Summer One Report: Genetic Evaluation to Improve Dairy Cattle Health and Production
Laidlaw Research and Leadership Scholars Program - 2021

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Introduction

The following report details my research experience and leadership development through 2021, the first summer of my participation in the Laidlaw Research and Leadership Scholars Program at Cornell University. This paper summarizes my research processes, goals, and outcomes, and additionally connects my experiences to personal developments and further reflections on leadership. My project, Genetic Evaluation to Improve Dairy Cattle Health and Production, was performed under the direction of Dr. Heather Huson, associate professor of animal genetics in the College of Agriculture and Life Sciences, in the Odyssey DNA Laboratory at Cornell.

Research Experience

My project primarily focused on a net merit analysis of the Cornell Veterinary School Teaching Dairy (VTD) cattle herd, a group of around 100 cattle cared for and bred by Cornell veterinary students and staff at the College of Veterinary Medicine. Net merit, a score awarded to every dairy cow, is a simplified genetic evaluation of a large group of traits possessed by each animal that allows farmers, breeders, and herd managers to evaluate the economic importance of a given cow. Net merit is one of several score indices evaluated by herd managers in the breeding process; using net merit and the detailed genetic evaluations from which the scores come, cattle can be bred for specific traits with great accuracy.

The management team of the VTD herd at Cornell, however, has previously relied on phenotypic data alone for their optimization of key traits ─ traits such as observed milk production and daughter pregnancy rate ─ rather than the available genetic data for breeding. This process, while reasonably cost-effective and simple, subconsciously assumes that the expected net merit scores of individual VTD cattle are identical to the observed net merit scores of those animals, a guess that has the potential to lead to undesired breeding outcomes. Ideally, an animal's observed net merit value *would* equal its expected net merit value, an average of its parent's net merit scores. The question was therefore raised: is there a statistically significant difference between the observed and expected net merit scores of the individual VTD cattle, and if so, does that support the argument for a new breeding approach for the VTD herd?

For this net merit analysis portion of my research project, I worked with Joe Thorsrud, a Cornell graduate student in the Odyssey DNA Lab. I began my summer parsing through several datasets, familiarizing myself with the available genetic data and the organization of Dr. Huson's animal database. After exploring these large datasets, I compiled a Microsoft Excel spreadsheet with rows for each individual

Date	Index	Cow Name (Farm ID)	Animal ID (Huson Lab)	Breed	Sex	USDA #	Birth Date	Sire Registration	Dam ID	Neogen ID
Feb-21	1	1766	5810	HO	F	21ZYX6359	7/26/20	1H14135	1515	NE01975541
	2	1767	5811	HO	F	21ZYX6360	7/27/20	1H13445	1442	NE01975542
	3	1768	5812	HO	F	21ZYX6361	7/29/20	1H13867	1497	NE01975543
	4	1769	5813	HO	F	21ZYX6362	7/30/20	1H14135	1461	NE01975544
	6	1771	5815	HO	F	21ZYX6366	8/3/20	1H13871	1618	NE01975546
	7	1772	5816	HO	F	21ZYX6369	8/11/20	1H13483	1460	NE01975547
	8	1773	5817	HO	F	21ZYX6371	8/13/20	1H12827	1596	NE01975548
	9	1774	5818	HO	F	21ZYX6372	8/14/20	1H12495	1587	NE01975549
	10	1775	5819	HO	F	21ZYX6373	8/15/20	1H12495	1576	NE01975550
	11	1776	5820	HO	F	21ZYX6374	8/15/20	1H12495	1603	NE01975551
	12	1777	5821	HO	F	21ZYX6376	8/16/20	1J922	1612	NE01975552
	13	1778	5822	HO	F	21ZYX6377	8/17/20	1H12996	1611	NE01975554
	14	1779	5823	HO	F	21ZYX6380	8/26/20	1H13356	11575	NE01975555
	15	1780	5824	HO	F	21ZYX6384	9/8/20	1H14121	1629	NE01975556
	16	1781	5825	HO	F	21ZYX6385	9/10/20	1H13483	1513	NE01975557
	17	1782	5826	HO	F	21ZYX6387	9/19/20	1H12477	1627	NE01975558
	18	1783	5827	HO	F	21ZYX6391	9/23/20	1H14121	1621	NE01975559
	19	1632	5764	HO	F	USA003220368768	11/15/18	501J889	1403	NE01975560
	20	1641	5765	HO	F	USA003220368773	12/9/18	1H11692	1416	NE01975562
	21	1642	5766	HO	F	USA003220368774	12/10/18	1H10396	1479	NE01975563
	22	1644	5767	HO	F	USA003220368775	12/16/18	1H10396	1474	NE01975564
	23	1656	5769	HO	F	USA003220368776	1/28/19	1H10396	1483	NE01975565
	24	1792	5837	HO	F	21ZZM6410	11/12/20	1H12477	1626	NE01975566
	25	1793	5838	HO	F	21ZZM6413	11/25/20	1H15057	1471	NE01975567

