Evaluation of Cattle Breed Crosses for Dairy Production in Costa Rica

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1. INTRODUCTION

1.1 Acknowledgements

Without the help and support of many influential people in my life my internship would not have been possible. It was a long journey from where I began to the end of my internship and without the constant support of others around me, I could not have completed the journey.

First, I would like to thank my high school FFA advisors: Mrs. Sarah Bell, Mr. Jay Davis, Mrs. Kellie Michaud and Mr. Keith Shane. Every single one of my FFA advisors and agricultural teachers played an integral part in my internship and helped me through the entire process with nothing but constant support. Without my FFA advisors I would never have participated in the World Food Prize Global Youth Institute or Borlaug-Ruan International Internship, but most importantly, I would not have developed my love for agriculture.

I would also like to express my sincere gratitude to Ms. Lisa Fleming and Ambassador Kenneth Quinn, as well as the World Food Prize Organization, because I literally would not have been able to have this amazing opportunity without your assistance. I thank you for your constant support and guidance throughout my entire internship.

A special thank you to EARTH University and all of the special people who made my internship and research such a wonderful experience: Ms. Sofia Montero, Professor Raul Botero, Professor Libia Hernández, Professor Yanine Chan, Mr. Jesus Quesada and Ms. Ivannia Sanchez. The never ending help and teaching by everyone at EARTH allowed by internship to be one filled with new knowledge and lasting experiences.

Lastly, I would like to thank all of my family and friends for their ultimate support and encouragement during my internship.

1.2 Personal Background

I have been surrounded by agriculture my entire life, but in a non-conventional way. I grew up in Smyrna, Delaware living in close proximity to soybean and corn fields; however, my earliest and fondest memories involved riding horses and spending time on the farm. It was not until I went to middle school and discovered the National FFA Organization that I truly fell in love with agriculture as a whole. Through the FFA I learned that there were so many other aspects of the agriculture industry that I did not even know existed. Once I started, I could not stop, I was hooked.

While in high school my passion for agriculture and the National FFA Organization has grown, exponentially. I involve myself with anything having to do with agriculture and enjoy learning anything I can about it. Throughout all of my experiences I have found what I really enjoy is animal science focusing on livestock and animals raised for production purposes. My experiences led me to the conclusion that not only do I want to work in the livestock industry, but I want to be involved on an international level. My career goal is to tackle the tasks of helping solve hunger, poverty, and food security through livestock production. Through my internship at EARTH University I have already begun the work I want to do for the rest of my life.

1.3 Work with The World Food Prize

I first learned of The World Food Prize in the spring of my freshmen year of high school when my FFA advisors introduced me to an opportunity I might be interested in, the Global Youth Institute. My agriscience teachers had recently been introduced to the World Food Prize and its extensive list of youth programs and my advisors thought that the Global Youth Institute was right up my alley. After he told me about the opportunity I was excited and knew I wanted to represent Delaware that fall, so during the summer I did my research and chose Animal Health in Mozambique as the topic for my research paper. I was fortunate enough to be chosen as one of two representatives from Delaware, and I attended The Global Youth Institute that October with my father. The Global Youth Institute was a life changing experience for me. Before attending, I did not really know what to expect and went to Iowa just to enjoy experiencing, I was in awe. It amazed me not only to meet so many people from all over the world, but to discvoer that each of them had developed their own individual way of helping solve the global food security crisis. Having the opportunity to talk with professions that were making a true difference in the world motivated me beyond belief, and fueled my desire to learn how I could contribute to this effort. On the last day of the institute, the current year's Borlaug-Ruan International Interns gave their presentation; when they finished I knew that my next step was to become an intern as well.

I distinctly remember sitting in Chicago-Midway Airport on my way home just pouring over the World Food Prize website; especially the Borlaug-Ruan International Interns. I think I looked at every intern's project since the beginning and I was so excited and wanted to apply right then and there. At the time, I was in my sophomore year of high school, so in order to be eligible I had to wait a year and apply the winter of my junior year. The wait did nothing to hinder my motivation; if anything I was even more excited for the experience and put my heart and soul into my application.

2. EARTH UNIVERSITY

2.1 History

EARTH University was founded in 1990 in Guacimo, Limon, Costa Rica, with the purpose of educating people about sustainable agriculture. The Costa Rican Government, U.S. Agency for International Development (USAID) and the W.K. Kellogg Foundation established EARTH as a private, non-profit, international university as a way to educate for a better tomorrow. Through a four-year undergraduate program, EARTH educates students from Latin America, South America, Asia, Africa, Europe and many other regions of the world on how to practice sustainable agriculture production in their own countries after graduation.

2.2 Impact on the World

Although EARTH University is currently only 25 years old, the university is already making an impact globally. For example, United States grocer, "Whole Foods" receives their bananas from EARTH University's banana plantation on campus, and while this is one thing that EARTH is well-known for, they do so much more. EARTH has more than likely had a positive impact on every single country around the world; whether it be through the education of a citizen or sharing of information and practices for implementation. This fact is extraordinary because at EARTH there really are differences being made, and a better tomorrow being created around the world.

2.3 A Day at EARTH

I spent my time at EARTH in a somewhat nontraditional way. When compared to other students, I was not attending the university nor was I spending time there studying abroad from another university; I was there on an internship. Due to the fact that I was an intern, I had a very independent schedule where I could have full reign over my research and devote my time to whichever aspects I felt were important. After settling my days were full and filled with something new learned every day. I would wake up approximately 5:45 a.m. every morning and dress in my work clothes and head to the cafeteria for a breakfast, that consisted of rice, eggs and fruit. I would walk a mile to work at the Integrated Livestock Farm and be there, ready to go, by 6:30 a.m. My mornings always started out milking the cows in the dairy herd that were currently in lactation, which was an average of 30 cows at any given time. I would milk with two other workers at the farm, and by the end of my internship I was almost as quick as them…almost. After milking I would complete various tasks on the farm like cleaning the milking parlor, equipment and pens, feeding the cows and calves, or working with different species like the pigs. I would finish work around noon and head back up to main campus and eat lunch, which usually consisted of rice and meat. After lunch I had the afternoon to spend how I wanted. Two days a week I attended Spanish class, which was extremely beneficial because soon after arriving at EARTH I realized my Spanish needed some work. Very few people spoke English, and I needed to communicate with the workers at the farm solely in Spanish. When I did not have class I spent the afternoons researching and working on my project or brainstorming with my professor on my project. Supper usually consisted of more rice and some sort of meat and after dinner I usually retired to my room for a good night's sleep because my next morning would start bright and early. Not all days were like this though. Sometimes I received the opportunity to attend different

field trips to farms all around the country with my professor's fourth year Animal Production class. This was probably my favorite part of my internship because I could see Costa Rica the way very few have the opportunity to: the real Costa Rica, the actual farms and people who are the agricultural industry. By being able to experience so much of the country, I felt it really made my time there the best it could be because I was not limited to one farm and production system, but I was able to experience many. I am so grateful that my time at EARTH was perfectly balanced between work, research, exploration and learning all that Costa Rica has to offer, especially through its agriculture industry, and the sustainable practices that Costa Rican farmers use on their operations.

