THE IMPACT OF RAISING CATTLE IN THE TOTONACAPAN REGION OF MEXICO: HISTORICAL DEVELOPMENT AND APPROACHES FOR A SUSTAINABLE CATTLE RANCHING

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SUMMARY

The development of animal husbandry in the northern region of the state of Veracruz, known as the Totonacapan, produced major environmental changes. The highlights of this development are the introduction of cattle in the sixteenth century and African grasses in the second half of the nineteenth century. Environmental changes rapidly ensued between the years of 1940 and 1970 when livestock operations were intensified. The analysis of three case studies allowed us to estimate the impact that livestock intensification initiatives had across the state and to identify elements that would allow for a sustainable model of cattle ranching in this region.

Key words: Sustainability, deforestation, land use.

INTRODUCTION

Following the appearance of the book, *Plague of Sheep*, by the American historian Ellinor Melville who argued that the arrival of ungulates had generated severe environment degradation in the Valle del Mezquital, Mexico (Melville, 1994), the idea was generalized among some historians that the arrival of cattle to the Americas had an overall devastating effect (McClung and Sugiyama, 2012). Others, such as B. Turner and K. Butzer, argued that the presence of the cattle had few or only moderately negative consequences (Sluyter, 2001). This divergence of opinion may also be witnessed in several studies highlighted in the book *Historia Ambiental de la Ganadería en México* (*The Environmental History of Cattle in Mexico)*. In the introduction, Sergio Guevara (2001) discusses the idea, as proposed by many ecologists, that cattle ranching has resulted in a large-scale disturbance of ecosystems. According to this argument, cattle

Bases de datos: http://polired.upm.es/index.php/pastos (España), AGRIS (Italia), CAB Abstracts (Reino Unido), CABI Full Text (Reino Unido), Catálogo LATINDEX (México), DIALNET (España), ICYT Ciencia y Tecnología (España)

ranching would have led to the demise of native species, the invasion of exotic species, and changes in the physical structure of soil and its fertility. However, the author also mentions that the impact of livestock ranching has been variable and depends on the type of animal being raised, whether cows, pigs, or goats. Guevara recognizes, as well as other authors, that the introduction of cattle to the Americas by the Spanish settlers was part of the colonial inheritance, as many Spaniards came from towns where the mixed agriculture and grazing were practiced. Even so, the introduction of cattle would be "violent" and its impact would change the environment drastically, particularly due to the speed in which herds were reproduced. Every 15 years the herds were doubled, especially in the arid and semi-arid highlands, which contributed, among other things, to the modification of the original landscape that harbored only small remnants of native vegetation. The alterations in the landscape provoked accelerated erosion processes, a higher incidence of flooding, and a loss of crops due to changes in the flora and fauna. Thus, the author concludes that the introduction of cattle was a transforming agent of the American territory, as well as a determining factor in the modification of the agricultural and natural landscape and the state in which it is found today (Guevara, 2001).

Miguel Aguilar (2001) pointed out that in the Huasteca Potosina region an explosive growth in the cattle was experienced beginning in the second half of the sixteenth century and continuing until the early decades of the seventeenth century, to the point that the documented sources mention that large herds of between 468 000 and 500 000 heads of sheep grazed in Valles and Tanchipa. The rapid growth was explained by the abundance of pastures and the relative lack of competition and predators, as well as the demographic decrease of native populations, which diminished the pressure on some ecosystems and made additional lands available for cattle ranching. Despite the large herds that grazed the Huasteca, the author proposes that the environmental impact of the cattle was in fact moderate, explained by the complementary way in which cattle ranching and agriculture were cyclically interchanged in the same fields. This process was adapted and adjusted to the specific conditions of the new colony. Thus, in the region of the Huasteca, agricultural fields were left fallow and grasslands allowed to recover, where large cattle grazed freely and were seasonally interchanged with smaller cattle (Aguilar, 2001). Andrew Sluyter came to a similar conclusion, where in his study on the tropical lowlands in Veracruz he establishes that despite the pressure that livestock placed on the land's carrying capacity during the colonial period, the vegetation cover and soil remained stable, in contrast with evidence of destabilization that occurred in the Pre-hispanic period as caused by population growth, deforestation by slash and burn farming, and intensification of land use that provoked landslides and erosion. In agreement with Miguel Aguilar, Sluyter also considers that the Spanish mode of cattle ranching was environmentally sustainable, due to the fact that the system of nomadic herding limited the possibility of overgrazing by allowing the movement of semi-feral creole cattle across the landscape between the humid and dry savannas (Sluyter, 2001).

While many hold the opinion that the environmental consequences of cattle ranching were minimal to moderate, at least during colonial times, the debate on the impact of the introduction of cattle in New Spain continues. There is some consensus surrounding the idea that cattle ranching would be modified and categorically distinct in the second half of the nineteenth century and the first decades of the twentieth century, especially in the warm-humid regions during what has been named the "Silent Revolution," a time period in which the establishment of pasturelands and the introduction of "artificial" African grasses were increasingly prevalent. The Spanish varieties of cattle were disappeared to make way for new species, leading to the precedence of grasslands at the expense of natural vegetation and high rates of deforestation in various regions of the country (Aguilar, 2001; Sluyter, 2001). The presence of a high density of cattle modified previous land uses, and management of the pastures allowed for the establishment of exotic species from Africa and Asia. The simplification of the associated habitats and the presence of an extensive and uniform system of pastures permitted an easy and rapid expansion of exotic, secondary, and ruderal species. Sergio Guevara considers that it is necessary to conduct more studies on the environmental history of cattle ranching in order to understand and situate ranching with the context of the current state of the Mexican ecosystems through evaluating current management practices and performance of ranching systems, as well as their environmental, economic, social, and cultural impacts. The lack of knowledge of cattle behavior, according to the author, has contributed to a lack of understanding of the ecological impact of cattle ranching and has limited the possibilities and alternatives for its rational management (Guevara, 2001).

