A Comparative Study on the Growth Rates Between Outbred and Inbred Chickens

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2017 Borlaug – Ruan International Internship
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THE WORLD FOOD PRIZE

African Chicken Genetic Gains

ILRI
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Abstract

Disease is the major cause of loss of chickens in Ethiopia. With a healthier and more disease-resistant breed of chicken, the survival rate of chickens in Ethiopia would increase drastically and consequently enable farmers to raise more chickens and produce more eggs. This is the main goal of The African Chicken Genetic Gains (ACGG) project at the Debre Zeit Agricultural Research Center (DZARC). In this study, the growth and mortality rates of breeds of chicken originating from Belgium, Ethiopia, and South Africa will be evaluated. The diversely bred chicken from Belgium is believed to be larger, more disease resistant, and more productive than the other two breeds of chicken from Africa. The data collection process includes counting the live chickens daily, weighing the chickens weekly, and measuring the chickens feed refusal daily. Data on the chicken's mortality rate, weight gain, and feed consumption will be collected throughout the extent of this study. Based on the gathered information, the breed of chicken that has the greatest survival rate, growth rate, and efficiency in utilization of available feed will be determined. When distributed to farmers, I hypothesize the breed from Belgium will be able to adapt to the prevailing production environment and withstand its conditions better than the other two breeds of chicken. I chose this hypothesis because the Belgian breed of chicken is part of a line consisting of 18 of the heartiest chicken breeds around the world. With this information, I assume the Belgian breed will have inherited the most desired traits from chickens around the world, making it a more adaptable and disease resistant breed. In order to confirm the Belgian breed is more resilient and productive than the Ethiopian breed, it would need to be raised from infancy to adulthood in different regions of the Ethiopia, comparing growth, mortality rate, and egg production, with that of the Ethiopia breed. If proven to be more productive and disease resistant than the breed of chicken from Ethiopia, the Belgian breed could produce more eggs for farmers, which would assist in improving food security and alleviating poverty.

Pursuing a Life of Service

Ever since I was in third grade, I have aspired to pursue a career which would allow me to help people and be around animals. The first career that came to my mind as a little third grader was a veterinarian. As the years went on my dream job became my life goal. Throughout middle school, I spent numerous hours shadowing a local veterinarian. I observed surgeries and helped with medical examinations. This is the time in my life when I secured my passion for veterinary science. I continued to set goals and immerse myself in activities which would set me apart from other prospective veterinary students.

One of my goals, which I achieved my junior year of high school, broadened not only my experience but my outlook on life itself. My journey through the World Food Prize started in the beginning of 2016 when my agriculture teacher, Mr. Russ, told me about the World Food Prize Iowa Youth Institute. He told me it was a program provided to young and motivated youth to educate them on issues facing world hunger and poverty. The first step required me to write and submit a five-page research paper on a country facing food insecurity. I was thrilled to write a paper about sustainable agriculture, something I had become very passionate about. My paper specifically focused on improving chicken production for rural farmers in Ethiopia. While conducting my research, I was struck by how little the people who lived there had. I had never

met a person from Ethiopia before, but what I had learned made me fall in love with the country and its people.

I went on to the Iowa Youth Institute in April of 2016, where I presented my findings and recommendations to experts and other students across the state. From there I was invited to attend the Global Youth Institute in October of 2016. My life and heart were forever changed by my experiences at the Global Youth Institute. I was joined by 500 students from across the nation who also shared my passion for impacting world hunger. I was able to share my research findings at another roundtable discussion with other students as well as renowned scientists from across the world.

By the conclusion of my time spent at the Global Youth Institute, I desperately wanted an opportunity to change the world. I heard about the Borlaug-Ruan International Internship at the Global Youth Institute and consciously made it a goal of mine. Following the Global Youth Institute, I immediately began filling out the application to become a Borlaug-Ruan Intern. After applying and interviewing, I was one of 24 other individuals chosen to complete this two-month internship. Never in my wildest dreams did I believe I would have the opportunity to spend my summer in an amazing country surrounded by remarkable people.

Throughout high school, I have always wanted to do more. I wanted to travel and learn more and most importantly, I wanted to help more people. This internship gave me the opportunity to accomplish those goals. Spending my summer in Ethiopia made me realize what part I can play in reducing world hunger. In the future, I hope to serve as an AgriCorps fellow for a year in Africa. Furthermore, I hope to provide veterinary services at low costs for smallholder farmers in developing countries. Along the way, I aspire to educate farmers about proper animal practices to increase their productivity. I am proud to say these goals of mine were brought to my awareness by the World Food Prize Foundation.

International Livestock Research Institute

The International Livestock Research Institute (ILRI) is a nonprofit organization whose mission is "to improve food and nutritional security and to reduce poverty in developing countries through research for the efficient, safe and sustainable use of livestock—ensuring better lives through livestock" (International). ILRI primarily focuses on research in animal and human health, livestock genetics, feed and forage development, sustainable livestock systems, policies, institutions and livelihoods, and biosciences. With smallholder farmers being their main target of interest, most of ILRI's researchers work in the field. These scientists gather data on current agricultural practices in the far reaches of Ethiopia. This data is then brought back to ILRI to be analyzed, where a solution can be formulated and programs will be put in place to alleviate those who are suffering from hunger and poverty.

With its headquarters in Nairobi, Kenya, a principal campus in Addis Ababa, Ethiopia and projects in West, East, and Southern Africa, Central America, and Southeast Asia, ILRI researches a variety of different projects to work towards a globally food secure future (International). Founded in 1994 to serve as a center for agricultural research, ILRI now hosts more than a dozen additional international organizations (International). Most of these

organizations are in affiliation with the Consultative Group on International Agricultural Research (CGIAR). These organizations contribute to groundbreaking research in various areas of agriculture, to reduce world hunger, poverty, and malnutrition.

