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Dairy Pipeline

School of Animal Sciences
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Beyond Boundaries and Inclusion and Diversity at Its Best

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InclusiveVT is a foundational project included in the *Beyond Boundaries* vision of Virginia Tech. According to the *InclusiveVT* project, "increasing faculty, staff, and student diversity" is one of the four major institutional goals. In their report *The Future of Food and Agriculture: Trends and Challenges*, the Food and Agriculture Organization stated that having access to good quality education is paramount for enhancing equity and creating jobs in agriculture. To meet the societal need of increasing the pool of a diverse academic and industry community, and in line with the *InclusiveVT* project, the School of Animal Sciences at Virginia Tech has initiated collaborations with the College of Agriculture at Virginia State University. The following are some of the activities and synergies we have worked on in collaboration with Virginia State University.

In 2021, Dr. Ferreira obtained funding from the ICTAS Diversity & Inclusion Seed Investment Program and initiated a collaboration with Dr. Laban Rutto, from Virginia State University. The outputs of this collaboration include a research project on ruminal fiber digestion of hops, a "faculty mixer" meeting hosted by Virginia State University (8 faculty present) to build collaborations with faculty from Virginia Tech (5 faculty present), a submission of a multimillion-dollar grant to USDA by Virginia State University in collaboration with CalPoly and Virginia Tech, and two virtual guest lectures from Dr. Ferreira at Virginia State University. By all measures, the outcome of the 2021 ICTAS Diversity & Inclusion Seed Investment has been a strong, synergistic, and growing relationship between the two land-grant universities.

During the "faculty mixer" mentioned above, faculty from both universities expressed two synergistic positions. Virginia State University expressed the need to expose students to hands-on activities to better prepare students interested in pursuing careers in Animal or Veterinary Sciences. In response to this, Virginia Tech offered to open the doors of the VT Dairy Complex or the VT Beef Complex to Virginia State University students for experiential learning activities during the summer. On the other side, Virginia Tech expressed the need to increase the diversity and number of applicants to pursue graduate studies in the School of Animal Sciences. In response to this, Virginia State University expressed its willingness to encourage their students to pursue post-graduate degrees in Animal and Veterinary Science.

Later in the fall semester (Figure 1), a group of 11 students and 6 faculty from Virginia State University led by Dr. Neil Brown, visited the School of Animal Sciences and its animal units (dairy, beef, sheep, equine, and swine) for one day. The Minorities in Agriculture, Natural Resources and Related Sciences (MANRRS) program supported this activity, which served as a

kick-off to start a week-long program in which four students from Virginia State University came to Virginia Tech to perform experiential learning research activities (Figure 2). The latter included performing an in situ digestibility study with rumen-cannulated cows, collecting urine from cows to measure urine acidity, and performing fiber analyses in the Dairy Nutrition Laboratory, among many other tasks. It is worth highlighting that the latter program has been funded by the College of Agriculture and Life Sciences and that Drs. Corl and Schramm are collaborators in this project.

As of right now, the final outcomes of these activities are unknown. However, the synergism between Virginia Tech and Virginia State University is a clear expression of the *Beyond Boundaries* and the Inclusion and Diversity initiatives of Virginia Tech that should definitively have a positive impact on enhancing equity and creating jobs in agriculture.

Figure 1. Virginia State University students and faculty, led by Dr. Neil Brown, visiting animal units at Virginia Tech School of Animal Sciences. Photo credit: Milton Schultz, VT SAS graduate student

Figure 2. Students from Virginia State University involved in experiential learning activities at Virginia Tech. Photo credit: Gonzalo Ferreira, associate professor, VT SAS.

Beating the Heat with a Slick Hair Coat

Authored by Mark Ellett, Jr., Ph.D. Candidate with Kristy Daniels, Associate Professor—Animal Systems Biology, School of Animal Sciences, Virginia Tech; *danielsk@vt.edu*

Common US dairy cattle breeds are not known for heat tolerance. Continued genetic selection for milk production is at direct odds with heat tolerance. The process of lactation is an energetically costly activity that generates heat; higher milk yield generally translates into higher metabolic heat production. High ambient temperature and humidity also negatively affect dairy cows, often resulting in reduced dry matter intake, milk yield, and reproductive performance. The number of annual high temperature and humidity days in most dairy states is predicted to increase over time. If high producing dairy cows cannot dissipate accumulated heat from metabolism and the environment, the condition of heat stress (HS) follows. Many dairy farmers currently try to combat HS by dissipating heat through facility modifications such as fans, soakers, and misters. These modifications use resources and can increase production costs. What if there were a way to make dairy cows more heat

tolerant without sacrificing production? This article explores the topic further.