The present investigation has the objective of bringing to light the impact of cattle ranching in the Totonacapan region of Veracruz, that in addition to other regions of Mexico, have suffered environmental changes because of the introduction of cattle and African pastures during the second half of the nineteenth century. Such changes were particularly accentuated and accelerated between the years of 1940 and 1979. In the first section of this investigation, a general historical revision of the region is elaborated, focusing on relevant land uses employed until the mid-twentieth century. It is important to highlight that during the colonial times special authorizations for the use and exploitation of the land were given by the Spanish crown, called "mercedes reales", and such land grants often established cattle ranches at the expense of the indigenous groups that sought to preserve their communal properties. This was the overarching scenario until the liberal land reforms modified land status in the 20th century with the goal of modernizing the Mexican territory. In the second section of this investigation, several case studies are presented for the Totonacapan region and other sites in the state of Veracruz, detailing how the cattle ranching initiatives and their intensification have unraveled. The goal is to determine more suitable land uses and management of cattle ranching regions. The third section of this investigation establishes recommendations oriented towards concrete actions that promote sustainability, highlighting how cattle

ranching must be understood within a historical context so that a new model may be established, not only for the Totonacapan region but for the entire state of Veracruz.

TOTONACAPAN: A BRIEF HISTORY

During pre-Hispanic times, the Totonacapan included a vast region delimited to the north by the Cazones River, to the south by the La Antigua River, to the west by the mountain range of the Sierra Madre Oriental, and to the east by the Gulf of Mexico. The largest populations were established in the northwest and southwestern areas, meanwhile the central region had the lowest population density. Two overarching zones have been identified: the "Llanura Costera," or the coastal plains, and the "Sierra of Papantla," or the mountain range of Papantla (Ortiz, 1995; Velázquez, 1995; Velázquez, 1996; Chenaut, 1996). After the Spanish conquest, 1,434 mercedes, or land grants, were given throughout the Totonacapan region. A total of 1383 grants were given to Spaniards and merely 51 grants to indigenous peoples. Benjamin Ortiz identified that 53% of the granted territory was used for haciendas, or ranches, where the manual labor of indigenous populations was exploited, 27% of the land was dedicated to raising large cattle, and 19% for small cattle. Most of the haciendas extended throughout regions that currently form the municipalities of Jalapa, Misantla and Cempoala. The coastal plains and the mountain range of Papantla had the fewest cattle concessions (Ortiz, 1995, Velázquez, 1995). This information can be corroborated in the *Relación de Hueytlapa y su partido* (*The History of Hueytlapa*), published in 1580 and written by Joseph Velázquez. According to this document, in the Hueytlalpa region of Veracruz cattle ranching did not take precedence over other activities because grass would not grow due to the "many stones that can be found there." The same situation that was seen in Jujupango, which was not hospitable to grass for grazing either, because of the "many abysses and landslides." Meanwhile in localities such as Matatlan and Chila grass was not grown due to the "thickness of the trees and the interwoven branches" (Velázquez, 1985).

A situation to the contrary occurred in Zacatlán, where there was "a lot of grass" owing to the abundance of water and the presence of lagoons, which formed a propitious environment for the raising of cows, lambs, goats, and pigs. In the region of Papantla, the existence of grass was mentioned by Velázquez (1985), and although he noted that many lands had been granted, only the large cattle ranches of Diego Cepeda and Diego Larios were mentioned, both of whom lived in Mexico City and whose properties were located along the rivers of San Pedro and San Pablo (nowadays known as Tecolutla River) (Velázquez, 1985). Despite the agricultural potential that the region demonstrated, extensive cattle operations would remain as the main motor of the local

economy. At the end of the eighteenth century fourteen large cattle ranches existed in the region of Papantla (Ortiz, 1990; Ortiz, 1995; Velázquez, 1995). The presence of the cattle generated problems with the indigenous populations, due the incursions of cattle in their fields. Although their complaints were formalized and the colonial government notified of their grievances, this conflict eventually provoked an indigenous insurgence in 1836 lead by Mariano Olarte[1]. It is necessary to clarify that issues of land invasion did not motivate the rebellion, because in the decade following 1839 the indigenous populations located in the coastal plains and the mountain range of Papantla held over 24 000 hectares (ha) where forest predominated, including 200 ha of corn fields, vanilla, and grassland savannas (Escobar, 1996; Blanco 1996).

During the decade of 1859 to 1869, vanilla plants were largely replaced by citrus trees and grasses for fattening cattle. The precedence of indigenous communal property, at least until the decade of 1870, had prevented the establishment of large haciendas in the region. Emilia Velazquez (1995) mentions that while more than 20 ranches existed in the area, only three had large extensions: Larios and Malpica in Tecolutla with a total of 33 017 ha, Palma Sola with 24 270 ha, and San Miguel del Rincon with 21 880 ha. Most of the haciendas were dedicated to growing vanilla, tobacco, sugar cane, bananas, corn, beans, and chili and the exploitation of rubber and the chicozapote fruit, in addition to cattle ranching (Velazquez, 1995; Ortiz, 1995). The encumbrance policies of liberal governments seeking to transform the rural people into small land-holders would face a stubborn resistance in the region. According to Victoria Cheanut (1996), the opposition of the Totonacan people to the division of their land found its basis in the wish to preserve and reproduce their identity as an indigenous group. Facing the possibility of an insurgence with weapons, the authorities determined, between 1875 and 1878, that the land would be divided into 25 large portions. However, in 1891 another insurgence with weapons occurred which caused in response, between 1893 and 1898, that the authorities would create smaller portions of land, divided into individual lots that would be sold as private property. The division of land did have the expected results and was not egalitarian, because in localities such as Coxquihui, Chumatlán, and Zozocolco, a total seven families were bequeathed with 50% of the divided land (Blanco, 1996; Chenaut, 1996).

