Cattle ranchers, colonists and deforestation of primary forests in Morona, Ecuador

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ABSTRACT

The objective of the article is to describe and analyze the productive characteristics, as well as the corresponding environmental impact of small and medium extensive livestock production practiced by mestizo settlers and by residents of the Shuar ethnic group, in the Morona canton, located in the Ecuadorian Amazon. It is indisputable that there are forms of extensive livestock production that are more sustainable than others, but the volume of deforested or cleared land constitutes a problem in itself that must be addressed. Such a productive system is based on the circulation of livestock between the pastures of a farm due, among other aspects, to the low nutritional potential of the so-called gramalote grass (Axonopus scoparius). This activity generates deforestation in large areas of land. Among the factors that accentuate such levels of deforestation are, on the one hand, the larger size of agricultural units and the need to compensate for the loss in the nutritional potential of grasslands and, on the other hand, the economic perception of forests. Extensive livestock production has proven, especially among settlers, to have a great capacity for resilience over the last forty years, despite fluctuations in urban demand for meat

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and its environmental impact on the forest. Cattle ranchers in the region have maintained cattle ranching as a source of income and capital accumulation, as a viable activity in a context of relative labor scarcity and as a means of obtaining social status in a frontier context. In short, a way of reproducing their family economy.

Keywords*: Amazon; extensive livestock production; deforestation; subsis-tence farming; Ecuador*

INTRODUCTION

Since the 1960s, the eight countries that make up the Amazon basin have experienced an increase in the number of livestock from 5 million to a minimum of 70 million (Walker *et al.*, 2009; Veiga *et al*., 2002). Such an increase was accompanied by a considerable impact on forests. However, the perception that exists about livestock activity is not homogeneous among all social actors. For medium and large ranchers, it represents *status* and more monetary income. On the contrary, for environmentalists it means the destruction of biodiversity, the disappearance of ecosystem services from forests, the rupture of energy flows that depend on the intact forest for their regeneration and also the emission of dangerous methane gas (Angelsen & Kaimowitz, 2001; Faria *et al*., 2023; Watson *et al*., 2018).

The fact is that livestock production was and is a very important activity both in terms of occupation of space as well as transformation of land use and destruction of forests. It covers a lot of territory and also leaves a deep ecological footprint (Walker *et al.*, 2009). Its environmental impact in the Amazon basin has been analyzed for more than thirty years from political economy, especially in Brazil (Hecht 1993). Recently, Skidmore *et al*. (2021) verified, after studying 113,000 farms in the three most livestock-producing Amazonian states in Brazil, that such activity becomes a factor prone to generating greater volumes of deforestation when it is practiced with comparatively small herds, in remote places, in grasslands of low productivity and above all with abundant forest available. That is, livestock production based on extensive use of the territory that requires continuous movement of livestock between pastures and, when necessary, resorts to the destruction of primary forests. Such a productive system has demonstrated resilience to public policies that have sought to convert it into a more sustainable system over time, with the aim of reducing deforestation (Pereira *et al*., 2020; Gibbs *et al*., 2016; Bowman *et al*., 2012).

The Ecuadorian Amazon is not immune to such a process of land use change. By 2013, of the total cleared hectares, approximately 75,8 % was covered with cultivated grasslands. Furthermore, between 1972 and 2013, while the amount of agricultural land grew in the indicated region from 30 000 to 178,000 hectares, the area covered with planted pastures increased from 384 000 to 876 000 hectares. That is, in 2013, for every hectare dedicated to agriculture, almost another five hectares were directed to livestock (National Institute of Statistics and Census – INEC Ecuador, 2013).

Several authors have analyzed the influence of the political and economic framework on Amazon deforestation in Ecuador, related to livestock production. Among them, Rudel and Horowitz (1993) studied the colonization process of the Amazon basin and its impact on the forests, introducing the concept of multiple coalitions, which describes how various social actors came together to carry out the occupation of the indicated space. According to both academics, the reason that encouraged colonization was the search for land that would allow them to reproduce a family economy based on self-consumption agriculture, accompanied by livestock production for the market. Next, using the multi-scalar methodology of political ecology, Buitrón (2017) analyzed the development of the livestock complex in Alto Nangaritza in the Amazonian province of Zamora and Chinchipe, as a result of a confluence of interests between the Ecuadorian State, the Church and the local actors. Researchers such as Grijalva *et al*., (2004) relate how the extension of cheap credit in the Amazon for livestock, allowed by surplus oil revenues and complemented by the World Bank, was important in livestock expansion in conjunction with the increase in demand for meat. milk and derivatives in the cities. Similarly, Gómez de la Torre (2020, 2011) establishes a clear link between the increase in livestock, increase in grasslands and deforestation in extensive livestock production in Cosanga in the province of Napo.

An important aspect is that livestock production in the countries of the Amazon basin is associated with a low demand for labor force per hectare and also with a small number of people at the regional level (Carr, 2004). Despite this, the impact on forests is considerable. Geographer Carr (2004) notes that livestock farms in the Amazon tend to occupy significantly larger spaces larger than the productive units dedicated to subsistence food production, and therefore, in territories with low population density highly destructive productive dynamics of forests also take place. This is in contrast to Boserup (1984), who argued that reduced population density was mainly associated with subsistence farmers in frontier areas, who

had very low levels of forest destruction. As argued by Blaikie and Brookfield (1987), environmental degradation processes in the countries of the global south occur mainly in areas of low and medium population density.

In this sense, this article maintains that the characteristics of a regional context of abundant land and low population density, such as the province of Morona and Santiago[1], where public policies were implemented and private activities were carried out that encouraged the expansion of the demographic and economic frontier in the Ecuadorian Amazon (Bilsborrow, 2003), made possible the development of extensive livestock production that drastically modified the biodiverse landscape of the primary forest into a productive system based mainly on grasslands, few trees and relatively few animals. This caused extensive damage to forest ecosystems.

In this context, our text describes and analyzes how the extensive productive practices of ranchers in the Amazon region of the Morona canton, in the province of Morona Santiago in Ecuador, have led to the deforestation of primary forests (See Figure 1). The study focuses on deforestation. It is indisputable that there are forms of extensive livestock production that are more sustainable than others, such as the so-called "smart livestock", but we believe that the large volume of deforested land constitutes a problem in itself that must be addressed (Ministry of the Environment, 2017). This article is the result of a field study conducted during the second half of 2014, which covered the canton of Morona together with the canton of Tena in the province of Napo (See Figure 1).[2]

Methodology

To carry out this research, qualitative and quantitative methodological tools (surveys), semi-structured interviews and participatory workshops were used. All of this with the purpose of collecting detailed and descriptive information on

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1 The province of Morona and Santiago had, in the years 1974, 1982 and 1990, a demographic density of 1.6, 2.1 and 2,8 inhabitants per square kilometer compared to 24, 30 and 36 inhabitants per square kilometer at national level respectively (Bilsborrow, 2003).

2 Funding for the study came from the Prometeo program of SENESCYT under the auspices of the Latin American Faculty of Social Sciences - FLACSO, Quito. Our most sincere thanks to Juan Ponce and the professors and all the administrative staff of Socio-Environmental Studies, in a very special way to Teodoro Bustamante, Anita Krainer, Nicolas Cuvi, Ivette Vallejo, Carolina Garzón and Carlos Espinosa, who at that time was in charge of the FLACSO Investigations Directorate.

the type of land use in extensive livestock production, as well as the perceptions and problems present in these activities.