Figure 1. Screenshot of 410-row Microsoft Excel spreadsheet of compiled VTD herd data

VTD cow, separated by date of data collection (*Figure 1*). This spreadsheet spanned 410 rows, with around 80 of those being the herd's current animals as of February 2021. The page organized the cattle by their birthdates and USDA Identification numbers, official registration numbers provided by the United States Department of Agriculture; alongside these columns were the identification numbers of each individual's dam and sire, mother and father, which provided the basis for forming pedigrees in a later part of my research project.

Over the first weeks of my Summer 2021 Laidlaw research, I learned to use the online statistical computing program R for data manipulation and visualization. In R, I wrote code to determine and view trends in the provided datasets, including the distribution of VTD net merit scores and comparisons of these scores with other key traits identified by the herd managers as important for optimization through breeding, such as fat in milk produced (*Figure 2*). Trend visualization served as another way to become familiar with the VTD data; learning the basics of R would set me up for success in creating pedigrees and performing a statistical analysis in the final portion of my project.

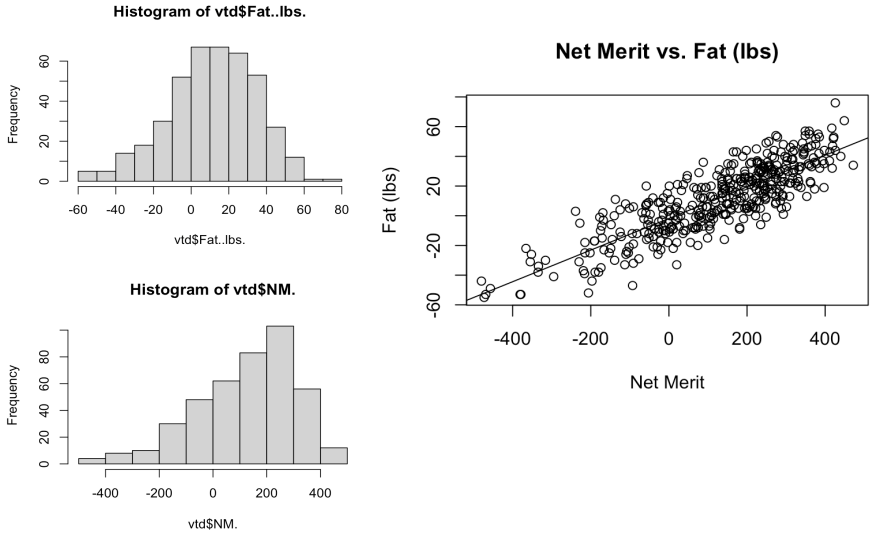

Figure 2. VTD optimized trait trend visualization in R, net merit and fat (pounds) histogram and net merit vs. fat (pounds) scatterplot

Using my compiled Excel data, I was able to create pedigrees for each of the 80 current VTD cattle, tracing back their parentage as far as possible with the available dam and sire identification numbers. Animals were placed in pedigrees according to their USDA ID numbers and dam and sire repeats were outlined and highlighted respectively in unique colors, denoting commonalities and relationships among cattle. For each cow, a second pedigree was created, this one containing net merit scores in order to visualize if averages of parents' net merit values were common among the VTD individuals (*Figure 3*).

