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Abstract: Latin America and the Caribbean offer the most favorable natural and social conditions for the emergence of cattle ranching that regenerate and maintains the ecosystem services on which life on Earth depends, that is energy efficient and that contributes to meeting fundamental human food needs. Unlike other major global producers, cattle farming in Latin America and the Caribbean is fundamentally based on pasture. Therein lies both its strength (due to the regenerative potential of well-managed pastures) and its vulnerability (due to the pervasive link between deforestation and pasture formation, especially in the Amazon, where 40% of the Brazilian herd is concentrated). The diversification of pastures (today marked by impressive monotony, with brachiaria accounting for 85% of the species in Brazil), the introduction of legumes and tree plantations within them, and the proper management of herds, open the way to the possibility of drastically reducing the area currently occupied by the activity (especially in the Amazon) while maintaining the supply of its products. Agricultural research has disseminated forms of moderate intensification of cattle ranching, which represent a low opportunity cost of animal feed and, at the same time, regeneration of ecosystem services that have so far been destroyed by the prevailing methods of farming.

Keywords: animal welfare; deforestation; moderate intensification; pastures; cattle farming

1. Introduction

The food guides for Brazil [1], Mexico [2], Peru [3] and Colombia [4] converge in two fundamental directions: the urgent need to reverse the increase in consumption of ultra-processed products and the need to reduce meat consumption [5]. It's not a question of advocating veganism or vegetarianism, but of promoting the diversification of diets, increasing the consumption of vegetables, fruit, legumes and whole grains, which paves the way for a diet less dependent on the consumption of animal proteins [6]. Of the five largest global per capita consumers of beef, two (Argentina and Brazil) are in Latin America [7]. The FAO's 2023 report predicts [8] an increase in demand over the next two or three decades, especially for beef products, which is much lower than that projected, for example, by the World Economic Forum [9], which predicts an 88% increase in global demand for meat by 2050. In Latin America and the Caribbean [8] per capita demand for milk is expected to remain stable until 2050, and for beef the estimate is for an increase in per capita demand of just 0.7%. It is only in sub-Saharan Africa that there will be a significant increase in per capita beef demand. But since the starting point for consumption is very low and since the main research organizations are committed to increasing the region's food sovereignty by strengthening crops adapted to its ecosystem conditions [10–13], the much-vaunted explosion in demand for animal proteins is increasingly distant from what the most balanced forecasts [14] point to.

If the demand for meat is not explosive, this means that it becomes even more urgent (and, above all, possible) to adopt regenerative methods of raising cattle, both in terms of deforestation and the methane emissions that are organically inherent in their rearing. This article, based on a series of interviews with entrepreneurs and researchers in the sector and an extensive review of the literature, seeks to combat the idea that the term "regenerative cattle farming" can only be considered an oxymoron. On the contrary, even in regions where cattle farming is currently associated with the large-scale destruction of ecosystem services, there are methods that allow the supply of their products on the basis of moderate intensification and the low opportunity cost of feeding the herds.

Latin America and the Caribbean account for 24% of the global cattle herd [15]. With 13.5% of the world's population, the region accounts for 23% of the world's beef supply and 11.8% of its milk production [16]. Brazil has the largest commercial herd in the world, with more than 224 million head of cattle, and is the world's leading meat exporter.

Both the size of the meatpacking plants and the size and social nature of the large cattle ranches hide a fundamental feature of Latin American and Caribbean livestock farming: a very important part of livestock farming (especially that known as "cria", which corresponds to the first eight months from the animal's birth and is the most demanding in terms of human labor and the highest risk of losses) is under the control of family farmers. In this initial phase, livestock farming is much less concentrated than in the final stages of rearing, immediately prior to slaughter [17,18]. Given the dispersion of the activity in units with a few dozen animals, it is also the stage in which it is most difficult to trace the animals, and in which a very significant part of the deforestation is concentrated.

