A New Step Forward: Trypanotolerant Cattle in Ethiopia

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Acknowledgements

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Introduction

My Background

Never in my wildest dreams would I have thought that I would be here at ILRI working on project that truly is a "new step forward" for agriculture in Ethiopia. I grew up in Charles City, Iowa and with a population of about 7,000 people, it is a very tight farming community. I have lived Northeast Iowa for the greater portion of my life even though I was not born there and I have always had a fascination with livestock. Since the age of 10, I have had sheep and horses around my family's 10 acre plot, 5 miles north of Charles City. Sheep were my livestock of choice since they are easy to manage but hard to keep from dying as I found out. Chore time at my house always consisted of mucking stalls and feeding sheep, whether I wanted to or not. Animals have to eat and I have had the dismal job of stacking hay in the loft of our barn since I was 14. As I look back there is no experience that will teach a person more than having to take care of livestock from an early age. Animals may not be able to talk, but they have taught me more about life than any book ever could.

I had no idea what lay in store for me when I entered high school but I did know that I wanted to be in the agriculture program with the teacher struck by lightning three times, Mr. James Lundberg. It was Mr. Lundberg who taught the class about Dr. Borlaug and the Green Revolution, and it was him who chose me to participate in the World Food Prize Symposium and Youth Institute. I saw the opportunity to take on a role of analyzing a country and making suggestions that I knew would surely work. I chose to analyze Zimbabwe, assured I could solve their problems. As I look back on that paper, I am both humbled and ashamed at the ignorance I put into that work. I didn't know then what I know now and I have learned from the mistakes and assumptions that I made.

Prior to the World Food Prize I had no idea internships were available and when I found out at the Symposium, I was intrigued and wanted to learn more. As the Borlaug-Ruan interns gave their presentations about their projects and adventures I could not help but be drawn to one internship center. It was the International Livestock Research Institute (ILRI) in Addis Ababa, Ethiopia. Of all the centers that were listed I knew that ILRI was the place for me. Exploring and evaluating plant species have never been my forte, but studying livestock has always been

my passion since I bought my first sheep. My family and Mr. Lundberg urged me to apply for a Borlaug-Ruan Internship and I was so excited by the thought of doing research over the summer that I sent in my application. I had no idea whether I would be granted an interview because I knew there were many quality applications also being sent in.

I was thrilled to learn that I was granted an interview and very nervous as well. When asked which center would be at the top of my list, I said ILRI would be my top choice because I have a love and passion for domestic livestock. Imagine my surprise a few weeks later when I tore open an envelope to find out that I would be traveling to ILRI over the summer. Words cannot describe the happiness I felt upon reading that letter. I would reread the letter just to make sure that it was real because for a few days I could not believe the opportunity that had been extended to me.

Before I knew it, I had graduated from high school and June was fast approaching. I spent my days researching Ethiopia and ILRI, as well as packing and preparing for the internship. I did not know what to expect and I was determined to keep an open mind to whatever situation I found myself in. Finally, the day came for my departure and as I went through the security checkpoint into the Lindbergh Terminal, I began my life changing internship with ILRI.

International Livestock Research Institute at a Glance

Nestled in the northeast portion of Addis Ababa is the International Livestock Research Institute. Here the noise and diesel fumes of the city are nowhere to be found. Researchers representing many different international centers converge at ILRI to work in a safe and friendly

environment. The ILRI campus in Addis Ababa is a principal campus and one of the many sites in Africa, Asia, Latin America, and the Caribbean. Headquartered in Nairobi, Kenya, ILRI employs 700 staff, 600 of which are recruited from Ethiopia and Kenya (About ILRL). The mission of ILRI is "To work at the crossroads of livestock and poverty, bringing high-quality science and capacity-building to bear on poverty reduction and sustainable development for poor livestock keepers and their communities." To achieve this mission ILRI has developed three key prongs to their strategy: (1) securing the assets of the poor, (2) improving the productivity of their livestock systems and (3) improving their market opportunities (Mission and Strategy). ILRI is funded by over 60 public, private, and governmental organizations and is governed by the Consultative Group on International Agriculture Research (CGIAR) which is a network of 15 Future Harvest Centers that use science to help the poor ("About ILRI").