Our methodology is derived from the multi-scalar approach of political ecology. It articulates the regional historical-political processes and the national demand for meat with the expansion of local extensive livestock production and its destructive impact on primary forests. That is, it links the national economic dynamics with local and regional socio-environmental processes. This does not exclude the role or "agency" of the local actors who are the ranchers. The latter developed productive strategies that strengthened the livestock production system of the Morona region. They generated a productive system with notable resilience or ability to survive despite economic changes at the national and regional level. Likewise, other authors have worked within a similar perspective, called regional political ecology, such as Schmink (1994), Blaikie and Brookfield (1987) and, most recently, Gómez de la Torre et al. (2017). They emphasize the use of the so-called progressive contextualization as a method of analysis of socio-environmental processes. This theoretical approach is criticized for not clearly defining the relationships between each of the multi-scalar levels (Peet & Watts, 2002, p. 8). However, we believe that progressive contextualization constitutes an initial methodological contribution by introducing the study of different scales, each with its own agency. Both approaches can be complementary.

In that sense, in the first part, a historical synthesis of the introduction of livestock in the area and its adoption by both the settler producers and some of their descendants, as well as by the Shuar population, is presented. This process is linked to the conflicts between both groups over the occupation and control of lands traditionally managed by indigenous societies. Then, the regional demographic evolution and the economic policies that explain the expansion of the frontier and livestock production are described. In a second section, based on the surveys and interviews carried out in Morona in 2014, the extensive nature of land use by ranchers as a driving factor of deforestation is analyzed in detail. It describes the way of occupation and use of the territory, the productive strategies of ranchers and the impact on the forests. To do this, the information is crossed, on the one hand, between grasslands and deforestation with the size of the agricultural units and, on the other hand, with the number of years that the producers have been managing their farms. Finally, the issue of how the economic orientation of ranchers, accompanied by credits and institutional incentives, strengthened the resilience of such productive units is addressed. As a whole, the information

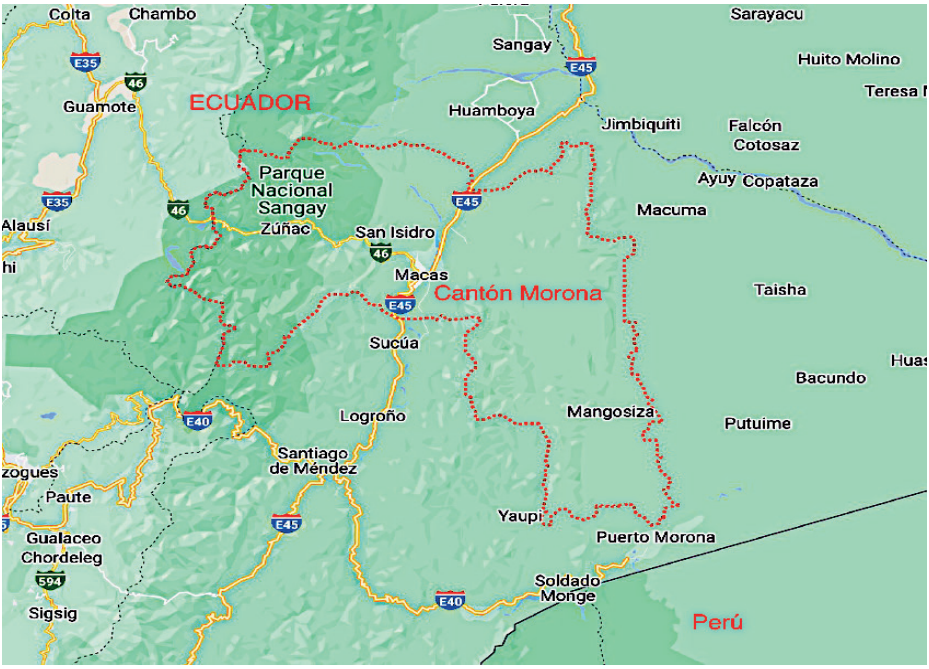
allows us to carry out a situational analysis and understand the evolution of the environmental impact accumulated over the years.

1. MORONA CANTON

The Morona canton is located in the southeast of the Ecuadorian Amazon, with a surface area of 465 448 hectares. The canton is home to indigenous populations of Shuar nationality and settlers (Decentralized Government of Morona Canton - GADM, 2012). To the east of the city of Macas, the main urban center of Morona, the Kutukú-Shaimi Protective Forest and the Abanico Protective Forest are located (CARE *et al*., 2012). The most representative life zones in the Morona canton are the Tropical Humid Forest, which makes up 34,19 % of the canton, and the Pre-Montane Very Humid Forest, which occupies 32,84 % of the territory (GADM, 2012).

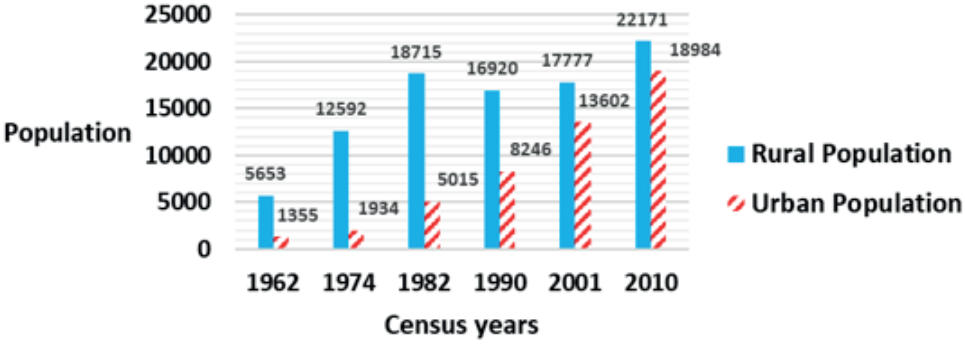
The 2010 Population and Housing Census registered a total of 41,155 inhabitants in the canton (27,87 % of the total population of the province of Morona Santiago). At that time, the most populated rural parish was Seville de Don Bosco with 13 413 inhabitants (32,59 %) (GADM, 2012). A notable feature was the fluctuation in the intercensal rural population volume of the Morona canton. As seen in Graph 1, between 1982 and 1990, the cantonal rural population decreased and then recovered very slightly in the following intercensal period from 1990 to 2001. However, in this last year, the size of the population was still below 1982. The data suggest that rural areas were not able to retain their population during several intercensal periods or, in any case, the evolution of their growth was stationary. The rural population migrated to Macas or to other cities on the Ecuadorian coast and mountains and even outside the country. It is only between 2001 and 2010 that there is an increase in the rural population.

Figure 1. *Location map of the Morona canton.*



Source: Edited Google Maps screenshot*, 2023.*

Graph 1. *Population growth of the Morona canton by census periods.*



Source: INEC-Ecuador (2010). 2010 Population and Housing Census, Quito.

2. LAND CONFLICTS AND THE EXPANSION OF LIVESTOCK PRODUCTION IN THE AMAZON BASIN OF ECUADOR

Since the mass colonization processes of the Ecuadorian Amazon began in the sixties and onwards, the problems of control and titling of indigenous territories constituted a factor of conflict and risk for the aforementioned sectors and, on the contrary, a condition of advantage for the settlers who invaded indigenous lands and incorporated different agricultural systems. The weakness of the institutional legal system for allocating land to indigenous sectors generated uncertainty and confusion. The forms of land allocation did not guarantee indigenous communities a clear definition of their rights over their ancestral territories (Uquillas & Shelton, 1992). Historically, colonization implied a compulsive productive reorganization of local Amazonian populations in the way they related to space, forests, and tropical ecosystems in general (Buitrón 2017; Trujillo, 1987; Uquillas & Shelton, 1992). In one way or another, especially in the initial phases of colonization, the Amazonian indigenous populations were made invisible by the State as well as ignored by the settlers of Andean origin. This actually constituted a permanent feature of colonization in all the countries of the Amazon basin (Fontaine, 2003) and has also been a component in many regions of the narratives constructed to encourage space occupation processes (Cronon, 1992).