In Peru, 88% of cattle are kept on farms of less than 10 hectares [8]. In Brazil, 2.5 million farms are dedicated to raising cattle, 75% of which are family farms [16]. In Colombia, 81% of the 623,000 establishments with cattle have fewer than 50 animals each [19]. In Central America, around 86% of livestock farms have less than 18 hectares and are home to between four and twenty animals, with an average load of 1.5 bovine units per hectare.

Cattle fulfill different functions for family farmers and ranchers. In many circumstances, especially when access to markets and banking organizations is difficult, cattle often serve as the basis of family savings, and their liquidity (greater than other assets controlled by farmers) allows them to be sold quickly in emergency situations [17,20–22]. Family farms predominate in milk production, as the entire production cycle is labor intensive [23]. The marketing and industrialization of milk and its derivatives often rely on cooperative organizations, and the entire dairy chain is a major generator of jobs.

The most important characteristic of dairy farming in Latin America and the Caribbean is that it is fundamentally pasture-based [24–28]. While in the United States and Europe 70% and 65% of cattle are confined respectively, in Latin America and the Caribbean the percentage is much lower. In the Brazilian herd, which exceeds 220 million head, for example, confinement is limited to the final stage of breeding and in 2021 reached only 15.6% of the animals [29]. It is in this predominant characteristic that both the strength and the main problems of Latin American and Caribbean cattle farming lie.

2. Moderate Intensification and Low Opportunity Cost

An important part of the Latin American and Caribbean cattle herd occupies areas of native grassland. These areas have been occupied by large herbivores since the beginning of the Holocene. The ecosystem services provided by these territories and the relationships between the soils, their microbiota and the plants that grow in them depend on the grazing activities of large animals [30–32]. The continent's native grasslands, such as those of the Pampa, the Pantanal, the Páramos, the Caatinga, the Patagonian steppes or the Guiana savannah, but also those located in the Amazon itself [33], are the most important Latin American examples of these ecosystems, which have two fundamental advantages for the agri-food system.

Firstly, the digestive system of ruminants, unlike that of monogastric animals, allows them to obtain energy and nutrients contained in the cell walls of plants, in the form of fibers. It is true that the rate at which ruminants convert calories and plant proteins into products that can be consumed by humans is much lower than that of monogastric animals [34,35], i.e., ruminants need more energy

(in the form of plants) for every unit of energy in the form of meat that they offer. However, the calculation of energy efficiency in the transformation of plant products into animals needs to take into account that humans do not have direct access to the nutrients that make up grazing cattle feed [36]. In other words, pasture-raised cattle compete much less with human food than monogastric animals [32].

Globally, Cheng et al. (2022) [37] found that raising monogastric animals (mostly fed on products that could be used directly for human food) requires four times more productive area than ruminants per unit of protein. The growing increase in poultry and pig farming has contributed to an increase in grain production which, despite the increase in productivity, is expanding territorially, compromising the biodiversity of the areas over which it advances [38,39].

The work of Mottet et al. (2017) [40] shows that 86% of ruminant feed worldwide cannot be digested by humans. As this average is global and therefore includes those livestock that are stabled and highly dependent on grains, the share of ruminant feed that does not compete with human food in Latin America and the Caribbean may be even higher. In addition, cattle can receive nutrients from brewery waste, citrus pulp, cottonseed and alcohol distillery waste, thus offering a strong opportunity to act as a recycling element within the framework of a circular economy.

In short, raising cattle on natural pastures and, in the case of tropical forests, with moderate intensification technologies marked by plant diversity, the introduction of legumes and tree plantations into the landscape, as in the Guaxupé method, results in what Van Zanten et al. (2023) [41] call the low opportunity cost of animal husbandry. This is because the Guaxupé System, proposed by Embrapa, makes it possible to intensify livestock farming with less economic investment and benefits for the environment [42].

