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Livestock resources and their conservation facing climate change

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ABSTRACT

Objective: To analyze the importance of local livestock resources facing climate change.

Methodology: A review of studies referenced in scientific databases disclosed in the livestock sector and animal genetic resources was made within the context of climate change.

Results: Livestock breeding is an economic activity that contributes to the food security of the country; in view of its importance, technologies and necessary changes to perform this according to the accelerated changes that occur in the environment, brought by human activity, should be implemented.

Implications: Using highly productive races that depend on external inputs and are not adapted to face the effects of climate change, make it a priority to appraise the use of local races that contribute to production under adverse conditions that prevail in warm weathers in the inter-tropical zone.

Conclusions: Adapted local race breeders should preserve local animal genetic resources so that they perform as a climate change adaptation alternative that will have repercussions on livestock production systems.

Keywords: Environmental change, local races, biodiversity.

INTRODUCTION

The preservation

and improvement of local animal genetic resources is essential so that those who breed these resources may satisfy the production needs of foodstuffs, both now and in the future, that derive from environmental changes. There are many challenges facing the animal breeding and production sector for food supply, such as an increase in demand, poverty, climate change, threats to support forms based on animal breeding, new animal health issues, environmental degradation, as well as the loss of species and races adapted at a local level. This is why efforts should be aimed at responding to changes in the demand of products of animal origin by consumers (FAO, 2016; Pilling *et al.*, 2008).

Resilience, understood as a system's capacity to recover from a negative event parallel to keeping its basic setup, is a relevant property of agroecosystems in relation to changes in the environment. Biodiversity keeps the resilience of the livestock breeding system, as it provides environmental goods and services that contribute to the profitability and sustainability of such system (Oyhantcabal *et al.*, 2010; Morales *et al.*, 2016).

One likely scenario accepted by several researchers (Oyhantcabal *et al.*, 2010), assumes exceeding the resilience of several ecosystems with the unprecedented combination of climate disturbances (floods, droughts, fires, insects) added to other global changes, such as changes in land use, pollution, and over-exploitation of natural resources. Increases in mean temperatures may exceed 1.5 to 2.5 °C, and include changes of great magnitude in the structure and function of ecosystems and species present, which implies predominantly negative consequences for biodiversity and goods and services, such as food production and water supply.

Currently, the effects of climate change on the production of food makes that the need of fulfilling the development objectives, as well as generating awareness toward the adoption of measures improving the management of animal genetic resources for nourishment become urgent (Pilling *et al.*, 2008). Therefore, this work analyzes the references that underlines the importance of local animal husbandry resources and the preservation thereof facing the effects of climate change.

Biodiversity preservation

Reduction in biodiversity compromises ecosystem functions and its capacity to generate essential services for society and the environment. Therefore, biodiversity preservation has gained relevance as a key factor for life sustainability in the planet. Hence the importance of considering the inextricable link of the biodiversity-ecosystem (functions)-agroecosystem trilogue (Velásquez, 2010).

Biodiversity represents the degree of variation of lifeforms. This is the total sum of genes, species, and ecosystems of a region. The suppression of a single species may affect the performance of local and even global ecosystems. Due to their importance as animal genetic resources, global efforts have been made in order to raise awareness on the reduction of biodiversity in animal livestock breeding agroecosystems as well as

promoting actions for the preservation thereof (Mara *et al.*, 2013; Sharma & Sharma, 2013).

The main objectives of animal genetic resource preservation are a) to keep genetic variation as gene combinations in a reversible manner, and b) to keep specific genes of interest (Figure 1) (Mara *et al.*, 2013). The Nagoya protocol sets forth that, upon using gene resources, the performance of research and development activities on the genetic and/or biochemical composition of these resources is allowed; such activities include the application of biotechnology, which is understood as all technology that uses biological systems and live organisms or the by-products thereof for the creation or modification of products or processes for specific uses (FAO, 2011).

PRESERVATION METHODS

In order to preserve animal genetic resources, methods have been used on site, i.e. In the natural or semi-natural habitat or in some specially designed environment. Therefore, the preservation of different animal autochthonous or local species has been performed through the formation of breeding populations (Figure 2); nevertheless, also off-site preservation is available (Micekiene *et al.*, 2003; Sawicka *et al.*, 2011; Sharma & Sharma, 2013). Specifically, on-site preservation means preserving live animals in a livestock production system in its surroundings and, if feasible, improving the production characteristics thereof. On the other hand, off-site preservation means two manners of preserving the race



Figure 1. Romosinuano breed cow and Hairless Tropical breed pigs, two local species in development and production in the same environment, the Capilla, Cotaxtla, Veracruz, Mexico.

outside the natural habitat: off-site *in vivo* refers to safekeeping live animals in zoos, natural parks, experimental farms or other specialized centers; off-site *in vitro* is cryopreservation of gene material in haploid form (semen and oocytes), diploids (embryos) or DNA sequences (Lascuráin et al., 2009; Mara et al., 2013).