African Chicken Genetic Gains

In November of 2014, ILRI and its partners initiated an African-wide collaboration to provide more productive chickens to smallholder farmers in Africa (Bruno). As a result, the African Chicken Genetic Gains (ACGG) program was founded to improve the genetics in farmer-preferred chickens (Bruno). Led by ILRI and funded by the Bill and Melinda Gates Foundation, ACGG is a five-year (2015-2019) project that tests and disperses improved breeds of chickens which suit the needs of farmers in low-input systems (Bruno). ACGG specifically tests selected chicken strains for egg and meat productivity, adaptation, and preference by farmers under semi-scavenging and intensive management conditions.

The latest breed of chicken to be tested by ACGG is the Mechelse Wyandotte. ACGG's specific goals include the creation of functioning community innovation platforms, strong public-private partnerships, empowering women, and further improving capacity development to tackle poverty and improve food security in Africa (Bruno). Although the ACGG's work has had a profound impact on improving the genetic material of Africa's chickens, it has the potential to impact millions of poor farmers around the world. Being in its early stage of existence, ACGG has the power to impact many more people in the near future.

Local Horro Literature Review

Horros originate from Ethiopia and are one of Ethiopia's many indigenous breeds of chickens. These indigenous breeds of chickens are known for their disease resistance, adaptability to the tropical production environment, and their camouflage plumage which protects them from predators (Padhi). It has been reported that Horros lay a maximum of 60 eggs per year when relying on scavenging as their sole means of food (Fisseha). Despite their relatively low output, Horros can survive and produce eggs well in the village scavenging system. This breed is built to thrive in conditions with an unreliable supply of food and water and little to no medical assistance. Indigenous Horros have economic and nutritional benefits with little maintenance provided by farmers. Horros are a source of high protein by means of eggs and meat. They can also be used as means of emergency income. With all these benefits, the greatest is their ability to tolerate harsh living conditions. Intensive feeding has the ability to raise the Horros average egg production to 150 eggs a year, but this costs farmers tremendous amounts money. Instead, scientists have turned to cross-breeding and selective breeding to improve the Horros productivity (Bruno).

In 2008, a project started at The Debre Zeit Agricultural Research Center (DZARC) to improve the productivity of the indigenous Horro through selective breeding (Rollings). In each generation, scientists breed the best layer and the fastest growing cock, which results in an improved variety of Horro. This project is currently on the 11th generation of improved Horro. At the start of their research, the Horro's egg production was measured at an average 34 eggs per year (Rollings). The 11th generation of Horro can now produce 169 eggs a year (Rollings). Through selective breeding, the Horro's egg production has more than quadrupled. Scientists have successfully bred the indigenous Horro for over 9 years (Rollings). The goal of this research is to produce a higher yielding and subsequently more profitable chicken (Rollings). Their minimal amount of needed maintenance makes them suitable and convenient for small holding chicken farmers in rural areas. Scientists will continue to improve the genetics of the indigenous Horro one generation at a time until they produce the perfect Horro.

As seen in DZARC's research, as well as my own, indigenous chickens are the most popular type of chicken in Ethiopia, accounting for over 95% of the total chicken population which consists of 38.1 million chickens (Rollings). The traits of chickens seen as important to farmers in Ethiopia are egg production, body weight, age at maturity, disease resistance, adaptability to environment, and ability to avoid predators (Padhi). While improvement is still needed in the indigenous Horro's growth rate and egg production, keeping this breed's genetic diversity is just as important. The genotypes of indigenous chickens have contributed to their adaption to the production environment (Rollings). Indigenous Horros have an upper hand on exotic breeds when it comes to adaptability in their production environment. As a result, researchers have cross-breed adaptable indigenous breeds with high outputting exotic breeds, to produce breeds well suited to the environment with higher productivity (Rollings). It has been shown that cross-breeding exotic breeds with the indigenous Horro have improved its productivity (Rollings).

Potchefstroom Koekoek Literature Review

Potchefstroom Koekoek is a breed of chicken originating from South Africa. It was crossbred with a White Leghorn, Black Australorp and Barred Plymouth Rock in the 1950s at the Potchefstroom Agricultural College (Dessie). Since its creation in the 1950s, the Potchefstroom Koekoek has become a popular breed in South African countries for its egg and meat production (Dessie). Koekoek cocks and culled hens are used for meat production. Unlike the indigenous Horro, the Koekoek comes from a larger framed stock of chickens. This provides them with a larger amount of meat, which makes them an excellent dual purpose chicken. Koekoek hens are also well known for their broodiness or ability to hatch their own offspring (Dessie).

The Koekoek lives in a similar tropical climate as the Horro, which makes it a suitable breed of chicken to survive in Ethiopia's harsh production environment. Like the indigenous Horro, the Koekoek does well as a free-range chicken and can survive and produce eggs well in smallholder production systems. However, since the Koekoek has a larger frame than the Horro, it requires supplementation to the food it gathers while scavenging to aid in its growth and production. Feed is the main contributor to growth, production, and reproduction, which is why the Koekoek requires little feed supplementation to aid in its complete development. The Koekoek's supplementations to scavenging may include various grains, maize, household leftovers, or feed,

which add up to 30% or less of its total diet (Dessie). For these reasons, the Koekoek needs very minimal assistance to aid in its development.

The Koekoek's average egg production in South Africa is 196 eggs per year, which is significantly higher than the indigenous Horro's average of 45 eggs per year (Fisseha). The Koekoek's average egg weight is 55.7g, which is exceptional compared to the average weight of a Grade A egg in the United States of 57g (Clare). The Koekoek has sex-specific feather colors and patterns, which makes it easier to sex day old chicks. This helps farmers select the right Koekoeks for their needs, whether they are focused on egg or meat production. Male Koekoeks reach an average weight of 3-4kg and the females reach 2.1kg (Dessie). Comparing the Koekoek's weight to the average weight of a butcher size Cornish Cross, which is 2.5-3.6kg; the Koekoek does a spectacular job in meat production for a dual purpose chicken (Clauer). From the information gathered about Koekoek's performance, it would be a great breed to introduce to smallholder farmers in Ethiopia.