In the case of Coxquihui three haciendas were established and dedicated to vanilla and tobacco cropping and cattle ranching. One of the main consequences of the change in the land ownership, which shifted from communal ownership to small holders, is that indigenous groups lost control of natural resources. By 1905, in Papantla Cantón, 34 haciendas were counted with an extension of 154 000 ha, among them particularly

1 Una de las peticiones de Olarte para acabar con el conflicto fue que el gobierno dispusiera lo necesario para evitar que el ganado invadiera los terrenos de los indígenas.

eminent were Larios y Malpica, which possessed 33 000 ha, San Miguel del Rincon with 24 000 ha, San Miguel el Grande with 20 000 ha, and San Lorenzo Palma Sola with 20 000 ha. The distribution of the communal land constitutes a key element in understanding the subsequent transformations that followed in the Totonacan landscape (Ortiz, 1990; Velázquez, 1996). Between 1910 and 1930 the deforestation process would begin in the region, among other things, due to the discovery of oilfields and the construction of a railway (Ortiz, 1995). In the decade of 1949 there was a resurgence of cattle ranching, stimulated by the construction of a road from Tuxpan to Mexico City, which allowed faster transport of the animals. Before the existence of this road, the cattle ranchers had to bring their herds from the train stations located in Veracruz, Tampico, Huauchinango, or Teziutlán, a trip that could last from one to two weeks in which the animals would incur a significant weight loss (Velazquez, 1996). Between 1940 and 1970 important land use changes were beginning to transpire in the Totonacapan, as the land was increasingly dedicated to the growing of coffee, citrus, and bananas, and the clearing of fields also facilitated the introduction of cattle ranching, allowing them to trample unchecked across the landscape (Ortiz, 1995; Chenaut, 1996).

Benjamín Ortiz (1995) mentions that by 1959 there were 156 005 ha of forest in the region, but in 1970 only 47 485 ha were registered. In contrast, the area of grassland incremented from 140 852 ha in 1959 to 216 807 ha in 1969, 309 079 ha in 1970, and 362 108 ha in 1984, which represented a total increment of 157% due to increases in the extension of cattle ranching (Ortiz, 1990), which converted itself into the most fundamental activity for rural families, surpassing the supremacy of cultivation of corn (Velázquez, 1996; Lazos, 2001). Testimony of a rural farmer from “Plan de Palmar” indicates that while he was able to achieve two regular corn harvests per year, the uncertainty of the harvests converted him into a rancher, andhe began to grow grass in pasturelands. Another farmer, further testament to the transition, only cultivated one hectare of grass but later decided convert his entire property of 5 ha to pastureland. In this last case, the rural farmer had obtained his land in 1968 and made a full conversion to cattle ranching within three years, introducing up to four different kinds of grass: guinea, angola, merqueron, and African star. Another study conducted in Plan del Palmar showed that another land owner began to substitute interchangeably grass and corn. When the production cycle was finished and corn was harvested, part of the field was often sectioned off to sow grass for pasturelands.

Between 1968 and 1992 there was a decrease in the surface area of native vegetation and other traditional land uses and a corresponding increment of the total area dedicated to pasture. Thus, traditional means of land management by rural Totonacan communities were increasingly replaced by cattle ranching, although often interchangeably. Their agricultural fields, or agro-forest units, were harvested and alternated in a cyclical

manner with those of pastures, which allowed for more diversification and complex vegetation mosaics. However, since the most recent introduction and extension of cattle ranching throughout the zone, new management practices have begun to take hold, and semi-intensive cattle ranching has risen in prominence. With this method pasture extensions averaged from three to five ha with five to seven cows per ha, where cows are sometimes rotated between fields. In cyclical systems a high productivity may be maintained due to the rotation of land uses, the presence of diversified grasslands, and a high density of organisms that maintain the fertility of the soil (Ortiz, 1995; Ortiz, 2001).

METHOD

A characterization of three identified cattle ranching systems, or initiatives, was carried out by analyzing several indicators, based on the modification of a proposal made by Astier and Masera to evaluate the sustainability of the primary productive systems (see Table 1.1) (Astier and Masera, 1997).

The following indicators were taken into consideration:

1. Ecological indicators

a) Richness of species in pasture (flora and fauna).
b) Richness of species in the soil (particularly earthworms).
c) Number of productive activities associated with the fattening of cattle.

2. Technological indicators

a) Capacity of animal load, expressed in units of animals per hectare (U.A./ha), where 1 U.A. is equivalent to a grown adult cow of up to 450 kg (De Alba, 1980).
b) Energetic productivity expressed in kilocalories (the energetic productivity corresponds to the relationship between the energy inverted in the system and the energy obtained). For this calculation it was considered that for every kilogram of balanced food entering the system, 3300 kilocalories can be generated (Koeslag, 1982). By this calculation, a day´s production is equivalent to 4200 kilocalories (INN, 1990) and the 56% of the living weight of an animal of 450 kg was considered as useful meat and bone for the human use (Williamson y Payne, 1975). A liter of fresh milk represents 680 calories (INN, 1990). For the conversion of electric energy to kilocalorie the conversion factor of 1 watt= 0.2983Kcal/seg (Holliday *et al.*, 1990) was used and for the animal traction, 15,000 Kcal/day (Koeslag, 1982).
c) Work productivity (quantity of a day´s wage/hectare/year).

TABLE 1.1

Social, environmental, and economic features of three systems of livestock intensification.

Características sociales, ambientales y económicas de los tres sistemas de intensificación de la ganadería.

System	Rancher	Indigenous	Technical
Social			
Type of Tenure	Private property	Ejido	Associated ejido
Total Surface (ha)	100	20	11
Antiquity (years)	150	30	5
Number of Beneficiaries	8	10	6
Division of Useful Species	3	31	3
Number of Acts of Solidarity	0	1	0
Environmental			
Annual Average Precipitation (mm)	1179	1169	1667
Annual Average Temperature (°C)	22.4	22.1	23.3
Dominant Soil Type	Vertisol	Feozem	Vertisol
Altitude (m above sea level)	50	200	150
Richness Above Ground (species)	34	50	3
Richness Below Ground (worms)	2	6	8
Type of Grass	*Digitaria decumbens*	*Cynodon plectostachyus*	*Pennisetum purpureum*
Type of Production	Dual purpose	Dual purpose	Fattening
Rotation Days	17	15	24 hours
Stocking (U.A. ha^{-1})	1.5	1.5	5.5
Pasture Size (ha)	2	0.4	0.2
Annual Production Cows	54	8	54
Annual Production Milk	109500 L	8640 L	0
Productive Divisions	1	4	0
Economic			
Gross Profit ha^{-1} $year^{-1}$	$ 3270	$ 1664	$ 9818
Net Profit ha^{-1} $year^{-1}$	$ 2598	$ 1489	$ 3435
Wages (W) ha^{-1} $year^{-1}$	21.9	16.5	33.1
Energy Efficiency	0.7	3.84	4.66
Economic Efficiency ($/W)	$118.63/W	$90.24/W	$103.76/W

3. Economic Indicators

a) Cost of production (day´s wage, food, medicines, vitamins, deparasiting, removal of ticks, vaccines).

b) Expenses (administration, sales, and financial expenses).

c) Gross profit (all economic inputs from the sale of the products such as milk, calves, and cull cows).

d) Net profits (total income minus expenses and production costs).