3. RESEARCH INTRODUCTION

3.1 Abstract

The project conducted at EARTH University in Guacimo, Costa Rica studied and tested numerous production factors to determine the effectiveness crossbreeding in a cattle herd for the environment and conditions of the rural lowlands of Costa Rica. The purpose of this experiment was to determine the most productive and profitable cattle breed cross for dual-purpose production, mostly for small-scale farmers. Ultimately, results and conclusions will affect how the farmers breed their herds and have a positive impact on their farms and lives. Based on my prior knowledge, research, and extensive help from professors at EARTH University, the experiment was developed by dividing the indicated factors into three sections: cow production, calf production, and milk analysis. The results from the cow and calf production factors were conducted and determined by analyzing and compiling the data from the herd records at EARTH University. The milk analysis part of the experiment was conducted at EARTH University in the Food Laboratory using milk samples taken from the different breed crosses.

The dairy herd at EARTH has approximately 30 cows in milking at any given time and EARTH chooses to crossbreed their cattle with a traditional dairy breed and Brahman beef cattle to create a dual purpose herd. The majority of the herd consists of crosses of Brahman x Holstein and Brahman x Jersey. The cows are separated into two lots determined by their production levels, with one lot of higher producing cows being milked twice a day and the lower producing lot only being milked once a day. All of the cows have the same living environment and are under the same care at all times. They are out at pasture overnight and come in for milking every morning. In addition, they are fed a mixture of shredded sugarcane plants, soybean meal, corn, vitamins and other mineral supplements. After milking is finished they are let out again to pasture until they are due to be milked again. When comparing the Brahman x Holstein and Brahman x Jersey cattle at EARTH University, only the F1 Generation, or (50% Dairy Breed and 50% Brahman) were used to ensure that there was equal representation of the beef and dairy breed and that the results could be justifiably compared.

For the first two sections of this experiment, the cow and calf production factors, the herd records from EARTH University were used to compare numerous aspects. For the milk analysis test, I used milk samples, beakers, a hot plate, stirring rods and the Ekomilk Milk Analyzer with accompanying sample beakers were used to complete the tests. The ten different factors used to determine the results were daily milk production, calf efficiency, full term pregnancy efficiency, service efficiency, birthweight, average daily gain (from parturition to weaning), milkfat percentage, non-fat solids parentage, protein percentage and total solids percentage. By testing a total of ten different production factors and dividing them into three respective categories the overall most successful breed was able to be discovered, because of such a large amount of data and different factors to compare.

The results concluded that, when taking all factors into consideration, the Jersey x Brahman was the most successful breed cross for dual purpose production in Costa Rica.

The original hypothesis, that the Holstein x Brahman breed cross would be the most productive, was rejected. Although the Holstein x Brahman did perform better in some categories, the Jersey x Brahman was better in the majority of factors tested. Therefore, it is concluded that for small-scale farmers in rural areas of Costa Rica who are raising cattle for dual purpose production, crossbreeding Jersey with Brahman will be the best and most successful. There is further research that could be done considering numerous different production factors, different breed crosses, different operations of cross bred cattle and possibly even different areas. If other areas of Costa Rica or even different countries are seeing the shift to dual purpose operations, they can use the steps taken to carry out this experiment as a fairly easy way to evaluate their cattle and determine the best breed cross for them. Ultimately, any research methods could be helpful in feeding the people of Costa Rica and creating a more successful and sustainable agriculture system and life.

3.2 Review of Literature

When one thinks of Costa Rica, warm sandy beaches and the many tourist sights come to mind, not a thriving agriculture industry. While most of the country's income does come from tourism the agricultural industry in Costa Rica has as much offer as the beautiful mountains and volcanoes. One of the major bragging points of the agricultural industry is that the country as a whole produces enough milk to feed their entire population plus have some left over for exportation. (Wisconsin State Farmer, 2012) The company Dos Pinos has a monopoly over the dairy industry in Costa Rica, with its cooperatives producing over 85% of the country's milk, encompassing 1,300 affiliates. (Costa Rica Information, n.d.) The majority of large size cooperatives and farms follow similar production methods and standards as farms in the United States. Farmers tailor their production and operations to meet the needs of the "standard" dairy breeds and take measures to ensure that breeds like Jersey, Holstein and Guernsey thrive in a very unfamiliar tropical climate. Though the cooperatives survive there is another side of the Costa Rican dairy industry that is not linked to the large milking operations, which is the small-scale rural farmer.

Many farms in the lowlands of Costa Rica have recently evolved from pure beef operations to more diversified operations that raise cattle for both meat and milk. (de Leeuwm, Omore, Staal, & Thorpe, n.d.) The majority of the farms that have completed this recent shift are small-scale, diversifying their operations as a means of sustainability for their families. In this size operation, it greatly benefits the farmer who may only have a few head of cattle to raise them for both meat and milk production so they utilize milk for their families but eventually are able to fill the freezer as well. This farm is not likely to have a state-of-the-art milking parlor and other technologies found in today's dairy industry, but rather follow along with old fashioned practices. Due to this fact, it is essential to ensure that the farmer make the most of the cattle he is raising, it is vital to find the best cattle breed cross for a variety of production factors. This enables the small scale farmers to make the most of their production.

When analyzing the different breeds of cattle in Costa Rica the Brahman is a breed that is prominent, due to their ability to adapt for survival in less than perfect conditions. Brahman cattle are known for their excellent heat tolerance, and insect resistance, especially in areas with a hot and humid climate like Costa Rica, and have proven to be an excellent match for the more traditional dairy breeds which prefer the temperate climates of their European origins. (Oklahoma State University Department of Animal Science, n.d.) For these reasons it is often found that many of the small-scale farmers of Costa Rica choose to cross breed Brahman cattle with a dairy breed like Holstein or Jersey for their favorable dairy characteristics.