In 2008, 960 Koekoek chickens were produced to conduct a study on performance at DZARC in Ethiopia (Dessie). The information gathered will be used to determine if the Koekoek would be a suitable breed of chicken to be introduced to smallholder farmers in Ethiopia. Just like the indigenous Horro, the mean mortality rate of the Koekoeks at sexual maturity was less than 3% (Dessie). The mean feed intake of a sexually mature female Koekoek was 122.68g per day, under ideal living conditions (Dessie). Keep in mind, indigenous Horros require little to no feed to survive and produce under a farmer's management conditions. In field trials, Koekoeks can sustain life and productivity while relying on scavenging as their main source of food with at least 30g of feed supplement a day (Dessie). The average days until the Koekoek's first egg was 147, which is not even close to the 223 days it takes an indigenous Horro to lay an egg (Fisseha). Although its egg weight dropped while being tested in Ethiopia, the Koekoek still managed to produce eggs weighing 51.9g (Dessie). The average weight of an egg in Ethiopia is about 44g, which is significantly lower than the South African Koekoek (Fisseha). This is another reason why the Koekoek is thought to be an excellent breed to introduce to Ethiopian farmers. Trials conducted at the research center made the Koekoek's future in Ethiopia look discouraging, but after more realistic trials were conducted under average living conditions, the Koekoek seemed to have great potential.

Debre Zeit White Literature Review

Broilers are almost obsolete in Ethiopia because they struggle to gain weight properly. This is due to there being a lack of nutritious food sources for the chickens to gain weight efficiently. The majority of Ethiopia's chicken population consists of free-range chickens. Most owners of

free-range chickens feed them a handful or less of wheat and maize per day. Ethiopia's local breeds of chickens thrive in the village scavenging system. Their feed intake is quite low which explains their low output in meat. Exotic breeds of broilers have been introduced to Ethiopia's environment before, but due to the relatively small amount of feed inputs, they were unable to thrive. Researchers at DZARC recognized this occurring problem and set out to improve the productivity of Ethiopia's broilers.

The Debre Zeit White breed of chicken was originally bred at DZARC. Unlike most Ethiopian breeds of chicken, the DZ White boasts its white plumage. This particular breed of chicken was bred to increase the average chicken's weight gain. Like most of Ethiopia's broilers, it is a dual-purpose breed which has a good output of meat as well as eggs. This breed of chicken grew better than the exotic broilers because it was created in Ethiopia, making it an indigenous breed. Most Ethiopian farmers keep their layers for a year or one production cycle and then use them for meat. The amount of meat on these layers is skimpy compared to that of the DZ White breed. Ethiopian farmers also raise roosters and harvest their meat. Although the roosters provide more meat than the laying hens, they are still lean compared the DZ White. The local rooster's lack of meat production is due to its undernourishment. DZARC plans to cross breed the DZ White with the local breed of chicken to enhance the local breed's hardiness and overall meat production.

Koen Vanmechelen and the Mechelse Wyandotte

Koen Vanmechelen is a Belgian artist who is internationally renowned. His most recent innovative project called the Cosmopolitan Chicken Project involves cross-breeding chickens from around the world to explore cultural, biological, and aesthetic diversity. Vanmechelen uses the chickens as a metaphor for global diversity. Vanmechelen launched the Cosmopolitan Chicken Project in 1996 when he started breeding his first crossbred chicken, the Mechelse Bresse, a cross between the Mechelse Koekoek and the French Poulet de Bresse (Amelinckx). For the last twenty years, Vanmechelen has been finding and selectively breeding chickens from different parts of the world to increase the genetic diversification for each successive generation of Cosmopolitan Chicken. Vanmechelen usually breeds about one hundred chickens of each generation to further increase his selection of strong genetic traits and qualities (Amelinckx). Vanmechelen keeps his personal collection of more than 3,000 chickens on a 25-acre farm near Meeuwen, Belgium (Amelinckx). Even more of Vanmechelen's chickens are scattered on farms across the globe.

Vanmechelen's latest crossbred has resulted in the Mechelse Wyandotte, which was born in 2016 (Amelinckx). The Mechelse Wyandotte is the 20th generation of Cosmopolitan Chicken. This new breed of chicken now carries traces of DNA from 20 different breeds across the world (Mcvey). Its enriched genetic material has over 13 million DNA strains versus the 4-5 million found in an average chicken (Mcvey). The Mechelse Wyandotte holds the DNA of chickens from Belgium, France, England, the United States, Germany, the Netherlands, Mexico, Thailand, Brazil, Turkey, Cuba, Italy, Russia, China, Egypt, Senegal, Slovenia, Austria, and Indonesia (About). Vanmechelen discovered each successive breed of Cosmopolitan Chicken was living longer (Amelinckx). As a result, he decided to form a foundation made up of scientists from various backgrounds to work on the project and study the chickens (Amelinckx). According to Vanmechelen and the scientists working with him on the Cosmopolitan Chicken Project, each successive breed tends to be healthier and live longer (Amelinckx). The Cosmopolitan Chickens are known to have longer lifespans, higher fertility rates, stronger immune systems, and be more adaptable to the changing environment than the average domesticated chicken (Amelinckx).

When Vanmechelen recognized his chickens possessed qualities which made them a top-quality breed, he decided to breed his roosters with hens from a variety of communities around the world (Govera). This is an effort to bring more genetic diversity to chickens with various growth and production problems, as well as those at risk of contracting various diseases. The intended result of Vanmechelen's effort is to produce a chicken which could benefit smallholder farmers (Govera). This new project was made possible by Vanmechelen's vision in conjunction with Chido Govera, which resulted in the creation of the Planetary Community Chicken Project (Govera). This project will make it possible for communities around the world to have access to the Cosmopolitan Chicken's genetic diversity, as well as make chickens suited to a community's particular environment (Govera). This project is currently underway in Zimbabwe at The Future of Hope Foundation and in Detroit at Wasserman Projects (Govera).