Livestock are an integral part of lifting the poor out of poverty. There are an estimated 1.3 billion people living in poverty around the globe and 678 million of these people depend on livestock for their well-being. Livestock provide meat, milk, traction, fiber, and the ability to use land unsuitable for crop production. Half of the world's population is malnourished in iron and 400 million people are Vitamin A deficient. This leads to anemia, blindness, stunted growth, and death in some cases. The way to solve the "micro-nutrient" problem is to supplement starch diets with small amounts of milk and meat. The demand for livestock products in the next 20 years is going to increase four times faster in developing countries than developed countries (Why Livestock Matter). This increase in demand is fueling an intensification of livestock numbers in developing countries. This livestock revolution is driven by demand and cannot be stopped, but it can be guided so environmental damage can be avoided to arable farmland. ILRI is the only institute to have a global mandate for livestock research. Through this research, ILRI hopes to increase productivity to meet skyrocketing demands and create sustainable agriculture for livestock farmers (Why Livestock Matter).

Research Background

Trypanosomosis and Trypanotolerance

When I arrived for my first research day at ILRI I did not know how to say trypanosomosis or what I would be doing concerning trypanosomosis. The first person to assist me in answering my questions was my mentor, Dr. Tadelle Dessie, who instead of showing me straight to my research, took me out for coffee at the Zebu club. This was definitely not what I had expected, and what struck me about Dr. Tadelle was how laid back and personable he was. I immediately trusted him and knew that I could go to him for anything. The rest of my first day was spent researching Ethiopian cattle breeds on the Domestic Animal Genetic Resources System (DAGRIS). It is a large database that has information on cattle on all continents, regions, and countries. I learned that there are 27 distinct cattle breeds in Ethiopia and that the majority of them are either Small or Large East African Zebu cattle. The most important breed to my research paper was not in either of these groups, but instead the breed Sheko, the only member of the hump less shorthorns class of cattle (DAGRIS). I would learn that this breed is of incredible importance to ILRI as well as in the interests of Ethiopia.

According to the Food and Agriculture Organization of the United Nations there are 50 million people and 48 million living in the trypanosomosis area called the "*tsetse belt*" after the main transmitter of the disease, the tsetse fly. The tsetse belt extends through 37 Sub-Saharan African countries in a total land area of 10 million km^2, roughly one third of Africa's total land mass. The estimated costs due to loss of livestock annually are between 1.0 and 1.2 billion U.S. dollars. Of the 50 million people that live in the tsetse belt, 50% suffer from food insecurity and 80% depend on agriculture for their livelihood (United Nations). There are three kinds of tsetse flies which carry different rates of infection: *Glossina mortisan submortisans, Glossina fuscipes fuscipes*, and *Glossina pallidipes*. Each of these species are found in different densities throughout the tsetse belt.

Trypanosomosis is a blood parasite disease transmitted when tsetse flies feed primarily on cattle, humans, and monkeys among other domestic and wild animals. There are three species of the trypanosomosis: *T. congolense, T. vivax,* and *T. brucei.* Research done with respect to these three strains have found *T. vivax* and *T.* congolense to be the most prevalent strains in cattle, and *T. congolense* to be the most deadly. These blood parasites are called trypanosomes and multiply rapidly. Cattle infected with trypanosomes release antibodies to destroy the parasites, which in turn cause lysis in red blood cells to occur, thus making the animal anemic. To survive the

onslaught of antibodies the trypanosomes change their outer coats so the antibodies are ineffective against them and new ones must be produced. The cow will continue to attempt to fight off the disease until it becomes so anemic that its immune system shuts down and the cow rapidly loses weight and dies (Towards Increased Use of Trypanotolerance). For the past half century, trypanocidal drugs have been used to control trypanosomes in cattle and maintain productivity. However, mounting evidence suggests trypanocidal drugs are only 60% effective in treatment of trypanosomosis and that strains have developed resistance to widely used trypanocidal drugs (Rowlands et al). Another method used is pesticide control of the tsetse fly. This method has only been somewhat effective when applied in high concentrations and under intensive management, however, the tsetse fly soon repopulates the area from which it has been eradicated (Towards Increased Use of Trypanotolerance).