3.3 Objective

3.3.1 Problem

On the surface Costa Rica appears to be a beautiful, flourishing country; but there is a deep rooted problem facing its people every day: hunger. In fact, 8.2% of Costa Ricans suffer from chronic malnourishment. This problem is due to the fact that Costa Rica has an approximate poverty rate of 20%, which greatly hinders the ability to afford the food they need to survive. The problem must be solved by looking at individual, small pieces to determine what can be improved given what the people of Costa Rica already have.

A small piece of the puzzle that requires attention is the livestock industry in Costa Rica, particularly cattle production in the rural areas of the country. Recently small-scale farmers have shifted to a dual-purpose system of raising their cattle for both meat and milk production, but finding the perfect balance of the two has been very difficult. Many farmers lack the knowledge and ability to do extensive research and testing to find the most successful breed cross for their operations. Therefore, farmers are not yielding the meat and milk possible, decreasing the potential of production and potential profit of their herds.

3.3.2 Purpose

The purpose of this project was to find the most productive and successful breed cross for dual-purpose, small-scale farms in Costa Rica. When the “best” breed cross is unearthed, the information can be shared and spread throughout the country and small scale operations can use the information to influence how they breed their herd. This will ultimately increase production and profits for each operation, creating a more sustainable and supportive life.

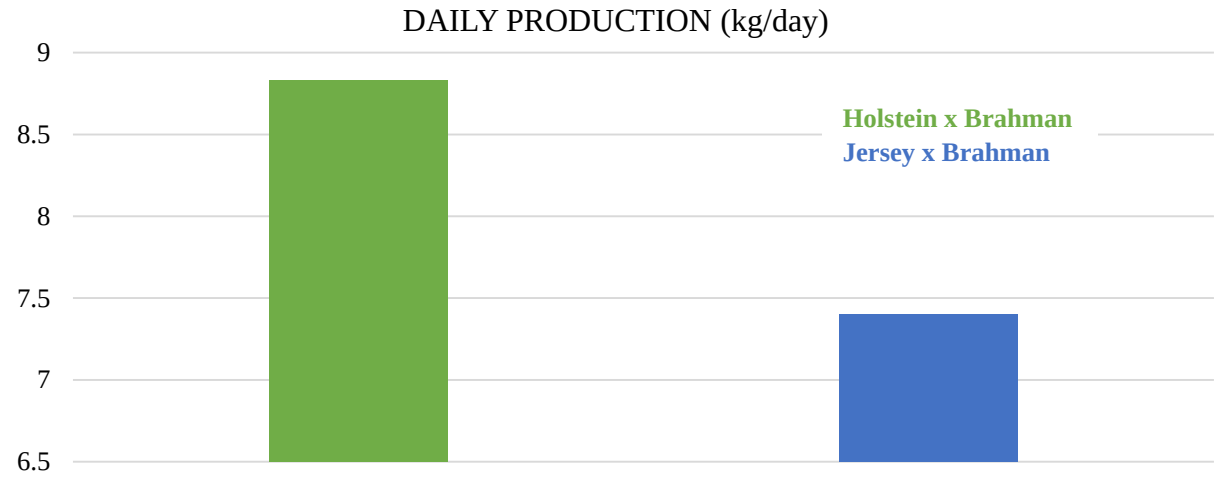
3.4 Hypothesis

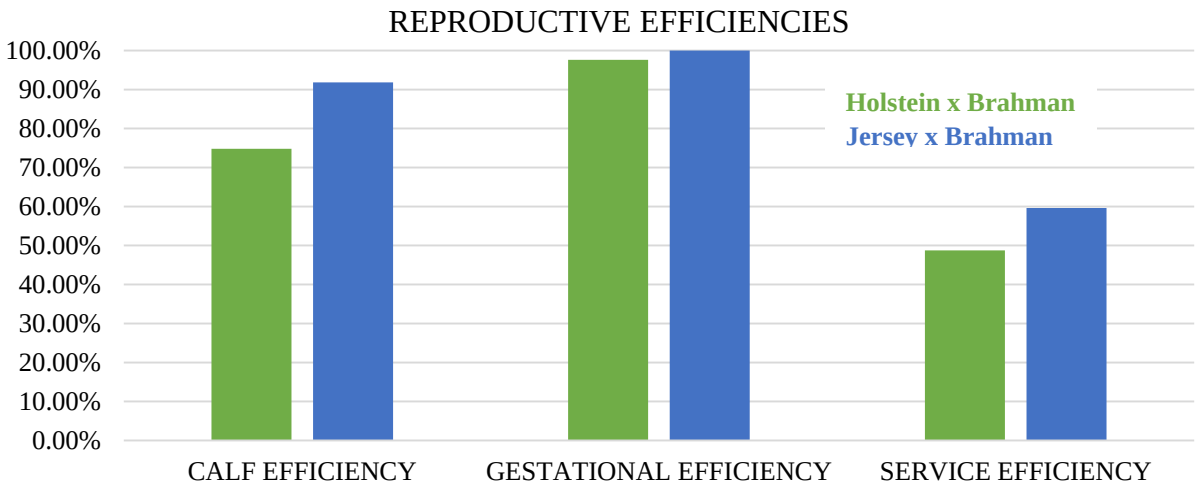
If the production factors for different cross breeds of cattle in Costa Rica are compared, then the Brahman x Holstein cross breed will be the most successful in terms of dual purpose production.

4. RESEARCH FACTORS AND DATA

4.1 Cow

	Holstein x Brahman	Jersey x Brahman
DAILY PRODUCTION (kg/day)	**8.83**	7.40
CALF EFFICIENCY	74.79%	**91.81%**
ABORTIONS	2.44%	**0.00%**
SERVICE EFFICIENCY	48.75%	**59.62%**





4.1.1 Daily Production

Daily production is the average daily production of milk from each cow in the herd and is measured in kilograms per day. The greater quantitative amount of milk produced each day per cow is more desirable for producers both large and small.

The Holstein x Brahman cross performed better in this category, producing an average of 8.83 kilograms per day *(see appendix 1.1.1)* compared to the Jersey x Brahman cross, which only produced an average of 7.40 kilograms per day *(see appendix 1.1.2).*

4.1.2 Calf Efficiency

Calf efficiency measures the reproductive efficiency of the cow while she is reproductively capable. Calf efficiency is found by subtracting two years from the age of the cow and then dividing by the number of calves she has calved. After calculating calf efficiency, it is most desirable to have a cow with calf efficiency closer to 100%; this indicates the cows are reproducing and having a calf every year they are reproductively capable, which is highly desirable and efficient, as this keeps the female in her regular reproductive cycle.