4. Cultural indicators

a) Number of useful species in the pasture recognized by the ranchers.

b) Number of persons directly benefitted by the productive cattle ranching unit.

c) Number of non-profitable activities that are part of the productive cattle ranching process, indicating solidarity of the group.

To obtain a sustainability indicator for the cattle ranching operations, 12 indicators were applied to the three separate initiatives or types of cattle ranching operations: indigenous, rancher, and technical. A range of categories (high, medium and low) were assigned and standardized for all of the indicators, so that all of indicators would be equally weighted. A score of 3 was assigned to the high category, 2 to the intermediate category, and 1 to the low category, where the highest scores indicate the best fit to the indicator. A matrix with columns may be obtained for each initiative where values for the total number of indicators are later summed. Thus the index values of sustainable cattle ranching oscillate between 1 and 3. These indicators are visually displayed by "pathogenic amoeba" graphs in order to compare all the indicators that influence the degree of sustainability of a grazing system (see Figures 1, 2 and 3).

RESULTS

From the point of view of richness of vegetal species, the indigenous and rancher initiatives presented the highest values with 50 and 34 species, respectively. For the technical initiative, due to the specialized management and extensive coverage of the utilized Taiwan grass, only 3 species were recorded. In regard to the species richness of earthworms, the technical initiative presented the highest value with 8 species found, followed by the indigenous with 6 species and the rancher with 2. The number of productive activities integrated with pastures also varied, where the initiative of indigenous cattle ranching is associated with the rotation of land uses, such as the cultivation of vanilla and corn plants, sowing of tall grass, and milk production. The rancher initiative of grazing is complemented with milk production, while the efforts of the technical initiative system are directed exclusively to the fattening of the cattle. The capacity of the animal load presented the highest values in the technical system (5.5 animal units per hectare), while the indigenous initiative as well as the ranchers presented a value of 1.5 units of animals per hectare. With respect to energy productivity

the highest values, which represent a better efficiency in the conversion of energy, were found with the technical and indigenous initiatives, which held a productivity index of 4.66 and 3.84 respectively, while the ranching system presented a negative energetic balance of 0.70, meaning that more energy is used than obtained.

Upon examining agro-ecosystems from the perspective of environmental fragility and resilience (Toledo, 1996), they may be characterized based on their capacity to persist in the face of varied or unavoidable disturbances, both physical, biological, and socio-economic. The three initiatives of technical, indigenous, and rancher present different degrees of resilience and distinct strengths and weaknesses. The rancher initiative presents a scenario of growing fragility, because of its high dependence on external inputs. In spite of the fact that this system presents a net profitableness per hectare, there is also a corresponding lack of ecological efficiency (Table 1.2). Ranching also received the lowest score in species richness. The technical initiative is a scenario of highly specialized production yet at the time offers high ecological efficiency and the highest profitableness. However, there is also an associated loss in the biological richness of the soil. On the other hand, what stands out about the technical system is its high species richness of earthworms, the highest of the group, despite the strong disturbance that the field suffered at the time when irrigation systems were introduced.

TABLE 1.2

Energy analysis of the three systems of livestock intensification.

Análisis de la energía en los tres sistemas de intensificación ganadera.

System	Rancher	Indigenous	Technical
Meal (kcal ha^{-1} $year^{-1}$)	326 592	241 920	2 969 018
Milk (kcal ha^{-1} $year^{-1}$)	744 600	24 480	0
Total Gain (G) (kcal ha^{-1} $year^{-1}$)	1 071 192	266 400	2 969 018
Wages (kcal ha^{-1} $year^{-1}$)	92 400	69 300	138 600
Balanced Food (kcal ha^{-1} $year^{-1}$)	1 445 400	0	0
Electricity (kcal ha^{-1} $year^{-1}$)	0	0	452
Animal Traction (kcal ha^{-1} $year^{-1}$)	0	0	497 727
Total Expenditure (E) (kcal ha^{-1} $year^{-1}$)	1 537 800	69 300	636 779
Energy Efficiency (G/E)	0.7	3.84	4.66

The indigenous farming system presents, curiously, an energetic conversion that is similar to technical initiative and does not require a large investment in day´s wages and money. In addition, the indigenous strategy conserves the highest number of species in the soil. However, it is also the least profitable of the group. While the results of the present study indicate that the technical initiative is the most profitable,

from the environmental and cultural point of view the indigenous initiative is the most resilient, as it implements a diversified production strategy. Such a strategy is important to maintaining biodiversity, in this case under a regime of communal management, and the sustainability of this system is reflected in the global index of cattle ranching sustainability. Although the rancher and technical initiatives managed to obtain the highest incomes, this occurred at the expense of the total elimination of forest cover (Table 1.3).

These findings turn the attention toward a search for new models of raising beef cattle in the Mexican tropics that would manage to incorporate the best of the three initiatives, such as an intensification in production (technical initiative) and the preservation and promotion of the above and below ground biodiversity (indigenous initiative). While perhaps cattle ranching had previously been considered as unsustainable, these reflections lead the discussion in a new direction that has not yet been addressed in Mexico: the possibility of sustainable cattle ranching.

TABLE 1.3

Sustainability indexes for the three systems of livestock intensification.

Índices de sostenibilidad en los tres sistemas de intensificación ganadera.