However, in Morona this process was not so simple. In a context of expansion of the economic frontier and institutional chaos, both settlers and indigenous people reoriented their agricultural activities towards livestock production and, therefore, cleared large areas of forests. In the case of the settlers, almost all of them had as their central motivation to become ranchers. Livestock production was a means of articulation with the market and a rise in their social status. No money had to be invested in its purchase and the technology of forest clearing was simple and relatively cheap. Furthermore, as we have mentioned, the care of livestock required little labor. Added to this is the regional macroeconomic context that benefited the expansion of livestock production. During the 1970s, when Ecuador's gross national product (GNP) per capita grew faster than the rest of Latin America due to booming oil exports, household economies experienced and benefited from a substantial increase in income. Such income growth was further reinforced when the government devoted almost 4/5 of its tax revenue to expanding employment and raising wages in the public sector (Southgate *et al*., 2009; Southgate & Whitaker, 1994). This improvement in the living conditions of

many middle class families led to an increase in the demand for food, especially meat and other livestock products.

Likewise, government policies encouraged those who wanted to become ranchers. Enriched by oil revenues, official organizations granted various types of subsidized credit that favored specific economic sectors. For example, almost all loans from the National Development Bank (BNF), a public institution specialized in agricultural credit, benefited livestock farmers (Southgate *et al*., 2009). In general, settlers responded positively to market indicators. These producers, with few economic resources in their areas of origin, found themselves in border areas with plenty of available land and a State that could finance the purchase of livestock. As a result of this set of economic measures, large areas of forest in the province of Morona Santiago were deforested, including part of the Upano Valley (Wasserstrom, 2010).

On the side of the Shuar, faced with the invasive nature of the colonizing migrations there was a reaction and a response. At the beginning of the 1960s, the religious congregation of the Salesians, acting in good faith and with the desire to favor and protect the indigenous populations, convinced the Shuar leaders in the Morona region that cattle raising was an alternative. that would allow them to implement an effective defense against the invasion of settlers' lands (Fitton, 1999). The religious group lent money and in some cases donated livestock to native communities. The Shuar, rightly, adopted livestock activity as a means to guarantee access and control of their ancestral territories. Furthermore, in the early 1970s, the Shuar Federation turned to other funds donated by European development agencies, and thus began to provide loans to Shuar families for the expansion of their livestock herd (Rudel and Horowitz, 1993). During those years, the Agrarian Reform Law of 1973 consolidated the aforementioned pattern of human settlements and productive activities in eastern Ecuador (Wasserstrom, 2010). Additionally, livestock production offered higher income than agriculture. As indicated by Meunier (2007), the added value produced by cattle farming was higher because the relative price of meat was higher compared to agricultural products. Finally, between the years of 1965 and 1985, both the settlers and the Shuar indigenous people, as a result of a series of processes and forms of allocation, managed livestock farms whose dimensions ranged between 30 and 70 hectares (Rudel *et al*., 2002).

The social impact for the native Shuar society was significant and was noted in the short and long term (Meunier, 2007). Communities settled near airstrips or religious missions and thus reduced the effort devoted to highly mobile seasonal

subsistence farming. They cleared portions of primary forests and planted grasslands. The reproduction of traditional indigenous communities - and the existence of extensive and relatively intact primary forests- was marginalized to the east of Morona Santiago, distant from existing roads. Livestock production became an important activity for the Shuar population. From nomadic farmers they transformed into commercial ranchers. They adapted to the circumstances and a sector of them was successful in their venture.

3. THE INFLUENCE OF LIVESTOCK ON THE CHANGE OF LAND USE IN MORONA

Colonizations in the different countries of the Amazon basin have always shaped processes of social and productive reorganization of the border space. They have functioned as mechanisms to promote productive systems, such as livestock, agricultural and extractive, with all the consequences that this implies. In all cases, large extensions of forests were destroyed and from there new spaces of productive use emerged, articulated to the market and modernity. In that sense, the pattern of land use changes in the Morona canton is one more example that reflects a dynamic of transformation of the primary forest that culminates in land covered by grasslands. Although the introduction of cattle ranching occurred gradually since the 1960s and 1970s, as settlers first cleared the forest to plant annual crops for sale and family consumption, and then introduced pastures, deforestation exclusively for the introduction of commercial cattle ranching was very intense during the last decade of the last century and the first eight years of the present century. In Morona, between 1990 and 2008, primary forest was reduced from 378 571,51 hectares to 337 387,47 hectares. That is, a decrease of 41 184,04 hectares (GADM, 2012). Primary forest went from covering 77 % of the entire area of the canton to 72 % of the total. Simultaneously, and during the same period, the planting of pastures had a notable increase from 13 094,42 hectares to 40 785,21 hectares. If in 1990 pastures covered 2,81 % of the canton, in 2008 they covered 8,76 % of the aforementioned territory, a consequence of the increase in pastures by 27 690,79 hectares.

Figure 2. *Pastures and livestock in Morona.*

Source: Photo taken by Susana Anda, 2014.

In general, over the course of 18 years there is a reduction in natural forests and, on a smaller scale, in shrub vegetation, while simultaneously an increase in pastures is observed. This shows a clear conversion of forests and shrubs to grasslands. The aforementioned expansion of the livestock frontier was a product above all of the productive activities of the settler population, and then, to a lesser extent, of the Shuar population.

However, the expansion of livestock production in Morona was not linear. It had significant fluctuations. As argued by Rudel (2019), the change in 1998 from the *sucre* to the dollar as the official national currency of Ecuador generated consequences in the livestock sector of Morona. This caused the bankruptcy and decapitalization of numerous livestock farms, who faced with a difficult economic context could not compete with the cheaper imported meat from Argentina. As a result, farmers were forced to sell most of their cattle. Years later and with the global economic *boom* of the first decade of this century, livestock activity was reactivated in the region (Rudel, 2019). Urban wages grew to such an extent that urban incomes far exceeded rural ones. Although this reduced deforestation in the Amazon as an effect derived from rural-urban migrations, the livestock economy was reactivated in Morona (Sierra, 2013). The urban demand for food justified such an increase. Ranchers again raised livestock or began to buy them in the market (Rudel, 2019).

Shuar settlers and ranchers

In the Morona Canton region, during the second half of 2014, we carried out a set of 31 surveys plus 9 in-depth interviews, aimed at settlers and/or children of settlers or Shuar indigenous people, the overwhelming majority of whom were ranchers, whose farms were located mainly in the Sinaí, San Isidro and Sevilla Don Bosco Parishes of the Morona canton. 70 % of those surveyed were settlers born in the inter-Andean province of Azuay, or children of ranching settlers, who were associated members of the so-called Fifth, Sixth and Seventh Cooperatives and also the Santa Ana Cooperative. The remaining 30 % were indigenous residents. of the Shuar ethnic group, belonging to the Shinktam, Wapu, Yukutais, Mutintsa and Shimpis communities, some located on the limits of the Morona canton. Among the Shuar, some were ranchers and others were dedicated to agriculture. Livestock producers, both settlers and Shuar indigenous people, managed relatively large tracts of land with the goal of raising cattle for commercial purposes. In both groups, they were family-based agricultural production and consumption units.

The livestock settlers of the aforementioned cooperatives were leading actors in the different processes of colonization and access to land. Some obtained land through the Economic Reconversion Center of Azuay, Cañar and Morona Santiago (CREA) with the support of agrarian reform institutions and policies. During the last decades, another sector accessed land through purchase or lease from other owners. Most of the ranchers had more than 25 years running family farms.