The Jersey x Brahman cross had the highest average calf efficiency, 91.81%, *(see appendix 1.2.2)* in comparison to the Holstein x Brahman efficiency of only 74.79% *(see appendix 1.2.1).*

4.1.3 Gestational Efficiency

Gestational efficiency is the success rate of the cow to carry the calf full term and have a successful parturition. In the herd records the number of abortions per cow was recorded. From there the gestational efficiency was derived by taking the percentage of total pregnancies that resulted in abortions or unsuccessful pregnancies. The least percentage of unsuccessful pregnancies is the more desirable option for gestational efficiency.

The Jersey x Brahman cross was the better crossbreed in gestational efficiency, having 100% pregnancies successful *(see appendix 1.3.2)* while the Holstein x Brahman cross had one abortion in the herd records, which resulted in 97.56% of pregnancies successful *(see appendix 1.3.1).*

4.1.4 Service Efficiency

Service efficiency is defined as the efficiency of the cow to become impregnated after artificial insemination servicing. In order to determine service efficiency the reproductive status of the cow was taken into consideration. For example is the cow is pregnant (P), if so then divide 1 over the number of artificial insemination services the cow received for that year. If the cow is vacant (V) or open, and has been serviced, then the service efficiency is automatically zero because none of the services were successful. If the cow is vacant (V) and has not been serviced, then that cow will not be accounted for in the calculations. If the pregnancy status of the cow is unknown at that time (I) then the data from that cow will not be used. The higher the service efficiency the better, because higher service efficiency translate to easier conception by the cow and less money and resources needed in order to successfully impregnate the cow and increase herd size. When evaluating service efficiency the breeding technician should be taken into

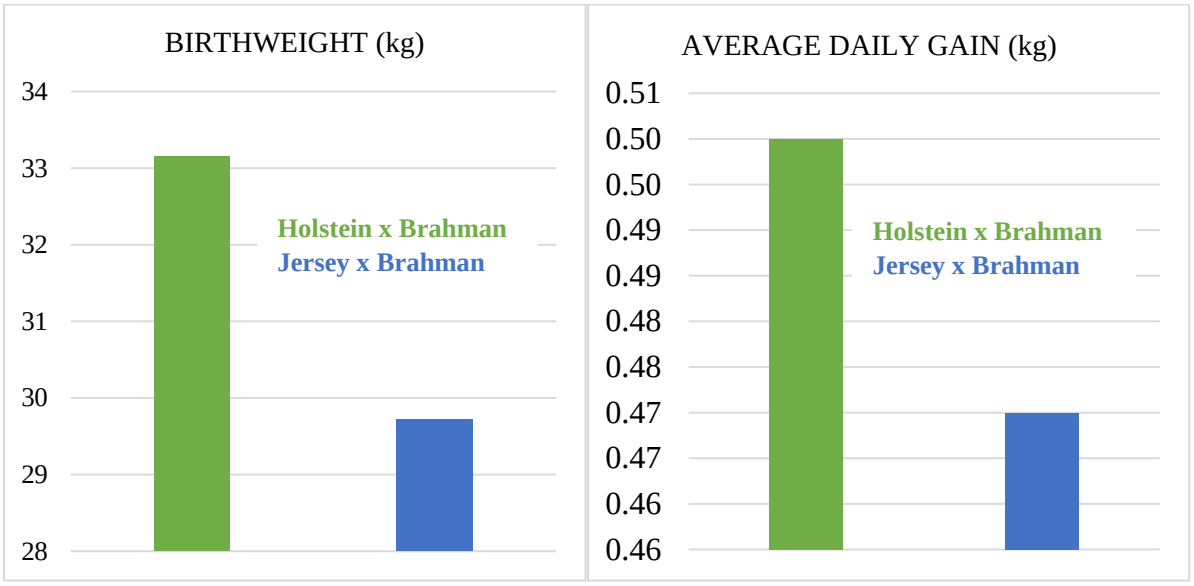
consideration. At EARTH University the cows are artificially inseminated by the students and closely monitored by the Animal Production Professor to ensure correctness and similar technique when servicing the cows and having comparable service efficiency data.

The Jersey x Brahman cross had a higher average service efficiency of 59.62% *(see appendix 1.4.2)* and is reproductively better in comparison to the Holstein x Brahman who only yielded a service efficiency of 48.75% *(see appendix 1.4.1).*

4.2 Calf

	Holstein x Brahman	Jersey x Brahman
BIRTHWEIGHT (kg)	**33.15**	29.72
ADG (kg)	**0.50**	0.47
MARKET PRICE (colones)	**₡252,954.55**	₡230,583.33
MARKET PRICE (USD)	**$476.02**	$433.92

CALF WEIGHTS



4.2.1 Birthweight

The birthweight of each calf is taken within 24 hours of birth and is measured in kilograms. It is more desirable to have a larger calf as long as parturition was successful and without problem, therefore the heavier the calf the better.

The Holstein x Brahman crossbreed had a greater average birthweight of 33.15 kilograms *(see appendix 2.1.1)* than the Jersey x Brahman cross, with an average of only 29.72 kilograms *(see appendix 2.1.2).*

4.2.2 Average Daily Gain

The average daily gain of the calves is the weight that the calf gains each day from parturition to weaning. This calculation is determined by subtracting the birthweight from the weaning weight and dividing the resultant by age in days at weaning. The greater the average daily gain the better because this translates to better feed efficiency in the calves, due to gaining more weight on the same feed and conditions in comparison to the other calves in the herd.

The Holstein x Brahman cross did in fact have the higher average daily gain of 0.50 kilograms per day *(see appendix 2.2.1) w*hile the Jersey x Brahman crossbreed had a close, but lower average daily gain of 0.47 kilograms per day *(see appendix 2.2.2).*

