



**FOOD
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Conservation Strategies for Livestock Diversity for Sustainable Production

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Livestock play diverse biological roles. These must be better understood and utilized to conserve livestock biodiversity for a sustainable agricultural future. Many native and local breeds are important reservoirs of this genetic diversity. Identifying and conserving these breeds will be key to the development of sustainable agricultural systems that can persist amid the challenges of a changing climate and a rapidly growing human population. This is an especially pressing need in locations with low levels of development, although it is also important in industrialized nations.

Livestock are vilified as disproportionate contributors to greenhouse gas emissions and environmental degradation. This conclusion is largely derived from studies of unsustainable industrial production, while ignoring the diverse array of livestock production systems that have low greenhouse gas emissions and positive biological impacts. When managed well, such systems offer agricultural sustainability and restorative environmental outcomes.

Livestock production contributes significantly to human welfare. Assuring beneficial, long-term outcomes from livestock production is essential for human survival. Sustainable systems need animals that fit well into a wide variety of environments, and this is served best by having genetic resources (breeds) to fit each situation. These resources have been developed over generations in response to human needs in various environments. The last century saw a dramatic loss of breeds, concurrent with environmental changes and increased human populations. That synergy inevitably threatens our food production systems.

At the very time in history that livestock breeds face their greatest challenges for survival, conserving the genetic variability of these breeds is vital for creating sustainable livestock production systems that assure human welfare. The high productivity and product uniformity of industrial livestock production has overshadowed systems that have lower yields, and advanced cost/benefit analyses are needed to document the many lower-input systems that can remain productive with low environmental costs. Native and local breeds are often the best fit for these production systems, yet many genetically and culturally valuable breeds that are highly adapted are in danger of extinction.

Livestock provide nutritional sustenance for people, and this relies on land. Land is most efficiently used for human sustenance when humans derive about 12% of their dietary protein from animals. Animals can transform feedstuffs that are inedible to humans into high-quality complete protein that is ideal for human nutrition. Livestock can be fed products that are not suitable for human consumption, and can be raised on lands that are not useful for crops. Such systems minimize competition between animals and humans for nutrients. This contrasts with industrialized production systems where animals are fed high-value nutrients (especially grains and soybeans) that could be used directly for human nutrition.

Livestock production must be transformed in ways that reverse environmental degradation, enhance conservation, and achieve sustainability, all in the face of rising human populations and climate changes that put pressures on agricultural systems. Matching appropriate genetic resources to specific situations is an effective way to implement sustainable livestock production. This requires documentation of the complex interactions of animals, production systems, and environments.

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The contribution of livestock to food is obvious, but livestock also provide economic security and well-being for rural populations. About 70% of the world's rural poor depend to some extent on animal production, and animals account for 30-40% of agricultural production. Livestock production involves billions of people. The importance of its future sustainability cannot be ignored. Research is needed to document the interactions of breeds, people, and landscapes to discover how each contributes to the others and to human wellbeing. This will allow decision-makers to maximize benefits and minimize costs.

Successful livestock production must balance several competing factors. Livestock production systems need to be adaptable to both environmental and social changes. Current industrial models are likely to be inadequate in responding to these demands. Sustainable production systems require effective conservation of their components. Research and training must address resources that farmers need in order to achieve sustainable production in specific situations. Examples include integration of livestock and crop production to increase soil organic matter, better use of plant residues, and genetic selection of livestock that tolerate fluctuating and extreme climatic conditions. Land use policies should address extreme weather situations and accommodate a modern transhumance that allows seasonal movements of people and animals.



Mapuche woman with a Linca lamb

Success of future systems will depend on the availability of a wide variety of genetic resources, many of which are found among smallholders and pastoralists. In livestock and poultry, these are breeds. A diverse range of available breeds allows specific ones to be used for specific environments and production goals. Efforts to define, conserve, and develop breeds are at different stages among different regions and cultures. Some efforts have been very successful in managing breeds for a secure future; other efforts have been less successful. No single approach succeeds in all situations, but a few basic principles have been broadly successful. These approaches apply to a wide range of livestock use and management practices. They require strategies for breed documentation, organization of breeders and conservation efforts, and detailed characterization of the productive and adaptive potential of different breeds in different environments.



