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**The Effects of Common Stressors on Poultry Production:
A Case Study in Northern Mozambique**

by

Grace Lehfeltdt

Advisor: Dr. Amy Farmer

**An Honors Thesis in partial fulfillment of the requirements for the degree Bachelor of
Science in Business Administration (or Bachelor of Science in International Business) in
Accounting (your major)**

**Sam M. Walton College of Business
University of Arkansas
Fayetteville, Arkansas**

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Introduction:

In the summer of 2019 between my sophomore and junior year of college, I had the incredible opportunity to travel to Mozambique on a service-learning study abroad program headed by Dr. Amy Farmer of the Walton College of Business and Dr. Lanier Nalley of the Dale Bumpers College of Agricultural, Food and Life Sciences. Dr. Farmer and Dr. Nalley have been leading this study abroad program for eight years, and therefore, have a very strong relationship with their local partners in Mozambique. Their main partners are the employees of New Horizons Farm, or Novos Horizontes, as it is known locally. New Horizons is an integrated chicken company started in 2005 with the intent to breed, raise, and see their chickens all the way through production and point of sale. In doing this, they are focused on “impacting the lives of hundreds of thousands of Mozambican farmers through profitable and diversified value chains in the agricultural industry,” as stated in their mission. (Novos horizontes) While participating in this study abroad program, I was on the Poultry Team. Our group developed and completed two research projects for the New Horizons executives. We were tasked with the research of the chicken feed recipe and the collecting data on how the temperature of each stage of production was impacting the overall product. These two different projects went hand in hand with gaining a better understanding of how well the chickens being raised by New Horizons could grow and develop into fat, meaty chickens which would sell for higher values and positively impact their profits.

Literature:*Mozambique Poultry Industry:*

According to the Food and Agriculture Organization of the United Nations, the agriculture sector contributed 21% of Mozambique’s GDP, and the poultry industry accounted for 0.3% (fao). The Food and Agriculture Organization estimates that this number will easily double in the future. “Poultry production in Mozambique can be categorized into two broad systems: small-scale village or scavenging system, which is the dominant system, and the intensive (commercial) system. The two systems vary widely with respect to numbers, types of

birds, bio-security practices and management” (fao). In 2011, the production of chicken meat reached 40,503 tons, 12,680 tons of which were derived from the smallholder family sector, 27,717 tons from the private sector, 96 tons from the cooperative sector and small quantities from other sources (fao). Within these two categories, New Horizons could be classified as both a small-holder farm and a commercial farm. They run a vertical integration from the breeders to the abattoir, employing the outgrower method and operating a feed mill to create their own chicken feed (Whiting, 2010). Contracted outgrowers receive training from New Horizon’s extension workers who travel into the villages on motorbikes to supervise the growing process. The outgrowers are required to build their own chicken houses under guidance with their personal funds. The house is generally 5x25 meters and made from local material, including thatch, wood, and sand. Each farmer receives approximately 1,600 day old chicks and feed. These are provided on credit with the debt being paid off if the outgrower’s flocks reach a profitable weight (Whiting 2010). With this method, they are empowering villagers outside of Nampula to run their own small-scale farms under the direction of New Horizon’s commercial practices. In addition to the outgrower method, New Horizons also houses and raises their own broiler chickens from their breeder farms on a large-scale as well.

Impact of Mozambique’s Poultry Industry on Families:

There are many positive impacts that society in Mozambique is experiencing due to the rise and growth of their poultry industry. These effects include nutrition, income, education, and more. According to a study done on community development in Mozambique, “The average annual income of the individuals surveyed before they began raising poultry was reported as 4,385 MZN (\$132 US). After partnering with New Horizons, the average cycle income was 7,950 MZN (\$240 US)” (Farmer). In addition, the same study found that 77% of those surveyed were able to add a metal roof, concrete walls, or other improvements to their homes with the increased income. The largest benefit, however, came in the form of well-being, with 92% of outgrowers reporting that they had increased health and wellness after deciding to raise poultry with New Horizons.

Hunger and malnutrition are two very prominent issues that plague many developing countries, and Mozambique is no different. They are considered by many to be one of the poorest countries in Africa, and over half of the country lives below the poverty line (The World Bank, 2012). Slow mental development, stunting, and wasting are all characteristics of children suffering from energy deficiencies in developing countries (Smith & Wiseman, 2007). Staple foods like rice are a major part of many diets in developing countries, but lack many essential fats, vitamins, and minerals (Farrell, 2013). Poultry products have almost all nutrients required by the body and contain all essential amino acids (Farrell, 2013). This means that not only is poultry a great source of protein, but poultry production at the village level can contribute to many nutrient deficiencies. A survey of those who had taken up poultry farming found that, “over 60% of those surveyed indicated that it was easier to send their children to school, and 75% reported that their children performed better while at school due to increased nutritional value of their food intake” (Davidson). Poultry is full of protein and tends to be low in cost to produce. “Small scale poultry farming has been studied for its poverty alleviation potential as well as for its nutritional benefits” (Johnson). In addition, the UN lists “supporting small scale farming” (UNDP, 2016) as an important part in ending hunger.

Raising Chickens in Developing Countries:

As discussed previously, the majority of poultry production in developing countries comes by way of small-scale farms. Within that, New Horizons plays a role, as they actively recruit and train families in the surrounding villages of Nampula to join their outgrower model where chicks from New Horizons are delivered to the outgrower farms, the outgrowers raise the chicks until they are ready for slaughter, and then, New Horizon's employees take the birds back to be processed for sale. The Food and Agriculture Organization's Poultry Review of Mozambique explains that, "extensive small-scale, rural, family-based poultry systems continue to play a crucial role in sustaining livelihoods in developing countries, supplying poultry products in rural but also periurban and urban areas, and providing important support to women farmers. Small-scale poultry production will continue to offer opportunities for income generation and quality human nutrition as long as there is rural poverty" (fao).