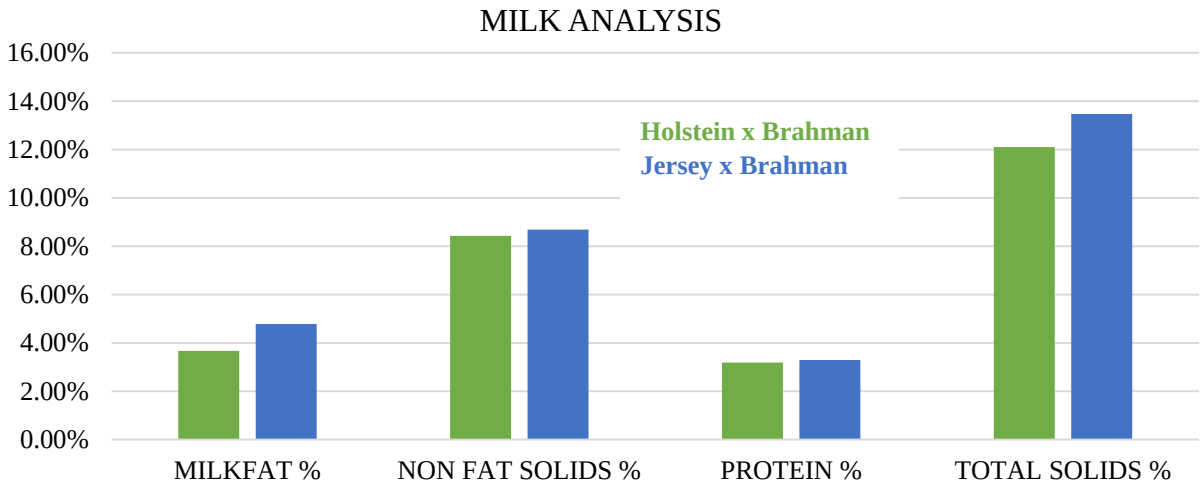
4.2.3 Market Price

The market price is the average price that a weaned calf from that breed is receiving when sold at market. The production at EARTH University the calves are completely weaned at around nine months of age and sent to slaughter shortly after. In Costa Rica, a weaned calf is on average being sold for 1500 colones (approximately $2.82 United States Dollars) per pound of body weight. Producers who are breeding and raising for dual purpose production want to have the greatest weight possible in order to make the most from their weaned calves when it is time to send them to market.

The Holstein x Brahman had a higher average weaned weight in comparison to the Jersey x Brahman and therefore theoretically yielded a higher market price of 252,954.55 colones in comparison to 230,583.33 colones.

4.3 Milk

	Holstein x Brahman	Jersey x Brahman
MILKFAT %	3.67%	**4.78%**
NFS %	8.43%	**8.69%**
PROTEIN %	3.19%	**3.29%**
TOTAL SOLIDS %	12.10%	**13.47%**
MARKET PRICE (colones/kg of milk)	₡ 865.03	₡ **962.42**
MARKET PRICE (USD/kg of milk)	$1.63	**$1.81**
MARKET PRICE (colones/cow/day)	₡ **2,648.64**	₡ 2,471.02
MARKET PRICE (USD/kg of milk)	**$4.98**	$4.65



4.3.1 Fat, Non Fat Solids, Protein and Total Solids

The milkfat, nonfat solids, protein and total solids percentages were determined by a milk analysis with the Ekomilk milk analyzer and is a measurement of the total percentage of the relative component in the milk. It is desirable to have higher percentages because the more nutritious the milk and the greater profit it will generate at the commercial level.

The Jersey x Brahman crossbreed held true to the Jersey dairy characteristics with high fat and solid contents in the milk *(see appendices 3.1.2, 3.2.2, 3.3.2 and 3.4.2).* The Holstein x Brahman crossbreed fell short in all four milk categories and did not perform better than the Jersey x Brahman *(see appendices 3.1.1, 3.2.1, 3.3.1 and 3.4.1).*

4.3.2 Market Prices

When looking at the data from a more commercial production standpoint, it is essential to consider what the milk will receive on the commercial market. In Costa Rica the buyers pay for milk according to kilograms of total solids in milk; per one kilogram of total solid the buyer pays an average of 7147 colones (approximately $13.45 in United States Dollars).

When analyzing the amount that one kilogram of milk will earn for each breed the Jersey x Brahman will gain more per kilogram of milk with an average of 962.42 colones per kilogram of milk. In comparison, the Holstein x Brahman cross only earned 865.03 colones per kilogram of milk.

On the contrary, when analyzing the amount that each cow will earn per day based the Holstein x Brahman cross performed better with the cow earning an average of 2648.64 colones per day due to the significantly greater average daily production of milk making up for the lesser amount of total solids percentage and surpassing the Jersey x Brahman crossbreed only yielding an average of 2471.02 colones per day.

5. FURTHER DIRECTIONS

5.1 Conclusion

The original hypothesis: If the production factors for different cross breeds of cattle in Costa Rica are compared, the Brahman x Holstein cross breed will be the most successful in terms of dual purpose production, this hypothesis was rejected after all data was analyzed.

The Holstein x Brahman crossbreed did perform better in some categories, but the Jersey x Brahman saw better results in the majority of production factors. The results were derived by comparing the different categories, equally weighted, and counting to see which crossbreed performed better and ultimately the Jersey x Brahman performed significantly better in a greater number of factors.

It can be theorized that the Jersey x Brahman crossbreed performed significantly better in the majority of categories due to the transfer of excellent milk quality traits that the Jersey dairy breed is famous for, such as high fat and total solids percentages. Also the excellent efficiency of the Jersey x Brahman cross breed in the reproductive factors really set it above the Holstein x Brahman crossbreed. The Jersey x Brahman cross was a significantly smaller cow when considering size in comparison to the Holstein x Brahman cross, meaning that it is a more efficient animal to feed.

Therefore, it is concluded that for small scale farmers in rural areas of Costa Rica who are raising cattle for dual purpose production, cross breeding their herd with a combination of Jersey and Brahman breeding will lead to the most efficient, sustainable and successful performance and production for their herds.

5.2 Further Directions

After completion of this project, conclusive results are drawn from the information collected; that for Costa Rica the best crossbreed for dual purpose is the Jersey x Brahman crossbreed. If shared correctly, this information can be extremely useful and effective in helping the agricultural industry in Costa Rica. If farmers take advantage and implement this crossbreed into their herd, they will see successful growth and change for production.

Further research could be done, considering numerous production factors, breed crosses, operations of crossbred cattle and various areas of the country.

If other areas of Costa Rica or different countries are seeing the shift to dual purpose operations, they can use the methods used to carry out this experiment as a fairly easy way to evaluate their cattle and determine the best crossbreed for them individually.

Ultimately, any research methods that make gains and provide new information for scientists, researchers and farmers both large and small scale would be helpful in feeding the people of Costa Rica and creating a more successful and sustainable agricultural system and life.

6. REFLECTIONS

During my eight-week internship at EARTH University in Costa Rica I learned more than I had ever imagined or hoped for; such a wealth of information and real-world experience that I am so thankful for. Not only did I learn about the agricultural industry, my research project, and about another culture, but I also learned a lot about myself and my own abilities, while abroad for the summer of 2015.

After my extensive research and work with my project I learned an immense amount about the dairy industry in Costa Rica, and the crossbreeding used for dual purpose production. Through different field trips and activities, I received a firsthand look at the different agricultural productions and got the opportunity to learn about the different sustainability methods used in Costa Rica. Due to the fact that I was instantly immersed in and surrounded by the culture, I learned how to be a real *tico (native Costa Rican)* and had the opportunity to improve my Spanish greatly.