The Planetary Community Chicken Project was dreamt up by a person who had created a beautiful breed of chicken, which symbolized cultural diversity around the world. Even still, this person wished to have a more direct impact on the world. Koen Vanmechelen came up with the idea and initiative to help others around the world by bringing his Cosmopolitan Chickens to others. Another initiative is underway in Ethiopia, to create a similar foundation as the Planetary Community Chicken Project to provide Cosmopolitan Chicken genetics to poor smallholder farmers. The Mechelse Wyandotte is currently being tested in Ethiopia to determine if it will be able to adapt to its prevailing production environment and therefore be suitable to smallholder farmer's needs. Koen Vanmechelen's cultural diversity project has transformed into something

bigger than he could have ever imagined. What started as a global diversity project led to the creation of a breed of chicken which could have a tremendous impact on global food insecurity.

Goals and Objectives

A staggering 84.3% of all Ethiopian chick deaths are attributed to disease (Fisseha Moges et al, 2010). With more hearty and disease resistant breeds of chickens, the survival rate of each brood would increase drastically. With a higher survival rate, farmers would be able to raise more chickens and produce more eggs. This is the ultimate goal which the ACGG is trying to obtain through chicken genetics. In order to improve genetics, it is known chickens must be selectively bred or crossbred with chickens that have desirable production traits. The Mechelse Wyandotte carries powerful traits from 20 other breeds around the globe, making it the most diverse breed of chicken in the world (Mcvey). Koen Vanmechelen claims to have made a more adaptable and disease resistant breed which will be the primary focus of this research.

The objective of this research is to compare collected data on the Mechelse Wyandotte with data from the Local Horro, Koekoek, and DZ White breeds. The hypothesized outcome is that the Mechelse Wyandotte will grow larger and faster with a lower mortality rate than the other breeds in this comparison. If the results agree with the hypothesis, the Mechelse Wyandotte will be able to increase smallholder farmers' productivity. With increased productivity, smallholder farmers will be able to have more protein and vitamin B12 in their diets as well as make a profitable income. This research has the capability to lift smallholder farmers from malnutrition and poverty.

Research Contributions

Upon my arrival in Ethiopia, I was assigned a research project by Dr. Tadelle Dessie and Dr. Olivier Hanotte. After being briefed on the Mechelse Wyandotte's reputation of having the potential to drastically increase egg production in Ethiopia, I was excited to start my research and contribution to such an amazing project. My duty was to assist in the ACGG project lead by Dr. Tadelle Dessie and Dr. Olivier Hanotte. I evaluated the growth and mortality rates of breeds of chicken originating from Belgium, Ethiopia, and South Africa. My work will help determine if the Belgian breed, the Mechelse Wyandotte, shows signs of being more resilient and disease resistant at a young age.

Samples of the Local Horro, Koekoek, and DZ White breeds were compared to the Mechelse Wyandotte's performance. Although a part of a separate research project led by another scientist at DZARC, I collected data from a pen of Local Horro, Koekoek, and DZ White, which are under improvement. This data was then compared with the data I collected from the Mechelse chicks to determine if this newly created breed of chicken was higher performing than its counterparts.

There are several projects currently taking place at DZARC including one on the Local Horro breed. Researchers have been selective breeding the Local Horro over the past several years to increase its egg production while preserving its genetic diversity. Researchers have recently created an 11th generation of Local Horro, which has drastically improved its productivity. The

DZ White is a new strain of chicken which was created at DZARC and will mainly be used as a meat production chicken. The Koekoek is a breed of chicken originating from South Africa. It was brought to Ethiopia with the intention of introducing it to smallholder farmers as a dual purpose chicken.

All testing for this experiment was done at DZARC in Bishoftu, Ethiopia. I studied the Mechelse Wyandotte chicks for the first six weeks of their lives and the Local Horro, Koekoek, and DZ White chicks for the first seven weeks of their lives. To further study these varieties, I traveled to DZARC once a week to weigh chickens, determine feed intakes/refusals, and collect deceased chickens for further examination. Based on the information I gathered, I was able to determine which breed of chicken in the study had the greatest survival rate, growth rate, and feed efficiency. I collected data every Monday to form a weekly comparison of growth rates.

As requested by my mentors, I weighed the Mechelse chicks individually to form a comparison between the nineteenth and twentieth generations. The three other remaining breeds were weighed in bulk every Monday. The project being led by the Debre Zeit scientist included different procedures than the project led by my mentors. However, feed consumption data was collected the same for all of the breeds in this study. The feed was measured out when given to the chickens in the morning and the remaining feed was weighed at the end of the day to determine feed refusal. I was able to calculate each breed's rate of gain from this data as well. Every Monday, I collected the deceased chicks in this study to bring back to ILRI for further examination and explanation of mortality. As the results of this procedure were not presented to me, I was unable to form an explanation for the mortality. However, I was able to calculate the mortality rate of each breed from the data collected. The remaining days of the week were spent in my office at ILRI analyzing collected data. I also conducted literature reviews on each breed of chicken in this study.

In addition to my assigned research project, I delved into a personal interest of mine by conducting surveys with over 20 farmers. I put together a survey of questions ranging from egg production to biosecurity practices. Gathering this knowledge gave me a better understanding of Ethiopia's value chains and culture. With this knowledge, I was able to depict the needs of farmers and see how my assigned research project would have the ability to impact smallholder farmers. I was able to dig to the root of Ethiopia's poor productivity issues and give farmers advice about biosecurity, animal nutrition, marketing animals, and medication dosage. With a combined background of FFA poultry events and work experience at veterinary clinics, I was able to provide farmers with simple advice in order to slightly increase their egg productivity and decrease their mortality rates. My advice was widely acknowledged by the female farmers I interviewed.