Common Stressors of Raising Chickens:

According to the Cobb Optimum Broiler Development Guide, ventilation, humidity, temperature, feed, water, and lighting are all factors that if not done properly can inhibit and even stunt bird growth. However, if handled well, these do not have to become stressors in the chick's environment. The first day after placement for broilers is especially important, and the main objective is for chicks to intake as much feed and water as possible. "Failure to achieve this objective will lead to irreversible compromised flock performance and will express itself as poor growth, poor feed conversion and poor flock uniformity" (Cobb broiler).

Are Westernized Processes the Answer for Ag-development in Developing Countries:

In America and other similar countries, poultry is processed for sale in large production facilities. Consider the big players in the game such as Tyson and Cobb (which is actually a part of Tyson after their acquisition), whose job it is to provide much of the nation, and even the world, with meat for consumption. Their facilities are state of the art, and their processes are scientifically perfected in order to raise the birds with the highest feed-conversion ratio (ratio of how much feed a bird intakes to its total weight). However, the ability for these same processes to be replicated in developing countries is not always possible. In fact, trying to do so may even lead to more issues.

The Food and Agriculture Organization claimed that in Mozambique, "advances in breeding have given rise to birds that meet specialized purposes and are increasingly productive, but that need expert management. The development and transfer of feed, slaughter and processing technologies have increased safety and efficiency of poultry production, but favor large-scale units rather than small-scale producers" (fao). According to an estimate from a study done in Kenya, smallholders own around 90% of livestock in developing countries (Upton), and in another study it was said that 90% of rural African households keep some type of poultry (Gueye).

The obvious difference is that much of Mozambique is composed of smallholder poultry farms that do not operate in the same manner as Western poultry producers. Therefore, production practices and processes cannot be expected to be the same. A study of smallholder producer needs in Rwanda was able to determine that nearly 100% of the farmers who were surveyed indicated an interest and need for a specialized manual covering practical poultry production practices. The topics that were surveyed included biosecurity, litter quality, feed,

housing management, and brooding (Henry). The same study concluded that, “the problem with smallholder flock is a lack of long-term guidance. Smallholder poultry production practices in developing countries are varied based on many different factors, but a basic guideline on poultry production would benefit smallholders as a whole. This type of manual could be used by smallholders as a starting point for information during the beginning of production” (Henry).

Background:

Mozambique is a country in the Southeastern region of Africa. In the most recent Human Development Index report by the United Nations, Mozambique ranked 181 out of 187 countries (hdr.undp). 70% of the population lives in poverty, almost one-third of the population suffers from malnutrition, and over half of Mozambicans do not have access to clean water (Borgen project). Based on these statistics and rankings, it is safe to assume that Mozambique is a developing country. After spending 16 years in civil war during the late 1900s, the country’s infrastructure was devastated and over six million people had been displaced, not to mention the nearly one million deaths that were reported (Borgen project). Since then, the country has been gradually recovering, which gives us a lens into how things looked at the time of this project.

In Mozambique, we stayed in Nampula, which is considered “The Capital of the North.” This is the city where New Horizons is located. Nampula is a bustling city with a population of over 700,000 people, and it is a business hub both locally and internationally. Some of the main roads are paved, but most are just made of the same red clay dust that covers everything. Everywhere you look in Nampula, people are packed in, whether it is in the assorted street markets, public transportation busses, or tiny shack-like housing. However, once you get outside of the city, Nampula turns into rolling hills of African countryside with the periodic appearance of enormous rock formations jutting out of the ground. This is where the New Horizons farm can be found.

The idea of New Horizons came out of the obvious need for more/better employment and opportunity within Mozambique. Founder, Andrew Cunningham, wanted to create an agricultural system that included local Mozambicans in its work, and taught them how to replicate that system on their own. The process that he chose was chickens, specifically live poultry production. New Horizons covers every aspect of poultry production from start to finish. The process starts with their breeders, chickens specifically bred for their ability to reproduce and lay eggs that will someday become raised for consumption. Those eggs laid by the breeders are then taken to the hatchery where chickens are hatched under artificial conditions. Once they hatch, the baby chicks are taken to the Broiler farm where they are raised. On the Broiler farm, they are fed a certain recipe of chicken feed created by New Horizons. New Horizons has a feed mill on site that it uses to produce this feed. Finally, once the chickens reach prime development, they are taken to the abattoir, or the slaughter house, where the chickens are processed for the production of frozen chickens that are then distributed and sold within Mozambique and other Southern Africa countries.

In summary, New Horizons is a live production chicken farm that sees the production of their chicken products from start to finish. At each of their sites, they employ local Mozambicans and teach them the skills necessary to run their farms/plants. They feel as though it is their social responsibility to empower their employees and give them the ability to rise above the situations that they live in. In addition to the employees that New Horizons has on site, they have also created an integrated system of families that raise chickens with their own infrastructure in their backyards. There are 151 families in this program, and it is the goal of

New Horizons that with this program they will be able to develop these families in the social and financial spheres, so that they can eventually give their children better opportunities for education, ensure health care, and improve their housing (Novos Horizontes). Overall, New Horizons exists to seek change in the local community of Nampula by giving its people real opportunities for success.