In addition to this advantage, the supply of cattle products on native pastures based on these moderate forms of intensification strengthens fundamental ecosystem services, both in terms of biodiversity and their capacity to capture greenhouse gases and store carbon in the soil. What's more, these services would be difficult to provide if these areas were no longer used for cattle farming [43]. The biodiversity of natural grassland soils is impressive. The native pastures of the Pampa biome, found in southern Brazil, Uruguay, Argentina and Paraguay, are made up of around 450 species of forage grasses and more than 150 species of legumes [44] and other families. In total, there are 3,642 species in this region alone [45]. In areas of native grassland in the south of the continent, emissions from livestock farming are reasonably neutralized when managed properly [46,47]. The link between the Alianza del Pastizal (which brings together cattle ranchers from the four countries that make up the Pampa, Brazil, Argentina, Paraguay and Uruguay) and North American conservation organizations is justified by the importance of this biome in maintaining migratory birds, threatened by the advance on pastures of both soybeans and wood species for cellulose [48].

But it is impossible to ignore the fact that these areas of native grassland, despite their importance, correspond to a minority of the land on which cattle farming is carried out in Latin America and the Caribbean. Livestock grazing on the continent is often marked by low productivity, destruction of biodiversity, monotony in the types of pastures planted, erosion and loss of the soil's capacity to store carbon. An aggravating factor in these problems in the Pan-Amazon and the Brazilian Cerrado is the fact that the mechanism for occupying what will become areas of low-quality pasture has much more patrimonial than productive purposes. A total of 75% of the forest that has been lost in the Brazilian Amazon to date is occupied by cattle ranching, the precariousness of which could not be greater [49,50]. This concern is due to the fact that pasture degradation time in the Amazon is much shorter than it was in the Atlantic Forest or Cerrado. Limiting the occupation of new areas is essential not only to preserve forest socio-biodiversity, but also to reverse the low productivity of livestock farming. Today, degraded pastures in the Brazilian Amazon alone amount to 56 million hectares [51]. In Colombia, no less than 60% of pastures were in a state of degradation [52].

Even in native pasture areas, the threats are significant. The South American Pampa occupies 6.1% (108.9 million hectares) of South America. The net loss of native grassland vegetation between 1985 and 2021 was 8.8 million hectares. The combined area of agriculture and planted pasture grew

by 10.6%, from 44 million hectares to 48.6 million hectares, and the area planted with exotic trees increased from 600,000 hectares to 2.8 million hectares (363% increase) [53]. This conversion reduces the composition and richness of the fauna [54,55] and flora [56,57] communities of the soil, and can affect the ecosystem services offered by this biome.

Thus, biomes suitable for cattle ranching, such as the Pampa [18,30,58–61], the Pantanal [62] and the Cerrado [63–66], could - if used appropriately [67,68], [43,69] - meet the current needs of the Pantanal) -, meeting current market demand without increasing the areas they occupy today [58,59,67], conserving biodiversity by maintaining pastures [28,58,59,70,71], and reducing greenhouse gas emissions from livestock [47,64,72–74]. One of the important factors in realizing this potential, as will be seen in the next section, is valuing native species and their diversity. Pastures with legumes, as advocated in the Guaxupé method, increase protein and mineral calcium (Ca) and phosphorus (P), improve the animals' diet, and fix nitrogen in the soil through symbiosis with bacteria of the Rhizobium genus [75].

Animals raised on well-managed pastures with high nutritional value emit less greenhouse gases than animals raised in confinement, mainly due to the variation in enteric fermentation of the diet and the reuse of manure in soil fertilization [76–79]. Beef production systems in areas with diversified and well-managed pastures can reduce the area needed for animal husbandry by up to seven times [13,80].

In addition, several studies [81–84] show that the addition of algae, especially Asparagopsis taxiformis, also known as red algae, has good results in reducing methane gas emissions in ruminant digestion. Some studies have shown a reduction of more than 50% in enteric methane emissions in lactating dairy cows [85] and more than 80% in beef steers supplemented with the algae [86].

The consequence of these innovations in moderate intensification is decisive for the very notion of regenerative livestock farming. As Scoones [85,87] rightly points out, "the notion of the l'ivestock sector' presented in many global assessment reports is largely meaningless". Between basically confined farms (industrial factory farms) and farms with open pastures in the Pampa, for example, the dynamics of emissions and the solutions to deal with them change radically.