Results

The Local Horros used in this experiment are the 11th generation of improved Horro. It is noted that the Mechelse Wyandotte and Mechelse Danish were the only breeds being tested by Dr. Tadelle Dessie and Dr. Olivier Hanotte at this time. The other breeds of chicken, Local Horro, Koekoek, and DZ White, were being tested by a scientist who works at DZARC. The data

collected from the Local Horro, Koekoek, and DZ White chickens would be used to compare with the data collected from the Mechelse chickens.

The Local Horro, Koekoek, and DZ White chicks were bred and hatched on site, whereas, the Mechelse Wyandotte and Mechelse Danish chicks were bred on Koen Vanmechelen's farm near Meeuwen, Belgium and hatched at DZARC. Being that the Mechelse Wyandotte is the latest generation of the Cosmopolitan Chicken Project, Vanmechelen was unable to supply ACGG with a large number of fertilized eggs. As Vanmechelen builds up his flock, he will be able to supply ACGG with a larger number of fertilized eggs so more tests can be performed and more scientific results can be compared and analyzed.

The Local Horro, Koekoek, and DZ White chicks were all hatched on the same day. It is noted that the Mechelse Wyandotte and Mechelse Danish were hatched on the same day but a week later than the Local Horro, Koekoek, and DZ White chicks. One hundred Mechelse eggs were shipped from Belgium and arrived in Ethiopia on June 24, 2017. During transportation, five eggs were found broken. Following their arrival, the eggs were immediately incubated with their hatch date being June 26, 2017.

Once the doors were closed, the incubation room remained sealed until the eggs were close to their hatch date. The incubation room was filled with racks which held and turned the eggs. The room had controlled temperature and humidity levels, providing the perfect growing conditions for the embryos. The eggs remained in the incubation room until two days prior to their hatch date. They were then moved to the hatch room which also had a controlled temperature and humidity level. Inside the hatch room, the eggs were kept in plastic egg trays with a higher humidity level to increase the hatch rate. The eggs were separated into two different areas of the hatch room correlating with the breed names written on the shell. During incubation, 16 chicks died in their shell and 18 eggs were found to be infertile. On June 26, 2017, 61 chicks successfully hatched. Five of the hatched chicks died inside the hatch room. All chicks were vaccinated for Marek's disease and banded for identification on the day they hatched. They were all vaccinated with HB1 on the second day to prevent against Newcastle disease.

After being vaccinated with HB1, the Mechelse chicks were moved to the brooder house where the week-old local Horro, Koekoek, and DZ White chicks were being raised. The chicks will remain here until they reach maturity. Once the chickens reach maturity the pullets and cockerels will be separated so they can be fed different rations to increase egg production and weight of gain. The Mechelse Wyandotte and Mechelse Danish chicks were housed together throughout the experiment. Every pen in the brooder house had teff straw bedding, one heat lamp, two feed containers, and two water containers. This insured all chicks could have access to feed, water, and heat at all times.

The test trials currently underway at DZARC for the Local Horro, Koekoek, and DZ White breeds require each pen to have a different ration and/or be given different amounts of these rations. This caused some discrepancy between the two experiments. Consequently, the feed rations and formula for the Mechelse breeds were significantly different from those of the three other breeds (see figure 1). It is noted that the same feed ration and formula, Treatment 5, was fed to the Local Horro, Koekoek, and DZ White chickens over the course of this study. This means the data collected from these three breeds can be properly compared and analyzed, whereas, the data collected from the Mechelse breeds cannot be properly compared to the other breeds. Both generations of Mechelse breeds, Danish (CP19) and Wyandotte (CP20), were kept in the same pen and ate out of the same feed containers making it impossible to calculate each breed's individual feed consumption and daily weight of gain.

Amount of Feed Given

	Mechelse	Horro, Koekoek, & DZ White
Age (week/day)	Feed Given (oz)	Feed Given (oz)
Week 1 (Mon)	N/A	0.60
Week 1 (Tues)	0.575	0.60
Week 1 (Wed)	0.575	0.60
Week 1 (Thurs)	0.575	0.60
Week 1 (Fri)	0.575	0.60
Week 1 (Sat)	0.575	0.60
Week 1 (Sun)	0.575	0.60
Week 2 (Mon)	0.575	0.60
Week 2 (Tues)	1.196	0.60
Week 2 (Wed)	1.196	0.60
Week 2 (Thur)	1.196	0.60
Week 2 (Fri)	1.196	0.60
Week 2 (Sat)	1.508	0.60
Week 2 (Sun)	1.508	0.80
Week 3 (Mon)	1.508	0.80
Week 3 (Tues)	1.508	0.80
Week 3 (Wed)	1.508	0.80
Week 3 (Thurs)	1.508	0.80
Week 3 (Fri)	1.508	0.80
Week 3 (Sat)	1.508	0.80
Week 3 (Sun)	1.508	0.86
Week 4 (Mon)	1.664	1.00
Week 4 (Tues)	1.664	1.11
Week 4 (Wed)	1.664	1.11
Week 4 (Thur)	1.664	1.11
Week 4 (Fri)	1.664	1.11
Week 4 (Sat)	1.664	1.11
Week 4 (Sun)	1.632	1.11
Week 5 (Mon)	1.887	1.11
Week 5 (Tues)	1.887	1.11
Week 5 (Wed)	1.887	1.26
Week 5 (Thur)	1.887	1.41
Week 5 (Fri)	1.887	1.41
Week 5 (Sat)	1.887	1.41
Week 5 (Sun)	1.887	1.41
Week 6 (Mon)	2.142	1.41
Week 6 (Tues)	2.244	1.41
Week 6 (Wed)	2.244	1.41
Week 6 (Thur)	2.244	1.41
Week 6 (Fri)	2.244	1.41
Week 6 (Sat)	N/A	1.41
Week 6 (Sun)	N/A	1.56

Figure 1

A survey was conducted around Bishoftu and the chicken farmers, agreed that feed efficiency is an important feature for their chickens to possess. Although they had 22 more chicks in their pen, the Mechelse chicks were given .71g less feed than each of the other pens during week one and on Monday of week two. This could potentially play a role in the Mechelse chick's relatively low weight of gain. The rest of the feed given and feed refused data collected from the Mechelse chickens is different than that from the other three breeds, which means it cannot be compared. The population sizes of each breed also varied which meant calculations had to be done to find the most feed efficient breed. However, by performing simple calculations, the average weekly feed intake for each breed was found (see figure 2). The Mechelse breeds had the largest feed intake and feed conversion rate in week two (see figure 3). In week three, the Mechelse breeds consumed the second greatest amount of feed and had the second largest feed conversion rate.