As outsiders to the country and company, myself and the other students on this study abroad trip, were eager to hear from New Horizons what they were going to have us work on. As stated earlier, I was part of the poultry team, and while we were there, they wanted us to complete two separate research tasks. The first was a trial based on their chicken feed recipe. Essentially, New Horizons wanted to better understand the impact of certain ingredients in their chicken feed on the weight the chicks would grow to. The second project was an assessment of the varying temperatures at each stage of production.

Both of these projects have one thing in common. They are testing what poultry scientists like to call stressors. Chickens are pretty basic creatures that don't require much. However, if any one of these four things are not correct, they will not develop well. The four basic causes of chicken stress are feed, light, air, and water. If a chicken is not taken care of properly and provided the right amount/quality of these things, they will have to spend more energy doing it for themselves which in turn leaves them less energy to grow bigger and fatter yielding higher profits. The two projects that the New Horizons team gave us to study were put together so that they could improve the health of their product, the chickens.

This project was and still is important because with every cause of stress that New Horizons can remove or improve upon, they have a better chance of producing chickens of greater weights and higher values. This in turn, allows them to sell their chickens for a higher price, giving them a greater profit margin.

Project Overview 1:

The members of the poultry team and I worked together under the direction of PhD student Joe Hiltz, Dr. Leasea Butler, and Dr. Kidd. We spent our four-week period in Mozambique completing two projects for New Horizons. The first was an experiment that tested three feed formulas on broiler chickens. This experiment compared the effects of three different feed formulas on average chicken weight gain. The purpose of the feed experiment was to use the results to help determine the best feed choice for New Horizons. The second experiment focused on gathering data to better understand how temperature was affecting the process of raising chickens during each stage. The goal of this project was to make pinpoint areas in production where temperature was negatively affecting chicken growth.

Methodology and Data

To run the feed experiment, we used two chicken houses (houses 11 and 12) at the Frango King Broiler Farm. Each house was divided into three separate brooding areas, or pens. Each pen was assigned a different feed. The feeds that we tested were as follows: Francious feed from South Africa (feed F), Gamma feed from Brazil (feed G), and the competition feed (feed C). All other factors influencing the chicks, besides the feed, were to remain the same in each pen. The vision of the experiment was that all chickens would experience regular feeding, frequent movement of the feeders, normal water pressure, adequate lighting for rest, and tarps going from the bottom up to regulate wind and temperature, so that the only variable factor was

the feed. However, nothing ever goes exactly how you think it will in Mozambique, so these other factors did end up having some effects on our results.

At the beginning of the experiment we placed approximately 20,000 chicks in each house, for a total of 40,000 chicks. The average starting weight per bird was 42 grams. Every other day, my team and I would travel to the Broiler farm to weigh the birds. Within each separate pen, we chose to weigh 200 birds and taking the average weight per bird. On day 3, in house 11, the average weight per bird was 88.89 grams for feed F, 87.99 grams for feed C, and 76.27 grams for feed G. In house 12, the average day 3 weights per bird were 74.12 grams for feed F, 72.98 grams for feed C, and 73.66 grams for feed G. At this stage in the experiment, the Francious and Gamma feeds were performing at a 14.3% difference.

Results

We continued to collect data on the average bird weights in each pen on days 5 and 7 as well. With that information, we were able to compile the following two graphs.