These changes are even reflected in the measures of emissions from cattle herds. The data on their emissions comes mainly from respiratory chambers of confined animals, especially in the United States and Europe. The report published by Houzer and Scoones [85,88] shows that almost all (86% of a total of 164) life-cycle analyses of cattle emissions come from Europe, the United States, Australia or New Zealand. 9% of these analyses come from Asia, 4% from Latin America and the Caribbean and 0.4% from Africa. Measuring emissions from livestock loose on pasture is immensely more difficult. Scoones [85,87] shows that both the Intergovernmental Panel on Climate Change (IPCC) [89] and Eat Lancet [90] make the mistake of generalizing methane emissions from confined cattle, as if they were universally the same for every herd in the world. One of the most cited scientific papers on emissions from cattle farming [91], published in Science, advocates a drastic reduction in human consumption of its products based on the systematic underestimation of the importance and particularities of pasture-raised livestock. Of course, following the guidelines of the most important food guides in the world (and especially in Brazil), the necessary diversification of diets involves reducing meat and increasing fruit, vegetables and legumes in meals. But what these studies tend to underestimate is the potential that pasture-based cattle farming offers for a supply that meets human needs and, at the same time, whose production can be regenerative and represent a low opportunity cost in what the cattle consume.

Cattle ranching can make highly relevant contributions to sustainable development in Latin America and the Caribbean through regenerative practices that, in the overwhelming majority of cases, are well-known, relatively inexpensive, economically profitable and can be taken to millions of farmers. Let's take a closer look.

3. Regenerative Livestock Farming: Principles and Practices

When you search Google Scholar for the term "regenerative livestock" in quotes, no more than 68 references appear. Few of these go on to define the term. However, it is still possible to draw on

this literature in order to use the term in an operational way. What predominates in the definitions of regenerative livestock farming is the relationship between soils, pastures, animal welfare and human working conditions. The emphasis is on soil management, pasture quality and herd health as a condition for minimizing dependence on both chemical inputs and "external foods" [92]. In their interesting survey of sustainable farming and forestry experiences in Latin America, Miatton and Karner (2020) [93] use the definition of the Rodale Institute (2014) [94], which insists on the idea that farming practices must regenerate the resources on which they themselves depend.

Regenerative livestock farming is an activity of an economic nature, which is why Spratt et al. (2021, p.15) [95] point out that "regenerative grazing is an agricultural practice that uses principles of soil health and herd management to increase farm profitability, human and ecosystem health, and food system resilience". Lal (2020) [96] emphasizes the reduction or elimination of synthetic inputs, the diversity of animals, plants and microbial life and the ability to generate income to maintain the activity. Living soils, vigorous and diverse plants, healthy animals, decent work and economically remunerative activity are the general components of regenerative livestock farming.

Learning from nature is also a general guideline of regenerative livestock farming: "it's about replicating, on the scale of cattle farming, the dynamics of wild herbivores in grassland ecosystems, such as those observed in savannas" (92, p. 2). Finally, the core of this way of raising livestock consists of respecting the socio-cultural predispositions of rural populations and their relationship with the livestock way of life. As Evans-Pritchard (2013, p. 27) [97] described when referring to cattle ranchers in Ethiopia, "The Nuer tend to define all social processes and relationships in terms of cattle. Their social language is a bovine language".

Despite its socio-economic importance for the different Latin American and Caribbean countries, for their exports and for the domestic market, cattle farming in Latin America and the Caribbean is currently marked by low productivity and is very often associated with the destruction of natural environments. The average stocking rate of pastures in the Brazilian Amazon, for example, is 0.73 animal units per hectare, when the average potential is 2.5 for cattle grazing in the region [29]. Köberle et al. (2023)[13] point out that increasing beef cattle productivity is already widely recognized in Brazil as having great potential for the sector to increase production and, at the same time, reduce the pressure to expand into new areas of land.