Average Individual Feed Intake (g)

Week Number	Mechelse	Horro	Koekoek	DZ White
2	4.397	3.818	4.305	3.714
3	5.657	5.287	5.786	5.216
4	6.344	5.575	7.802	6.038
5	7.236	7.267	9.450	8.198
6	4.882	7.262	8.788	7.380

Figure 2

Average Individual Feed Conversion Rate (g)

Week Number	Mechelse	Horro	Koekoek	DZ White
2	0.0999	0.0720	0.0957	0.0554
3	0.0844	0.0789	0.0697	0.1110
4	0.0857	0.1394	0.1300	0.0839
5	0.0832	0.1453	0.1062	0.0882
6	0.1085	0.0698	0.0623	0.1318

Figure 3

As time progressed, the Mechelse consumed less feed than the three other breeds. The Koekoek consumed the most feed each week from the third week through the sixth week, but it never had

the highest feed conversion rate out of the four breeds. This means the Koekoek's feed efficiency is very low, and farmers would have to feed it more than scratch grains in order to keep its production. Due to limited time, the feed consumed by the Mechelse breeds during the last three days of week six was not collected. Without a complete week of feed consumed by the Mechelse, the results from week six were thrown out so the final analysis would not be hindered. A scoring system was created to identify the most feed efficient breed of chicken. The results are as follows: Horro being the most feed efficient breed, followed by DZ White, Mechelse, and Koekoek.

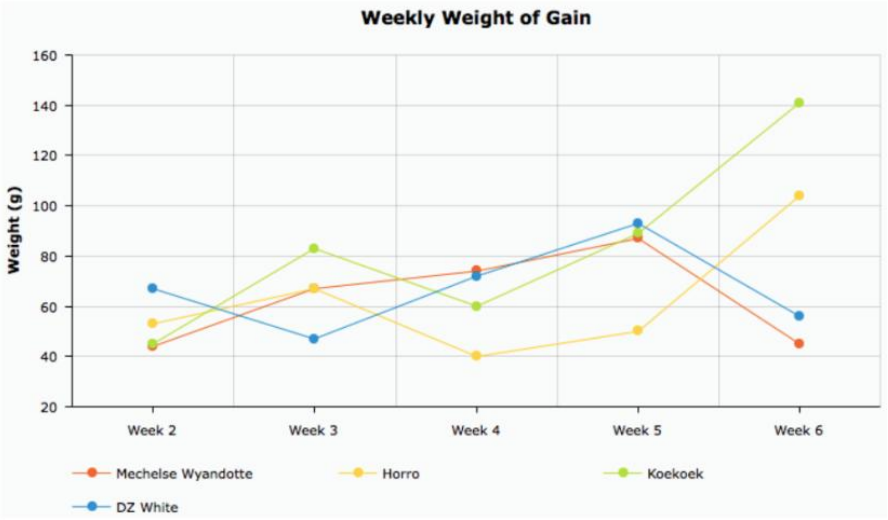

Figure 4

Another important production feature to smallholder farmers is growth rate. The growth rates of all four breeds were collected once a week for six weeks. Calculations were made to determine each breed's weekly average weight gain (see figure 4). By looking at the Weekly Weight of Gain line graph, it is shown that DZ White and Horro gained weight sporadically over the six-week study. Another feature which was found to be important to farmers is consistency in feed consumption, growth, and mortality. Farmers want their chickens to be especially consistent in production. Unfortunately, production was not measured over the course of this study because the chickens did not reach maturity.

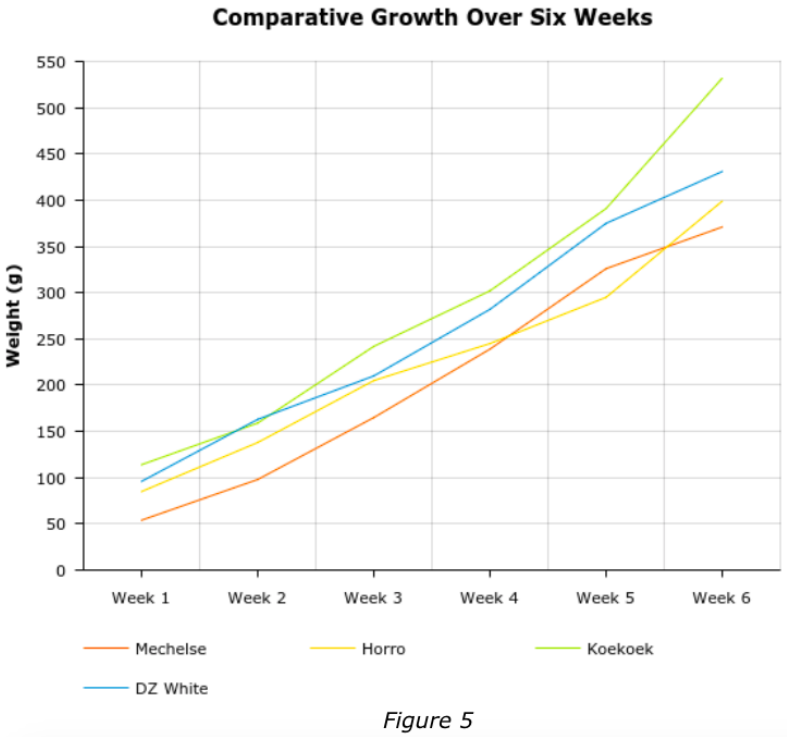

Figure 5

The DZ White breed had the largest weekly weight of gain during weeks two and five. Koekoek had the largest weight of gain during weeks three and six, and both Mechelse breeds had the highest weight of gain in week four. Data was collected and analyzed to determine which breed had the highest growth rate overall (see figure 5). The fastest growing breed was Koekoek, followed by DZ White, Horro, and Mechelse. Although they were not the fastest growing breeds overall, the Mechelse's had the largest average weight of gain out of all four breeds during the fourth week