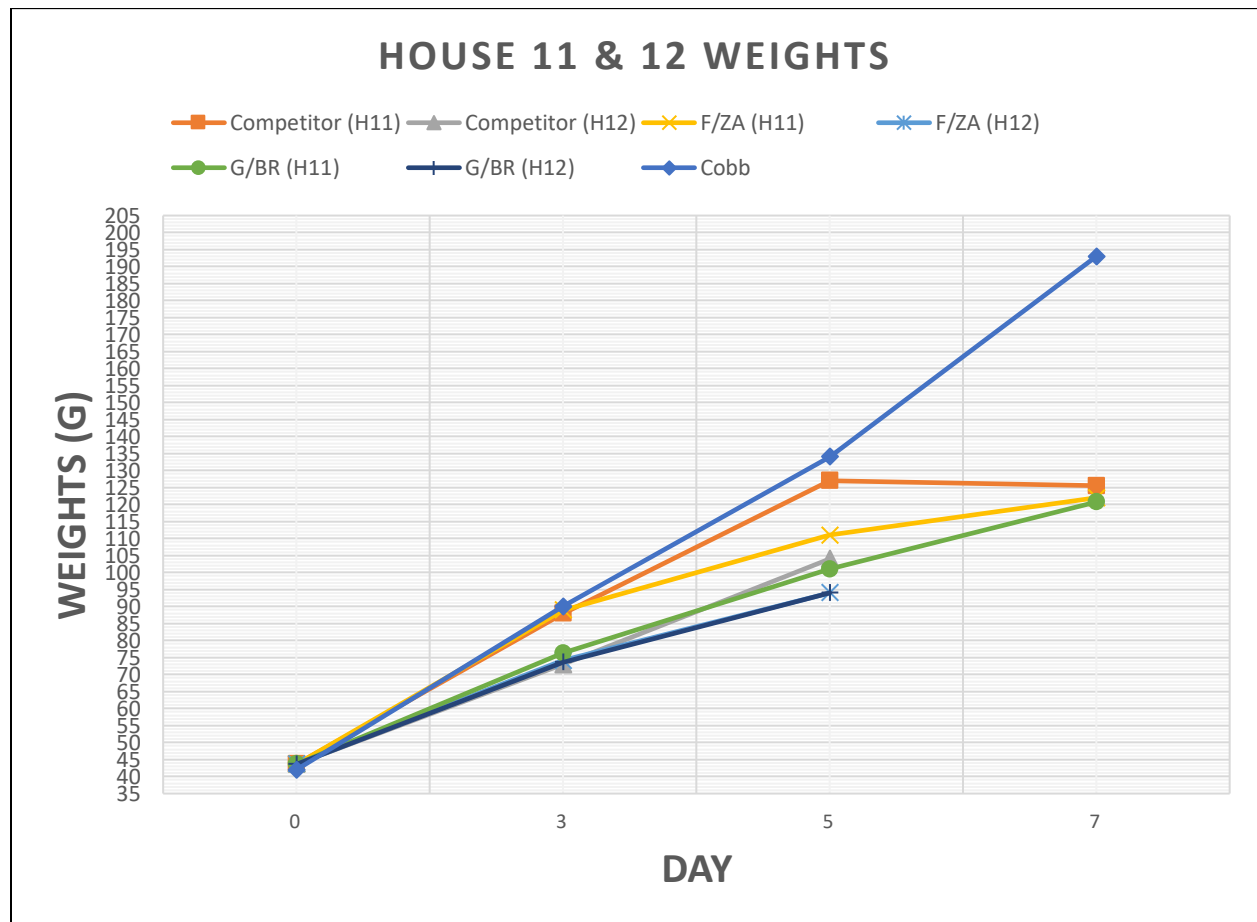


Figure 1 – Linear Analysis of Average Bird Weight on Days 0-7 by Feed Formula

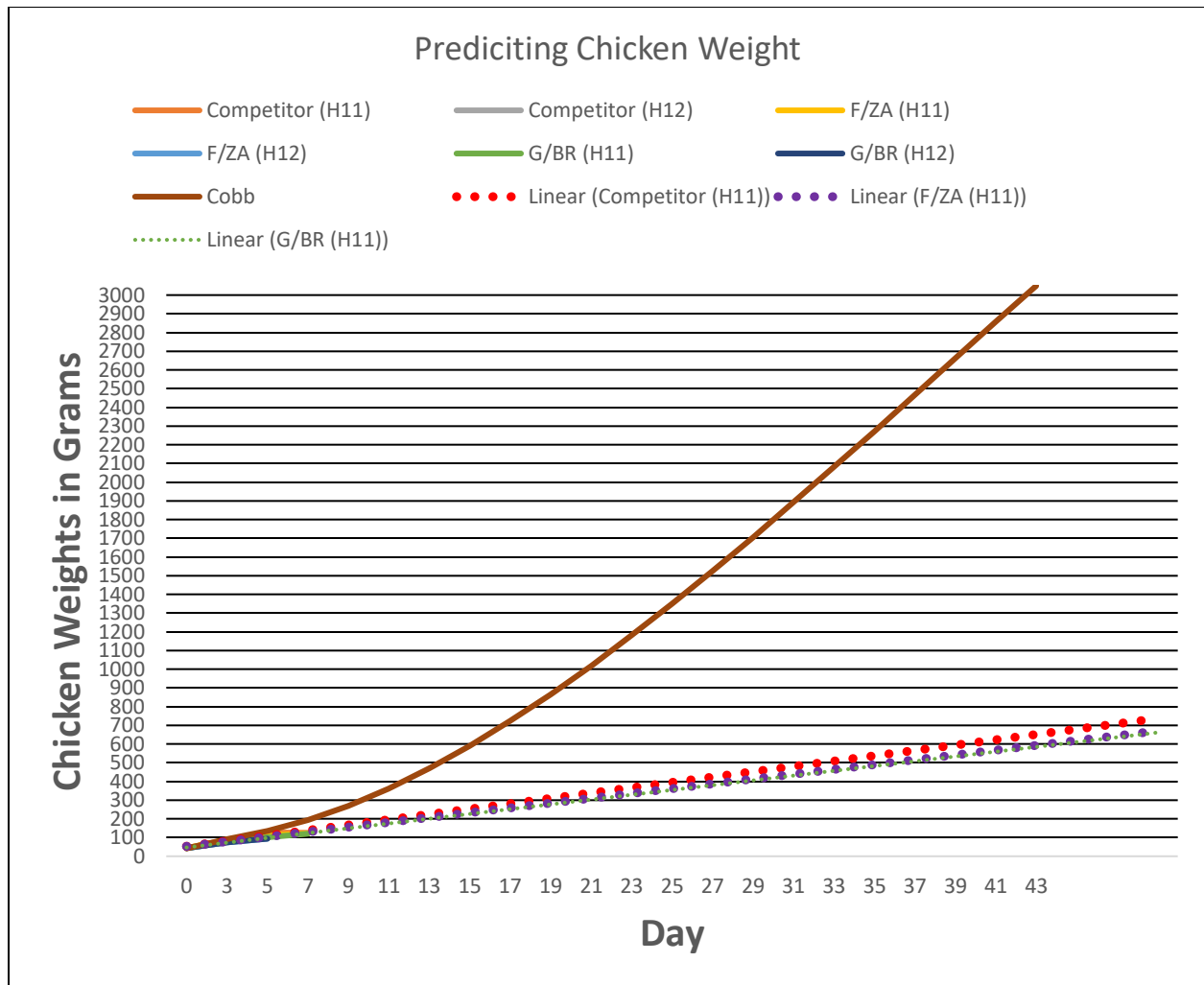


Figure 2 – Linear Regression of Average Bird Weight Through Day 43

The first graph is a linear depiction of average bird weights starting on day zero and going through day seven. The blue line that reaches the highest is the Cobb standard for bird weights on those days. (Cobb is an international pedigree broiler breeding company that supplies New Horizons with their breeder birds). You can tell from the graph that the weights for the new feed formulas were on track with the Cobb standard through day three and even kept in close proximity through day five. However, after day five, the weights began to plateau, and we noticed that birds were not growing. Based on these results, we concluded that water pressure, air quality, and exposure to bacteria played a large role in skewing the data, making it difficult to truly pinpoint which feed was best for the farm.

