

Virginia Cattle Industry Board

Final Report

9/30/2022

Project Lead: Fernando Biase
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Title: Identifying molecular markers to reduce economic losses due to infertile heifers in beef cattle

Project Type: Education Market Development Promotion Research Youth Development

Original Funding Amount: \$20,000

Remaining Balance: \$0

Objectives and Results:

Objective 1. Produce whole-genome sequencing for 10 heifers of different fertility fitness

Results: We have produced genotypic data from 770,000 single nucleotide polymorphisms from 12 Angus heifers. Five of these heifers were pregnant and delivered a healthy calf after only one artificial insemination service. Seven of these heifers did not get pregnant after two services of artificial insemination plus 60 days with a clean-up bull.

Objective 2. Analyze the data to identify variations in the DNA sequence that can predict infertility in heifers.

Results: After filtering the genotypes to maintain those that were informative, we analyzed 606,553 genotypes across the cattle genome. The analysis of these genotypes identified two single nucleotide polymorphisms that were significantly associated with fertility fitness in heifers (Table 1).

Table 1. Single nucleotide polymorphisms associated with fertility in heifers.

SNP	Chromosome	Nucleotide	Allele 1	F_A	F_U	Allele 2	P value	OR
BovineHD1200026258	12	89664275	G	0	0.7083	A	6.75E-07	0
Hapmap31720-BTA-126418	11	37519673	G	0.7778	0.125	A	2.66E-05	24.5

We identified that the majority of the animals (one in six) having a genotype adenine:adenine (AA) for the single nucleotide polymorphism located on the chromosome 12 nucleotide 89664275 had no pregnancy detected after multiple attempts of artificial insemination and exposure to a bull, whereas all animals that had a guanine (G) in one of the two copies of the DNA (AG or GG) produced a calf after the first artificial insemination. Similarly, for the polymorphism detected in the chromosome 11 nucleotide 37519673, all animals having two copies of adenine (AA) produced a calf after the first artificial insemination (Table 2).

Table 2. Genotypes indicative of the fertility fitness of Angus heifers.

SNP Name	Genotype	Phenotype	n
BovineHD1200026258	AA	Fertile	1
BovineHD1200026258	AA	Sub-fertile	5
BovineHD1200026258	AG	Fertile	1
BovineHD1200026258	GG	Fertile	5
Hapmap31720-BTA-126418	AA	Fertile	5
Hapmap31720-BTA-126418	AG	Fertile	2
Hapmap31720-BTA-126418	AG	Sub-fertile	4
Hapmap31720-BTA-126418	GG	Sub-fertile	1

Overall Benefit for Virginia Cattle Industry:

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We expect that the identification of these genotypes that are associated with animals having a calf early in their reproductive season, will allow us to develop procedures to aid in the selection of these animals, increasing the selection intensity for fertility in beef cattle heifers.

Activities Associated with Project:

Training of a graduate student: Two graduate students (Chace Wilson, Mackenzie Marrella) have been involved with this work and were trained in several aspects of animal handling, molecular genetics, bioinformatics, statistical analysis, and the writing of scientific reports.

Abstract presentation: Chace Wilson wrote an abstract and presented his work at the 55th Annual Meeting of the Society for the Study of Reproduction, Spokane, WA. See citation below.

Wilson C*, **Biase FH**. Differential Transcript Abundance in Peripheral White Blood Cells of Holstein and Angus Heifers Relative to Fertility at the Time of Artificial Insemination. 2022. 55th Annual Meeting of the Society for the Study of Reproduction, Spokane, WA.

Lessons Learned:

Since we have experience with handling of samples, we had no problem with the collection of samples and data production. There was a minor delay in the time that it took for the student to learn the bioinformatic procedures and statistical work needed to complete the research.

Future Work:

Currently, we are preparing a manuscript to disseminate these results to the scientific community, and we are working to partner with extension faculty in our School of Animal Sciences who will help us disseminate our results to the producers in Virginia.

Next, we will seek funds to collect more samples to confirm our results and to initiate the development of potential tests that will identify these animals that have a significantly lower likelihood of delivering a calf at 25 months of age.

Regions:

Please indicate what Virginia cattle production areas were impacted by this grant activity:

Select all that apply:

District I – Western South West

Buchanan, Dickenson, Lee, Russell, Scott, Smyth, Tazewell, Washington, Wise

District II – Eastern South West

Bland, Carroll, Floyd, Giles, Grayson, Henry, Montgomery, Patrick, Pulaski, Wythe

District III – Southern Valley

Alleghany, Amherst, Augusta, Bath, Botetourt, Craig, Highland, Nelson, Roanoke, Rockbridge

District IV – Northern Valley

Clarke, Frederick, Page, Rockingham, Shenandoah, Warren

District V – Northern Piedmont

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Accomack, Albemarle, Arlington, Caroline, Culpeper, Essex, Fairfax, Fauquier, Fluvanna, Gloucester, Goochland, Greene, King and Queen, King George, King William, Hanover, Henrico, Lancaster, Louisa, Loudoun, Madison, Matthews, Middlesex, New Kent, North Hampton, Northumberland, Orange, Prince William, Rappahannock, Richmond, Stafford, Spotsylvania, Westmoreland

District VI – Southern Piedmont

Amelia, Appomattox, Bedford, Brunswick, Buckingham, Campbell, Charlotte, Charles City, Chesapeake, Chesterfield, Cumberland, Dinwiddie, Franklin, Greenville, Hampton, Halifax, Isle of Wight, James City, Lunenburg, Mecklenburg, Newport News, Powhatan, Nottoway, Pittsylvania, Prince Edward, Prince George, Suffolk, Sussex, Southampton, Surry, Virginia Beach, York

Final Budget and Justification:

Item Type	Original Awarded Amount	Final Amount Spent
Personnel	644.00	644.00
Fringe	6,576.00	6,576.00
Travel	[\$0.00]	[\$0.00]
Supplies & Materials	2,780.00	2,780.00
Contractual	10,000.00	10,000.00
Other	[\$0.00]	[\$0.00]
Total	\$20,000.00	\$20,000.00

[How does the original budget relate to the final? Discuss any differences. Please include source and amount of other supporting funds, facilities, and personnel, if applicable.]

Credits:

Wilson C*, **Biase FH**. Differential Transcript Abundance in Peripheral White Blood Cells of Holstein and Angus Heifers Relative to Fertility at the Time of Artificial Insemination. 2022. 55th Annual Meeting of the Society for the Study of Reproduction, Spokane, WA.

We are currently drafting the paper associated with these results and will acknowledge the funding from the Virginia Cattle Industry Board.