and the second biggest weight of gain in the third week. With the average Mechelse Wyandotte weighing 326g in week five and the average Horro weighing 295g, the Mechelse Wyandotte weighed an incredible 35g more than the Horro. This was the only week during the entire experiment that the average Mechelse Wyandotte weighed more than any of the other breeds.

A couple factors which should be taken into consideration include the different feed rations and formulas which were fed to each breed. Clearance was not permitted to have access to the ingredients list for the breeds being tested by the Debre Zeit scientist. However, similar ingredients were found in both the Mechelse's feed dishes and the other three breeds' dishes. Those ingredients include corn, soybean, noug cake, limestone, and wheat middling. By visual examination, it was determined the feed content consisted mainly of corn, soybean, and wheat middling. The limited amount of time given to conduct this research was another factor which made analyzing the fastest growing breed a challenging task. It takes roughly 16 to 24 weeks for a hen to start laying eggs and this study only lasted six weeks.

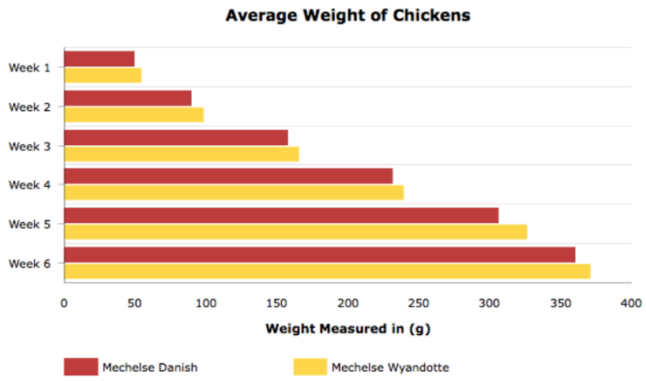

Figure 6

Since the Mechelse chicks were tagged when they were born and each chick was weighed separately, a qualitative comparative analysis on growth was created between the Mechelse Danish (CP19) and the Mechelse Wyandotte (CP20). Koen Vanmechelen's observations were correct. The Mechelse Wyandotte grew significantly faster than the Mechelse Danish (see figure 6). These two breeds were only one generation apart, yet their average weight difference over the six-week experiment was nine grams. The Mechelse Wyandotte grew consistently faster than Mechelse Danish. The closest the Mechelse Danish ever came to passing the Mechelse Wyandotte was within four grams. This proves that each successive generation of Mechelse chicken is faster growing. Unfortunately, feed efficiency was not able to be determined for both the Mechelse Danish and the Mechelse Wyandotte because they were housed together and had access to the same food.

The third most important feature to farmers is mortality rate. Breeds of chicken with lower mortality rates are usually more immune to disease than other breeds. With disease being the major contributor to loss of chickens in Ethiopia, it is incredibly important for farmers to invest in breeds with strong immune systems in order to avoid the risk of having their flocks wiped out by disease. This devastation is one of the many afflictions farmers in Ethiopia face on a daily basis and which I saw firsthand. Once a week, deceased chickens at DZARC were counted and collected for further examination. From collected data, mortality rate was configured for each of the breeds in this study. The indigenous Horro and DZ White both had 0% mortality from their hatch date until the end of the study, the Mechelse Wyandotte had 4% mortality, the Mechelse Danish had 6.9%, and the Koekoek had an 11% mortality rate. The mortality rate from the Mechelse Danish to the Mechelse Wyandotte dropped over one percent, concluding that the Mechelse Wyandotte is indeed more disease resistant than the Mechelse Danish.

Conclusion

From the data collected at DZARC over a six week period, calculations were made and data was analyzed to determine which of the four breeds would best withstand the prevailing production environment. The fastest growing breed was Koekoek, which is a dual purpose breed from South Africa. Coming up a little short in this classification is the DZ White, which is a new strain of dual-purpose chicken created in Ethiopia. The most feed efficient breed by far is the Horro, which is indigenous to Ethiopia. This breed has survived by scavenging off the land for hundreds of years. Two breeds had an impressive zero percent mortality rate, DZ White and Horro, both of which are indigenous breeds to Ethiopia. Their disease resistance has come from selective breeding and adapting to their surroundings. The overall best breed is the DZ White, followed by the Horro, Koekoek, and Mechelse. The DZ White would be the best option for smallholder farmers because of its fast growth rate, mild feed consumption, and disease resistance. The DZ White has the ability to bring relief to poor farmers.

Future Implementation

Being that this was the first concrete research conducted on the Mechelse Wyandotte, ACGG will be conducting more tests in the near future. Bigger quantities of the Mechelse Wyandotte will be tested and compared under various production environments. Tests will occur at the research center under perfect production conditions and on farms under practical farming conditions to determine the Mechelse Wyandotte's egg productivity. The Mechelse Wyandotte will be crossbred with the Local Horro in order to increase its resistance to diseases in Ethiopia. The results gathered from these tests will help scientists determine if the Mechelse Wyandotte would be beneficial to smallholder farmers, by decreasing poverty and malnutrition.