The most important thing I learned in Costa Rica was that as an individual I could make a difference. Before embarking on my journey I strived to be like the professionals who made advances and improvements because they were career men and women who received PhDs and extensive awards for the work they were doing. Under no circumstances did I believe that I could do something even fractionally similar, compared to the work they did, and I could only hope and dream one day I would make a difference like one of them; but I was wrong. After completing my internship, I had the realization that I could make a difference before I reached that stage in my life. It did not matter that I was a girl or that I was only seventeen and had not yet graduated high school, none of it mattered, because I still made a difference in my mind. I was the one who traveled to a foreign country, immersed myself in their lives and culture, saw a question and made a plan to find out the answer, and in the end I did. In my mind I had done something like one of the household names who make grand differences in our world. Even though I did not necessarily find the cure for a famous disease or similar renowned discovery, in my mind I found a piece of information that could help at least one person, make a difference in the life and livelihood of at least one person.

After coming home and reflecting on my internship I crafted the most important lesson learned by my internship: no matter your age, gender, educational status or any other demographic, you can still make a difference. If individuals have enough passion and drive for something they can do something that has a positive impact, whether it be in agriculture, medicine, politics, whatever they put their mind to. Personally for me its agriculture. I believe during my eight-week internship I made a contribution to bettering the agriculture in Costa Rica. No matter how small, just the fact that I know I have the ability to make a difference strikes such emotions, which can scarcely be described in words. Right now I may not be one of the greats, like Dr. Norman Borlaug, but through this internship, I know that one day I can be like him. I want to make a difference in this world, and I am capable and will do just that.

7. PHOTOGRAPHY

8. APPENDIX

1. Cow Production Factors

Number (cow)	Age (years)	Breed	# Times Milked/ Day	Daily Production (Kg/Day)	Calves	Calf Efficiency	Abortions	Services 2015	Status	Service Efficiency
4400	5	Jersey x Brahman	X	4.83	3	100.00%	0	1	P	100.00%
4408	5	Jersey x Brahman	2	9.24	2	66.67%	0	2	P	50.00%
4410	5	Jersey x Brahman	2	11.3	3	100.00%	0	3	I	X
5412	5	Jersey x Brahman	1	4.68	3	100.00%	0	1	P	100.00%
5416	5	Jersey x Brahman	1	3.98	2	66.67%	0	1	P	100.00%
5418	5	Jersey x Brahman	1	11.3	3	100.00%	0	0	V	X
15100	14	Holstein x Brahman	1	5.78	11	91.67%	0	1	P	100.00%
21404	3	Jersey x Brahman	1	4.66	1	100.00%	0	7	P	14.29%
31400	12	Jersey x Brahman	1	4.44	10	100.00%	0	1	P	100.00%
32402	12	Jersey x Brahman	2	12.9	9	90.00%	0	0	V	X
33404	12	Jersey x Brahman	2	9.02	10	100.00%	0	0	V	X
42100	11	Holstein x Brahman	X	4.84	8	88.89%	1	2	P	50.00%
51104	10	Holstein x Brahman	2	10.9	7	87.50%	0	5	P	20.00%
51400	10	Jersey x Brahman	1	4.91	8	100.00%	0	2	P	50.00%
51402	10	Jersey x Brahman	1	3.81	9	100.00%	0	4	P	25.00%
52404	10	Jersey x Brahman	2	8.21	8	100.00%	0	1	P	100.00%
64106	9	Holstein x Brahman	2	12.4	6	85.71%	0	0	V	X
72400	8	Jersey x Brahman	1	5.82	6	100.00%	0	3	P	33.33%
73402	8	Jersey x Brahman	1	5.41	6	100.00%	0	3	P	33.33%
82400	7	Jersey x Brahman	1	3.43	4	80.00%	0	1	P	100.00%
84406	7	Jersey x Brahman	1	5.24	5	100.00%	0	1	P	100.00%
92104	17	Holstein x Brahman	2	10.7	3	20.00%	0	0	V	X
93400	6	Jersey x Brahman	2	11.8	3	75.00%	0	0	V	X
93402	6	Jersey x Brahman	2	13.7	3	75.00%	0	1	V	0.00%
93404	6	Jersey x Brahman	1	7.16	3	75.00%	0	5	P	20.00%
93406	6	Jersey x Brahman	1	5.47	4	100.00%	0	2	P	50.00%
93412	6	Jersey x Brahman	2	11.7	4	100.00%	0	2	V	0.00%
94420	6	Jersey x Brahman	1	8.26	3	75.00%	0	1	P	100.00%
94424	6	Jersey x Brahman	1	6.29	4	100.00%	0	2	P	50.00%
51-08	10	Holstein x Brahman	X	8.33	6	75.00%	0	4	P	25.00%

1.1 Daily Production

1.1.1 Holstein x Brahman

NUMBER (Cow)	DAILY PRODUCTION (kg/day)
15100	5.78
42100	4.84
51104	10.9
64106	12.4
92104	10.7
51-08	8.33

1.1.2 Jersey x Brahman

NUMBER (cow)	DAILY PRODUCTION (kg/day)
4400	4.83
4408	9.24
4410	11.3
5412	4.68
5416	3.98
5418	11.3
21404	4.66
31400	4.44
32402	12.9
33404	9.02
51400	4.91
51402	3.81
52404	8.21
72400	5.82
73402	5.41
82400	3.43
84406	5.24
93400	11.8
93402	13.7
93404	7.16
93406	5.47
93412	11.7
94420	8.26
94424	6.29

1.2 Calf Efficiency

1.2.1 Holstein x Brahman

NUMBER (Cow)	AGE (years)	CALVES	CALF EFFICIENCY
15100	14	11	91.67%
42100	11	8	88.89%
51104	10	7	87.50%
64106	9	6	85.71%
92104	17	3	20.00%
51-08	10	6	75.00%

1.2.2 Jersey x Brahman

NUMBER (cow)	AGE (years)	CALVES	CALF EFFICIENCY
4400	5	3	100.00%
4408	5	2	66.67%
4410	5	3	100.00%
5412	5	3	100.00%
5416	5	2	66.67%
5418	5	3	100.00%
21404	3	1	100.00%
31400	12	10	100.00%
32402	12	9	90.00%
33404	12	10	100.00%
51400	10	8	100.00%
51402	10	9	100.00%
52404	10	8	100.00%
72400	8	6	100.00%
73402	8	6	100.00%
82400	7	4	80.00%
84406	7	5	100.00%
93400	6	3	75.00%
93402	6	3	75.00%
93404	6	3	75.00%
93406	6	4	100.00%
93412	6	4	100.00%
94420	6	3	75.00%
94424	6	4	100.00%