A new way to maintain and increase production of livestock in the tsetse belt has been desperately needed. In the past 50 years, research has been done in West Africa which offers a solution to the problem: trypanotolerant cattle. These cattle are able to live trypanosomes and tolerate the effects the blood parasite has on the body. Trypanotolerance has not only been defined as a genetic trait, but also a combination of physical traits which enable the cow to receive fewer tsetse fly bites. These trypanotolerant cattle are select indigenous *Bos taurus* cattle breeds, primarily the N'Dama and West African Shorthorn (WAS). Studies have shown these breeds exhibit resistance to the disease, maintain bodyweight, and have higher packed red blood cell volume (PCV) (Towards Increased Use of Trypanotolerance). Most of the research has been done on the N'Dama breed of cattle, originating in The Gambia, Guinea, Senegal, Guinea-Bissau, Sierra Leone, Côte d'Ivoire, Mali, and Liberia (Tibbo et al**).** Though the N'Dama is a smaller breed than Zebu cattle, it has been shown to be just as productive in tsetse free environments and more productive in low to high tsetse challenge (Ageymung et al). These findings have led Central African countries, like the Congo Democratic Republic and the Central African Republic, to import thousands of N'Dama cattle into the tsetse infested areas and has led to an increase in N'Dama populations across the whole of West and Central Africa. During a period of 10 years (1977-1987), the N'Dama grew at a rate of 4.5% and most recent estimates set N'Dama populations at 4.8 to 7.0 million head of cattle in West and Central Africa (Tibbo et al).

Cultural Acceptance and Willingness to use Scientific Research

Scientific research to improve people's lives is very important and needed throughout the world. However, all the research in the world may not help those it is aimed at if the population is not willing to accept it. Ethiopia is celebrating its 2000 year anniversary this September and farmers are still farming the same way countless generations of past Ethiopians have farmed. Imposing new and radical changes on these farmers is a recipe for disaster because of deep rooted traditional farming methods. Positive changes need to be introduced slowly and in consultation with the communities so they will be accepted. Through my research, I have come to understand that respect for indigenous methods is essential. They can form the basis for successful methods to improve the livelihoods of farmers and also meet the demand of rapidly growing populations around the globe. In the words of my chemistry teacher Mr. Dan Pavlovich, "You can lead a horse to water, but you cannot make it drink."

My project at ILRI was focused on the Ghibe Valley, 230 kilometers southwest of the capital city of Addis Ababa, inhabited only for the past 20 years. This is due to ILRI's control of tsetse populations in the Ghibe Valley. Since 1986, ILRI has been analyzing rates of trypanosomosis infection in cattle and attempting to find solutions to reduce trypanosome prevalence and increase production (Lemecha et al). One way ILRI attempted to control trypanosomosis was to trap the tsetse fly. Initially this program was very successful with a high level of reduction, but after the first year the program was failing. This was due to people stealing the black cloth used to attract the tsetse fly and using it for clothing, bedding, and bags. One suggestion to turn the program around was to gauge public willingness to fund the program or contribute labor on a monthly basis by a survey of households in the area. The results of the survey showed nearly 60% of the households involved would contribute money and labor on a monthly basis to continue tsetse control measures. Another conclusion that can be made from this survey is when given the opportunity to participate in research that has a direct impact on their live, people are willing to help and accept new changes (Swallow and Woudyalew).

A Foundation Study of Indigenous Trypanotolerant Breeds

While hundreds of projects concerning trypanotolerant cattle in West Africa have been carried out, there have been very few done in East Africa (Hoste et al). In 2000, ILRI began a study to explore possible trypanotolerant breeds. This study was done under medium to high

tsetse challenge at the Tolley/Gullele station, known as the Upper Ghibe station. This study analyzed four different breeds that live in the area surrounding the Ghibe Valley, the Horro, Gurage, Sheko, and Abigar breeds. As a control group, the Gurage breed of Zebu cattle were known to be trypanosusceptible and thus provided something to gauge trypanotolerance. The Abigar and Horro are indigenous *Bos indicus* cattle breeds without known trypanotolerance or trypanosusceptibility. The Sheko breed is the one of two indigenous *Bos taurus* breeds in Ethiopia and was rumored to have trypanotolerance traits (Lemecha et al).

This study was done in traditional management system followed by local farmers so results could easily be transferred from the study to farmers. Approximately 50 heifers and 5 bulls, aged 12-18 months, were obtained for each breed. These cattle were obtained from as many as 10 different villages to have representative samples of animals from their respective production environments. Prior to the commencement of this study all animals were quarantined at the National Animal Health Research Center at Sebeta, Ethiopia for a period of 2 months. The cattle were vaccinated for blackleg, anthrax, and pasteurellosis before transport to the Ghibe Valley.

