AG2PI SEED GRANT PROPOSAL: WORKING GROUPS

Title of Proposed Working Group:

Goat Together: Partnerships to Advance Goat Genome to Phenome Research to Ensure Food Security

Working Group Lead/ PI (Name, Title, Affiliation(s), email)

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1. Objectives/aims

Goats are the most adaptable and geographically widespread livestock species [1]. Over one billion goats from more than 600 breeds are dispersed across the world, providing an important source of food for human from milk and meat [2]. Despite the popularity and economic importance of goats, there are ***significant gaps*** in 1) the knowledge base of goat genome, pan-genome, and pan-epigenome, as well as their associations with goat phenome; 2) capacity such as expertise and resources dedicated to goat research; 3) adoption of advanced genomics technology by the goat industry. The ***overall goal*** of this project is to bring together experts from diverse disciplines and multiple research institutions to explore collaborative research opportunities in advancing goat genome to phenome research to improve goat sustainability and resilience to climate change.

The International Goat Research Center (IGRC) at Prairie View A&M University (PVAMU), an 1890 Land Grant Institution and prominent HBCU, currently houses more than 400 goats and has equipment and facilities to measure various economically important traits in goats. The PI and the Co-PIs at the IGRC have a breadth of expertise that is directly relevant to the goal of this proposal. Our collaborators at Agricultural Research Service (ARS) are the first in the world to develop a "golden" goat genome (ARS1) [3, 4]. Our collaborator at the University of Idaho has recently received a grant from NIFA to develop the Ovine Pangenome [5]. Our collaborator at Cornell University has led the African Goat Improvement Project to identify distinct genetic goat populations for future genetic improvement [6]. Our collaborator at the University of Pittsburgh has expertise in functional and computational genomics applied to immunology. The members of the working group have met on February 13, 2023, via a virtual meeting, and **propose the following objectives/activities:**

(1) Create a network of researchers from diverse disciplines and multiple institutions to bridge the knowledge gaps in goat genome to phenome research.

We will invite scientists to visit the IGRC, at PVAMU, to explore collaborative opportunities in goat genome to phenome research. After the on-site meeting, the group will host regular meetings to discuss current progress and future directions in goat (pan)genome, (pan)epigenome, and GoatGTEx research; explore multi-omics approaches to study economically important traits in goats; discuss potentials to study soil, plants, and animals in a systems approach; discuss key hurdles in implementing genomic selection in American dairy and meat goats to ensure food security in the US and the world. We will broaden our group to include experts from diverse disciplines, industry and goat producers, and will visit other's research centers to further explore collaborative research and develop joint grant proposals. We will write and publish a concept paper addressing the needs identified by the working group and give a presentation at an AG2PI workshop.

(2) Build upon existing resources and identify emerging precision phenotyping technologies needed to improve goat sustainability and resilience.

The team will exploit the rich phenotypic data accumulated at the IGRC and develop plans to incorporate genetic and genomic information to study economically important traits in goats. It will leverage existing resources, e.g., the GrowSafe (Vytelle) System, and identify emerging precision phenotyping technologies that can be used to improve goat sustainability and resilience. Our extension specialists will work with goat producers and consumers to better understand the needs and opportunities of this industry and translate our research outcome to benefit this underrepresented yet globally important species.

2. Furthering the aims of the AG2PI

The project seeks to establish an expert team with members from diverse disciplines across multiple research institutions in the United States to explore opportunities in advancing goat genome to phenome research. We will convene an in-person meeting at the International Goat Research Center at PVAMU. The meeting will address the AG2PI working group priority areas including: 1) defining additional areas of expertise that need to be represented in order for the group to be successful; 2) identify influential members of those communities and seek out their input/establish a network of researchers from a variety of disciplines and agencies with a shared vision; and 3) determine short- and long-term research objectives that will be needed to realize the shared vision. As of today, we have assembled a team of scientists from multiple research institutions across the US with a shared vision in goat genome to phenome research. We will continue to expand our team to include expertise from much broader areas, which will include but not limited to plant, soil, and data sciences, to tackle specific research topics identified by the group. This project will address the gaps in the knowledge base and identifying main hurdles and key opportunities in implementing genomics and precision phenotyping technologies to improve goat sustainability and resilience to climate change and therefore to ensure food security. This project will also work with underrepresented goat producer and consumer groups to better understand the needs and opportunities of this industry and create a community to further research efforts in this underrepresented yet globally important species.