System	Rancher	Indigenous	Technical
Species Richness Above Ground (Animal and vegetable)	2	3	1
Species Richness Below Ground	1	2	3
Activities Associated with Livestock Production	2	3	1
Stocking (Number of cattle per pasture)	2	2	3
Energy Production	1	2	3
Production Costs	2	3	1
Gross Profit	2	1	3
Net Profit	2	1	3
Wages (kcal ha^{-1} $year^{-1}$)	2	1	3
Useful Species Recognized	1	3	1
Beneficiaries	2	3	1
Solidarity activities	1	3	1
Livestock Sustainability Index	1.6	2.4	1.8

1=Low, 2=Medium, 3= High

PROPOSALS FOR THE INTENSIFICATION OF CATTLE RANCHING IN VERACRUZ

The history of land use in Mexico and particularly in the Mexican tropics has been characterized in the second half of the twentieth century by a massive deforestation that has affected more than 50% of the total surface area of the country (Toledo, 1990; Masera, 1995) and 91% of the surface in the state of Veracruz (Ordoñez and García, 1992). The grand extensions of cattle ranching may be explained by the fact that most grazing systems practiced in Mexico are extensive and have made little use of agro-technology to intensify production, as only a 5% of the total land dedicated to ranching makes use of intensive cattle ranching techniques (Toledo, 1990). Free grazing requires large extensions of large yet offers a very low productivity, which varies according to the region. The carrying capacity of pastures in Mexico range from 0.8 ha per animal per year in the tropics up to 50 ha per animal per year in arid zones. This section seeks to evaluate, from the point of view of energy usage and economic profitability, some initiatives that could potentially intensify cattle ranching over a smaller surface area and potentially allow for the reforestation of the Veracruz tropics. While the production of cattle has been one of the most important productive activities in tropical countries, few technical or economic efforts to increase animal productivity have been successfully achieved (Preston and Leng, 1987; Preston and Murgueito, 1992). This may be explained by the absence of frames of reference to understanding the ecological, socio-economic, and cultural impacts and limitations of the region and, at the same time, a failure to recognize the enormous potential for a sustainable cattle ranching initiatives.

In this sense, other authors (Toledo, 1992; Serrano and Toledo, 1990) have suggested that a sustainable system of a cattle ranching is determined by exogenous and endogenous factors. Exogenous factors refer to the natural quality of the environment (soil and weather), security in land ownership, the existence of tax incentives, soft loans, and market demand. Endogenous factors deal with the quality of the germoplasm used, taking into account the relatively low productivity in the tropics where operations are unable to finance expensive modifications to the environment. Thus the efficiency of grazing, the optimization of local fodder resources, and the use of economically viable technology that would improve the venture's competitiveness in the market are key. The management of grazing requires a clear vision and knowledge of the relationship between over and under-grazing, and the rancher must be aware of the most efficient management options. Therefore, the principal intensification strategies for cattle ranching through sustainable grazing may be grouped in the following categories:

1. ***Agrosilvopastoral systems***, which consist in the spatial and temporal association of forested areas, systems of grazing, and the annual cultivation of crops. This strategy represents a promising alternative for restoring degraded pastures, as

well as a means of management in a family and community-oriented economy (Hecht, 1982).

2. ***Grazing systems of fast rotation***, which is characterized by management practices where the cattle are moved from pasture to pasture and allowed to graze in each for a determined length of time. The pastures may be grazed for a few days or only a few hours, and they are subsequently left to rest according to the rate of recuperation of the grass (Savory, 1988;Voisin, 1974; Canudas, 1995).
3. ***Integrated grazing systems***, which are grazing systems that are coupled with the organic cropping of sugar cane, cereals, and plantains, which are also commonly used as fodder for the cattle (Preston and Murgueito, 1992).

The mentioned grazing systems propose an innovation in management over the current extensive and specialized models of cattle ranching, representing a shift to a semi-intensive method of ranching that is based on the efficient use of the available, local biological resources. Thereby ranching may be integrated as part of a more inclusive system of rural production. This alternative model is directed toward the creation of mosaics of productive spaces composed of annual and commercial agricultural crops, managed forest, and controlled grazing.

INITIATIVES FOR THE INTENSIFICATION OF CATTLE PRODUCTION IN VERACRUZ, MEXICO

Initiatives to intensify the production of cattle ranching in Veracruz have resulted from a general economic crisis in rural areas due to current national economic policy. The liberation and opening of the markets to the exterior, including meat and milk products, has created a decrease in the demand and consumption of local beef (Suárez and López, 1998). This economic model, stemming from the 1990s, has lead both cattle ranchers and various researchers and technical assistants from academic and governmental institutions to search for alternative methods that would allow cattle ranching and meat production to become more efficient and competitive in the broader market. Three kinds of alternative management approaches for cattle ranching in Veracruz are presented.

The first management alternative, hereafter referred to as technical (Figure 1), corresponds with proposals on behalf of a the National Institute of Forest, Agricultural, and Livestock Investigations (Instituto Nacional de Investigaciones Forestales, Agrícolas y Pecuarias or INIFAP), which holds experimental agricultural fields and pastures in La Posta and Medellin de Bravo, Veracruz. Several lines of research have been development, involving the generic improvement of cattle breeds that would have more than one purpose, the construction of silages to preserve fodder, the creation of protein banks or the provision of high quality proteins to cattle, and the management

of grasses through intensive rotational grazing. At the Center for Cattle Research of the National Autonomous University of Mexico, located in El Clarin, Martinez de la Torre, Veracruz, training for cattle ranchers in the intensive grazing techniques is offered, developed based upon previous research (Castillo, 1995). A researcher from the INIFAP made a production agreement with local communal land holders from Lomas del Porvenir, Medellin de Bravo, Veracruz, establishing in 1994 a production system to aid in the fattening of young cattle by quickly rotating them through pastures, as well as the implementation of a drip water irrigation system to speed the growth of grasses. The land had a total surface area of 11 ha, where 1.8 ha are dedicated to sugar cane cropping as a food supplement for the cattle. Waste from sliced bread was also incorporated into the cows' diet. However, in order to implement this system it was necessary to remove all vegetation cover, and heavy machinery was used dig over 30 cm deep, bury the irrigation lines, and connect the lines to the main water source. The entire surface area was divided into 46 smaller pastures of 2000 m^2, each sown with Taiwan grass (*Cynodon plectostachyus*). The entire herd, between 40 and 50 young cows, were grazed on one section of land during a period of 24 hours before they are rotated to the next section. Such an example represents a technical alternative that has been implemented through extensive research.