The second graph is a linear regression which predicts how the chickens would continue to grow through day forty-three. This was based on the weights we gathered in the first seven days. We also included the Cobb standard in this graph to compare where we predicted the chickens would be to where Cobb expects them to be. The difference was drastic, but there were many factors that played into chicken stress at the Broiler farm.

Recommendations

As stated earlier, chicken stress is anything that causes the chicken to become uncomfortable. When chickens are uncomfortable and under stress, they are not able to develop at the standard rate. This is because they have to burn more calories in order to stay warm, for example, rather than building muscle and growing larger.

The conclusion of the Feed Formula experiment was that the Francois feed was likely the best option for maximum chicken weight gain. From the beginning, the chickens that ate this feed, grew larger and faster than the others. However, with other variables that proved difficult to control, it would not be right to claim this a sure fact.

After our feed experiment, we were able to give New Horizons four recommendations based on our observations regarding conditions at the Broiler Farm. First, the water lines should be disinfected between each placing and the water pressure needs to be lowered. At the moment, the water pressure level for the baby chicks could be comparable to a child drinking from a fire hydrant. Second, lowering the water pressure should help to decrease the moisture content in the litter which will improve the air quality. If the air is too wet, the CO₂ levels rise, especially without proper ventilation. Third, we recommended a temperature-controlled transportation process for the chicks. Unfortunately, due to open air truck transportation from the Hatchery to the Broiler Farm, there was a stark initial mortality that occurred at placement. 40,000 chicks were delivered, but 810 were dead from transportation (2.1%). This happened because the chicks on the outside were very cold from all the wind that they received, causing death for some. However, the chicks on the innermost section, were burning up due to the lack of air flow, and essentially died due to smothering. Fourth, there needs to be a set list of SOPs that are completed before each house has chicks placed in it. The Standard Operating Procedures need to include disinfection of water lines, cleaned feeders, and migration fences set up 24 hours ahead of chick delivery.

The time that we spent on the Broiler Farm and touring each stage of production allowed my team and I to gain an understanding of how New Horizons raises their chickens from start to finish. Compared to poultry production in the United States where everything is done to a set regime and each process has been carefully and scientifically crafted to give chickens the most perfect environment for growth, places like Mozambique do not have that same luxury. Their supply chain is broken and awkward, often leading to lower growth rates and high mortality among birds, something we learned in conversations with New Horizons Management.

Project Overview 2:

In addition to the first experiment, we also conducted a study relating to the temperatures of the environment at different stages of production. The purpose of this experiment was to understand the impact that hatchery transportation and broiler conditions have on eggs and embryo development.

Methodology and Data

We used data logging “eggs” to capture the temperature data. The study was simple. We placed fake eggs that record the temperature of where it is placed every hour at the Breeder farms. These “eggs” were then transported to each stage of production with the rest of the real eggs while constantly recording the temperature. These “eggs” started at the Breeder farm, where then taken to the hatchery, went through every part of the hatchery process, and were then

transported to the Broiler farm. The data that we received from these “eggs” gave us the exact temperatures at each stage, which helped us to identify stages in production where temperature was causing a problem.

Results

The data we collected is shown in the graphs below. In addition, the standard temperature requirements set by Cobb in their Hatchery Management Guide are also given.