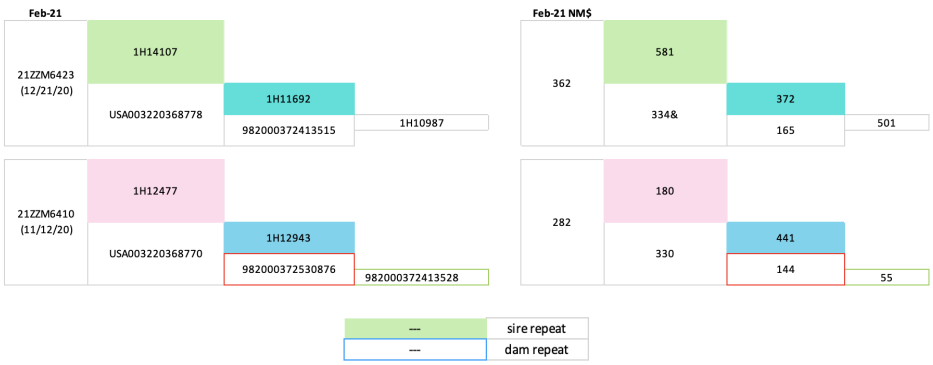

Figure 3. Side-by-side USDA ID and net merit example Microsoft Excel pedigrees for two individual VTD cows

Next, I visualized these pedigrees in R with the same dataset previously used to visualize trends, incorporating both ID numbers and net merit scores. Since several net merit values were uncertain, this dataset was separated in two: the first new file excluded the unknown net merit scores while the second included all scores regardless of my certainty. Pedigrees in R were created using the inclusive file (*Figure 4*). These pedigrees allowed for the determination of cattle relationships, most notably those between half-sisters, cattle with the same father and unique mothers.

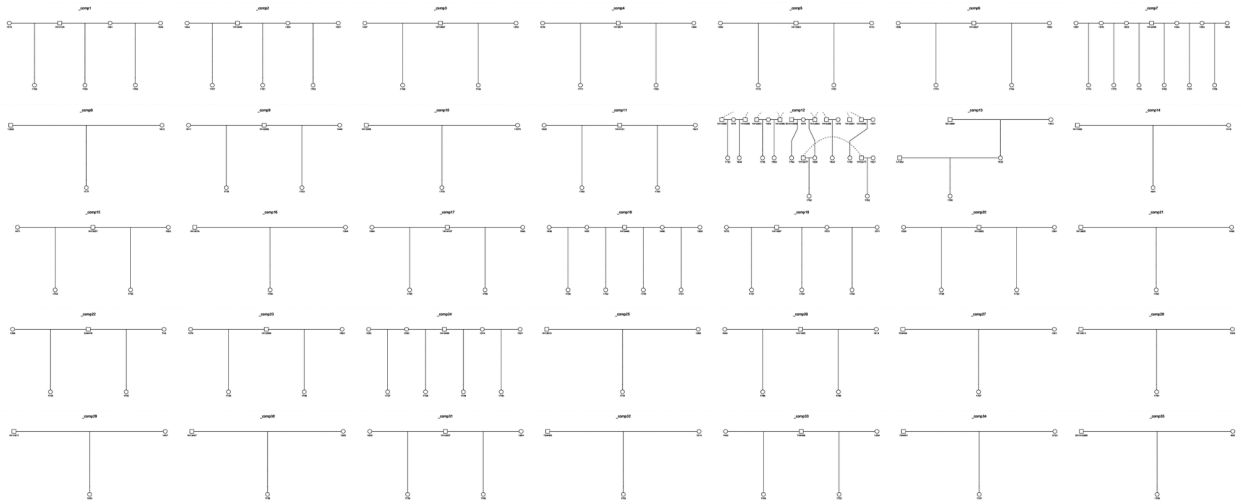

Figure 4. Sample set of pedigrees visualized in R

Both the inclusive and exclusive datasets contributed to my statistical analysis. Using a simple calculation of averages from dams and sires, expected net merit scores were calculated for each VTD cow from each file. I then performed paired t-tests, first comparing expected net merit scores with all VTD scores (inclusive) and then comparing expected net merit scores with only certain, known VTD scores (exclusive). The null hypothesis, or assumption, for both statistical

tests was that the mean difference between the two variables, expected net merit and observed net merit, was zero. The inclusive test yielded a p-value of 0.5562, while the exclusive test yielded 0.9181, both higher than the determined alpha value of 0.05, and thus indicating that there was, in fact, no significant difference between the expected and observed net merit scores of the VTD cattle herd. With these high p-values, I was able to conclude that for now, the use of only phenotypic data for the breeding of the Cornell VTD herd is acceptable.