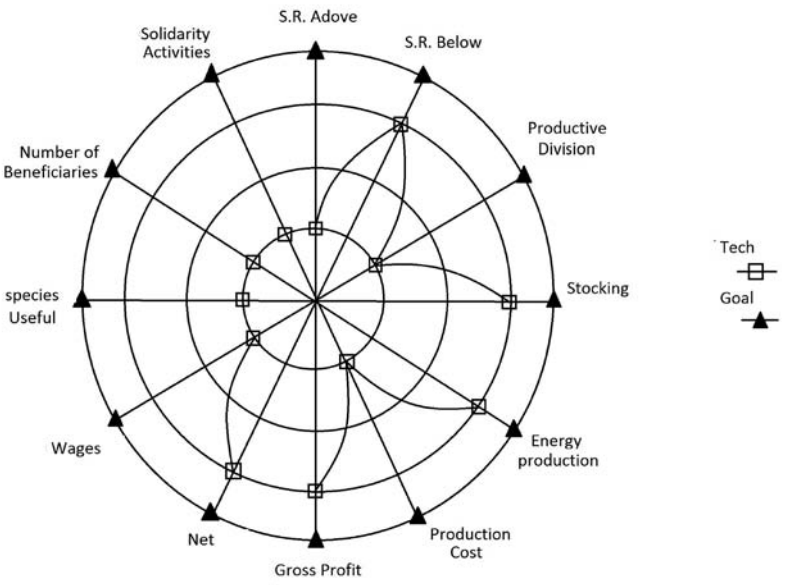

FIGURE 1

Technical management of the farm.

Manejo tecnificado del potrero.

The second management alternative, or the ranching alternative (Figure 2), combines the personal initiatives and experience of private ranchers with new strategies. One example of this is a dual production system, located in Vega de Alatorre, Veracruz, which combines agricultural cropping and cattle ranching. In this example, the ranch belongs to a family of third-generation ranchers. In 1987 the family adopted a rotation system for their cattle and electric fencing in order to manage them. Such a system may be referred to as a slow rotation system, as cattle are rotated every 1.7 days in a space of 2 to 3 ha. This technique was developed by the previously mentioned Center for Cattle Research of the National Autonomous University of Mexico, located in El Clarín, Martínez de la Torre, Veracruz. As in the previous initiative, living fences or borders of trees that once delimited pastures are replaced in favor of electric fences, where trees are completed cleared from the pastures. In this system the diet and growth of the cattle is often balanced or supplemented by commercial crops.

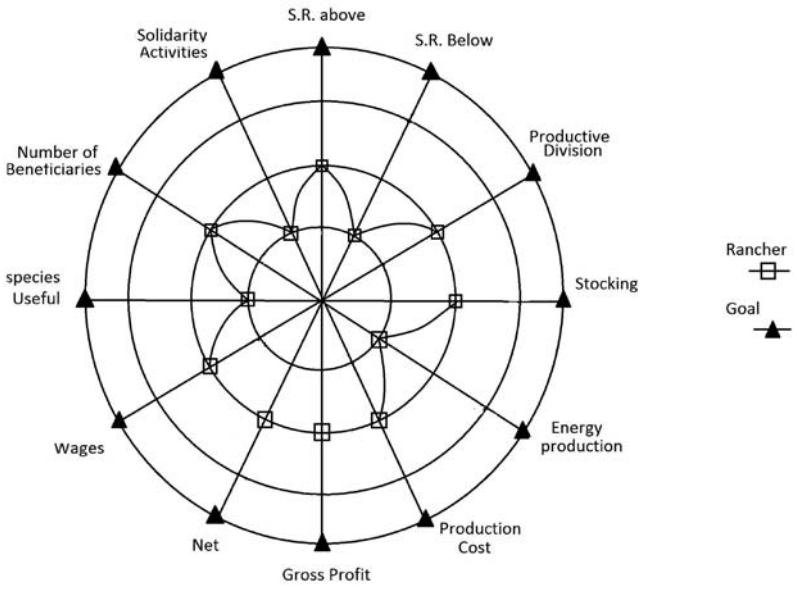

FIGURE 2

Rancher management of the farm (conventional).

Manejo ranchero del potrero (convencional).

The third management strategy, or indigenous initiative (Figure 3), corresponds to ranchers with communal land holdings whom have integrated the management of cattle with that of agro-forest systems, resulting a mosaic of productive spaces (Ortiz and Toledo, 1998, Ortiz, 1995). An example of this kind of management has been

implemented by a Totonacan indigenous communal land owner, 50 years in age, and his 17 year-old son. The area of pasture is located next to areas of rain forest, vanilla, and corn plants, forming a diversified, agrosilvopastoral mosaic. This configuration of productive spaces nestled within forested areas is the result of a long-standing Mesoamerican tradition of natural resource management, which has been conserved by the communal land owners of Plan de Hidalgo, Veracruz since its founding in 1968. In this system the pastures are abandoned after a period of approximately 20 years, after which a regeneration of the tropical rainforest ensues. The regenerating rain forest has various uses to the rancher family, such as providing sources of fuel, construction materials, and areas for hunting and collecting useful wild plants. After a maximum of 10 years, these sections of land are re-used for the annual sowing of crops during a period of 4 to 5 years, after which the land is converted into pasture. This grazing system that was developed for slow rotations, where the grazing period lasts for 15 days in pastures of 4000 m^2.

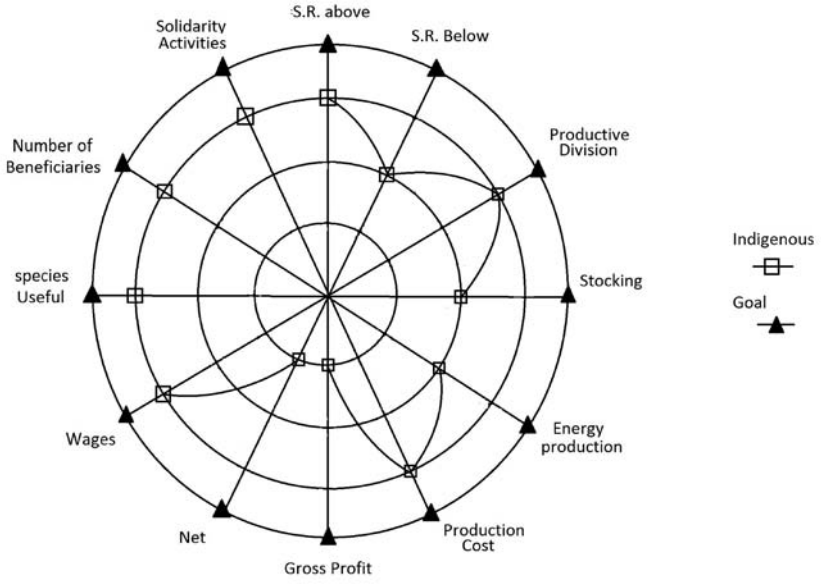

FIGURE 3

Indigenous management of the farm.