Nguni bulls

Breeds vary from one another due to differences in their histories of foundation, isolation, and selection. Documenting these details helps to identify repeatable genetic resources with high priority for

conservation. Long-term success in conserving the genetic diversity of different breeds must be broad enough to include populations that, while satisfying the genetic definition of breed, may not presently have official recognition. An inclusive approach can adequately conserve the genetic variability of important populations. Conservation success relies on three elements: 1) discovering populations, 2) securing them, 3) and sustaining them for long-term survival. Each element has important components.

Conservation success relies on discovering populations, securing them, and sustaining them for long-term survival.

Discovering breed populations is easiest for breeds that have a long association with a region or culture. Breed populations that have not yet been formally recognized are more challenging, especially those managed by disenfranchised people or in peripheral, compromised environments. These populations are especially important, and targeting them helps conserve valuable genetic variation

Once located, candidate populations must be defined by documenting foundation influences, breeding practices, and selection pressures. Population definitions should be sufficiently narrow to exclude randomly-bred animals but wide enough to capture sufficient variation for population sustainability. Definitions should include animals that are more similar to one another than they are to other breed resources, and should emphasize the uniqueness of the population. After evaluating the population’s history, phenotype, and genetics, candidate animals can be considered for inclusion into a conservation population.



Myotonic goats

Historic investigation and phenotypic evaluation can proceed simultaneously. History documents foundation events and identifies specific sources of animals from which the population descends. The ideal history is a foundation long ago from specifically recognized sources, or a local foundation with a high degree of genetic isolation. These characterize important conservation priorities. In contrast, constant or recent introduction of outside animals of differing breeds or types leads to insufficient genetic uniformity to serve as a resource. Evaluations of external appearance and historical investigation almost always converge on a similar conclusion: populations with a foundation long ago and a high degree of genetic isolation contain externally uniform animals with consistently reproducible traits. Populations receiving a constant influx of external influences are more variable and less immediately useful.



Meishan sow

Genetic studies help to define breeds and facilitate the inclusion or exclusion of animals into conservation programs. They reveal relationships between breeds and help assess priorities for action. Genetic studies must be both comprehensive and carefully designed because technologies change over time. No one genetic technique is uniformly suited to all aspects of population analysis. Reference samples must include all bloodlines within a breed in order to avoid omitting legitimate variation. Genetic characterization can become the definition of a breed and must not leave out portions of the breed. The animals most likely to be overlooked are those that are isolated, yet these are likely have unique genetics of high importance for breed conservation.

Once a breed is defined, it is important to secure the population. Organizing breeders to work together is useful for most breeds and ideally keeps the breed in its original location, for its original purpose, and under its original management. Breed security today depends on some degree of breeder organization, but this step may meet resistance. Many breeds survived for centuries without such organization, but failure to effectively organize in today's increasingly uniform and globalized agricultural community often leads to breed loss. When local organization of breeders is impossible, it may be necessary to remove and maintain some animals outside their original setting.

Securing a breed also requires ongoing genetic management. Management must be instituted early and should maintain the influence of all available founders. In the early stages of a conservation program, the first concern must be managing the genetic structure of the population. Once the population's structure and numbers are secure, it is possible to successfully select for productivity. After a population is secure it must be sustained for the long term. This involves both genetic management and assuring the utility of the breed. Both require broad participation of animals in the breeding population so that the population does not narrow into a few favored bloodlines or individuals. Inattention to this detail can sharply restrict genetic variation, even in large populations. Genetic variation is essential for ongoing success in selection programs and for the viability of individual animals.

Market demand is necessary for a breed's successful conservation and security. Production of breeding animals, and end-products such as meat, milk, eggs, fiber, or labor, are common sources of demand. Breed-specific products are especially useful for breed promotion and security, but not all breeds have these. Even breeds without breed-specific products can be promoted for their useful and positive roles in sustainable systems where they contribute to lower impacts and restorative outcomes.

Breed conservation is a complex task. Targeting the fit of breeds to specific environments, specific production systems, and specific products is essential for assuring conservation and continued availability of a wide variety of breeds. Conservation can, and should, balance human needs and environmental concerns in a sustainable and positive way. Native and local breeds are crucial components of resilient and sustainable animal agriculture. Diverse breeds are necessary for production systems in both local and regional systems. They will all be needed to meet the challenges of feeding growing urban populations. There is tremendous need and opportunity to create a diverse and resilient livestock agriculture system that balance environmental, economic, and social factors and incorporate livestock in sustainable and restorative production systems.



Gulf coast sheep



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