Alongside the online net merit analysis portion of my Laidlaw research project, I was able to be physically present in the Odyssey DNA Lab to work with Azwan Jaafar, another Cornell graduate student, on several DNA extraction and purification processes. My in-person work this summer focused on DNA extractions from blood samples and mouth swab samples of working dogs; while not directly related to the cattle of the VTD herd, the wet lab processes I learned and performed are similar, if not identical, to those used for cattle samples. Over the course of my research period I performed DNA extractions on 225 samples of frozen blood, 50 samples of fresh blood, and 9 mouth swab samples. Around the laboratory, I learned various important and essential techniques, including micropipetting, solution making, and centrifuging. In the future ─ and possibly in my second summer of Laidlaw research ─ I plan to use these procedures for dairy cattle samples, building on my genetics and animal knowledge in meaningful, career-advancing ways.

Leadership Development

During my summer research period I found myself able to develop and hone various leadership skills, assisted greatly by the knowledge I acquired through my semester of leadership training through Cornell's Office of Engagement Initiatives. Below are four accounts of instances in which I learned or utilized a leadership skill over my Laidlaw experience thus far, summarized as "critical reflections" in an informal journal format.

1. April 14, 2021

Meeting with my faculty mentor, Dr. Heather Huson, for the first time truly kicked off my Laidlaw experience. I remember being pretty nervous to hit "send" on the email formally asking for her mentorship, and that was a relatively foreign feeling to me; being a freshman at Cornell, I'd never even reached out to a professor over email, let alone asked a professor to commit to two years of a new research project with a student who wasn't a member of their lab. Receiving a positive email response the next morning felt encouraging, but actually talking over Zoom with Dr. Huson later that week was the first time I realized that my goals were achievable and that my research proposal might have promise in the first round of Laidlaw applications. Right away, Dr. Huson brightened up the call with a smile and a big "hello." And that's all it took; I could immediately tell she was going to be interested in working with me, which felt terrific after a week of worrying about whether she had wanted to meet just to reject my offer. Being the only two people on the call, our conversation felt intimate, and I felt truly valued as a student and potential researcher.

While I often resent myself for it, I do admit that sometimes I am a pessimistic person. Reflecting back, I think that negative attitudes I hold toward myself and my own actions ─ I'm probably not good enough, there have to be many people better than me ─ had led to the doubt I had regarding our initial relationship. I tend to assume the worst, especially when the

circumstances are focused on me, and Dr. Huson proved helpful in challenging those beliefs even if she wasn't aware of doing so. I am extremely grateful to have had that experience with her, and I feel incredibly lucky to have her now as my faculty mentor. In future pursuits, I think that I'll be able to reflect on my meeting with Dr. Huson to remind myself that I am much more capable than I often give myself credit for. I am coming to realize that it's important to be positive in my thinking, but also that it's okay to experience rejection. Academically, I can do poorly or well on a test and my self-worth doesn't change. Leadership-wise, I can get through to some people but not to others and my skills as a leader still ring true. I am grateful to Laidlaw for helping me realize these things, and I hope that I get to have more experiences that allow me to develop positive thinking in the near future.

2. July 9, 2021

Some days ago, I realized how grateful I am to be working with Azwan, a graduate student in the Odyssey DNA Lab at Cornell, this summer. As the DNA extraction and DNA quantification processes are long and laden with breaks, I have gotten to see this mentor not only while working, but also in his downtime. I have come to see these Azwan as a friend rather than some high figure who holds the answers to my questions and the mastery of research skills. During a break in the extraction process, as I was walking to sit down to work on another component of my Laidlaw project, Azwan asked, "Is it always this hot in Ithaca this time of year?" I could tell he was hesitant to ask, which made sense as I was surprised by the question. I turned to look at him with a blank stare, my mind vacant for a split second, before snapping back to reality. I felt apprehensive and uncomfortable at first, but knowing that he did as well made the conversation that followed easier.