Most of the producers who obtained their land with the 1964 and 1973 agrarian reforms were peasant settlers who obtained large tracts of vacant land covered by primary forests. In this new scenario, the first settlers cut down large areas of the forest to demonstrate that they were working the land and thus obtained certificates or property titles (Rudel *et al*., 2002; Rudel, 1983). This was a very common requirement in countries of the Amazon basin (Southgate *et al*., 1990). Subsequently, the modality was through purchase, a practice that in recent decades allowed the acquisition of entirely deforested lots. In 2014, at the time of the study, several of the ranching settlers had been part of the land buying and selling process, in which they or their parents became owners of large amounts of land (between 30 and 76 ha) purchased to other owners.

Initially, Shuar ranchers ran farms as large or larger than those of the settler ranchers. Some managed farms ranging in size from 35 to 100 hectares. The aforementioned ethnic group managed their productive units within communal or collective properties, whose dimensions reached thousands of hectares, unlike

the settlers who were exclusive owners of their farms. In normal situations, Shuar families could plant grasses within the collective territories as long as they were members, received authorization, and participated in what is known as *mingas* or community work. Although these pastures were part of the so-called collective lands of the Shuar Federation, the considerable extension of the pastures reflected a notable market orientation.

4. LIVESTOCK AND AGRICULTURAL PRODUCTION SYSTEMS IN MORONA

The predominance of an extensive livestock production system

In 2014, a variety of livestock and agricultural systems were reproduced in the study area of the canton of Morona. There were farms dedicated to livestock combined with small agriculture, others were exclusively livestock and some were small agricultural properties. To practice extensive livestock production, farm producers required large areas of land. Almost 90 % of those surveyed were ranchers —settlers or Shuar— who managed areas of land larger than 10,1 hectares and within that group, more than half ran livestock farms larger than 30,1 hectares. On the contrary, producers with less than ten hectares, who made up a minority in the study, were preferably Shuar farmers.[3]

The average of each farm among ranchers was 57,92 hectares and that of exclusively farmers was 3,62 hectares. Some of the ranchers reached or exceeded 150 hectares. In general, livestock production was dominant in Morona and was visible in the predominance of farms of more than ten hectares (Table 1). One aspect that stands out is that, in all ranges of land distribution, both among ranchers and farmers, the average number of cleared hectares was always higher than the land still covered with primary forests.

The quality and productivity of the pastures planted in Morona constituted a characteristic factor of extensive livestock production. Most of the ranchers managed pastures planted, in some cases for several years, with grasses of the species called gramalote (*Axonopus scoparius*). This variety only had at the time of the study between 6 % and 7 % protein (see also Meunier, 2007; Ríos-Núñez

[3] The distribution of land among the agricultural units surveyed in the study is similar to the III Agricultural Census of 2000, the last one carried out. In this census, in Morona 77 % of the units covered more than 10,1 hectares, 7 % from 5,1 to 10 hectares and 16 % less than 5 hectares.

& Benítez-Jiménez, 2015). Technically, to raise approximately 30 animals, a minimum of 50 hectares was required. That is, due to the low nutritional value of the grasslands, the carrying capacity had a limit of around six head of cattle per hectare. According to the study data, the productive units surveyed that practiced livestock production managed an average of 32,5 hectares with pastures, 11,28 animals on average and, therefore, the load was 0,34 animals per hectare. In other words, a very extensive land use pattern. Few heads of cattle and many cleared hectares.

Table 1. *Land use among livestock producers and agricultural farmers in Morona in 2014.*

Range of land distribution (percentage of agricultural and livestock)	Average agricultural and livestock unit (ha)	Agricultural crops (ha)	Land in fallow or *lusara* (ha)	Pastures (ha)	Total deforested area (ha)	Forests (ha)
0,1 to 5 (10%) Agricultural farmers	1,83	0,69	0,81	0,16	1,66	0,17
5,1 to 10 (3%) Agricultural farmers	9	5	1	0	6	3
10,1 to 30 (35 %) Livestock farmers	23	0,59	1,6	12,77	14,96	8,04
30 and +(52 %) Livestock farmers	81,93	0,95	5,1	40,62	46,67	41,31

Source: Database of the study on *The Causes and Dynamics of Deforestation in the Ecuadorian Amazon.* Bedoya *et al*. (2014), SENESCYT-Prometeo.

Figure 3. *Photo of overgrazed pasture in Morona.*

Source: Photo taken by Susana Anda, 2014.

However, there were differences between types of producers according to their higher or lower level of capitalization. On the one hand, a first majority group that covered 83 %, made up of ranchers-farmers who managed between six and 12 heads. They drove an average of 31,52 hectares covered with gramalote grass, between eight and nine heads of cattle and a load of only 0,27 animals per hectare, mostly mixed breeds considered to be of regular genetic quality. In this sector of livestock farmers, the low number of animals and the high number of cleared hectares was the most significant feature. A very inefficient production system. Given the technological characteristics, such as gramalote grass with low nutritional value, to drive an average of eight or nine heads of cattle, farmers cleared around 31 hectares of forest. The volume of their monetary income and capitalization levels were medium or small.

With some exceptions, and despite being a very diverse group, this sector of farmers provided the livestock with medium-quality food, and veterinary care was not always adequate. In general, their productive strategy revolved around generating monetary income for family subsistence. A sector of this last group was of Shuar origin (Meunier, 2007), who marketed livestock according to the most pressing economic needs. The sale of livestock depended on the need for economic resources and its productive organization combined livestock production with small agriculture for self-consumption and sale. Due to their economic needs,

they sold their bulls before a year and a half. Likewise, the indicated producers carried out a series of work activities outside the family livestock production unit.

As a whole, a greater presence of grasslands did not mean a greater number of cattle. The extensive use of the land was a consequence of its technological and productive conditions. Finally, another aspect is that in this group of farmers, 85 % of those surveyed stated that their objective was to increase the area of pastures to compensate for the effects of the low quality of the existing pastures. That is, if ranchers deforested, in most cases, it was to increase pastures and in this way counteract the decreasing returns of older pastures. The continuous need for forests for their transformation into specialized agricultural systems was a characteristic of the settlers' production system (Fitton, 1999).

On the other hand, a second minority group, which amounted to 17 % of those interviewed, was made up of those who managed between 20 and 40 heads of livestock with an average of 30,12 hectares and 27 animals per livestock unit. In other words, a load of 0,9 head of cattle per hectare. A use of the land above what was recommended, which exceeded the carrying capacity of the predominant pastures in the area, which, as we indicated, was six heads due to their low nutritional value. Because the indicated farmers had exceeded the carrying capacity in numerous cases, their pastures showed symptoms of overgrazing, even more visible than the previous group. This caused considerable deterioration of the soil, the emergence of weeds and a considerable degradation of ecosystem services. It is worth mentioning that, in this small group of ranchers, some made improvements to the care or maintenance of the pastures and provided additional food to their animals. In addition, a sector of the producers handled Holstein Friessian and Charolais cattle.

In any case, as a result of the larger number of livestock they managed, their income and level of capitalisation was comparatively higher than that of the previous group. For this reason, this sector of livestock farmers was much more sensitive to market indicators. This was manifested in the management of their forest resources and in the expansion of the number of animals they had. If the regional or national demand for meat justified it, to the extent permitted by the size of the farm, its productive strategy was to expand the number of hectares with pastures and in this way more cattle were raised or introduced. Therefore, they not only deforested in order to plant more pastures and counteract the decreasing yields of pastures, but also to increase the number of livestock. It was a more intensive land-use strategy.

It is worth noting that in both groups of livestock farmers, whether in the majority group of farmers with a very extensive land use or in the other minority group with a more intensive land use, the environmental impact of both production systems was the deforestation of large areas of forests. In both cases, this is a land use pattern that is highly destructive to primary and secondary forests.