The animals were blood sampled form the ear-vein in to heparinized capillary tubes fortnightly for the first 3 months and then monthly thereafter. The blood was examined using the buffy-coat technique (BCT). Parasiteamic animals showing a PCV value of 20% and below were treated with the trypanocidal drug Berenil at 3.5 mg/kg body weight. Animals that didn't show parasiteamia but were anemic were also treated with the same dosage. In anemic animals thin blood smears were prepared to check for other haemoparasites, such as *Anaplasma spp*., *Babesia spp*., and *Theileria spp*. External parasites were monitored continuously and treated individually when the individual infestation exceeded 10 ticks on each side of the animal. Fecal samples were collected quarterly from all young animals up to 2 years old for gastro-intestinal parasites. Deworming was given to those animals with eggs per gram (EPG) counts of trematode and/or strongyles of more than 500 as measured using the McMaster egg counting technique. Each animal was weighed monthly using a weighing bridge and Barlo reader. Calves were weighed at birth and all abortions, deaths, diseases and abnormalities were monitored and recorded (Lemecha et al).

The tsetse population through the four years of study was analyzed for density, infection rates, proportion of feeds taken from cattle, and species prevalence. Tsetse fly populations were

determined using 20 cow urine baited biconical traps. These traps were placed over an area of 20 square kilometers of pasture. More specifically, they were placed at frequently used water holes, grazing pastures, and around barns. These traps were set up for five consecutive days per month at the same sites. The cages were emptied daily and the flies that were caught were identified, sexed, and some fresh flies were dissected for trypanosome detection using the methods of Lloyd and Johnson (this method analyzes the salivary glands and midgut for trypanosome prevalence). Fly challenge was determined by the relative density of tsetse flies, their trypanosome infection rates and the proportion of feeds that they have taken from domestic livestock (Lemecha et al).

The results of the first four years indicated that the Sheko breed of cattle were trypanotolerant with significant differences in mean PCV, trypanosome prevalence rate, trypanocidal drug treatments per year, and mortality rates (Lemecha et al). Table 1. shows the comparisons of the four breeds with averages over four years (2000 to 2004).

Table 1: Mean PCV, Prevalence Rates, No. Treatments, and Mortality %.

Breed	Mean PCV %	Mean Prevalence Rate %	Mean Number of Berenil Treatments/Animal/Year	Mortality % During First Year	Mortality % During Second Year	Mortality % During First 24 Months
Abigar	24	26.10	4.00	35.2	11.4	42.6
Gurage	22	27.40	6.70	32.3	14.3	41.9
Horro	23	23.20	4.60	8.2	2.2	10.2
Sheko	25	8.90	1.39	25.9	2.5	27.8

Reproductive performance of the four breeds was also recorded. The results showed that the Sheko had more calves than other breeds, slightly higher birth weights, and the highest calving rate of 51%. The Abigar breed exhibited the worst reproductive performance with only 1 calf in the study time, less aggressive sexual behavior, and the lowest calving rate of 3% due to high tsetse challenge (Lemecha et al).

Tsetse populations were found to be primarily *G. pallidipes* and *G. f. fuscipes* with very low populations of *G. m. submortisans*. The average density of tsetse flies caught from October 2000 to August 2004 was 0.4 flies per trap per day. Of the 1421 flies caught over the course of the study 65% were *G. pallidipes*, 30% were *G. f. fuscipes*, and 5% were *G. m. submortisans*. The infection rate of 210 flies that were dissected was 5.7% with the highest infection rate in *G. pallidipes* and the lowest in *G. fuscipes*. Tsetse challenge was calculate to be in the medium to high range (Lemecha et al).

The conclusions drawn based on the results of the first 4 years of this study is that the Sheko breed does indeed have trypanotolerant characteristics. This breed has low trypanosome prevalence, higher PCV levels, fewest trypanocidal drug treatments, highest calving rate, and lowest mortality rates after environmental adjustment. However, the Sheko cattle were found to have the highest tick load during the study when compared to the other 3 breeds. Another interesting finding was the ability of the Horro breed to respond to trypanocidal treatment and low mortality rate during the first 2 years (Lemecha et al).

