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Introduction, Acknowledgments and Contributors

INTRODUCTION

Raising livestock is the most extensive productive system in the tropics and subtropics. The domestication of animals arose almost at the same time as the domestication of plants in different parts of the world. Both types of production created two large guilds, that of the crop farmers and that of the ranchers, who throughout history have battled over land use. This confrontation has produced different results over time and in different parts of the world, producing the environmental and cultural characteristics that are particular to each region.

In the Americas, we see the most recent episode in the crops vs. livestock battle. Throughout these enormous and diverse continents of mainly crop-oriented heritage, livestock burst onto the scene in the 16th century when the Europeans introduced domesticated animals large and small, changing a landscape that had been largely defined by the crop raising vernacular, and becoming the most powerful tool of European colonization.

Owing to its extent and profound effect on biological and cultural diversity, the ecology of raising livestock is essential to understanding the current landscape if we are to aspire to balanced and sustainable management of the soil, biodiversity and the natural resources of the Americas. We know little about the interaction between livestock — cattle, donkeys, horses, pigs, goats, fowl and bees— and local flora and fauna, or of the effect that environmental conditions have on the animals. The scarcity and fragmented nature of our knowledge mythifies the ecological impact of livestock and limits our possibilities and alternatives for their rational management.

To scientists, raising livestock causes a monumental disturbance of ecosystems and landscapes that entails the disappearance of native species, facilitates the invasion of exotic species and causes irreversible changes in the physical structure and fertility of the soil.

From this perspective, the scientists reaction is extreme, they overlook the biodiversity associated with the cattle pastures, ignore their role in the structure and functioning of the landscape and the possibility of understanding certain mechanisms and ecological processes that facilitate the movement of the flora and fauna that maintain the diversity of natural systems

When speaking about livestock, we are referring to the diverse species of introduced herbivores: cattle, pigs, goats, sheep, donkeys, chickens and bees. Each has its own foraging habits and its impact depends on the ecogeographic region where it occurs, though it can generally be stated that cattle ranching is the most widespread and common livestock activity in the Americas and the Caribbean.

The ecology and behavior of cattle in Europe, Asia and Africa have been under study for some time now, and the results are useful for understanding cattle ranching in the Americas. However, the huge diversity of American ecosystems in terms of their flora and fauna, and the short time that has elapsed since the introduction of cattle, compared to the long history of domestication on Europe, Asia and Africa, make for quite a different story.

The European colonists were cattle ranchers, as were their ancestors, who practiced mixed agriculture and herding from 4500 years before the discovery of America. They brought cattle to the Americas for the first time in the Antilles in 1512, to Mexico in 1520, to the Andes region in 1530 and to Florida in 1565. By the end of the 16th century cattle had spread as far west as New Mexico and by 1769, to upper California.

The Iberian cattle (*Bos taurus*) adapted to the American environment quickly, both on the arid and semiarid high plains, and in the humid lowlands, as evidenced by the fact that the herds doubled in size at a much higher rate than they did in Europe. From the 16th to the 19th centuries, *Bos taurus* —a fast, lean and average-sized beast— rapidly occupied each ecosystem, in contrast to the more robust British and French cattle, which progressed much more slowly. From the time of their introduction in the eastern United States, they only reached the center of the nation in the 19th century.

The capacity of cattle to transform cellulose into meat, milk, fiber and leather gave them enormous efficiency and an aptitude for changing the environment, even on a continental level. On the arrival of the Spanish, the Mesoamerican landscape was molded by extensive and intensive crop growing activities. Permanent and shifting cultivation occupied large tracts of flat land, hillsides and ravines. Because of colonization, the indigenous population decreased and relocated, the best lands were abandoned, monocultures proliferated and herds of cattle spread, changing the landscapes, leaving only a few remnants of the natural ecosystems.

Livestock became the main agent of transformation of nature in the Americas and some authors believe it was the determining factor in European colonization.

When livestock was introduced, some animals were left to roam free in the forests and rainforests from the last third of the 16th century, and continued to do so until the end of the 19th century. It was left to move freely on the islands and the mainland, and in particular pigs and cows adapted to the savannas, scrub, and the sparse and dense woodlands of warm, moist and dry temperate climates.

It is surprising that, over this period of 500 years, the domesticated European animals that roamed freely caused no severe damage to the original structure of the vegetation, nor did they cause any considerable changes in the species composition of ecosystems and natural formations. It seems that the number of head of cattle and their behavior

adapted to the prevailing environmental conditions and to the carrying capacity of each of the natural systems they occupied.