3. Expected outcomes & deliverables

Outcomes and deliverables from this project include: 1) a database that includes the rich phenotypic data that has been generated at the IGRC; 2) a strategic plan to integrating genomics and phenomics technologies to study goat feed efficiency, methane emission, and in-pen environmental indicators and relate that with goat sustainability and resilience to climate change; 3) list of resources needed to study soil, plants, and animals in a systems approach to address goat sustainability and climate change; 4) a clear picture of current progress and future directions in goat (pan)genome, (pan)epigenome, and GoatGTEx research; 5) a better understanding of challenges and opportunities in implementing genomic selection in American dairy and meat goats; 6) better knowledge of emerging precision phenotyping technologies that can be used by researchers and goat producers to improve goat sustainability and resilience; and 7) a community of scientists, extension specialists, technology translators, and industry stakeholders with concerted efforts in delivering knowledge and technology to underrepresented goat producers. The project will establish a team with diverse expertise to advance goat genome to phenome research. It will train highly qualified personnel with more advanced knowledge and skills to conduct genome to phenome research. The project will establish a community of scientists and extension specialists to help better translate the knowledge to the goat producers and help the scientists to better understand the needs and opportunities of the industry. One seminar presentation will be given at an AG2PI conference or workshop. Literature review papers produced by the working group will be published in a scientific journal. These will catalyze the AG2PI community efforts with respect to the priority areas mentioned in section 2.

4. Qualifications of the project team

Dr. Liuhong Chen (PI) is a Research Associate Professor of Animal Breeding and Genetics in the College of Agriculture and Human Sciences at Prairie View A&M University. He has gained extensive research experience from both academic and industrial environments. His expertise includes quantitative genetics and genomic, animal models for genetic evaluation, genomic prediction algorithms, and machine learning. **Dr. Erdogan Memili (Co-PI)** is Professor and Executive Associate Director of Cooperative Agricultural Research Center at Prairie View A&M University. His expertise includes functional genomics and epigenomics associated with economically important traits in livestock. **Dr. William Foxworth (Co-PI)** is the Director and Lead Scientist of the International Goat Research Center at Prairie View A&M University. His expertise includes goat reproduction and production. **Dr. Juan Romano (Co-PI)** is the Chief Veterinarian of the International Goat Research Center at Prairie View A&M University. His expertise includes ruminant health, production and reproduction. D**r. Ben Rosen** is a Research Biologist at Animal Genomics and Improvement Laboratory of USDA ARS. He is currently leading genome assembly and pangenome initiatives in cattle, sheep, and goat as well as generating long-read sequence data sets for population level variant discovery. **Dr. George Liu** is a Research Biologist at Animal Genomics and Improvement Laboratory of USDA ARS. His expertise covers genome assembly and annotation. His achievement has been evidenced by high influential papers published on top journals [7, 8, 9, 10] and co-foundation of the FarmGTEx Consortium. **Dr. Curt Van Tassell** is a Research Geneticist at Animal Genomics and Improvement Laboratory of USDA ARS. He is a renowned scientist known for the development of MT Gibbs Sampler for genetic parameter estimation, leadership in the Bovine HapMap and other assembly development projects, pioneering in the development of BovineSNP50 genotyping chip. **Dr. Heather Huson** is an Associate Professor at Department of Animal Science at Cornell University. Her expertise includes genetic improvement of animal health and production, dairy cattle management and genetic evaluations, population structure and adaptation, genomic tool development, wildlife and indigenous population conservation, and canine genetics. **Dr. Olanrewaju Morenikeji** is an Assistant Professor at the Division of Biological and Health Sciences at the University of Pittsburgh at Bradford. His expertise encompasses integrative approach of both experimental and computational genomics to understand the underlying mechanism of phenotypic and genotypic differences shaped by the evolutionary forces and elucidating biological pathways of complex trait expression in animals and humans, using state-of-the-art molecular and computational techniques.

5. Proposal timeline

Objective / Activity	2023 4-5	2023 6-7	2023 8
Visit the International Goat Research Center at Prairie View A&M University.	▓	▓	▓
Exploit the phenotypic database at the IGRC.	▓	▓	▓
Discuss goat (pan)genome, (pan)epigenome, and GoatGTEx.	▓	▓	
Explore multi-omics approaches to study economically important traits in goats.	▓	▓	
Explore systems approaches to study soil, plants, and animals in goat research.			▓
Identify emerging precision phenotyping technologies needed to improve goat sustainability and resilience.			▓

6. Engaging AG2P scientific communities & underrepresented groups

Discussions from this working group will be directly disseminated to undergraduate and graduate students, extension specialists, technology translators, and other underrepresented groups at the HBCU through seminars and/or presentations on farm field days. One seminar presentation will be given at an AG2PI conference or workshop. Review papers will be published in scientific journals.

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