To cover the fields with pastures, trees were cut down and grasses (gramalote or sectaria) were planted 2,5 to 3 meters away. The pastures were then maintained through slashing (not burning), cutting small and medium-sized branches, which allowed the grassland to remain free of large trees.[4] In most of the pastures, scattered medium and small trees grew that were not felled by the ranchers. These provided shade for the animals and projected an image of the destruction of the biodiverse tropical forest and its conversion into a landscape that increasingly resembles a tropical savannah. Many farmers claimed to plant new land with gramalote grasses every year.

Ranchers practiced two possible types of livestock care and breeding techniques. Some ranchers used free grazing, where the animal moved without any type of control, and other ranchers resorted to the rope method. In this case, each animal was tied with a rope of about six meters and then relocated once or twice a day. When all the grass was consumed, the herders would move to another paddock and return to the same place months later, depending on the amount of land available to them. The grazing interval (more precisely the rest of the paddocks) depended on the time required for the plant to sprout or renew itself, recover organic reserves and complete the formation of green leaves. This, in turn, occurred depending on the intensity of grazing (or overgrazing), the amount of land available, the forage species, the fertility of the soil, the climate and the frequency of rains and, equally, the type of management the grasslands. In that sense, the rest period of a paddock could vary between several weeks or extend to a few months. The low nutritional value of gramalote grass influenced their long duration (see also Ministry of the Environment, 2017; Meunier, 2007). However, this was not always true. If the cattle were left completely free in the pastures, large areas had to be available both for grazing and for deforestation if necessary. Many ranchers considered that the type of grass used did not support free grazing. However, if adequate fertilization was applied to the gramalote

[4] In the Ecuadorian Amazon basin, due to the abundance of rain throughout the year, the practice of burning is less frequent compared to other regions of the Amazon. First, the clearing is carried out, then the trunks and branches of all sizes are crushed with a chainsaw or machete, and, finally, they are expected to rot and become natural fertilizer.

grass and adequate maintenance, livestock could be rotated between pastures with shorter time intervals (Arias *et al*., 2020; Huebla-Concha *et al*., 2021).

In short, it was a type of extensive livestock production based on the movement of cattle between paddocks and whose carrying capacity did not allow for the reproduction of a considerable number of head of cattle. It can be defined as extensive rotational livestock production, an activity that, due to its technical characteristics, required the concentration of large areas for each productive family business. However, it ended up being inefficient because, in most cases, it required a lot of land for relatively few heads.

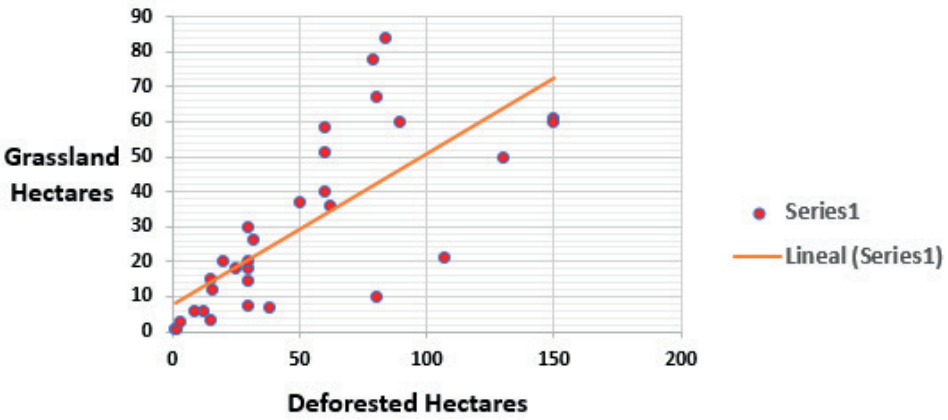
Livestock Production and deforestation

In Morona, extensive cattle ranching was synonymous with deforestation. Ranchers interviewed with farms larger than 10 hectares, and especially those larger than 30 hectares, had cleared land mainly dedicated to cattle ranching, while on small farms smaller than 10 hectares, agriculture had the greatest influence on deforestation. In Morona, extensive livestock production was synonymous with deforestation. However, due to the greater weight of livestock farms in the region, which was reflected in the surveys and interviews (87 % of the sample), it was livestock production that determined the magnitude of deforestation in the canton of Morona. In the indicated livestock farms, in most cases, agriculture was an activity preferably for self-consumption.

For the same reason, livestock was the major direct cause of deforestation. (Graph 2). In 2014, the bulk of the land that had been cleared in the region was to plant grasslands. This is reflected in the very high correlation between deforested land and land covered with grasslands: 0,98150132.

In general, there was a great difference between the management of natural resources of ranchers and that of exclusively farmers. On livestock farms, the average size of cleared land was 32,76 hectares, while on agricultural farms it was 2,74 hectares. That is, the cleared spaces among ranchers were 12,5 times larger in contrast to small farmers. The areas of land cleared for livestock production were considerably larger compared to agriculture. This was a consequence, on the one hand, of its extensive nature, its commercial orientation, and, on the other hand, of the small scale of agriculture aimed mainly at direct family consumption.

Graph 2. *Hectares deforested and hectares with grasslands in 2014 (Correlation 0,98150132).*



Source: Database of the study on *The Causes and Dynamics of Deforestation in the Ecuadorian Amazon.* Bedoya *et al.* (2014), SENESCYT-Prometeo.

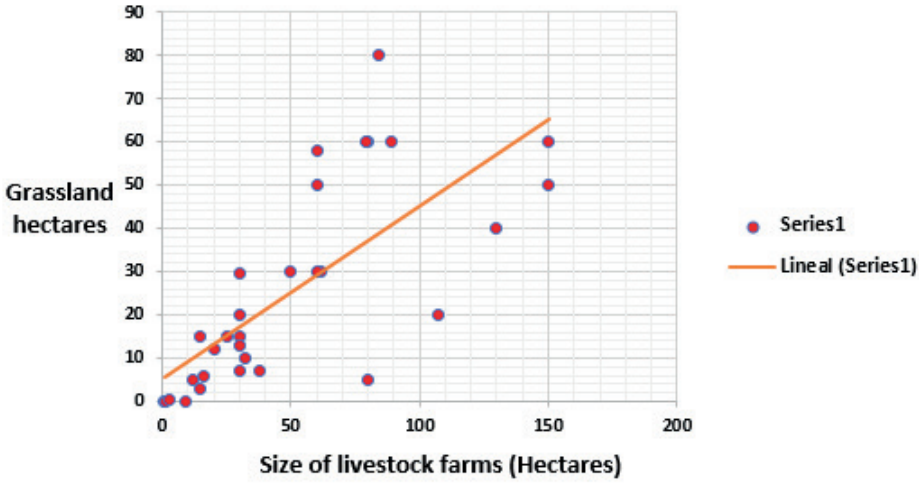
It should be noted that, over the years, forest transformation was less among the Shuar than among the settlers. For example, Rudel (2002 *et al*.) highlights that within the farms managed by the Shuar in 1987, 38 % of the total property was cleared and in 1997 this figure was 55 %. On the contrary, among the settlers it was 78 % and 79 % respectively. This is partly because the settlers usually managed larger livestock herds (between 16 and 24 heads of cattle) in contrast to the Shuar (between 2 and 5) (Rudel 2003 *et al*.). The Shuar, despite the shift towards livestock production, always maintained more conservative productive and economic strategies than the settlers.

