Indigenous livestock, national heritage for livestock production in 21st century from the genomics perspective

Joram M. Mwacharo

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Distribution of Sheep and Goats (FAOSTAT: 1993 - 2013)

- Large genetic diversity and well adapted to diverse production systems and agro-ecologies

- Plays critical socio-cultural and economic roles in many communities

- Provides a wide range of products: milk, meat, skins and fiber

- A high level of participation by women - empowering women and youth
Diversity of goats and sheep - Examples from Africa (about 98 and 122 local breeds of goats and sheep (DAD-IS/DAGRIS - http://www.dagris.info/))
Unique role of indigenous livestock small ruminants

- Indigenous livestock - Most common in smallholder, pastoral and nomadic systems and are a unique set genotypes:
  - Adapted to survive under harsh conditions, are disease/parasite resistant: Red Maasai - resistance to endo-parasites;
  - Well adapted to specific agro-ecological zones: Kaffa goats, Djalonke Sheep and West Africa dwarf goats - humid zones and trypanotolerant

- Consequently most of the initial molecular genetics research has focused on understanding and harnessing genetic diversity and in recent times adaptive unique features.
Genomic data reveals the genetic uniqueness of indigenous livestock
Genetic diversity and structure

a) African vs Non-African goats

African goats:
- Differ from Non-African goats
- Shows their unique genetic makeup

African goats only

African goats:
- Show wide genetic variation
- High genetic diversity and structure

Huson et al 10th World Congress on Genetics Applied to Livestock Production
Phenotypic diversity in indigenous livestock
Genetic diversity and structure

Genetic diversity and structure in Asian native goat analyzed by newly developed SNP markers

Bang Zhong LIN, Taiki KATO, Makoto KANEDA, Hirokazu MATSUMOTO, Shinji SASAZAKI and Hideyuki MANNEN

Population genomic structure and linkage disequilibrium analysis of South African goat breeds using genome-wide SNP data

K. Mdladla*, E. F. Dzomba†, H. J. Huson‡ and F. C. Muchadeyi*

Characterizing neutral genomic diversity and selection signatures in indigenous populations of Moroccan goats (Capra hircus) using WGS data

Badr Benjelloun1,2,3*, Florian J. Alberto1,2, Ian Streeter4, Frédéric Boyer1,2, Eric Coissac1,2, Sylvie Stucki5, Mohammed BenBati2, Mustapha Ibeliebachy6, Mouad Chentouf7, Abdelmajid Bechchari9, Kevin Leempoel1, Adriana Alberti9, Stefan Engelen9, Abdelkader Chikhi6, Laura Clarke8, Paul Flice8, Stéphane Joost5, Pierre Taberlet1,2, François Pompanon1,2 and NextGen Consortium10

Heterozygosity > 0.27
Summary of findings

• The high genetic diversity in indigenous stocks provides the flexibility to respond to unpredictable future changing environmental conditions as well as consumer demands.

• Admixture has created a unique mosaic of reservoir of genetic diversity that provides the raw material for breeding while ensuring the resilience of the populations to survive in different environments.

• Populations with unique genetic backgrounds reflect most likely adaptations to specific biotic and abiotic environmental conditions.
Genomic data reveals genetic adaptation to extreme environments in indigenous livestock
Adapted to extreme environments

Desert like environments

High altitude environments
Adaptations to Climate-Mediated Selective Pressures in Sheep

Feng-Hua Lv,1 Saif Agha,2,3 Juha Kantanen,4,5 Licia Colli,6,7 Sylvie Stucki,2 James W. Kijas,8 Stéphane Joost,2 Meng-Hua Li,*1 and Paolo Ajmone Marsan6,7

Exome sequencing reveals genetic differentiation due to high-altitude adaptation in the Tibetan cashmere goat (Capra hircus)

Shen Song1,2, Na Yao1, Min Yang1, Xuexue Liu1, Kunzhe Dong1, Qianjun Zhao1, Yabin Pu1, Xiaochong He1, Weijun Guan1, Ning Yang2, Yuehua Ma3 and Lin Jiang1

Genome-wide analysis reveals adaptation to high altitudes in Tibetan sheep

Caihong Wei1,*, Huihua Wang1,2,3,*, Gang Liu2,*, Fuping Zhao1, James W. Kijas4, Youji Ma5, Jian Lu2, Li Zhang1, Jiaxue Cao2, Mingming Wu1, Guangkai Wang1, Ruizao Liu1, Zhen Liu1, Shuzhen Zhang1, Chouchen Liu2 & Lixin Du1

multiple genomic signatures of selection in goats and sheep indigenous to a hot arid environment

E-S Kim1,2, AR Elbeltagy2,5, AM Aboul-Naga2, B Rischkowsky3, B Sayre4, JM Mwacharo3 and MF Rothschild1

Whole-genome sequencing of native sheep provides insights into rapid adaptations to extreme environments

Ji Yang,1,5 Wen-Rong Li,1,5 Feng-Hua Lv,1,5 San-Gang He,1,5 Shi-Lin Tian,1,5 Wei-Feng Peng,1,5 Ya-Wei Sun,2,3 Yong-Xin Zhao,1,4 Xiao-Long Tu,3 Min Zhang,1,5 Xing-Long Xie,1,4 Yu-Tao Wang,6 Jin-Quan Li,7 Yong-Gang Liu,6 Zhi-Qiang Shen,9 Feng Wang,10 Guang-Jian Liu,9 Hong-Feng Lu,2 Juha Kantanen,11,12 Jian-Lin Han,13,14 Meng-Hua Li,*1 and Ming-Jun Liu*2
Summary of findings

- Indigenous goat and sheep populations found in extreme environments, most of which are found in developing countries, provide a genetic resource that is well adapted to perform cost effectively in such environments.

- Therefore, they are a resilient livestock genetic resource for sustainable livestock production under worsening climatic conditions.
Thank you very much