Students at Cornell are known for their competitiveness, sometimes even referred to as cutthroat in nature. My preconceived notions of Cornell graduate students therefore included the idea that a competitive spirit was innately present in all aspects of their work. Yet instead of rushing back to work meticulously on his other projects or thesis during his lab work breaks, Azwan began talking to me regularly, truly interested in getting to know me as a person and friend. Falling into Cornell's competitive stereotype, I recognize that I sometimes have a hard time admitting to myself that I am wrong; in this case, however, I was delighted to discover and accept that my previous assumptions were incorrect. While I imagine that some graduate students are not as kind as Azwan, I will no longer enter interactions with Cornell students thinking that they will be aggressively single-minded. I will hopefully be able to view more experienced students as peers rather than superiors in future research and academic courses, as well as trust that leaders are willing to teach me even if they have additional goals in mind. Clearing my mind of these assumptions will help my learning, and in turn, I expect to feel more confident when passing on my knowledge, getting to know colleagues, and making friends.

3. July 31, 2021

A few days ago, I wandered into the Odyssey Lab in Morrison Hall to begin my typical 9-to-5 day of Laidlaw research. This particular morning, I waltzed straight into the room, not having any interactions before sitting down at my laptop at a lab bench. For the most part, I had been working on my own, becoming self-sufficient in skills to which I was introduced only weeks before. After all, my 6-week research period was almost over, and by this point I was able to —

and expected to ─ perform tasks individually without fault. Prior to this morning, I had learned all the skills necessary to complete the online portion of my research project, including writing code (a practice that, when introduced to me, was completely new). What I still required some assistance with, however, was DNA lab work. On this morning, I opened my email to see a message from Azwan, one of the lab's graduate students, urging me to "go ahead and continue on with the extraction processes from earlier this week." I remember immediately feeling nervous; he made it sound so simple. Yet I was able to gather my courage and get started, slowly at first, and then faster as my comfort grew.

Azwan had trusted me with a massive amount of lab data. I now know that he must have seen something in me, some skill or some drive, that resulted in his decision to grant me full responsibility. Previously, I would not have trusted myself to perform in the lab alone; surely I would mess something up and ruin the hard work of others. But Azwan saw past his worries, and so I did the same. I learned to trust myself, trust that I could successfully follow instructions and stay on course. I hope to be able to transfer these thoughts to future endeavors beyond academics. As I gain confidence and determination, I hope to trust myself in my leadership abilities, even if I am nervous at first.

4. August 24, 2021

On the last day of my Laidlaw research this summer, I gave a short, prepared presentation to Dr. Huson, my faculty mentor, and Joe and Azwan, the graduate students with whom I had worked. Dr. Huson had received brief updates on my progress during weekly meetings, but this presentation encompassed all parts of my work and served as a reminder of all I had accomplished; for Joe and Azwan, this presentation connected the two parts of my project, each previously only having seen one. While this presentation was in no way high-stakes, nor formal even, I felt nervous to sit down with Dr. Huson. I remember the thought clogging up my mind: should I have done more? I could recognize that this was "imposter syndrome" setting in, the feeling that I wasn't qualified enough to be presenting on these topics, let alone to have performed research in Dr. Huson's lab. I remembered this feeling from my very first meeting with Dr. Huson, but this time I was better equipped to handle it. I reminded myself that Cornell professors don't always want more, they aren't some greedy, power-hungry monsters; I knew Dr. Huson was ready to accept all that I was to present.

Unlike that first meeting, this time I was able to challenge my assumptions of distinguished faculty at Cornell. A year at college had taught me a lot, but one of the most important things, I've decided, was that professors truly want their students to succeed. I had accomplished all I could in my 6 weeks of summer research, and I was proud of my work; perhaps even more importantly, I had fun and can absolutely say that I learned a lot. In future meetings with professors and academic courses, I will be able to remind myself that my pride should triumph over my stress. The more experience I have with uncomfortable situations in which I can maintain self-composure, the more my confidence will grow, and thus I hope to seek out those conditions ─ especially in leadership opportunities.

Conclusion

I was fortunate enough to partake in a Laidlaw research project which included both online and in-person elements, an unlikely find given the state of the COVID-19 pandemic. I feel

incredibly lucky to have had these experiences and grateful to have met such amazing faculty, graduate students, and other undergraduates in the Odyssey DNA Lab. I look forward to using both my research and leadership skills in future academic and community engagement endeavors, and I cannot wait to build upon and utilize my skills in my second summer of the Laidlaw program.