In short, however polysemic the notion of regenerative livestock farming may be, in Latin America and the Caribbean its usefulness derives from two crucial considerations. Firstly, it's not just a question of dissociating cattle farming from the different forms of forest destruction. The largest Brazilian meatpackers have made formal commitments to promote this decoupling by the end of this decade [98]. But it is clear that this is a starting point and not an end point.

The second fundamental consideration lies in the urgency that Latin America and the Caribbean's trump card of being the region in the world with the highest proportion of livestock grazing is not only expressed in zero deforestation, but also in diversification of pastures and animal breeds, increased yields, neutralization of methane emissions, expansion of carbon in the soil, enrichment of biodiversity, animal welfare, decent human work and economically viable activity.

It is in Latin America and the Caribbean (more than any other region in the world) that the term regenerative livestock farming can no longer be seen as an oxymoron. It is true that livestock farming currently plays a key role in emissions, particularly of methane and nitrous oxide. Brazil, for example, is the fifth largest emitter of methane in the world, according to data from the Greenhouse Gas Emissions Estimates System - SEEG [99]. Almost half of Brazil's emissions come from deforestation and another 27% from agriculture, with cattle farming accounting for the majority. A study by the NGO Global Forest Watch (2023) [100] revealed that in 2022 Bolivia lost 594,000 hectares of vegetation cover, which is equivalent to emitting 298 million tons of carbon dioxide into the atmosphere. 72% of the total loss was the result of deforestation for commodity production.

Halting deforestation and drastically reducing emissions from cattle ranching are the possible ways for Latin American and Caribbean countries to reduce their emissions, strengthen the biodiversity of their biomes and rationalize a fundamental economic activity that today is so strongly marked by backwardness and destruction. Recovery of degraded pastures, biological diversification

of cultivated species, crop-livestock and forest integration, together with genetics that encourage diversification and the adaptation of breeds to different climatic situations, are innovations that do not require huge investments, that can be widely distributed socially and whose positive effects on cattle farming in Latin America and the Caribbean can appear in a fairly short time.

3.1. Soils, Plants, Animals and People: the Foundations of Regeneration

The fact that the vast area of native grassland on the planet's surface provides ecosystem services for which the presence of large animals is decisive is something that has already been established in the best recent scientific literature [69,101,102]. But can these services exist (and within the framework of viable socio-economic activities) in forest ecosystems or in those where the introduction of pastures was based on large-scale biological destruction? Is it possible to promote a radical dissociation between cattle farming and the loss of ecosystem services linked to soil carbon storage, greenhouse gas emissions, biodiversity and water use? More than that, is it possible to make this decoupling economically relevant or is it doomed to be confined to virtuous market niches, but with a necessarily limited social reach?

The answer to these questions lies in the relationship between soils, plants, animals and people, and if the promising nature of this relationship can be summed up in one word, the term to use is diversity [103]. Latin America and the Caribbean have a wide diversity of pastures and breeds that pave the way for the socio-environmental and economic viability of the most important challenge facing livestock farming: reducing the space currently occupied by pastures and, at the same time, increasing productivity per hectare, reducing the time it takes to finish animals and, therefore, their emissions [104]. This, of course, involves scientific research into the different types of soil and their suitability, as well as research that can help livestock farmers manage their livestock: concentrating the birth periods of calves, for example, is manageable and can offer an advantage to producers, as it increases their negotiating margins when it comes to selling the animals due to the homogeneity of the batch and their weight gain. As a result, more animals are sold at the same time, reducing costs for the whole chain. Picketing, mineral salt and afforestation of pastures are also accessible techniques that can increase productivity by reducing the lifespan and the need for new areas.

Good soil management in native pastures or through diversified cultivation in cultivated pastures makes it possible to capture and store significant amounts of carbon in a way that is integrated into production, which allows for a neutral or positive balance and, consequently, contributes to mitigating climate change. The use of monoculture in pastures invites the invasion of pests, since it reduces the diversity of beneficial insects [105]; an example of this is the attack by the pasture leafhopper [106]. The heterogeneity of the systems and the genetic improvement of the animals are characteristics of the resilience of regenerative livestock farming.