1.3 Gestational Efficiency

1.3.1 Holstein x Brahman

NUMBER (cow)	CALVES	ABORTIONS
15100	11	0
42100	8	1
51104	7	0
64106	6	0
92104	3	0
51-08	6	0

1.3.2 Jersey x Brahman

NUMBER (cow)	CALVES	ABORTIONS
4400	3	0
4408	2	0
4410	3	0
5412	3	0
5416	2	0
5418	3	0
21404	1	0
31400	10	0
32402	9	0
33404	10	0
51400	8	0
51402	9	0
52404	8	0
72400	6	0
73402	6	0
82400	4	0
84406	5	0
93400	3	0
93402	3	0
93404	3	0
93406	4	0
93412	4	0
94420	3	0
94424	4	0

1.4 Service Efficiency

1.4.1 Holstein x Brahman

NUMBER (cow)	SERVICES 2015	STATUS	SERVICE EFFICIENCY
15100	1	P	100.00%
42100	2	P	50.00%
51104	5	P	20.00%
64106	0	V	X
92104	0	V	X
51-08	4	P	25.00%

1.4.2 Jersey x Brahman

NUMBER (cow)	SERVICES 2015	STATUS	SERVICE EFFICIENCY
4400	1	P	100.00%
4408	2	P	50.00%
4410	3	I	X
5412	1	P	100.00%
5416	1	P	100.00%
5418	0	V	X
21404	7	P	14.29%
31400	1	P	100.00%
32402	0	V	X
33404	0	V	X
51400	2	P	50.00%
51402	4	P	25.00%
52404	1	P	100.00%
72400	3	P	33.33%
73402	3	P	33.33%
82400	1	P	100.00%
84406	1	P	100.00%
93400	0	V	X
93402	1	V	0.00%
93404	5	P	20.00%
93406	2	P	50.00%
93412	2	V	0.00%
94420	1	P	100.00%
94424	2	P	50.00%

2. Calf Production Factors

Market Price (Colones)	₡ 336,000.00	₡ 285,000.00	₡ 220,500.00	₡ 277,500.00	₡ 325,500.00	₡ 190,500.00	₡ 339,000.00	₡ 231,000.00	₡ 310,500.00
Adg (Kg/Day)	0.54	0.62	0.43	0.60	0.67	0.36	0.72	0.49	0.69
Weaning Weight (Kg)	224	190	147	185	217	127	226	154	207
Weaning Age (+/- Days)	339	259	270	257	279	266	263	248	247
Weaning Age (Months)	11.3	8.62	9.01	8.58	9.31	8.88	8.78	8.25	8.22
Birth Wgt (kg)	40	30	30	30.1	30	32	37.1	32.9	38
Sire Breed	Brahman (100)	Holstein (100)	Holstein (100)	Brahman (100)	Jersey (100)	Holstein (100)	Simmental (100)	Simmental (100)	Simmental (100)
Dam Breed	Holstein (50) xBrahman 50)	Holstein (50) xBrahman 50)	Jersey (50) x Brahman (50)	Jersey (50) x Brahman (50)	Jersey (50) x Brahman (50)	Jersey (50) x Brahman (50)	Jersey (50) x Brahman (50)	Jersey (50) x Brahman (50)	Jersey (50) x Brahman (50)
Breed	Holstein (25) x Brahman (75)	Holstein (75) x Brahman (25)	Holstein (50) x Brahman (25) x	Jersey (25) x Brahman (75)	Jersey (75) x Brahman (25)	Holstein (50) x Brahman (25) x	Jersey (25) x Brahman (25) x Simmental	Jersey (25) x Brahman (25) x Simmental	Jersey (25) x Brahman (25) x Simmental
DOB	8/6/13	10/29/13	12/16/13	12/29/13	12/23/13	2/25/14	1/8/14	1/12/14	1/13/14
Number	**134627**	**135700**	**136300**	**136303**	**136751**	**141301**	**141450**	**141452**	**141454**

Market Price (Colones)	₡ 265,500.00	₡ 261,000.00	₡ 264,000.00	₡ 285,000.00	₡ 270,000.00	₡ 195,000.00	₡ 117,000.00	₡ 181,500.00	₡ 175,500.00	₡ 309,000.00
Adg (Kg/Day)	0.44	0.42	0.57	0.59	0.56	0.41	0.22	0.38	0.31	0.68
Weaning Weight (Kg)	177	174	176	190	180	130	78	121	117	206
Weaning Age (+/- Days)	324	333	251	271	251	275	239	275	261	251
Weaning Age (Months)	10.8	11.1	8.35	9.04	8.35	9.17	7.96	9.17	8.71	8.35
Birth Weight	35.4	35.6	33.5	30.8	40.9	16.7	24.7	17.7	36.4	35.6
Sire Breed	Brahman (100)	Holstein (100)	Holstein (100)	Holstein (100)	Holstein (100)	Jersey (100)	Jersey (100)	Jersey (100)	Jersey (100)	Holstein (100)
Dam Breed	Jersey (50) x Brahman (50)	Holstein (50) xBrahman 50)	Holstein (50) xBrahman 50)	Holstein (50) xBrahman 50)	Holstein (50) xBrahman 50)	Jersey (50) x Brahman (50)	Jersey (50) x Brahman (50)	Jersey (50) x Brahman (50)	Jersey (50) x Brahman (50)	Jersey (50) x Brahman (50)
Breed	Jersey (25) x Brahman (75)	Holstein (75) x Brahman (25)	Holstein (75) x Brahman (25)	Holstein (75) x Brahman (25)	Holstein (75) x Brahman (25)	Jersey (75) x Brahman (25)	Jersey (75) x Brahman (25)	Jersey (75) x Brahman (25)	Jersey (75) x Brahman (25)	Holstein (50) x Brahman (25) x
DOB	1/26/14	1/19/14	2/15/14	1/25/14	2/15/14	1/21/14	1/28/14	1/21/14	1/23/14	2/3/14
Number	**141651**	**141700**	**141701**	**141702**	**141703**	**141750**	**141752**	**141753**	**141755**	**141759**