Reflection

Aside from the knowledge gained from this internship, I learned an array of information about Ethiopia as a whole. Ethiopia is a country filled with kind, hardworking, and resilient people. Living abroad allowed me to connect with the country and its people on a personal level. It allowed me to see and experience many things most tourists overlook. I saw poverty, beggars, and homeless people on a daily basis.

When I returned to the United States I experienced reverse culture shock. I missed Ethiopia's atmosphere, landscape, and above all, my Ethiopian family. Returning to high school after spending two life-changing months in Ethiopia was no doubt a difficult challenge. I tried expressing the needs of people across the world to my peers, but no one seemed to understand the multitude of poverty that existed. After taking a great deal of time to reflect on my summer experiences, I realized I was the only person in my school that had the extraordinary opportunity to live in a developing country for two months. A thought provoking question eventually arose

from my reflection, “How could my peers even begin to imagine the extent of poverty and malnutrition that existed in this world without seeing it for themselves?” It was in this moment I knew my life would be different from those around me. I could not eat, sleep, or even go to school without having memories of Ethiopia flash through my mind.

This internship gave me the opportunity to see the world through a different lens. Learning about poverty and hunger is one thing, but coming in direct contact with it is completely different. My time spent in Ethiopia allowed me to match faces with the statistics I had researched regarding malnutrition and poverty. These experiences made world hunger a personal issue of mine.

My time spent in Ethiopia ignited my passion and confidence to do something about food insecurity. I am determined to use my skills and passion to make an impact on the world and contribute to the demise of world hunger. Ethiopia holds a special place in my heart. When asked by others if I would go back to Ethiopia, I always respond, “The question is not if I will return to Ethiopia, but when I will return.” When I return to Ethiopia, I will be better equipped with the knowledge and skills to make a difference. Until then, I will use the experiences I have as a fuel to impact the lives of those around me.

Acknowledgements

First and foremost I owe many thanks to Norman Borlaug and his family. Without Dr. Borlaug, I would have never been exposed to worldwide issues and discovered I can be a part of the solution to ending world hunger. Although I did not have the chance to meet him, he has greatly impacted my life and for that, I am eternally grateful. Another big thanks goes to the World Food Prize Foundation and its members for granting me this incredible opportunity. Thank you, Ambassador Kenneth Quinn, for your dedication to the World Food Prize and its mission and for carrying forward Norman Borlaug's legacy. You were absolutely right when you said I would come back from my internship a changed person with a very different perspective on life and the world. I must give a special thanks to Lisa Fleming for coordinating my entire trip and ensuring my safety throughout. Thank you for being my advocate and source of knowledge throughout my entire journey with the World Food Prize.

A huge thank you goes out to my high school agriculture teacher and FFA advisor Mr. Russ. Since day one, you have supported me in everything I have done and have encouraged me to pursue my passions. You never thought my outrageous dreams were unattainable and indeed played a major role in helping me pursue them. I cannot thank you enough for making me aware of many amazing opportunities through FFA, which led me to the World Food Prize. There are not powerful enough words to describe how incredibly thankful I am for your continuous support and presence in my life.

I would not have known about this incredible opportunity if it were not for Sam Reicks, a former classmate of mine. Sam was the first Borlaug-Ruan Intern from New Hampton High School. She paved the way for my success in obtaining this internship and supported me throughout my entire journey. Thank you for the advice of bringing Frisbees to Ethiopia to share with the kids in the villages. The amount of joy I gained from teaching them how to throw a Frisbee will never escape my heart.

I offer many thanks to my travel mate and friend Kelli Wicks. Thank you for your constant emotional support throughout the duration of our time in Ethiopia. This journey would have been very difficult without your presence and friendship. I am happy to say you are the sister I never had.

Thank you to the best driver on earth, Michael Temesgen. You made long car rides seem short with your laughter and humor. Thank you for answering all of my random questions about Ethiopia and its culture. Another thanks goes to Nardos for buying me my first cappuccino and making my Fourth of July celebration extra special.

My deepest regards towards my supervisors Dr. Tadelle Dessie and Dr. Olivier Hanotte. Your passion for chickens and your work were inspiriting. You gave me the opportunity to work with an amazing breed of chicken. I am incredibly thankful for the opportunity to be a part of such an extraordinary project and will be looking forward to hearing about its success.

The most heartfelt thanks goes to my Ethiopian mother Tigist Endashaw. I am so incredibly thankful you reached out to me while I was in Ethiopia. You made me feel like a part your family, which made being away from home much easier. Thank you for taking me to church on Sundays and for introducing me to your two amazing daughters, Sitota and Aryam. I really want to thank you for checking up on me while I was ill and bringing me sacks of bananas and apples. I thank God for your tender and caring heart. You and your family will always be welcome at my house during your visits to the United States.

I am incredibly blessed to have such a wonderful loving family. The constant support from grandparents, uncles, aunts, and cousins was unwavering throughout my trip. I was glad to spend my last and first days in the United States with you. I am grateful for your support throughout my life and throughout my time in Ethiopia. My biggest thanks goes to my mom, dad, and brother. Thank you, mom and dad, for raising me around the idea that I could achieve anything I set my mind to. During the rollercoaster of my trip, you were always there to keep me grounded. Mom, although you could not give me a hug or kiss, I still felt your never ceasing love over 7,700 miles away. Finally, to the best big brother anyone could ever ask for. You have instilled in me the idea that there is always more to be done, which explains why I am never content with helping just one person. Jordan, you have taught me what hard work looks like, which has challenged me to work harder than the person next to me. It is because of the values you have instilled in me that I traveled to Ethiopia in pursuit to make a difference. Thank you, mom, dad, and Jordan, for your unwavering love and support and for being the most influential people in my life. God has blessed me in more ways than are possible to count.

To every person who has interacted with me throughout my lifetime, you have changed me into the person I am today. Thank you, Ameseginalehu.

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