My work is directly related to this landmark study because I traveled to the site and sampled the cattle there to continue to create an accurate average of how trypanotolerant the Sheko breed is. I also went to find out if the Horro breed's ability to respond well to trypanocidal treatment is not a fluke. All of this research that has been done and the sampling I have done will ultimately help farmers. ILRI plans to implement the Sheko breed in the Ghibe Valley with farmers so their livestock will be more productive. This will lead to an increased supply of meat and milk to respond to the growing demand in the region.

Evaluating Indigenous Breeds for Trypanotolerance

Methods of the Sampling Process

On July 14th, 2007 I left ILRI to travel to the Upper Ghibe station to participate in sampling the cattle for the month of July. I was there until July 20th, when I completed my data collection of the four breeds of cattle. This portion of my internship taught me the most about the practicality of using trypanotolerant cattle and also to compare the first four years of this study to the present results. I hoped to be able to analyze the differences in this month's data between cattle breeds as well. However, the main reason for taking this data was to gain knowledge on the farmer's level about how this research can help them be more productive, raise them out of poverty, and achieve food security for generations to come by using land that was originally unproductive due to tsetse infestation.

Samplings began on Monday the 16th with the Gurage, Horro, and bulls first since they were the smallest groups. On Tuesday, the Sheko were sampled and on Wednesday the Horro were sampled. In addition to sampling the original breeding stock purchased in 2000, the calves of all breeds were also sampled. I was surprised to see the difference in numbers of calves that each of the breeds had produced during the 7 years of this study. There was a large difference, from 6 calves by the Abigar to 40 calves by the Horro. The cattle of the breed being sampled were herded into a cattle shute where preliminary observations were recorded. First all of the cattle in each group were identified by a metal tag and a plastic tag in the right and left ear respectively. Next they were weighed on a scale and finally the sampling began.

Figure I. Weighing the Cattle

Figure II. Sheko Cattle in the Shute

The sampling process involved taking blood from the ear vein of cow, calf, or bull using a lancet to pierce the vein and two heparinized capillary tubes to collect blood. Each capillary tube was filled ¾ of the way full so the PCV could be taken after one of the two tubes was put through the centrifuge. There were 24 pairs of capillary tubes taken, the number of tubes the centrifuge

could handle at one time. Each tube was sealed with putty at the bottom of the tube so that no blood would evaporate from the tubes during centrifugation. The tubes were centrifuged for 5 minutes at 12,000 revolutions per minute and then removed. The PCV was taken using a haemocrit reader that based PCV on the amount of plasma and red blood cells in the tubes. After the PCV was recorded, the tubes were broken below 1 mm below the buffy coat, which is a white band between the red blood cells and plasma. This is the area where trypanosomes are most likely to be found. Three tubes were emptied on one microscope slide and analyzed under microscope to search for trypanosomes. If a strain of trypanosomosis was found, then it would be given a score based on how many trypanosomes of that strain were present in the buffy coat. The highest score is 6, with 100+ trypanosomes per field, and the lowest 1, with only 1 trypanosome for the entire preparation. This scoring system was critical to deciding what dosage of Berenil would be given. I was able to view two strains of trypanosomosis which have different sized flagellums so they have different movements. The two strains were T. congolense and T. vivax. T. congolense has a spinning movement due to a short flagellum and T. vivax travels in straight line across the field. It is crucial to differentiate between the two strains because T. congolense is deadlier than T. vivax.

Figure III. Making a Blood Smear

Figure IV. Measuring PCV

Figure V. Taking Blood

Figure VI. Capillary Tubes in a Putty Tray

While all the cattle were examined using the buffy coat, only the ones with PCV percentages of 20 or less also had a blood smear to further examine the cause of the low PCV value recorded. The capillary tube that was not centrifuged was used for this purpose and I learned a little blood would make a great smear. These smears were fixed by methanol and then stained to look for trypanosomes or tick borne diseases that can also contribute to moderate anemia. The stain would highlight the nucleus of the trypanosomes and make them easy to spot in the red blood cells. All of the slides were looked at under microscope and the most interesting sight that I saw while viewing the slides was a trypanosome caught attempting to multiply using binary fission.