The size of the farm and the total area with grassland or pastures

In the indicated production system, the total area for livestock purposes depended on the size of the farm (Graph 3). The greater availability of land was a cause that encouraged the extensive pattern of livestock production. Access to large areas of land at a low cost induced extensive land use. As the size of the property increased, the surface area of hectares with pastures also increased. Because settlers migrated from areas with little land and where land use was very intensive to a region like the Amazon with greater land accessibility, they did not perceive land as scarce, so they introduced extensive agricultural and livestock systems. Indeed, the

lack of knowledge about the fragility of the tropical forest or the importance of the respective ecosystem services was part of a mentality that was very present in historical experiences in frontier areas. Such was the case of farmers in Tena, Ecuador, who practiced highly commercial extensive agriculture (Gómez *et al*., 2017) and other Amazon regions such as Huallaga in Peru (Bedoya *et al*., 2023).

Graph 3. *Size of livestock farms and hectares with pastures in 2014 (Correlation 0,7279659).*



Source: Database of the study on *The causes and dynamics of deforestation in the Ecuadorian Amazon.* Bedoya *et al*. (2014), SENESCYT-Prometeo.

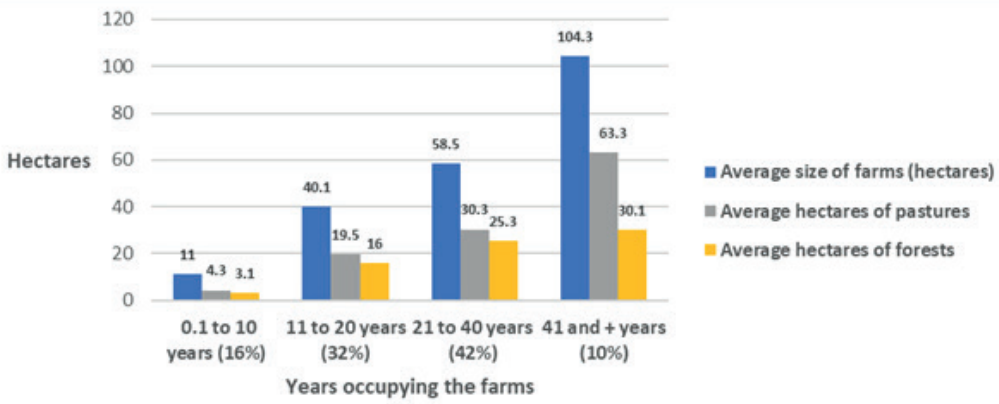
Taken together, this confirms what researchers such as Skidmore *et al*. (2021) found in a sample of thousands of ranchers in the Amazon basin of Brazil. The authors verified that the abundance of forest can function as an invitation to more deforestation in regions where extensive livestock production and extensive commercial agriculture predominate, if more sustainable and friendly modalities with the local ecosystems are not introduced. That is, if ranchers or farmers do not have or cannot access production systems that promote land-saving technologies, the absolute or relative abundance of land induces destructive use of primary forests. This is what happened in Morona with the ranchers. The combination of extensive livestock production with large amounts of freely available forests constituted a powerful stimulus and invitation to permanent deforestation (Pichón 1996).

Years of land occupation and the impact on the existence of forests

The age of paddock management was another key factor in understanding the extent of forest destruction from cattle grazing. Over the years, farmers increased the hectares of pastures. Such a strategy depended on the accessibility of land. If they did not have enough space, the most capitalized producers would acquire land with the aim of expanding their pastures. In the case of the settlers through purchase, and among the Shuar requesting lands that belonged to the Federation. Over time, the size of the productive units increased and the absolute number of hectares in pastures increased, given that the extensions of the largest farms allowed the development of extensive livestock production.

In Morona, this led to a concentration of land in a few ranchers (Figure 4). Because this type of livestock production required large areas for paddock rotation and herd movement, as well as a result of the increase in livestock, the lands covered with forests could eventually be cleared. As happens in other Amazonian regions of Ecuador (Gómez de la Torre, 2011), the more hectares covered with available forests, the greater the probability of being transformed into pastures.

Graph 4. *Average size of agricultural farms, hectares covered with pastures and forest according to years of occupancy*



Source: Database of the study on *The causes and dynamics of deforestation in the Ecuadorian Amazon.* Bedoya *et al*. (2014), SENESCYT-Prometeo.

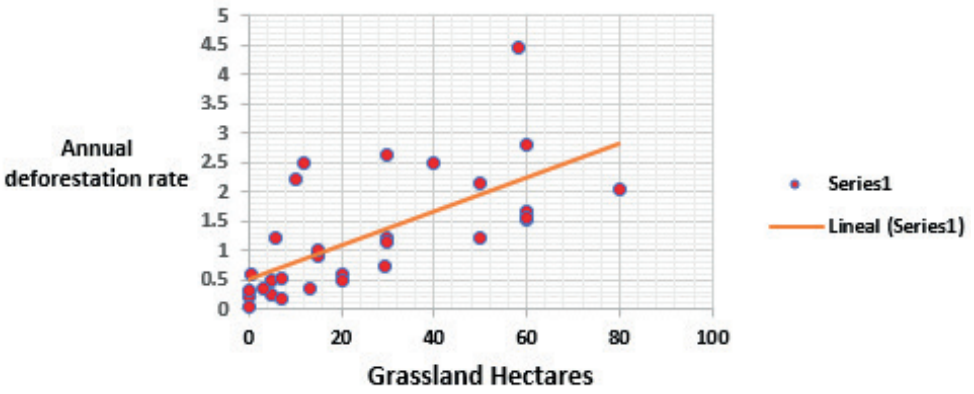
As a consequence of the way space was occupied and transformed to develop the practice of extensive livestock production, the pressure on forests was very

intense. Although in all cases the size of pastures exceeded that of primary forests, this trend was particularly accentuated on the oldest farms, which were also the largest (Figure 4). As a result, the relative extent of forested land decreased over the years. On farms between 11 and 40 years old, hectares covered with grassland slightly exceeded primary forests. However, on livestock units older than 40 years, hectares under pasture were twice as large as those under forest (Figure 4).

In the context of commercial livestock expansion, 64 % of the ranchers interviewed who ran farms with relatively extensive primary forests considered primary forests as places for future expansion of livestock or agriculture, either for themselves or their children. The forest was a frontier for possible livestock expansion, as a reserve for future investment and not so much a place that housed biodiversity and/or an ecosystem that fulfilled important environmental functions. In their own words: "The forest that remains is there for my children or grandchildren, so that they can do whatever they want with it, they can cut it down and plant it or raise livestock, or they can give it productive value" (Anonymous rancher interviewed); "the forest is our reserve for future livestock activities, to earn money" (anonymous rancher interviewed), other settlers stated. The possible uses of the forest were defined with strictly economic criteria.

The speed of deforestation depended on the greater or lesser amount of land that was transformed into grasslands. For those who had more land and were in a position to extend their pastures, the alternative was a rapid pace of clearing areas originally covered in primary or secondary forests. In other words, the greater the number of hectares with grasslands that were incorporated, the faster the rate of forest clearing was (Graph 5). This was generally the case among the most capitalized ranchers, who cleared between two and three hectares per year. Those who cleared fewer forests to convert them into pastures and who managed fewer livestock did so at a lower rate (between 0,5 and less than one hectare per year on average). In both cases, nevertheless, the cumulative medium- and long-term impact was still significant.