This type of feral cattle still exists in parts of Mexico and the Caribbean, where for various reasons it continues to inhabit natural systems that are reasonably well preserved.

One explanation of why these ecosystems remained in such good ecological conditions is that these large herbivores did not have to compete with or displace other species in the natural American ecosystems. Large herbivores disappeared from the continent *en masse*, with the exception of bison, moose, caribou and some deer in North America, and llamas and vicuñas in South America during the Pleistocene, leaving a void. Livestock filled this gap in natural grasslands, scrubland and dense forests in both dry and humid regions, fulfilling the task of dispersing fruit and seeds, preying on seedlings, reducing plant biomass and recycling soil nutrients. One might suppose that they contributed to maintaining local biodiversity, favoring those species adapted to the presence of herbivores for their dissemination and establishment.

The disappearance of large herbivores has been documented for arid and semiarid regions of the Americas. There, the presence of cattle, horses and donkeys has taken over the function of the extinct herbivores, rescuing tree species that might otherwise have disappeared had large livestock not arrived on the scene.

Calculations of the number of native herbivores that were present before the Pleistocene indicate there was an average of 21 animals per km^2, with a variation of 15 to 50 animals per km^2, each weighing approximately 450 kg.

This would mean there was an average of five hectares per animal, with a range of two to seven hectares, suggesting a large carrying capacity, which would explain why the presence of livestock did not drastically change natural habitats in the Americas.

Unfortunately, we do not have similar calculations for the humid tropics, though everything seems to indicate that the carrying capacity of the forests was high. Recently, the rapid decline of the medium-sized to large wildlife species most affected and the decrease in their populations in the tropical rainforests of southern Veracruz over the past 25 years has been documented. This defaunation included wild herbivore species, the disappearance of which could change the physiognomy and species composition of the rainforest.

From our point of view, the greatest decrease in herbivorous fauna occurred in the late 19^{th} and early 20^{th} centuries, about 100 years ago, when the feral cattle of *Bos taurus*, which had roamed freely in the area was removed and replaced by *Bos indicus* feedlot cattle. The disappearance of *Bos taurus* doubtless had a negative effect on the rainforest plant populations, which once again were left “widowed”, without their dispersers or primary consumers and carnivore populations, among others.

This change in the species of cattle was the result of a trend toward intensive production in enclosures and planted pastures. Spanish breeds of *B. taurus* were removed from natural systems and new breeds of *B. indicus* introduced. This change induced a massive opening of pastures at the expense of the natural vegetation, and from that time onwards, cattle ranching has meant deforestation. The concentration of high densities of livestock modified the soil and pasture management facilitated the arrival and establishment of grass species associated with livestock from Africa and Asia. Habitats were simplified and an extensive and homogeneous system emerged, where vegetation was cleared to make way for fields and pastures, areas with physical conditions that led to the proliferation of both exotic and other secondary and weed species, which eventually colonized these open areas.

In both the dry and humid tropics, clearing for fields has reduced the forest to very small fragments. Huge areas of the tropics are dominated by livestock landscapes within which there are fragments of the original forest that vary in size immersed in the pastures. The forest fragments that remain are on hilltops, very steep slopes, and on rocky terrain or where flooding occurs. Within the pastures a few trees from the original forest have been spared, some form strips along rivers to protect the channel, and some are used as living posts to tend barbed wire, or occur as solitary trees to provide shade for livestock.

This remnant of the forest is worked into livestock management in an incipient way. Over the past four decades, the expansion of pastures has been impressive. In ecological terms deforestation and forest fragmentation is very recent and has happened very quickly. Given the current degree of fragmentation, we do not know if the sections of forests that remain on the ranching landscapes can be conserved, or for how long. Nor do we know for certain which and how many of the forest species, or what kind of ecological processes, can continue to occur in these landscapes.

Livestock management in fragmented landscapes must not only contemplate grass and cattle, but also the scattered cover provided by the native trees that are present as isolated trees, as well as the gallery vegetation and the protection of forest edges to facilitate the movement of the fauna, seed dispersal and pollen exchange among plants in dispersed populations.

This can lead to the maintenance of the structure and dynamics of this type of landscape, protecting a number of the species of the original forest in areas dedicated to raising cattle, which we could describe as a tropical *dehesa*, an agroforestry system that originated in the Mediterranean region where the timber, grazing, livestock and cultivation activities interact beneficially in economic and ecological terms.