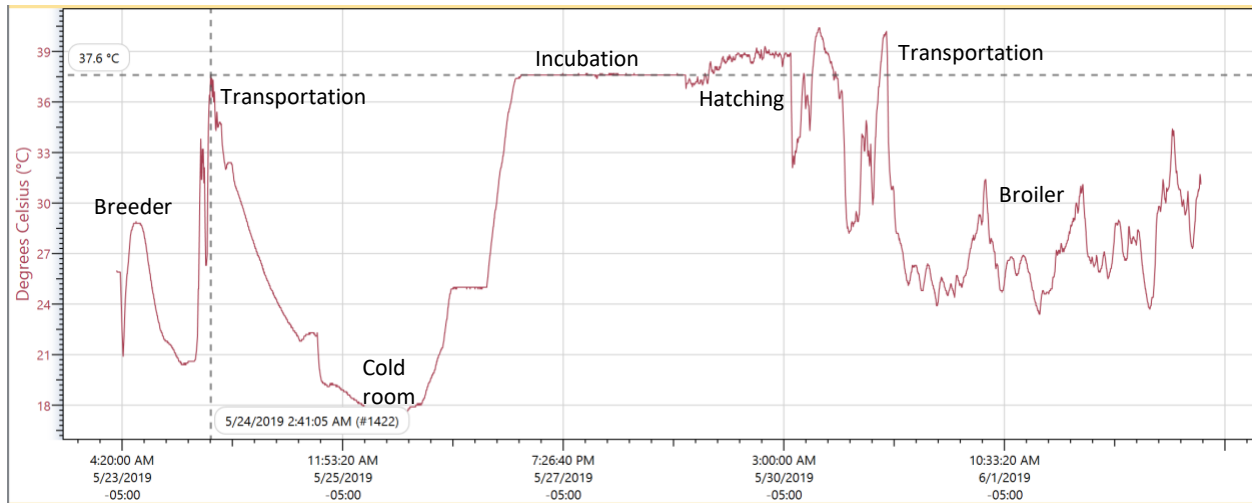


Figure 3 – Results of temperature ogging eggs at multiple stages of production

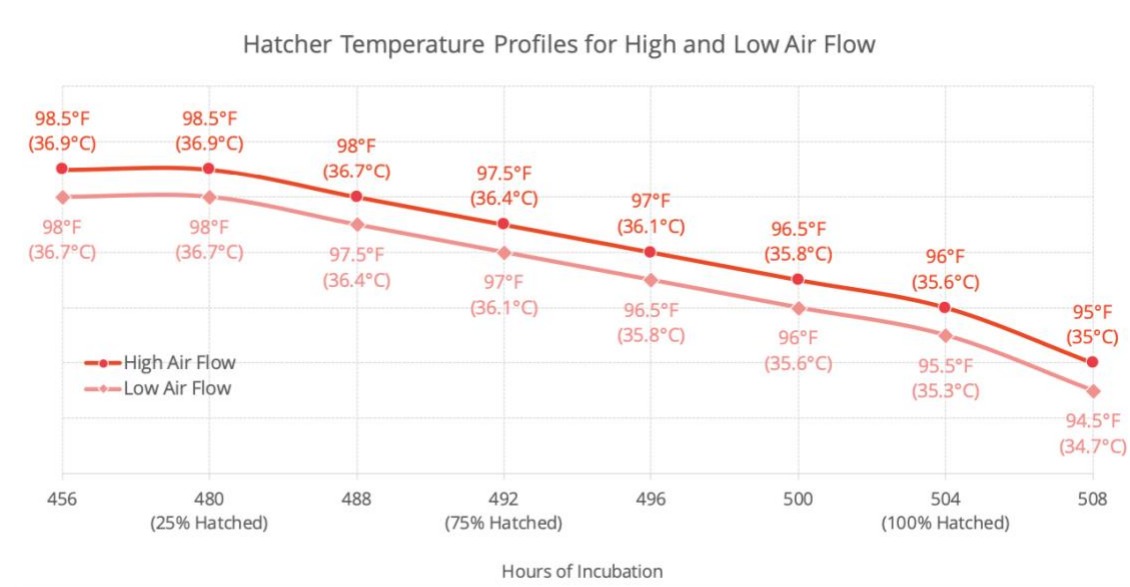


Figure 4 – Cobb standard of temperatures during hatching stage

The ideal temperature curve for eggs after laying through storage.
 The reduction of temperature occurs gradually until the storage temperature is reached with no elevation of temperature until preheating.

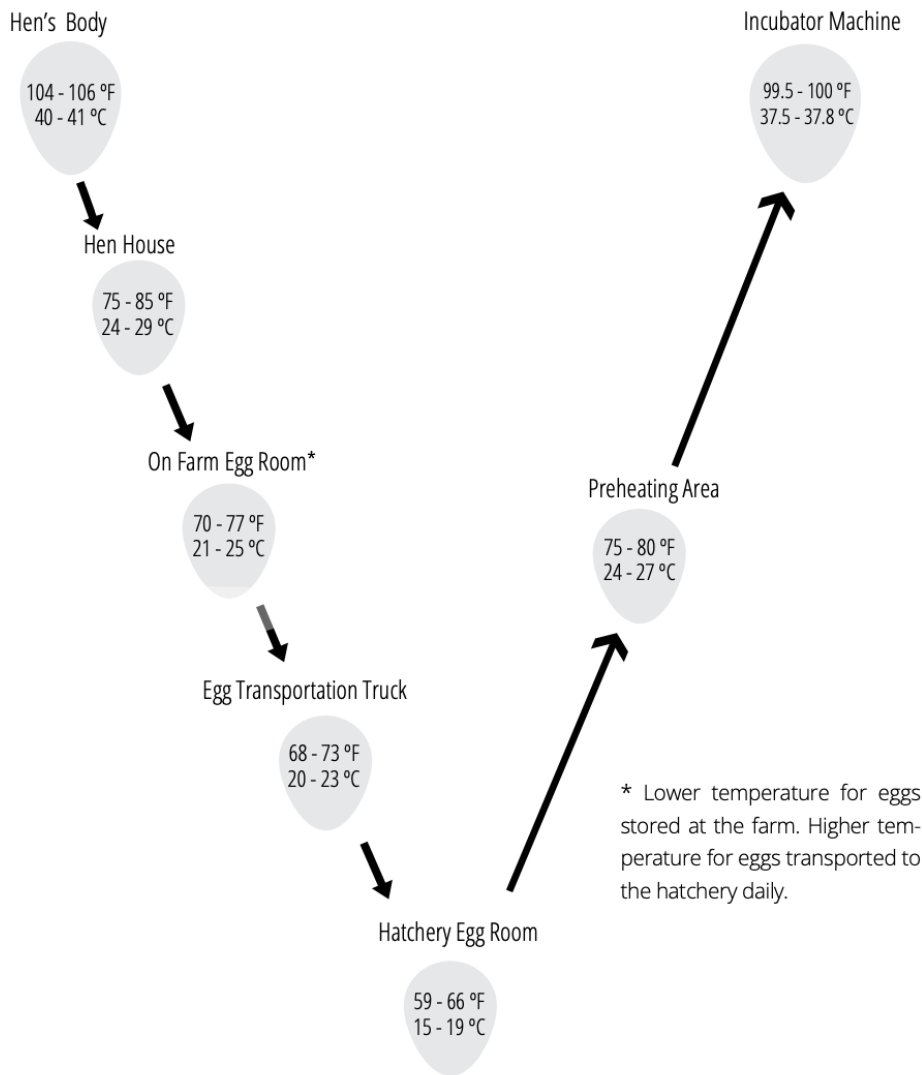


Figure 5 – Ideal temperatures provided by Cobb for eggs from the Breeder farm through the incubator machine