Market Price (Colones)	₡ 225,000.00	₡ 367,500.00	₡ 198,000.00	₡ 142,500.00	₡ 171,000.00	₡ 151,500.00	₡ 225,000.00	₡ 216,000.00	₡ 261,000.00
Adg (Kg/Day)	0.42	0.89	0.39	0.27	0.36	0.26	0.44	0.46	0.49
Weaning Weight (Kg)	150	245	132	95	114	101	150	144	174
Weaning Age (+/- Days)	274	241	266	272	237	281	257	247	289
Weaning Age (Months)	9.14	8.02	8.85	9.08	7.89	9.37	8.55	8.22	9.64
Birth Weight	34.4	31.1	28.3	22.2	28.5	29	35.9	30	31
Sire Breed	Holstein (100)	Jersey (100)	Jersey (100)	Jersey (100)	Jersey (100)	Jersey (100)	Jersey (100)	Jersey (100)	Jersey (100)
Dam Breed	Jersey (50) x Brahman (50)	Brahman (100)	Jersey (50) x Brahman (50)	Jersey (50) x Brahman (50)	Jersey (50) x Brahman (50)	Jersey (50) x Brahman (50)	Jersey (50) x Brahman (50)	Jersey (50) x Brahman (50)	Jersey (50) x Brahman (50)
Breed	Holstein (50) x Brahman (25) x	Jerey (50) x Brahman (50)	Jersey (75) x Brahman (25)	Jersey (75) x Brahman (25)	Jersey (75) x Brahman (25)	Jersey (75) x Brahman (25)	Jersey (75) x Brahman (25)	Jersey (75) x Brahman (25)	Jersey (75) x Brahman (25)
DOB	4/7/14	3/25/14	3/29/14	4/22/14	4/27/14	3/13/14	6/9/14	6/19/14	9/2/14
Number	**142303**	**142401**	**142754**	**142756**	**142758**	**142763**	**143760**	**143762**	**145764**

2.1 Birthweight

2.1.1 Holstein x Brahman

NUMBER (calf)	BIRTHWEIGHT (kg)
134627	40
135700	30
136300	30
141301	32
141700	35.6
141701	33.5
141702	30.8
141703	40.9
141759	35.6
142300	21.9
142303	34.4

2.1.2 Jersey x Brahman

NUMBER (calf)	BIRTHWEIGHT (kg)
136303	30.1
136751	30
141450	37.1
141452	32.9
141454	38
141651	35.4
141750	16.7
141752	24.7
141753	17.7
141755	36.4
142401	31.1
142754	28.3
142756	22.2
142758	28.5
142763	29
143760	35.9
143762	30
145764	31

2.2 Average Daily Gain

2.2.1 Holstein x Brahman

NUMBER (calf)	BIRTH WEIGHT (kg)	WEANING AGE (months)	WEANING AGE (+/- days)	WEANING WEIGHT (kg)	ADG (kg/day)
134627	40	11.3	339	224	0.54
135700	30	8.62	259	190	0.62
136300	30	9.01	270	147	0.43
141301	32	8.88	266	127	0.36
141700	35.6	11.1	333	174	0.42
141701	33.5	8.35	251	176	0.57
141702	30.8	9.04	271	190	0.59
141703	40.9	8.35	251	180	0.56
141759	35.6	8.35	251	206	0.68
142300	21.9	8.39	252	91	0.27
142303	34.4	9.14	274	150	0.42

2.2.2 Jersey x Brahman

NUMBER (calf)	BIRTH WEIGHT (kg)	WEANING AGE (months)	WEANING AGE (+/- days)	WEANING WEIGHT (kg)	ADG (kg/day)
136303	30.1	8.58	257	185	0.60
136751	30	9.31	279	217	0.67
141450	37.1	8.78	263	226	0.72
141452	32.9	8.25	248	154	0.49
141454	38	8.22	247	207	0.69
141651	35.4	10.8	324	177	0.44
141750	16.7	9.17	275	130	0.41
141752	24.7	7.96	239	78	0.22
141753	17.7	9.17	275	121	0.38
141755	36.4	8.71	261	117	0.31
142401	31.1	8.02	241	245	0.89
142754	28.3	8.85	266	132	0.39
142756	22.2	9.08	272	95	0.27
142758	28.5	7.89	237	114	0.36
142763	29	9.37	281	101	0.26
143760	35.9	8.55	257	150	0.44
143762	30	8.22	247	144	0.46
145764	31	9.64	289	174	0.49

3. Milk Analysis

Number (Cow)	Breed	Milk Fat %	NFS %	Protein %	Total Solids %	Market Price (Colones/Kg)
4408	Jersey x Brahman	4.19%	9.07%	3.42%	13.26%	₡ 947.69
5418	Jersey x Brahman	4.79%	8.04%	3.05%	12.83%	₡ 916.96
15100	Holstein x Brahman	3.70%	7.87%	2.98%	11.57%	₡ 826.91
31400	Jersey x Brahman	4.81%	8.24%	3.13%	13.05%	₡ 932.68
33404	Jersey x Brahman	4.47%	8.26%	3.13%	12.73%	₡ 909.81
51104	Holstein x Brahman	3.18%	8.70%	3.28%	11.88%	₡ 849.06
64106	Holstein x Brahman	4.13%	8.73%	3.30%	12.86%	₡ 919.10
93406	Jersey x Brahman	5.63%	9.83%	3.72%	15.46%	₡ 1,104.93

3.1 Fat

3.1.1 Holstein x Brahman

NUMBER (cow)	MILK FAT %
51104	3.18%
64106	4.13%
15100	3.70%

3.1.2 Jersey x Brahman

NUMBER (cow)	MILK FAT %
4408	4.19%
5418	4.79%
33404	4.47%
31400	4.81%
93406	5.63%

3.2 Non Fat Solids

3.2.1 Holstein x Brahman

NUMBER (cow)	NFS %
51104	8.70%
64106	8.73%
15100	7.87%

3.2.2 Jersey x Brahman

NUMBER (cow)	NFS %
4408	9.07%
5418	8.04%
33404	8.26%
31400	8.24%
93406	9.83%

3.3 Protein

3.3.1 Holstein x Brahman

NUMBER (cow)	PROTEIN %
51104	3.28%
64106	3.30%
15100	2.98%

3.3.2 Jersey x Brahman

NUMBER (cow)	PROTEIN %
4408	3.42%
5418	3.05%
33404	3.13%
31400	3.13%
93406	3.72%

3.4 Total Solids

3.4.1 Holstein x Brahman

NUMBER (cow)	TOTAL SOLIDS %
51104	11.88%
64106	12.86%
15100	11.57%

3.4.2 Jersey x Brahman

NUMBER (cow)	TOTAL SOLIDS %
4408	13.26%
5418	12.83%
33404	12.73%
31400	13.05%
93406	15.46%

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