Graph 5. *Hectares in grasslands and annual deforestation rate in 2014 (Simple correlation: 0.65534286).*



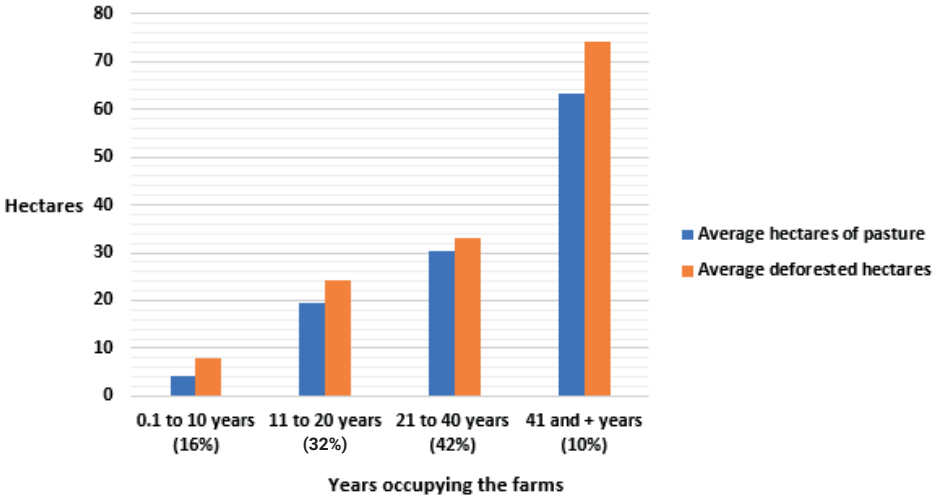
Source: Database of the study on *The Causes and Dynamics of Deforestation in the Ecuadorian Amazon.* Bedoya *et al*. (2014), SENESCYT-Prometeo.

Figure 4. *Grasslands cornering the forest*

Source: Photo taken by Susana Anda, 2014.

In the initial and intermediate phases of migration to the frontier region, the scale of destruction of deforestation for livestock purposes was not considered or perceived by settlers as a problem. In the mindset of professionals or civil servants, it was not defined as a fundamental issue of concern. This was especially true in the sixties, seventies and eighties of the last century. Faced with the gigantic abundance of land that the Amazon showed, deforestation was not an environmentally questioned activity. The paradigm of occupying and transforming the Amazon forest into a territory that would increase regional and national gross value was deeply rooted in the minds of politicians and planners. However, over the years, such a production system caused the accumulation of large cleared areas. As in other regions of the Amazon basin, the environmental impact began to be observed and experienced gradually after a few years. The volume of cleared land in the older livestock farms made visible (and still does) such levels of forest destruction. Graph 6, in that sense, is conclusive.

Graph 6. *Hectares covered with pasture and accumulated deforested hectares, according to number of years occupying farms in 2014.*



Source: Database of the study on *The Causes and Dynamics of Deforestation in the Ecuadorian Amazon.* Bedoya *et al*. (2014), SENESCYT-Prometeo.

Compared to, for example, large oil palm corporations in the Amazon or industrial agriculture in general (Fontaine 2006), which destroy hundreds or thousands of hectares of forest in a short period of time, Morona's annual

deforestation rates are relatively low. Typically, "a settler cleared about two hectares of land per year until 1974 […] Over the next two years, he cleared 16 hectares and then returned to the previous rate of deforestation" (Rudel & Horowitz, p. 120). Such fluctuations depended on multiple factors, including market indicators - greater or lesser demand for cattle - as well as land availability.. Nevertheless, after years of settlement and work on livestock farms, the destructive effects on the primary forest were considerable. Over time, the cumulative impact on the land and the biodiverse ecosystems formerly covered by primary forests was considerable.

The economic resilience of extensive livestock production

The production conditions of the livestock farmers were a factor that largely enabled the high level of resilience of extensive livestock production in Morona. Livestock production, compared to agriculture, was less expensive and easier to set up and maintain. For the group of producers, both settlers and Shuar, the availability of heads of cattle on farms far from the road was not an economic or logistical disadvantage since the animals were moved on foot to the points of sale, negotiated with an intermediary and then taken to the market (Rudel *et al*., 2002; Rudel, 2019). As described by Meunier (2007), groups of middlemen traders who traveled through the province of Morona and Santiago bought the cattle directly from the farms themselves and then marketed them both in the slaughterhouse and in the trade fairs of the cities of Ambato and Cuenca.

Access to credit by producers was a very important mechanism to reinforce and reproduce livestock activity, especially among those who drove more head of livestock. In 2014, some ranchers relied on the acquisition of credits granted by local financial cooperatives that varied between 7000 and 20 000 US dollars. Credits were used for any activity or investment linked to livestock, including medicine or field work, and, in particular cases, to invest in businesses or in the maintenance of their homes. When cattle ranching generated profits, the ranchers paid off credit debts, bought food from local stores, medicines or appliances they considered necessary for their family household, and even saved.

Likewise, Leguía and Moscoso (2015) highlight how the existence of economic incentives created by the Decentralized Autonomous Government of Morona (GADM) and Santiago, wrongly directed towards artificial insemination, made it possible to increase production, economic profitability and the increase in livestock. Similarly, the land tenure titling system created institutional incentives

that transformed primary forests into grasslands (Leguía & Moscoso, 2015) and strengthened the Morona livestock complex.

If in an initial phase, for the settlers, livestock production represented a strategy of consolidating land occupation and articulation with the market, in a second phase it was transformed into an economic mechanism that facilitated maintaining the family economy and attempting to accumulate capital. On the contrary, for the Shuar, if in an initial phase, livestock activity meant an effective instrument for defending their territories, in a second period, it constituted a source of monetary income mainly as part of a family survival strategy and, to a lesser extent, as a means of capitalization. In any case, both settlers and Shuar traded their livestock with the aim of increasing their capital or reproducing the family economy. Livestock were usually sold after a reasonable period of growth and fattening, but also in times of family emergency or urgent expenses. Most of the livestock ended up being marketed through intermediaries in the national market (Ministry of the Environment of Ecuador, 2017). The livestock functioned both as a large currency box for the most capitalized sector and as a petty cash box for the ranchers of both groups. Likewise, although livestock raising was intended for sale, both milk production (which was not abundant) and cheese were used for family self-consumption and to a lesser extent as a source of income (Ministry of the Environment of Ecuador, 2017).

Likewise, small agriculture was one of the factors that allowed the economic resilience of extensive livestock production. The small-scale agricultural production dynamics, within the livestock farms, provided food for families' self-consumption. For this reason, small agricultural plots were part of a family and regional economy based on a complex of livestock and small agriculture. They reduced food costs for families and facilitated family reproduction. Small subsistence agriculture and commercial livestock were two sides of the same reproductive strategy of rural families in Morona.

Finally, the lower availability of workers also facilitated the resilience of this productive activity. Because livestock production in the Amazon involved a relatively lower use of labor, many producers intensified livestock work, especially when the oldest children had left the family unit (Carr *et al*., 2006; Walker *et al*., 2002). The livestock option was rational in a context of labor shortage. At least 36 % of ranchers claimed to have problems with a lack of workers for livestock care and pasture maintenance. In some cases, due to the high relative hiring costs and in others as a consequence of the migration of younger workers to the cities.

In Morona, the majority of settler and native livestock producers surveyed and interviewed began their activities more than 25 or 30 years ago. Therefore, at the time of the study, many families had children who were already young adults but who lived or worked outside the productive unit. Furthermore, in the intercensal period from 2001 to 2010, in the Sinaí parish of the canton of Morona, where a large part of respondents and interviewees were concentrated, a slight but significant demographic decrease occurred from 837 to 766 people (Ecuador Census, 2010).

In this context, livestock activity constituted a logical productive alternative for the conditions of shortage of family labor force (Pichón, 1996). However, in spite of the lower demand for workers, salaried workers were eventually required to cover certain cattle-raising tasks. Those producers who made a living from raising livestock or whose income from such activity was indispensable, hired labor and thus prevented the rest of the family from getting involved in such work. However, sometimes productive bottlenecks arose as a result of a certain deficit in the workforce, both family and salaried.

