvania State University, December 3, 2014.

"A Solution to Importation of Emerging Zoonotic Diseases," Civic Engagement Public Speaking Contest, The Pennsylvania State University, December 3, 2014.

"A Comparison of Zulu and Rwandan Basketry Past and Present," The 2nd Annual Black Doctoral Network Conference, Philadelphia, PA, October 25, 2014.

"A Comparison of Zulu and Rwandan Basketry Past and Present," The Africana Research Center Undergraduate Research Exhibition, The Pennsylvania State University, October 4, 2014

"Factors Influencing the Accuracy and Precision of Fecal pH Measurement in the Horse," The California Animal Nutrition Conference, Fresno, CA, May 16, 2012.

Publications

Hydock, K. L., Fish P., & DeClementi C. Brodifacoum toxicosis in two Andean condors at the National Aviary. *Unpublished data*.

Hydock, K. L., Brown, J. Cytologic diagnosis of avianpox virus in wild turkeys. *Unpublished data*.

Hydock K. L., Nissley S. G., Staniar W. B. (2014). A standard protocol for fecal pH measurement in the horse. *Professional Animal Scientist*, 30, 643-648.