The importance of implementing this optimal landscape design and its new management rules becomes even more evident when we acknowledge that the entire

area of dry and rain forest in Mexico, Central and South America and the Caribbean —which there is still in time to conserve in its current state— is now surrounded by fragmented livestock landscapes. In large part, the future success of the conservation of Neotropical forests depends on what we can achieve in the landscapes that surround these remnants, especially with regards to the maintenance and proliferation of the trees in pastures.

In this context, cattle as herbivores that are potential fruit and seed dispersers could contribute to maintaining those fragments and the landscape in general, decreasing the isolation of species and their populations. Naturally, it would be necessary to reflect on the most appropriate breed of cattle for this purpose.

Knowledge of the ecology and environmental history of livestock will allow us to understand the current American landscape and will open new perspectives for the management of biodiversity in livestock areas. This issue brings together a set original research articles that represent a substantial contribution to our understanding of the adaptation of livestock to American landscapes and ecosystems, and of the impact its management and development has had on biodiversity and on the landscape.

The contributions are organized into three chapters. In the chapter on **Biodiversity,** Irene Martín-Forés *et al*. analyze the Mediterranean region in Chile where more than 25% of the flora is not native. This is especially important in the *espinales* vegetation, agroforestry-pastoral systems that are very similar in their functioning to the Spanish *dehesas* and are of great ecological and socioeconomic interest. The native/nonnative characteristic of central Chile is compared with that of areas on the Iberian Peninsula, highlighting possible mechanisms (filters) that may have been acting on floristic colonization from the Mediterranean basin toward the Chilean Mediterranean zone.

Evidence is provided by Mario Favila for the success of the introduction of livestock. The dung beetles of Mexico —and those of the Americas in general— were able to exploit livestock dung and incorporate it into the nutrient cycles of the tropical and temperate soils. This ability to make use of an exotic resource is explained in the context of the evolutionary, biogeographic and ecological history of these beetles.

In the **Landscape** chapter, Patricia Moreno-Casasola *et al*. explain how, from the beginning, wetlands were used for cattle grazing, and they describe the transformations occurring in grazed wetlands that convert them into flooded pastures. The degree of impact depends on the number of head of cattle, the time they are in the wetland, and modifications to hydroperiod and vegetation. The changes in the level of flooding, soil characteristics (organic matter, water retention, bulk density, pH, micro- and macronutrients) and floristic composition, are described, along with how all this affects the environmental services provided by wetlands.

Sergio Guevara S. and Javier Laborde D. demonstrate that the Mesoamerican rainforest is home to high biological diversity, in spite of its being intensely fragmented and the isolation of the remnants of the rainforest. There, biodiversity is rich because of the good connectivity of the landscape, itself the result of natural events, traditional agricultural practices and, more recently, by cattle raising activities. This historical overview allows for landscape management to conserve the biodiversity and develop sustainable production systems.

In the third chapter on **Environmental History**, Katherinne Giselle Mora Pacheco challenges the traditionally accepted explanation that environmental problems in the Saquencipá Valley of Colombia originated during the colonial period from a combination of wheat monoculture, deforestation and the introduction and expansion of livestock.

She indicates that low rainfall, the influence of dry winds and the presence of clay soils were factors that from pre-Hispanic times made most of the inhabitants prefer to live on the fertile riverbanks. Prior to the Conquest, slash and burn activities in the dry forests, the demand for firewood and the occupation of land that was less fertile or on slopes led to the loss of vegetation in specific areas, and this loss was notable, even before the arrival of the Spanish in the region.

Benjamín Ortiz Espejel and Rogelio Jiménez Marce describe the development of cattle ranching in the Totonacapan, an indigenous region on the Gulf of Mexico, examining the pros and cons of three models: indigenous, peasant and agroindustrial. From their analyses, they extract a proposal to build a model for the sustainable development of raising livestock in this type of region.

In this volume, a notable group of researchers propose a novel approach to the relationship between raising livestock and biodiversity in the Americas. This is a landscape comprised of plant and animal species —both native and those brought from the Mediterranean— where biodiversity has been managed in the American and European ways, and supported by the biological precedent resulting from the disappearance of the great abundance and species richness of large herbivores. This compilation opens a new vista for the investigation of the introduction of livestock to the Americas.

Sergio Guevara Sada

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