At first I just watched all of this happening, for maybe 10 minutes, and then I couldn't help but get involved. I really enjoyed my work and had a good part in the sampling process. I took blood, centrifuged the capillary tubes, recorded tag numbers and weights, measured PCV, made blood smears, fixed the smears, and then stained the smears. I delivered the centrifuged tubes to the doctors applying the buffy coat technique and smears for Dr. Yaregal to analyze. After Monday the doctors didn't have to help me with any of the techniques and I was able to understand just what the results I obtained meant for Ethiopian livestock agriculture.

Results of My Samplings

Every day after lunch I recorded all of the data collected, so for the month of July, I could see how the breeds competed against each other and which are the most productive and cost effective. I analyzed the foundation stock in the study and also the first generation calves produced during the study period for weight, Mean PCV, positive T. congolense results, T. congolense prevalence percentage, and the percentage of cows that had PCV equal to or lower

than 20%. I chose to only analyze T. congolense prevalence because this strain is the hardest to treat and causes the greatest loss of life in cattle. Figure 2 shows the comparison of cows and calves for the month of July.

Table 2. No. Animals, Av. Wt., Mean PCV, Total No. Positive T. c. Results and %, % of Animals <20 % PCV for Month of July, 2007

Cows	Number of Cows	Average Weight (Kg)	Mean PCV	Total Number of Positive T. c. Results	T.c Prevalence %	Percentage of Cows <20 PCV
Gurage	19	160.11	21.37	4	21.05	36.84
Horro	36	180.39	21.19	2	5.55	38.89
Abigar	28	179.29	22.21	4	14.29	39.29
Sheko	35	157.86	22.54	0	0.00	31.43
Calves	Number of Calves	Average Weight (Kg)	Mean PCV	Total Number of Positive T. c. Results	T.c Prevalence %	Percentage of Calves <20 PCV
Gurage	9	81.89	29.78	0	0.00	0.00
Horro	40	108.00	23.30	4	10.00	25.00
Abigar	6	49.33	33.33	1	16.67	0.00
Sheko	39	111.64	24.49	0	0.00	15.38

Another important vector of disease in the Ghibe valley is the tick burden and tick-borne diseases that if left untreated can result in moderate anemia and loss of productivity. Dr. Yaregal explained to me the tick burden for the month of July is particularly high because of ideal weather and the cattle are likely to suffer more from these diseases as well as trypanosomosis. The only tick-borne disease found in this month's sampling was *theileria*, a milder disease than the more deadly *apepsia* or *babesia*. Theileria was not prevalent in calves, but was a contributing factor to low PCV in the cows. Table 3 shows the comparison of theileria in the cows.

Table 3. No. Cows, No. Positive Theileria Results, and Theileria Prevalence % for July 2007

Cows	Number of Cows	Number of Positive Results of Theileria	Theileria Prevalence %
Gurage	19	3	15.79
Horro	36	2	5.55
Abigar	28	3	10.71
Sheko	35	1	2.86

Conclusions: A New Step Forward

These results may not look like the results indicated by the first four years of study published by Lemecha et al in 2006. Considering the cattle had been in the Upper Ghibe station for 7 years, it was fascinating to compare the breeds and observe changes in their prevalence. When it comes down to deciding what breed of cattle to raise, the Sheko breed is still more trypanotolerant with no trypanosomes detected, highest average PCV, lowest theileria prevalence for the month of July. I cannot conclude anything about a long term trend of PCV or prevalence rates based on only one month's data. Only through years of data can clear trends be seen. The material I would seek to make these trends clear is already being used.

Dr. Azage, my "academic father" during my internship, told me, "farmers cannot eat scientific research" and it is easy to lose focus of the overall goal scientific research addresses. A farmer does not care about PCV or prevalence rates in his cattle, instead he cares about having a living animal that produces well for his livelihood. I can say Sheko and Horro breeds are best suited for agriculture in the Ghibe Valley. In 7 years the Sheko produced 39 calves and the Horro produced 40 calves, the Gurage only produced 9 calves and the Abigar produced 6 calves. There were the same numbers of animals to start with and the sheer difference in numbers of offspring tells more than PCV or prevalence rates ever could. The other striking thing is the number of original cattle that are left from the beginning of the study. As shown by Tables 2 and 3, there are 19 Gurage, 36 Horro, 35 Sheko, and 28 Abigar left of the original 50 approximately of each breed. Farmers will be better able to embrace the Horro and Sheko breeds by knowing the excellent reproductive performance and stamina clearly shown by these breeds.