From this data, the following can be concluded. Initial transportation from the Breeder farm to the Hatchery should have temperatures from 20-23 °C (figure 5), according to the Cobb recommendation. However, according to the temperature logging eggs, during this phase, temperatures hit a high of 37.6 °C. This is problematic because these temperatures reflect the same temperatures as the incubation process resulting in early incubation of eggs leading to early embryonic mortality. In addition, in the hatchery egg room (also referred to as the cold room), temperatures were recommended to be at 15-19 °C (figure 5), and that is what the temperature logging eggs showed. Next, was the incubation period. The temperatures recorded at this phase

were also a perfect match to the standard set by Cobb. However, during the next three phases (hatching, transportation, and broiler), temperatures fluctuated drastically, and did not match with the temperature standards set in place by Cobb. As shown in *figure 4*, Cobb expects the temperature to slowly decrease from 36.9 °C to 35 °C during the hatching phase, but at the New Horizons Hatchery, temperatures during this phase ranged from 36.5 °C to 39 °C. According to the Cobb Hatchery Management Guide, “As chicks begin to emerge from the shell, the temperature in the hatcher must be gradually lowered to prevent overheating and dehydration of the newly hatched chicks.”

As mentioned in the previous section, the transportation of the newly hatched chicks from the Hatchery to the Broiler farm caused a high percentage of mortality due to the fluctuation of temperature which can be seen in *figure 3*. Essentially, the crates of chicks were loaded onto the back of an open-air truck and the ones exposed to the wind were freezing cold while the ones closest to the middle were very warm. Neither of these extremes is good for chick development.

Finally, once placed at the Broiler farm, it can be seen in *figure 3* how the temperature fluctuates often. This can be harmful to chick development because temperature is a stressor for chickens, and if they have to exert energy to stay warm or exert energy to cool down, they are not using that potential energy to grow bigger and stay on track with their development. Our temperature logging eggs were only at the Broiler farm for the first day that the chicks were there. On that day, temperatures ranged from 24 °C to 34.5 °C. According to the Cobb Broiler Management Guide, temperature should have been a consistent 34 °C, without deviating by more than two degrees Celsius over a twenty-four hour period.

Recommendations

Based on our findings, we gave New Horizons five recommendations to improve temperature stability. They are as follows:

- On site cool storage at the Breeder houses prior to pick-up
- Temperature-controlled transportation of eggs from Breeder farm to Hatchery and from Hatchery to Broiler farm
- Eggs should immediately be placed on plastic egg racks upon arrival at Hatchery
- Temperatures in Boiler farm houses should have minimal fluctuation from day to night
- Chick behavior should be more closely monitored in the first 24-48 hours after placement so necessary changes can be made sooner

Overall, this project was a deep dive into the way temperature has a direct impact on eggs/chickens from the day they are laid, through hatching, to the Broiler farm. By comparing the standard temperature requirements given by Cobb to the temperature data gathered on the New Horizons facilities, it is easy to make assumptions about how New Horizons’ shortcomings are resulting in smaller chickens and higher mortality rates. However, it is important to remember that processes designed in developed countries cannot be copied and pasted into developing countries. Therefore, it is more important to work with local producers such as New Horizons to figure out practical solutions to some of these issues.

Evaluation:

In theory, both projects had a lot of potential. On paper, the first experiment included an independent variable (type of feed) and a dependent variable (growth of the chickens) with all other factors remaining the same for each group (supposedly). However, as we all quickly learned, keeping all conditions the same and eliminating chicken stressors for every house is much easier said than done. The second experiment ran very well and gave adequate results that we were able to analyze and turn into recommendations.

Most difficulties that we encountered during the first experiment were from a lack of continuity/consistency when it came to the care of the chicks. Often, there would be farm employees who were supposed to help us, but we couldn't always convey our exact needs and desires to them. Sometimes this was a language barrier issue, and other times it was caused by inadequate knowledge of poultry science techniques. We also struggled to keep our experiment consistent across all pens in both houses. The water pressure, chick density, and temperatures varied within the pens and houses, causing a handful of stress factors to likely contribute to the results of the experiment.

One aspect of this project that was very good was the time we got to spend meeting and talking with some of New Horizon's outgrowers. After weighing the chicks in the morning, we had the rest of the day to tour New Horizon's different facilities and meet outgrowers. This was an incredible opportunity to see how New Horizon's system impacted and empowered so many families in the outlying villages of Nampula.

Overall, we believe that this project did assist in community development for a couple of reasons. There were multiple opportunities that we were able to provide practical advice to outgrowers and in-growers on raising healthier chickens. We were also able to provide New Horizons with concrete evidence regarding feed recipes that they could use to make improvements to their processes.