There are studies [107,108] showing that, in Latin America and the Caribbean, there are different types of grass with high protein levels and rapid development that could be used in the composition of pastures. But seed markets tend to focus on a few species, thus inhibiting farmers from taking advantage of the region's huge biodiversity. Farmers with greater access to technology and technical assistance make use of this information.

Moderate intensification [109] of cattle ranching is the main strategy for reconciling increased productivity with reduced environmental impacts in Latin America and the Caribbean. This intensification is associated with the reform or recovery of pastures, which includes the supply of nutrients, mainly nitrogen (N), which can occur through the application of chemical or biological fertilizers. The high cost of chemical fertilizers limits the adoption of pasture fertilization by Latin American and Caribbean producers, as well as leading to external dependence. In this scenario, the adoption of pastures combined with grasses and legumes aims to make up for this shortfall and promote biological N fixation (BNF), without the need for external inputs [110].

The most important thing is that this is moderate intensification [13,111], whose costs tend to be accessible to family farmers and whose implementation does not require sophisticated technological skills. It is an activity that benefits from the abundance of solar energy and rainfall in the region and relies fundamentally on renewable and abundant resources. If extensive livestock farming maintains

biodiversity but with low production, and intensive livestock farming increases production but uses chemical inputs that often compromise biodiversity, moderate intensification has the virtue of reconciling biodiversity with high production performance.

The adoption of legumes in the formation of pastures, in consortium or exclusively, is guided by the choice of crop best suited to the environmental conditions, the nature of the farm, the capacity for intervention and the availability of resources, among others. In this context, trained technical assistance is essential for making decisions and drawing up the appropriate management plan for these pastures.

Last but not least, there is a considerable diversity of cattle breeds. In Latin America and the Caribbean, there are mixed breeds of pure European and Zebu origin, as well as creole and native breeds. The good performance of regenerative livestock farming depends on choosing breeds that match the potential of the environment, adopting genetic improvement whenever possible.

Integrated crop-livestock-forestry (iLPF) systems are an important tool for sustainable food production. This is because they provide ecosystem services and contribute to social benefits such as generating demand for labor, resilience to economic factors and reducing risk. For example, conventional livestock farming generates one new job for every 1,000 steers, while iLPF systems generate more than one direct job for every 100 hectares of pasture [112].

iLPF systems are a production strategy in which the forestry, agricultural and livestock components are synergistically integrated on the same temporal or spatial scale. This method seeks to maximize production and product quality while respecting the social and environmental dimensions. Among its benefits are: optimization and intensification of nutrient cycling in the soil, improved animal welfare due to greater thermal comfort, diversity of products that can be generated in the area, such as grains, meat, milk and wood and non-timber products, and consequently greater financial security for the producer, more job creation, carbon storage and the possibility of being applied to properties of any size [113–115].

Crop-livestock-forest integration improves the soil's chemical, physical and biological attributes, with an increase in organic matter. This management can also increase the productivity of soybeans grown in these areas by 20%, increase the stocking rate of pasture by at least five times, increase meat productivity by eight times and reduce the slaughter age by one year, which leads to a reduction of at least a quarter of methane per kilogram of meat produced [112,116].

In addition, crop-livestock integration under moderate-intensity grazing has resulted in better carbon stock levels, higher forage production and liveweight gain, and greater resistance to moderate and extreme weather events [117]. This is because the presence of domestic herbivores plays a positive role in the carbon cycle [118] and helps to increase biomass production through manure and urine during the grazing period or as a final residue of the season [117]. This accumulation of organic matter in the soil also tends to increase the resilience of systems to climatic disturbances [119].

In this way, it is possible to see that there are managements that make it possible to increase production while reducing greenhouse gas emissions, such as methane. One study analyzed 24 methane mitigation strategies in Latin America and the Caribbean. 58.3% of the strategies involved cattle grazing [15]. Of these, 16 showed decreases in methane without compromising animal productivity and, of these, six reduced methane emissions by approximately 27% and increased animal productivity by around 68%.