Manejo indígena del potrero

TOWARDS SUSTAINABLE CATTLE RANCHING

The economic and political scenario surrounding land use in Latin America is changing due to the crisis of the traditional mode of cattle ranching, provoked by the decrease in meat prices, the elimination of subsidies for ranchers, the degradation of pastures by overgrazing, soil erosion due to inadequate pasture management practices over inclined terrain, and the exhaustion of the availability of cheap land. On the other hand, new policies have emerged promoting the reforestation of areas previously without trees. Such factors will influence decisively in the future management of grasslands, as the livestock sector must develop new productive strategies. The stimulus of wood production is a potential opportunity for the conversion of large, uniform areas of pastures of crops, where the planting of trees may represent future commercial value. Due to low profits, a spontaneous reforestation of abandoned pastures in beginning to take hold, where regenerating species of high commercial value may be taken advantage of. Although for a long time researchers and planners have ignored the phenomenon surrounding the regeneration of native vegetation in pasturelands, it is well-known to many ranchers and farmers whom have taken advantage of these processes in the past.

The search for a sustainable cattle ranching includes, from our point of view, defining a new concept of cattle ranching in the tropics. The management must change from uniform pasturelands and specialized management to one that takes advantage of new market opportunities in the preservation of biodiversity (rancher and technical initiatives). Such models would be more flexible, and with the correct use of natural resources and biodiversity cattle ranching may become compatible with the natural environment. The nature of indigenous and peasant farmers, fisherman, and foresters in these environs has been one of duplicity, in the sense that many have traditionally dedicated themselves to a variety of productive and cattle ranching activities. Supporting this mode of farming could uphold a new model of sustainable development, where not only specialized production projects are supported and financed, but rather projects that would support multiple economic endeavors of the farmers. Thus, the sustainable future of cattle is dependent upon an integral management of every aspect of the economy of rural farmers, under a policy that would promote the rational use of natural resources (indigenous initiative).

There has been important progress in the management scheme of intensified grazing, which has demonstrated the possibility of increasing up to 10 times the animal load per hectare (technical initiative). Even if these values are not achievable in every region, improvements in grazing that would increase the animal load can be introduced. With an intensive grazing scheme that, for example, reduces of the surface area of pastures by between one-third and one-tenth of the ranch's original area, more land would be freed for forested, agro-forested, or agrosilvopastoral activities. An agrosilvopastoral

model allows for a design that spatially and temporally integrates cattle ranching, tree formations, and agricultural spaces, either interspersed or in rotation with one another (Ortiz and Toledo, 1998; Nigh, 1995). The key to this kind of diversification of land use is in the building of "mosaics of productive spaces," following the indigenous initiative, which means incorporating the best aspects of the technical initiative and avoiding the rancher's model altogether. Such productive mosaics must be supported by a solid base of social organization that incorporate principles of equality in decision making that would affect the management of the system. Any effort for productive integration that does not incorporate the local population will be, as previous attempts have shown, full of good wishes but ending in failure.

Therefore, with the current data and evidence (ecological, economic, technological, and cultural) shown, it is possible to design practical, eco-productive models (Ortiz y Toledo 1998), in which cattle ranching is structured upon "mosaics of productive spaces," diversified in land use and including the following design elements:

a) ***Annual poly cultivation***. Interspersed corn fields, livestock pastures, and intensive agricultural fields based on organic farming (composting, zero tillage, green fertilizer, etc.).

b) ***Intensive grazing***. Smaller pastures where cattle are rotated, including the introduction of useful trees species within the pasture.

c) ***Forest or fruit tree plantations***. Plantations implemented in areas of sloping terrain, interwoven with different crops of ornamental species, forage, condiments, medicinal crops, and other commercial species.

d) ***Areas of reforestation and forest management***. Areas of potential reforestation generated by the intensification of agriculture and cattle ranching, where different groups of characteristic or commercially valuable forest species are grown. Depending on the state of regeneration, a continuous economical productivity during the regeneration process is guaranteed.

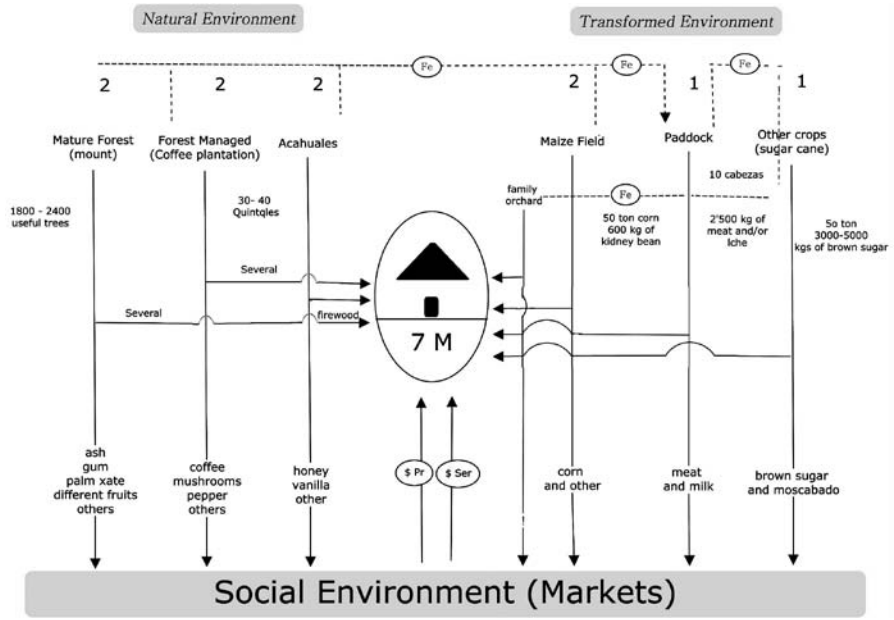

FIGURE 4

Multiple ecosystem management.