Regarding the literature that already exists on this one and similar topics, our results were consistent in the fact that the most common stressors that affect chicken growth and development did play a large role in our own experiment. In addition, we learned through experience that implementing basic practices that are routine in live poultry production in the United States are not always common or feasible in Mozambique. With this, it is my evaluation that as researchers, we cannot expect to be able to "copy and paste" the processes that we are accustomed to. Rather, it should be our job to take the necessary time to understand and think critically about creating new systems that effectively accommodate production norms while also making realistic changes for improvements.

Finally, I believe it is important to note that the barriers we encountered were not related to systematic issues in Mozambique. With more time and knowledge, I believe we could have worked in tandem with the employees of New Horizons to create an experiment built around what we know now that would have yielded more comprehensive results.

Next Steps:

Because Dr. Farmer and Dr. Nalley return to Mozambique with students on a yearly basis, designing a follow-up project that builds off of the research in this one is conceivable. It is my opinion that the lessons we learned when doing our own research, could be used to further this same project, while also incorporating new methodologies to learn more about live poultry production and its role in Nampula, Mozambique.

Incorporating the literature, the projects we put together, and the lessons that we learned, is a beneficial first step to designing a new project. Based on those things, the following stand out:

- Knowledge of common stressors that affect chicken growth is not common
- There are plenty of simple improvements that could be made regarding chicken well-being, if knowledge of them were available

Based on that, I believe a two-part study could be conducted. Very similar to the research conducted in Rwanda by Holly Henry (mentioned on p. 5), the first part of this study would include a survey given to as many outgrowers and New Horizon's employees as possible asking them what type of information regarding the live production of poultry they would benefit from. From, biosecurity, to feed, to housing, to the way all these inputs impact the growth and final weight of a chicken, the survey would need to assess the interest that these people have in learning more about their poultry production and improving it.

After conducting the survey and analyzing the results, students could work with the upper-level management at New Horizons to put together a simple manual for success in raising poultry. This would include basic instructions for the best chicken care, tips, and reasoning/motivation behind wanting to improve their bird's environment. With the help of translators, this manual could be printed and distributed to the outgrowers and the employees at the different stages of poultry production.

The second part of this study would be to measure its success. Once the manual has been distributed, another study should be conducted to see if having more knowledge and information available had an impact on the way chickens were raised/cared for and if it had a positive effect on their weights. The success of the manual could be measured by comparing the final weights of chickens before outgrowers/employees had the manuals and after.

While this study would not solve every problem linked to stunted growth in chickens due to common stressors, it would begin to address the issues in a way that was curated to fit the needs of the outgrowers and the employees at New Horizons, rather than placing unrealistic expectations on them.

Personal Reflection:

We live in a world that seems so big, but when I travel out of my bubble, and out of my own country, I've realized that somehow, it's really not that big at all. Mozambique is home to thousands of families with the same goals and intentions of my family back in America. They want to provide for each other, protect each other, and celebrate life with one another. While everything on the outside may look much different, very chaotic, and somewhat confusing, there are so many similarities that connect all of us around the world. It reminds me that my life and their lives are never really that far apart.

With that in mind, I want to remember that the world isn't as big or scary as some people may say. Yes, there are many miles that separate one place from the next, but there's no reason to not step out and experience new people, places, and cultures. I should never let fear or lack of comfort deter me from doing something that others may call crazy. In addition, the way American society defines success does not have to be my own definition as well. Whether life takes me to an international career someday, or I stay here with the intentions of helping to send others on their own international experiences, I don't want to limit my own possibilities to what everyone else thinks is "normal."

Another way that my research in Mozambique impacted me, was in the service-learning component. Without ever stepping foot into a classroom, I learned more in the four weeks away from home, than I did in entire courses. It wasn't just that I learned the technical processes of a live production chicken farm (although I did learn so much about that), it was the people we encountered and what they taught me about life and how to live. In addition, after returning home, I felt a new sense of independence and the ability to overcome different types of challenges. We didn't just learn about textbook subjects. We were taught character traits that will hopefully stay with us for a lifetime.

While this was not my first time in a developing country or my first time to experience the effects of real hunger and poverty, this time was different for multiple reasons. Our professors and advisors on this trip did an exceptional job of instilling in all of us a sense of respect for the country of Mozambique and its people. It did not matter that their clothes or jobs or homes looked different than ours. We were also prompted by our professors and advisors to think critically about the situations we were encountering every day. They provided us with many opportunities to discuss openly what we saw, how it made us feel, and what our initial reactions were to it. This process helped me to sort through my emotions, form new ideas, and share them with my peers.

Some of those emotions were guilt and frustration prompted by the way I lived my life in America compared to life in Nampula, but others were sheer awe and admiration for the generosity, hospitality, and joy that embodied so many of the people we encountered. Furthermore, out of this experience came a passion for poultry science, something I would have never realized I possessed. However, it is not just the chickens that excite me, but the potential that small-scale poultry farming possesses to transform how we deal with the issue of world hunger. Finally, I would like to close by saying that anyone from anywhere can enact change. The first step is always seeing something that needs to change and deciding to do something about it.

Conclusion:

Mozambique is a very unique place full of culture, history, and wonderful people. Despite its hardships as a country, there is so much hope for the future. Part of that hope comes from organizations such as New Horizons that are actively working to empower locals and drive economic development. This project contributed to that goal in the way it revealed areas that common stressors on chickens were causing negative effects on the live poultry production process. With our recommendations and a new project design, there is so much more that can be done to increase knowledge and application of simple solutions to poultry stressors. These will only lead to larger profits and organizational growth, so that economic development can continue in Nampula and its surrounding area.

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