The future for livestock production in tsetse infested areas of Ethiopia has never been brighter. This ability to take unproductive land and make it productive, through trypanotolerant livestock, will help to ensure sustainable agriculture for generations to come. Now all that is left to do is boldly and confidently implement this "new step forward" so not only farmers but the rest of Ethiopia and the world can feed on what scientific research has provided.

Reflections of My Internship

When I arrived in Ethiopia I had no idea what kind of world I would be entering or what I would learn during my internship. Initially I came to do work on trypanosomosis and trypanotolerant cattle in Ethiopia. Over the course of the internship I learned the research I was doing pales in comparison to what I have learned about Ethiopia, the world, and myself.

I started my internship meeting and relying on those around me that. At orientation in May, I was told to expect culture shock and I thought I was in for a lot after my first glimpse of Addis Ababa. Not only was I a foreigner and far away from the comforts of home, but my first few hours in Ethiopia were ones of utter chaos. Diesel fumes choke the lungs when traveling on the crumbling roads and flocks of sheep and herds of goats cross the highway at every roundabout. The new meets the old so vibrantly in Addis Ababa, the contrast is overwhelming. New skyscrapers sit next to ghettos, cars and city buses intermingle with donkeys on the same roads, and people in business suits walk with those in rags. I asked myself how I would ever be able to adjust to such contrasts of life and then I arrived at ILRI.

Nestled in the northeast corner of Addis Ababa is the 31 hectare campus of ILRI. Situated back from the main road a security post serves as the only portal into ILRI and what lay beyond that post greeted my eyes so much that I was taken aback. Here in the middle of a city of concrete, ghettoes, and mud was a refuge that resembled nothing of the outside world. Tall trees, tended lawns, brick buildings with white trim, imported flowers, and stone walkways made me think I had stepped into a European resort, rather than a research institute. I had no idea this little paradise would serve to teach me some of life's most important lessons.

Everyone I met was very friendly and I found myself greeting people when traveling across the campus. I took every opportunity afforded to me to interact with different people and experience new things. I made a routine of working out after work and then talking with researchers at the Zebu club during dinner. I may have educated my brain in with trypanosomosis and trypanotolerance in my office, but my soul was educated in world views and culture differences in the Zebu club. I met many different and fantastic people in the Zebu club, but no one taught me more about myself than Dr. Azage. His knowledge and wisdom not only taught me many things that young people, like myself, need to know, but also to have a worldly view instead of limiting myself to domestic activities. He taught me to look past the bureaucracy and obstacles

of scientific research to remember why the research was started in the first place. I am glad to have met such a fantastic person who not only guided me, but also became a mentor and friend.

The weeks went by and as my research progressed, so did my understanding of just what the goal of the work that I was looking into. The significance of finding a trypanotolerant taurine type of cattle called the Sheko slowly dawned on me. This breed could ensure food security to a region that was very fertile, but otherwise unproductive. Ethiopia has one of the largest cattle populations in Africa and farmers rely on their livestock for traction, meat, dairy products, and savings. Enabling farmers in tsetse infested regions to prosper, as a result of switching breeds, will bring about food security for more than just the farmers. The livestock revolution cannot be stopped, because people will not stop demanding meat and milk products, but this research will definitely rein in out of control livestock intensification.

As my internship drew to a close, I reflected on how far I had come in understanding food security and poverty. I like to think there are two stages of accomplishing anything, research and implementation. While the research part is easy and enjoyable, the implementation part takes courage and confidence. Research is important, but cannot be eaten by those who are starving. As a result of this internship, I have transitioned from asking myself "Why" to "Why not" and "How". Nothing is stopping me from changing the world. I believe the purpose of this internship program is not to get bogged down with the scientific details, but allow young people to open their eyes and see the world in a different light, to tell students they are capable of thinking and achieving results once believed impossible.

I will be attending Iowa State University this fall, majoring in Animal Science. This internship has given me new confidence, patience, and wisdom to excel in college. I only hope life will give me a chance to pay back those who have given me these tools that I have received. ILRI has taught me lessons which only come once in a lifetime. Now my challenge is to implement what I have learned.

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