Improving Robustness and Climatic Resilience in US Sheep Populations through Genomics

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Introduction

For my research project, I partnered with Dr. Ron Lewis at the University of Nebraska-Lincoln. Dr. Ron Lewis is leading the research project titled *Improving robustness and climatic resilience in US sheep populations through genomics.* For short, we like to call this project "Sheep GEMS", which stands for Genetics, Environment, Management, and Society, which are all concepts that are recorded and analyzed through this project.

The majority of the research data will be collected from three USDA Agricultural Research Service (ARS) locations, but Dr. Ron Lewis and his research team were looking for supplemental flocks of Katahdin, Polypay, Rambouillet, and Suffolk sheep, which we like to call "Innovation Flocks". The "Innovation Flocks" are a key component to this research in order to create a large enough sample size across different geographical regions. When this project was presented to Dr. Scott Greiner and me, we came to the agreement that the Suffolk sheep flock at Virginia Tech would serve as a great data set.

This research project requires quantitative and subjective data to be collected on ewes and lambs around lambing, at weaning and/or postweaning, and around breeding. While I served as an undergraduate research assistant for 7 months, data will need to be collected on the Suffolk flock until 2025.

Objectives

The objective of this research is to develop a better understanding of robustness and climatic resilience traits in sheep located across different geographic regions by collecting genotypes (DNA) and phenotypes, such as teat and udder scores, which can be used in the project to develop genomically-enhanced EBVs to use in the sheep industry. Robustness and climatic resilience are an important part of the sheep industry's viability, but the traits associated with these concepts have not been incorporated into many genomic evaluations of sheep breeds. Genomics could help as a selection tool for these traits, but to do so we must develop the tools to apply to wider populations. We are hopeful that findings from this research will allow scientists and producers to improve these traits in the major sheep-breed types in the United States – hair, semi-prolific maternal, fine-wool, and terminal-sire.

Materials and Methods

From 2022-2025, data will be collected at lambing, at weaning and/or post-weaning, and at breeding. All of the data collected was inputted into an Excel Sheet. Codes were provided in our research criteria for lambing assistance, health intervention, disposition, and death. Scores were to be assigned for the ewes' udder depth, teat placement, body condition score, and FAMACHA score. The quantitative data collected included body weight, and fecal egg count will be collected at a later date. It is important to note that the lambs' data is collected as they will eventually become ewes in the research sample, a big component of the data analysis.

This research project was presented to us at a later date than our breeding season, so for this beginning year, the data collected "at breeding" was actually collected 2 months post-breeding; however, the data collected during this major production cycle should be back on track for the Fall of 2023.

Dates of collection and data that was collected are as follows:

- Around breeding (November 16th, 2022) :
  - Ewes' body weight and body condition score.
- Around lambing (February 1st – March 27th, 2023):
  - Pedigree information
  - Lamb(s) birth date, birth type, and sex
  - Lambing assistance code in relation to ewes and lambs
  - Udder depth, teat placement, body condition score, and FAMACHA score
- Around weaning and/or post-weaning (yet to be collected):
  - Lamb
  - Lamb rearing type
  - FAMACHA scores and fecal egg counts of lambs
  - Ewes' body weight, body condition score, and FAMACHA score
- Year-round (when/if needed):
  - Health intervention codes for ewes and lambs
  - Disposition codes for ewes and lambs
  - Death codes for ewes and lambs

Timeline of Events for Data Collection

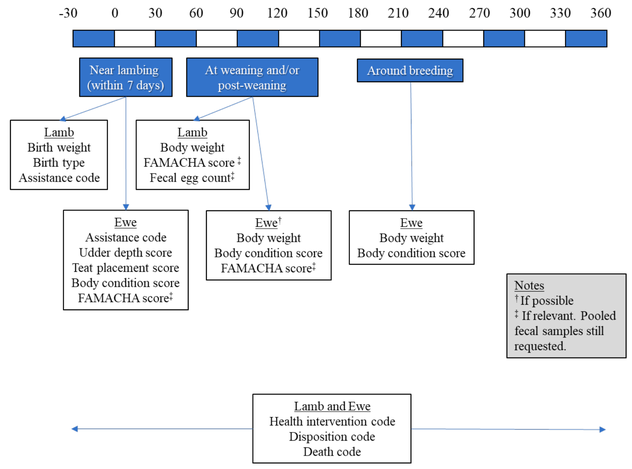

Figure 1. Schematic of measurements collected near lambing, at weaning and/or post-weaning, around breeding, and year-round in lambs and ewes.