Manejo múltiple del ecosistema.

The ecological viability of the proposal is based on the dynamics that would be established between the productive systems and by the rotation in time and space of different productive activities so that energetic and biotic synergies may be established through the recycling of material, providing the foundation for the efficiency of this model. Deforestation may be decreased by drastically reducing the surface area needed for agricultural activities. The implication of this eco-productive model are many, and while legal, planning, social, and other considerations would need to be addressed, this model represents a possible and real alternative for sustainable development in the future humid tropics of Mexico.

IN CONCLUSION: STRATEGIES TO PROMOTE THE SUSTAINABILITY OF CATTLE RANCHING

Based on the experiences of the present investigation, interviews with farmers and with technicians and medical and zoological veterinarians, as well as an extensive review of the literature on the region and topic of study, we have listed below some concrete

actions that would help to achieve a sustainable, tropical cattle ranching, in addition to providing topics for further research and investigation.

- Establish an intensive grazing program according to the biological capacities of the grass and the environmental conditions (weather and soil).
- Promote and conserve the biological diversity (fauna and flora) in spaces of natural vegetation, along vegetation corridors, and alongside rivers (riparian vegetation).
- Promote the use of living fences with species of semi-deciduous trees (*Bursera spp., Eritrina spp., Gliricida sepium*).
- Produce food supplements and fodder for the cattle that are local and adapted to the socioeconomic environment.
- Implement agrosilvopastoral management practices by integrating diversified land uses both spatially and temporally.
- Grow plants that serve as protein banks, or nutritional supplements, for the cattle utilizing species such as (*Leucaena spp.; Ichlyomethia spp. Glirisidia sepium*).
- Encourage the use of trees within the pastures.
- Promote an ideology of resource conservation by preserving resources such as water, soil, and vegetation.
- Practice zero tillage to minimize soil erosion and the loss of animal species above and below ground.
- Avoid the use of chemical products, herbicides, and pesticides that modify and eliminate the natural processes that promote biological fertility in the soil.
- Eliminate grazing in zones with a slope inclination of more than 20%.
- Protect and renovate the natural vegetation near water sources and rivers.
- Induce and encourage “islands of vegetation” next to pastures that would serve as carbon sinks and promote biodiversity, in addition to supplying wood and poles for pasture fences.
- Strengthen the self-reliance of the production system, community, and farmers through product diversification.
- Reduce the costs from external inputs by using a diversified system that allows for the production of balanced food, for example.
- Increase the economic viability of the system by taking advantage of the synergisms between different local and regional economic activities by for example, using organic waste products generated by corn, sugarcane, and citrus cropping.

- Reduce the fragility of the biological system by implementing rotational grazing pastures and the reduction of chemical dependency.
- Stimulate the biological control of plagues and diseases.
- Undertake hydraulic works to mitigate the effects of drought.
- Encourage the use of grass silage.
- Avoid mono-cultivation and promote biological diversity within the production system.
- Promote the development of other economic activities in addition to cattle ranching to consolidate the family economy of the participants.
- Enhance solidarity in facing market, social, or environmental uncertainties and fluctuations.
- Promote the use of local labor in order to prevent emigration within the community.
- Impulse the financial autonomy of production projects through wise investment and avoiding the mediation of institutions that offer credit an rates that put farmers at a disadvantage.
- Establish equality between participating members of the productive system regardless of gender, ethic, or religious group.
- Establish mechanisms of equitable and fair distribution of the costs and benefits generated.
- Encourage the participation of all partners in different project activities.
- Promote autonomy and control in the decision making process, whereby farmers are able to make decisions on the critical functional aspect of the productive system.
- Consolidate a democratic structure during the decision making process.
- Encourage the use of local knowledge to promote livestock production

FUTURE LINES OF INVESTIGATION

While the conversion of native vegetation to pasturelands has been the main factor in the destruction of the tropical rain forests of Latin America, it is also true and has been demonstrated by the present investigation that the search for production alternatives must be part of a team effort between investigators and rural, peasant farmers. The following themes are suggested as future lines of research:

- The efficiency of synergistic productive activities, such as using fodder from corn plants to feed livestock and tree litter to enrich the soil, among others.
- The availability and balance of the flow of nutrients in the system of intensive grazing under permanent rotation throughout the year.
- The conservation and mobilization of soil nutrients for plants that are grazed upon through the establishment of fodder trees and protein banks.
- The optimal spatial and temporal arrangements in pastures that would stimulate the synergisms through the establishment of biological corridors in the form of living fences and the maintenance of riparian vegetation and forest fragments.
- The adaptability and complementarity of in the use of animals and plants.
- The presence of earthworm communities in other agro-systems, such as in vanilla plantations, secondary rain forest, tall grass, cornfields, and pastures at rest and low grazing.
- The synergisms between the communities of saprophagous beetles and earthworms as regulators of soil fertility in pastures.

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EL IMPACTO DE LA GANADERÍA BOVINA EN LA REGIÓN DEL TOTONACAPAN, MÉXICO: DESARROLLO HISTÓRICO Y ALTERNATIVAS PARA UNA GANADERÍA SUSTENTABLE

RESUMEN

El desarrollo de la ganadería en la región norte del estado de Veracruz conocida como Totonacapan, produjo cambios ambientales importantes. Los eventos más destacados de este desarrollo son la introducción del ganado en el siglo XVI y de los pastos africanos en la segunda mitad del siglo XIX. Los cambios ambientales se precipitaron entre los años de 1940 y 1970. El análisis de tres casos de estudio permitió estimar el impacto que tuvieron las iniciativas de intensificación ganadera en el estado, e identificar algunos elementos para definir un modelo sustentable de ganadería bovina en esta región.

Palabras clave: Sustentabilidad, deforestación, uso de suelo.