



**Sustainable
Southwest Beef**
Knowledge and tools for
ranch and rangeland resilience

RARÁMURI CRIOLLO: A GENETIC RESOURCE FOR CLIMATE RESILIENT LIVESTOCK PRODUCTION

What are Rarámuri Criollo cattle?

Rarámuri Criollo (RC; Figure 1) is a heritage cattle biotype introduced to the U.S. Southwest from the Sierras of the Copper Canyon of Chihuahua, Mexico. These cattle have been raised with minimal artificial selection or crossbreeding by the Tarahumara communities for about five centuries.

In 2005, a small herd of a few young bulls and cows was imported and marked the beginning of a network of research collaborations exploring adaptations to changing climatic and vegetation conditions of the southwest, with implications for local beef supply chains and rangeland conservation.

Research suggests that RC cows may travel farther, use rugged and larger shrubland areas and be more heat tolerant than conventional breeds. This repertoire of behaviors may also represent traits and attributes that can potentially translate into a lower carbon, water and rangeland footprint, and help them cope with variable forage conditions and hot summers.

Identifying genomic regions and genes that are associated with these traits is crucial to facilitate the selection of livestock more resilient to climate change. In this regard, RC may represent a valuable genetic resource for use in the challenging environmental conditions and beef production systems of the U.S. Southwest.

How do we study the cattle genome?

The rapid technological advances in genomics have allowed the genetic characterization of livestock. Through genomic analysis, information relevant to the management of livestock genetic resources can be obtained:

- Breed/biotype origin and history
- Pedigree errors
- Crossbreeding
- Inbreeding
- Distinctive phenotypes
- Genetic defects

Among the available genomic technologies, Single Nucleotide Polymorphisms (SNP) arrays are widely used for studying livestock genomes. SNP arrays test genetic variation at thousands of specific locations across the genome.

The use of SNP arrays, combined with advanced statistical and bioinformatics tools, allows the assessment of genetic diversity and structure within a breed or biotype, as well as the relationships among different populations. Furthermore, SNPs can serve as biological markers, aiding in the identification of genes associated with various traits related to performance, reproduction, adaptation, and resilience, among others.



Figure 1: Rarámuri Criollo cattle have a small frame size (2-3 score). Both cows and calves (top) and bulls (bottom) are horned animals and may exhibit a variety of coat colors and patterns.

Highlights

- Rarámuri Criollo represents a distinctive heritage genetic biotype.
- Rarámuri Criollo may be a valuable genetic resource pool for the selection of livestock resilient to climate change.
- Measures are being implemented for the long-term conservation of the Rarámuri Criollo gene pool.

Rarámuri Criollo appears to be a unique Criollo cattle biotype

Studies conducted at the USDA Jornada Experimental Range (JER) revealed that the RC herd exhibits low levels of inbreeding and sufficient genetic variability and diversification (Figure 2). Further analysis explored the relationship of RC and other criollo biotypes from South, Central and North America. Results indicated that RC formed a separate group from the other heritage cattle, with the distant U.S. Texas Longhorn being the most closely associated population (Figure 3).

Genomic regions of Rarámuri Criollo related to important traits.

Signatures of selection are regions in the genome that have been preferentially selected within a population due to their functional relevance in specific physiological processes. This phenomenon can be driven by natural and/or artificial selection.

The identification of selection signatures has become an important tool for animal geneticists as it can be used to identify genes and beneficial mutations that result in a selective advantage in a particular livestock population. Studies conducted at the USDA JER revealed that the RC cattle have beneficial mutations for several traits of economic, ecological and management interest:

- Length of productive life,
- Thermo-tolerance,
- Immune response,
- Meat tenderness and marbling,
- High fatty acid milk content.

These studies suggest that RC could provide a valuable source of genes associated with economic, productive, and resilience traits. This knowledge could aid the selection of livestock resilient to climate change and extreme weather conditions, while also maintaining positive productive indices and product quality parameters.

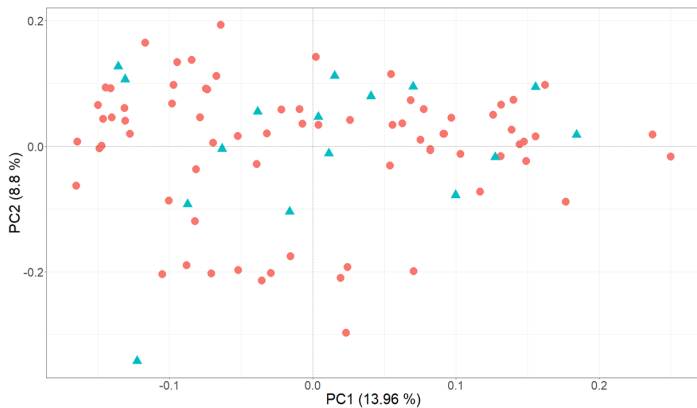


Figure 2: This plot illustrates the genetic diversity of the USDA JER Raramuri Criollo. Each symbol represents one individual. Red dots represent females and blue triangles represent males. This principal component analysis of Raramuri Criollo individuals was conducted using thousands of SNPs per test subject.

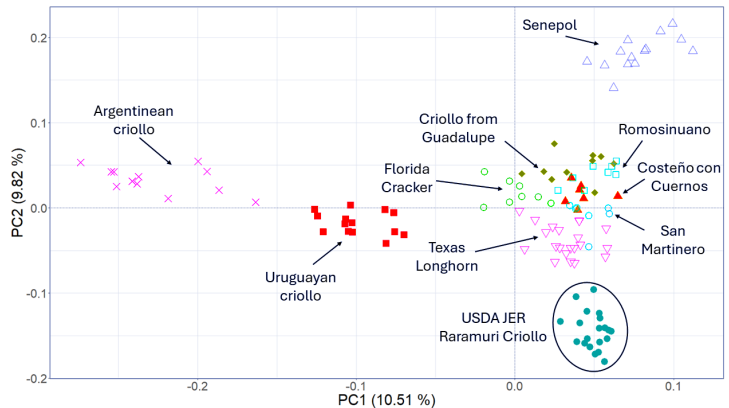


Figure 3: Genetic relationship of the USDA JER Raramuri Criollo with other heritage cattle from the Americas. Each symbol represents one individual, while each color represents a Creole biotype. The JER Raramuri Criollo cattle are highlighted with a circle. This principal component analysis of cattle biotypes was conducted using thousands of SNPs per individual.



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For further reading: Spetter MJ, Estell RE, Utsumi SA, Armstrong E, Jara E, Ross P, Macon L, Perea AR, Cox A, Spiegel SA. Genetic characterization of Raramuri Criollo introduced into the Southwestern United States. ASAS-CSAS-WSASAS Annual Meeting 2024