Nevertheless, the productive resilience of livestock activity has not been the same between settlers and Shuar. Rudel *et al*., (2002) argues that the scale of livestock activity differs between both groups. This author points out that the Shuar at the end of the last century drove a smaller average number of cattle. The Shuar had difficulties in increasing the number of livestock as a result of the difficulties in obtaining credit since their property titles were not individual but collective. For this reason, they could not use the land as collateral for the loan. In our study, we found a few Shuar with relatively large livestock herds but the majority actually managed small livestock herds. Furthermore, Rudel demonstrates that the Shuar have begun to abandon livestock production, given their preference for meat from wild animals and because they consider cattle to be "dirty." Rudel's data are conclusive. For example, between 1986 and 1997 at the Uunt Chi-wias community center, the percentage of Shuar ranchers who owned livestock decreased from 88 % to 28 %.

5. THE ENVIRONMENTAL IMPACTS OF DEFORESTATION AND THE INTRODUCTION OF LIVESTOCK PRODUCTION

Livestock production, by drastically eliminating the forest cover, stripped the soils in the face of heavy rains, causing their erosion. As stated by several agronomists

working in the area and some ranchers, the soil was becoming compacted as a result of the change in land use from forest to pasture, the erosive effect of rainfall, as well as overgrazing and excessive trampling by cattle, which hindered water infiltration and root penetration, with the consequent intensification of runoff. Likewise, at the regional level, environmental externalities were multiple. On the one hand, deforestation caused the destruction of countless small water sources. On the other hand, the accumulation of livestock excrement generated a series of damages to water resources, through the filtration of nitrites both to groundwater and to streams that culminate in major rivers. This modified and contaminated the physicochemical quality of the water, affecting different types of animals and forest species. Over time, livestock production ended up generating large externalities to forestry and water resources, both at the level of each farm and at a regional scale. Indeed, it is the same socio-environmental process that has occurred not only in other Amazon basin countries but also in other tropical regions where this type of livestock production expanded, such as Brazil and Colombia (Gallo & Sanabria, 2019; Murgueitio & Ibrahim, 2004; Bowman *et al*., 2012; Hecht, 1993).

In general terms, the problem lies in the productive strategy of each rancher who decided to deforest without internalizing the negative externalities generated by the destruction of their own forests. Similar to the shifting agriculture of colonists in the Amazon, their strategy has always been evasion and not correcting or confronting the degradation of grasslands *in situ*. The existence of available land covered with intact forests allowed them to implement this type of natural resource management. For the ranchers of Morona, the transformation of the primary forest made it possible for them to have large spaces with very little investment, which allowed some to accumulate capital and for others it represented monetary insurance for emergency situations. Conversion to grassland was equivalent to transforming unused land into useful land with economic value. Additionally, in either case, it meant an increase in the *status*, prestige and symbolic value of the family business (Buitrón, 2017; Jong *et al*., 2011). Paraphrasing Hardin (1968), the case of extensive cattle ranching in Morona, and in many regions of the Amazon basin, resembles a private tragedy whose negative consequences end up affecting an entire region. It is not exactly spaces managed as common goods that are affected, but lands managed by private agents whose consequences end up affecting an entire region and community of people. The destruction of important fragments of the tropical forest impacted the ecosystem functioning

of the forests, regional water resources and increased their vulnerability as a socio-ecological system (Perz *et al*., 2016; Watson *et al*., 2018; Wunder, 2000; Sierra & Stallings, 1998).

6. CONCLUSIONS AND ADDITIONAL COMMENTS

In a framework of abundant land and scarce labor in a border area, the highest probability is very extensive land use (Boserup, 1984). This was, and still is, the case in frontier regions such as the Amazon basin, where both extensive cattle ranching and shifting agriculture have developed. (Guha and Martínez, 1997). However, as highlighted by the environmental historian Hughes (2009) and the geographer Carr (2004), in a context of land availability where simple technologies can be used to clear the forest and introduce small or medium-sized herds of livestock, as happened in Morona, extensive livestock production can cause intense and prolonged environmental damage in the medium and long term.

As demonstrated in this article, as a factor that drives and accelerates deforestation, this type of livestock production is even more destructive than small-scale shifting agriculture. It is the main cause of regional deforestation over the last 30 to 40 years. The more land the ranchers had, the greater the conversion of forests into pastures. Over time, the cumulative effects on forests were and are considerable and indisputable. Relatively large tracts of land, originally covered with biodiverse primary forests, were replaced by homogeneous landscapes where today one animal species —cattle— and one plant species —gramalote grass— predominate. On the largest farms there are still fragmented forested areas, which are reserved as future areas to be cleared in order to eventually give them economic value.

The issue is that small and medium-sized extensive livestock production has shown great resistance to its disappearance, especially among settler ranchers. This, despite the fact that the yields of the grasslands of the gramalote variety were not very productive, in addition to being a productive system that was detrimental to the forests and tropical ecosystems of the region. Although it is an economic sector characterized by fluctuations or oscillations linked to the national macroeconomic context, the local and national demand for meat has maintained this activity as an important source of monetary income, both for the settlers or their descendants and for the Shuar population. Furthermore, the system of private credits especially granted to livestock settlers helped reinforce

the care and maintenance of cattle. Extensive livestock production is similar to the shifting agriculture method of clearing and land rotation that exists in other regions of the Amazon basin. It is highly destructive of the environment and yet continues to reproduce.

Additionally, livestock work is not as labor-intensive, in contrast to agriculture. It fits into a context of population decline, emigration of young people and shortage of workers, as has been the case of the Morona canton during the period described. A high number of ranchers in Morona are families that began their ranching work three decades ago and whose children of productive age no longer reside in their parents' homes. For this reason, to maintain a certain level of income or capitalization, the heads of families or parents have reproduced their productive units precisely through livestock.

Among the population of ranchers of Shuar origin, there were those who achieved a level of economic capitalization and in others, the economic strategy was small livestock production combined with small productive agricultural plots, and in this way, they guaranteed their family economic survival. Likewise, another group of Shuar rented their lands or pastures to livestock settlers, in addition to carrying out a variety of other activities such as fishing, hunting and gathering or working as wage earners.

Despite the environmental damage of deforestation, there are reasons to be optimistic. As we have mentioned, among the Shuar there has been a desertion of livestock production. In this process, they have returned to biodiverse horticulture, where they combine crops such as naranjilla (*solanum quitoense*), for the market and for self-consumption. This constitutes a clear demonstration that, despite having experimented with this activity for years, they have maintained their sophisticated ecological culture linked to the management of the forest's natural resources.

Likewise, authors such as Lerner *et al*. (2015) and Rudel *et al*. (2013) describe the emergence of silvopastoral systems among settlers, in the province of Morona and Santiago, which seek to integrate animal husbandry and forage with the care of trees for mutual benefit. In those lands that used to be dedicated to pasture development, trees now grow spontaneously and dispersed, some of high commercial value, which provide shade for livestock, help to refertilize the soil and allows a more sustainable production system. The aforementioned productive dynamic, where grasslands are associated with certain tree species, facilitates carbon sequestration. This modality is based on the settlers allowing forest species to grow within their pastures, thus benefiting the environment.

Moreover, during the study we observed an increase in reforestation and forest conservation activities. Some ranchers, with large plots of land, had planted up to 1500 trees, including cinnamon, balsas, and laurels. Another group of ranchers planted scattered fruit trees, such as orange (*citrus sinensis*) and quince (*cydonia oblonga).* On some farms, land partially covered with primary or secondary forest was used to collect wood, orchids (*oncidium maculatum*) for sale, and medicinal plants for domestic use. In general, Morona producers who ran large livestock farms cut trees for commercial purposes and to obtain firewood. However, there were more and more ranchers, especially settlers, who let the trees grow and were aware of the benefits that this generated (Rudel, 2019).

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