Thermal conditions provide selective pressure and drive evolution in dairy cattle. *Bos taurus* breeds of cattle (e.g., Holstein, Jersey) are adapted to temperate climates. Senepol cattle, also *Bos taurus*, from the island of St. Croix are tolerant of the tropical Caribbean climate. Heat tolerance of Senepol cattle is attributed to a mutation in the gene that encodes the prolactin receptor (PRLR). The mutation manifests in animals as a shorter hair coat, lower hair follicle density, and larger sweat glands and is known as the *SLICK1* mutation or *SLICK1* allele. The *SLICK1* allele is heritable and dominant; heterozygous individuals express the SLICK1 phenotype. Cattle with this short, "slick looking", hair coat phenotype can dissipate excess heat easier than wild-type counterparts.

Dairy scientists at the University of Florida have been interested in the heat tolerant traits conveyed by the *SLICK1* allele for the past three decades. They have found that Holstein cattle with this heat tolerant mutation (introduced through crossbreeding with Senepol cattle) are better at dissipating heat than wild-type counterparts. During HS, SLICK1 cattle have a core body temperature that is approximately 0.9°F lower than wild-type counterparts; this is notable because a rise of 1.8°F or less in rectal temperature is enough to reduce productive performance in most livestock species. The SLICK1 cows also exhibited an increased sweating rate and produced 2.9 lb. of milk more per day than the wild-type Holsteins in HS conditions. From an energetic standpoint, it is presumed that SLICK1 cattle have comparatively lower maintenance costs when challenged with HS, allowing them to divert more energy toward milk, but this remains to be examined experimentally. Also lacking is an economic investigation into the utility of introducing this trait. That said, semen from bulls carrying the *SLICK1* allele is commercially available in the US. So, traditional crossbreeding is one way to introduce the trait into a dairy herd. Another way to introduce the mutation is through gene editing.

In March of 2022, the Food and Drug Administration approved the use of gene-editing technology to create cattle with the SLICK1 phenotype. CRISPR technology is used to make an intentional genomic alteration (IGA) in the PRLR gene that truncates the receptor. The cattle that are produced via this gene editing technology are not classified as a genetically modified organisms (GMO) because unlike GMO, which have genes from other organisms inserted into DNA, the IGA used to produce SLICK1 cattle mimics the naturally occurring bovine *SLICK1* allele. Thus, IGA technology produces purebred SLICK1 cattle without the need for crossbreeding. Once the initial group of gene-edited cows are produced, the *SLICK1* allele will be passed to the next generation in the same dominant fashion as cattle that acquire the mutation naturally. Products produced from the gene-edited cattle will be identical to the products produced from cattle that are bred to have the SLICK1 phenotype.

The use of CRISPR technology allows for insertion of the *SLICK1* allele into dairy cattle embryos without sacrificing production performance. The use of this gene editing technology will allow for the production of a genetically diverse population of SLICK1 dairy cattle faster than producing these cattle through selective breeding techniques.

Overall, SLICK1 cattle appear to be more tolerant of HS conditions than wild-type cattle. The use of selective breeding for heat tolerance may aid in preventing the cost of heat mitigation from increasing in parallel with global temperature. Although this phenotype may help curb HS related losses, more research is needed to determine how these cattle will perform in different climate conditions. For example, how will SLICK1 calves tolerate winter conditions? This question, along with many others, need to be

evaluated to determine productive and economic impacts of incorporating these genetics into US dairy herds. As of now, SLICK1 genetics seem like a promising method to increase heat tolerance but time will tell if SLICK1 cattle can truly beat the heat without breaking the bank.

Figure 3. The photographs depict the SLICK phenotype (a) and the wildtype (b) in Senepol crossbreeds. The SLICK1 phenotype has shorter hair on the face, poll, and topline. - Photo taken from Littlejohn, M. D. et al. Functionally reciprocal mutations of the prolactin signaling pathway define hairy and slick cattle. Nat. Commun. 5:5861 doi: 10.1038/ncomms6861 (2014).

Upcoming Events

SWVA 4-H Tractor Club Trip to Southeast Old Threshers Reunion Show in Denton, NC
July 1, 2023

Southeast Dairy Youth Retreat
July 9 - July 12, 2023 (Statesville, NC)

Farm Dinner Theatre
July 14, 2023 (Franklin Co.)

Virginia Dairy Expo
July 14, 2023 (Shenandoah Valley Produce Auction)

Cheese Making Class
July 17, 2023 (Franklin Co.)

SWVA 4-H Tractor Club Toy Tractor Display Contest
August 1-3, 2023 (Rich Valley Fair)

State 4-H / FFA Dairy Youth Field Day
August 3, 2023 (Harrisonburg, VA)

Virginia Summer Showdown - Summer All Breed Dairy Shows
August 4-5, 2023 (Rockingham Co. Fairgrounds)

Virginia State Fair
Jr Dairyman's Contest - September 22, 2023
Dairy Show - September 23, 2023

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