Practices such as forage diversification, mixed crops of grasses and legumes with a high soil fertility recovery content, rational grazing and agroforestry are examples of regenerative management that increase animal productivity. The Fundación para la Conservación del Bosque Chiquitano (FCBC), a Bolivian non-governmental organization, has been carrying out research into the interactions between regenerative livestock farming and biodiversity in the region for over ten years, and the application of such management has made it possible to double the animal load per hectare: the average productivity is usually 1 to 1.5 UA ha in the region, and in these areas with regenerative livestock farming practices it reaches 2.3 UA ha [120].

The Promoting Climate Smart Livestock Management project [121] in the Dominican Republic covers eight provinces in the Yuna River basin. On a family farm, the project implemented techniques

such as a drip irrigation system, rotational grazing management, afforestation and shading, planting selected grasses, creating the Mulberry protein bank and recording production activities, which allowed productivity to increase by 117% in two years, reducing GHGs by 19%, increasing the availability of pasture and fodder and promoting greater vegetation cover on the farm, which led to greater carbon capture.

It is part of the regenerative nature of livestock farming that cattle feed is not based on products that can be consumed by humans, i.e., the low opportunity cost of animal feed [41]. In regions with rich biodiversity, not only can pastures increase their feeding power by introducing legumes and diversifying species, but the finishing phase of animals, which often relies on grain consumption, can also be based on products that do not compete with human food, such as cottonseed and wet barley residue. In addition, cassava stalks are an important example, as they are widely available throughout Latin America and the Caribbean. But it is clear that, in the context of crop-livestock-forest consortium, the potential is immense for Latin American and Caribbean livestock farming, even in its final stages, not to require products that can directly supply human food needs. Eduardo Roxo Franciosi (2022) [122] shows the immense potential for integrating babassu (present on no less than 15 million hectares of the Mata dos Cocais, in the Brazilian state of Maranhão) and livestock farming.

For regenerative practices to become a reality, it is important to promote technical assistance and rural extension, through training that dialogues with the local reality of livestock farmers, in order to overcome the specific challenges of each region, such as the lack of infrastructure, and based on respect for different cultures.

5. Conclusions

Reducing emissions from livestock farming, making cattle farming a component in the regeneration of biodiversity and thereby increasing the supply of food that is essential for human health are objectives whose technological bases and economic costs are much lower than those of decarbonizing the industrial sectors that emit the most greenhouse gases. There are no technical obstacles to regenerative livestock farming dominating the countryside of every country in Latin America and the Caribbean in the short term. This does not mean expanding the territory currently occupied by livestock. On the contrary, it is essential to reduce this area, especially in territories where the degradation of livestock farming is most evident, such as the Amazon. This reduction requires technological improvements that will pave the way for absorbing carbon in the soil and increasing the productivity of livestock. This increase will come from diversifying pastures, intercropping with legumes and trees, managing calving periods, improving and diversifying breeds, in short, technical changes that are accessible to producers of all economic sizes and whose individual and social return is quite rapid. The gains from this transformation can be immense. If its adoption is still slow in the territories most susceptible to degradation, it's because credit policies have focused much more on the acquisition of animals than on the changes that will allow them to be managed more appropriately.

Of course, the basic prerequisite for the innovations already available to enable livestock farming to help regenerate the socio-environmental fabrics that it has so often destroyed is zero deforestation. Establishing, in each country, a zoning of areas suitable for livestock farming and guiding credit and technical assistance policies so that, in these areas, the economic and socio-environmental performance of livestock farms improves is a decisive way to guarantee food supply, strengthen carbon storage in the soil, biodiversity and the profitability of farms.

No sector of economic life in Latin America and the Caribbean has the potential to transform itself in the direction of biodiversity regeneration as quickly, cheaply, profitably and technically as cattle farming. It is essential that governments, companies and civil society take advantage of this asset to strengthen sustainable development in the region.

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