In recent years, off-site *in vitro* preservation programs of livestock gene resources have centered their interest on the cryopreservation of gametes, embryos and somatic cells, as well as testicles and ovary tissues in a cryogenic bank. A cryogenic bank is a place where biological samples are frozen or cryopreserved to keep their integrity for a variety of foreseen and unforeseen uses; it offers unique opportunities to advance basic knowledge on biological systems and the evolution thereof. Also, it represents a useful form for re-directing selection or limiting the loss of gene diversity of a selected race and it is a vital component of efforts to recover gene variability of endangered races or restore races that have extinguished as a consequence of disuse, an epidemic or the destruction of their natural habitat (Lermen et al., 2009; Leroy et al., 2011; Sawicka et al., 2011; Mara et al., 2013). The above actions do not apply as an exclusion; they may be incorporated into a preservation program that integrates, organizes, and coordinates different preservation alternatives with congruency, efficiency and reasoning (Delgado, 2012).

Livestock breeding and climate change

Animal production systems, climate change and animal health are related among themselves through complex mechanisms. Animal production influences climate change upon emitting greenhouse effect gases (GEI) such as methane and nitrous oxide. This situation allows animal production to present significant opportunities for reducing emissions, as well as increasing greenhouse effect gas capture (Oyhantcabal et al., 2010).

On the other hand, the effect that climate change exerts on livestock breeding may be analyzed from several viewpoints:

- Nutritional - the bovine will consume more lignified pastures, resulting from the increase in temperature,



Figure 2. The creole hen is a local genetic resource of greater importance in feeding rural families. Flock of chickens in the selection process as breeders at the Huilango farm, Cotaxtla, Veracruz, Mexico.

more frequent extreme events, and a decrease in rain.

- Health - animal health may be affected both by extreme events (e.g., temperature) and the emergence and re-emergence of infectious diseases, some transmitted by vectors, highly dependent on weather conditions, as the climate effect also affects plague insect populations, as they move through thermal floors.
- Social - there are changes in plant comfort zones and, together with this, cultivation zones in order to improve production, as well as the increase in the incidence of frosts, droughts and floods; and
- Environmental - heat detrimental effects reduce reproduction rates and livestock productions. Livestock breeding produces greenhouse effect gases (methane and nitrous oxide), the enteric fermentation in ruminants and manure are the main contributing factors for gas emissions in animal production. On the other hand, livestock breeding is one of the few economic sectors that have the possibility to decrease the emission of these gases and extract CO₂ from the atmosphere through mitigation practices as the great potential of pastoralism to increase the efficiency of productive processes, reduce deforestation and sequester carbon in soils under grasslands (Figure 3) (FAO, 2016; Garzón, 2011; Oyhantcabal et al., 2010).

Local livestock resources and climate change

It is likely that livestock breeding is one of the activities that suffer more with climate change due to the modification of the agroecosystem that it inhabits. Therefore it is necessary to analyze the part of local races, traditional production systems and, above all,



Figure 3. Herd of goats in grazing system in dry tropical environment in Copalillo, northern zone of the state of Guerrero, Mexico.

grazing, as this activity searches balance between greenhouse effect gas emission and production upon correctly dimensioning the number of animals per sustainable territory unit (Delgado, 2011). For many, it is easy to distinguish between animal production with good environmental sustainability practices and criteria (either traditional or extensive) that generate multiple benefits and animal production that pollutes water, degrades soil, generates deforestation, and erodes biodiversity. Nevertheless, today both types of livestock breeding search the implementation of a greater number of technologies and handling practices that allow improving production processes and reducing GEI emissions (Morales *et al.*, 2016).

The advance toward a sustainable livestock breeding that optimizes systems would be a more intelligent response than reducing meat production and consumption (Oyhantcabal *et al.*, 2010). Local races and their gene biodiversity make it possible to produce in the most diverse conditions and territories; they support the spread of production in great areas and offer the capacity for soil to sequester carbon and perform other mechanisms, such as balancing the emission of GEI with its capacity of fixation thereof, which contributes to the ecology balance of agroecosystems. Therefore, the preservation of animal genetic resources becomes even more necessary before global warming (Delgado, 2011; Delgado, 2012).

Both traditional livestock breeding and that of high technology based on local races, grazing and the balance of livestock loads is related to the preservation of biodiversity and cultural diversity and takes part in the correct management of GEI, especially in

the sequestration of carbon (Rodríguez *et al.*, 2011; Delgado, 2011).

CONCLUSIONS

The preservation of local animal genetic resources consists in preserving gene variability and genes of economic interest in animal populations used in production. Upon fostering practices that favor diversification and the interaction of local races within the livestock agroecosystem, the use of local livestock resources is fostered, and these constitute a development alternative in the intertropical warm weather zone of the Mexican territory. Livestock breeding production systems that use local races represent a competitive economic reconversion alternative that reduces the environmental impact before climate change.

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