Teat and Udder Scores

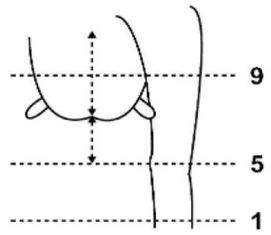

Figure 2. Udder depth score. Scores are assigned on a scale of 1-9.

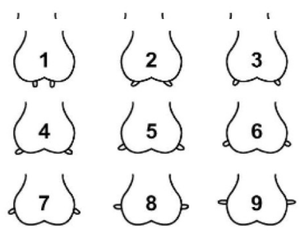

Figure 3. Teat placement score. Scores are assigned on a scale of 1-9.

Lambing Assistance Codes

Assist_Ewe code	Description
1	Not observed
2	No assistance required
3	Assisted as a management decision (for benefit of shepherd)
4	Moderate lambing difficulty (assistance given for benefit of ewe)
5	Severe lambing difficulty (veterinary assistance maybe required)

Figure 4. Codes assigned to ewes based on lambing difficulty.

Assist_Lamb code	Description
1	One or two legs back
2	Head back
3	Back legs first
4	Breech
5	Two (or more) lambs together
6	Oversized lambs
7	Caesarean birth
8	Other
9	Normal presentation

Figure 5. Codes assigned to lambs based on birthing position. .

Procedures

Subjective scores must be collected within 7 days after lambing. During lambing season, from the beginning of February until the end of March, I was at the barns every other evening collecting lamb and ewe data. Since these scores are subjective, it is important that I was the one who was collecting them at all times to ensure consistency among the data collection. Some ewes would lamb during the day while I was in class, and I was unable to observe and assign an assistance code. I am grateful for the sheep barn managers and sheep barn staff for keeping record of any ewe or lamb who required assistance while I could not be at the barns. In total, I collected data on 45 Suffolk ewes.

Results

Since this is an ongoing research project and I began collecting data at the forefront, it is too early for any final results to be drawn on how sheep producers can improve robustness and climatic resilience across the country. As the research project continues and lambs begin to become ewes in the flock, we will be able to better understand what genomic traits to improve on to increase productivity in the sheep industry.

While no results could be drawn, here are some averages from the data collected on the Suffolk ewes:

Description	Average	Range
Average Ewe BCS at Breeding	3.0	1.0– 5.0
Average Ewe Body Weight at Breeding	182.7 pounds	123 pounds – 247 pounds
Average Ewe Udder Depth Score	7.0	1.0 – 9.0
Average Ewe Teat Placement Score	6.0	1.0 -9.0
Average Ewe BCS at Lambing	2.8	1.0 – 5.0
Average Ewe FAMACHA at Lambing	2.0	1.0 - 5.0

Next Steps

Beginning in May and June of 2023, the Suffolk lambs will be weaned and their body weight and FAMACHA score will be recorded. In addition, a stool sample will be collected to determine their Fecal egg count, a beneficial measuring tool to determine parasite resistance. Ewe data collection during this time will include body weight, body condition score, and FAMACHA score.

In addition to the data collected, we will begin taking DNA samples to ensure accuracy in our genetic lines. If DNA samples have already not been collected on the Suffolk ewes, lambs, and rams, those samples will be taken and put into a database. DNA testing provides another constant in our research data.

Acknowledgements

Dr. Ron Lewis, University of Nebraska-Lincoln, *Professor – Animal Breeding and Genetics*

Dr. Scott Greiner, Virginia Tech, *Professor – Extension Animal Scientist*

Conclusion

As mentioned earlier, this is an ongoing research project until the year 2025. With this being said, undergraduate research assistants will be needed for the upcoming years. Being an undergraduate student with limited research experience, I can say this project was a great way to gain a better understanding of research concepts and procedures. I have also appreciated the opportunity to work in conjunction with another university with the common goal of improving the livestock industry.

If "Sheep GEMS" is a research project you would be interested in, please feel free to reach out to me at baileyreinwatson@vt.edu.