

5 Amerindians, Mestizos, and Cows in the Ecuadorian Amazon: The Silvopastoral Ecology of Small-Scale, Sustainable Cattle Ranching

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Denny (see chapter 7) ends her global survey of greenhouse gas (GHG) emissions from livestock with the hope that cattle ranching, with particularly high rates of emissions, might be reformed in such a way as to reduce its emissions intensity. The following pages describe a silvopastoral path to reforming cattle ranching that would reduce its emissions intensity. A case study of a spontaneous conversion to a silvopastoral landscape in the Ecuadorian Amazon illustrates the promise of this path to lower-emissions cattle ranching. The analysis begins with a brief exploration of the socio-ecological conditions that foster resource conservation.

Economists have long maintained that high discount rates encourage resource users to engage in ruinous exploitation of natural resources (Clark 1973). If the value of a resource ten years from now is only a small fraction of its value to an investor today, she will probably be looking to exploit that resource as much as possible in the short-term, then abandon it, and move on to exploit another resource with more lucrative prospective returns to an investment. Applied to a natural resource like land, high discount landholders anticipate that they will stop using a tract of land in a few years, so they will do little to conserve the productive potential of their lands for future growing seasons. Alternatively, a landholder with low discount rates will value the productivity of the land ten years from now almost as much as the value of the land this year. She does so because she anticipates earning her livelihood from these lands in ten years. For this reason, the low-discount-rate landholders will implement conservation measures designed to maintain the productivity of the land.

These calculi translate directly into different postures towards resource conservation among landowners and land renters. The renters, who may

not cultivate a rented tract of land in the coming growing season, have few incentives to engage in conservation practices. Landowners, with longer time horizons, may value their land in ten years nearly as much as they value it right now, in part because landowners, confronted with the inevitable uncertainties of selling their land, plan to reside on it and earn their livelihood from it for an extended period of time. Studies from a range of settings, the American Midwest (Carolan 2005), the Amazon basin (Rudel, Katan, and Horowitz 2013), and a worldwide meta-analysis of tropical deforestation (Robinson, Holland, and Naughton-Treves 2014) all confirm that individuals who own their land are more likely to embrace environmental stewardship than people who rent land, use government land, or use open-access lands.

More broadly, this line of reasoning about the affinity between land-ownership and environmental stewardship of the land is consistent with arguments about the social bases for sustainable agriculture. Netting (1993) in his work on the ecology of small-scale, sustainable agriculture assumes that smallholders own at least a large portion of the land that they use, that they work full time on their farms, and that they think in terms of long-term occupancy of the land. In this world, small-scale ranchers would make environmental improvements through laborious inputs of labor like the digging of drainage ditches, the planting of trees, and the recycling of manure. Landowners can carry out these tasks because they work full time in agriculture. They also expect that either they or their families will continue to work these lands for the foreseeable future, so they or their descendants will live to see the benefits of their labor in sustaining production on their lands.

In sum a positive association between owner-occupied pasture lands and the environmental stewardship of these lands seems both theoretically plausible and empirically supported in at least some instances. The difficult question concerns countervailing trends. Two of them, more globalized markets and more part-time farming, are prevalent throughout Latin America. Their prevalence could curtail the spread of sustainable agricultural practices in this region. The socio-logic behind these countervailing trends is outlined as follows.

Globalization has characterized cattle ranching in Latin America over the past thirty years. Markets have extended across regional and international boundaries. Shipping of Brazilian beef to Europe began after the

Brazilians eradicated hoof and mouth disease at the end of the last century (Nepstad, Stickler, and Almeida 2006). Argentine beef began to be sold in large quantities outside of the Southern Cone of South America, especially when the economic collapse of 1998–2002 led to the rapid devaluation of the Argentine peso against the dollar and made Argentine exports like beef very inexpensive outside of the country. With the arrival of cheap Argentine beef on the shelves of supermarkets, ranchers in an importing country like Ecuador have few ways to preserve market share. An increase in the scale of operations offers one potential way to survive in a newly globalized market because inputs like veterinarian services cost less per animal. Ecuadorian farmers opted to take this path: renting pastures from other landowners offered a relatively inexpensive means of expanding the scale of cattle operations, so the extent of rented pastures increased as the pressures of globalization became more palpable. In this way globalization would indirectly reduce the incentives for environmental stewardship among cattle ranchers.

The logic that ties landowning cattle ranchers and their livestock to sustainable practices also begins to break down when farming becomes a part-time occupation and farm families decline in size. The work unrelated to farming reduces working hours on the farm. It may also encourage off-farm residence that in turn could reduce the time available for farm work if getting to the farm entails a commute. Renting pastures to others may become appealing in this context. With farm labor scarce, the attractions of sustainable regimens like agroforestry or silvopastoral ranching diminish because farmers cannot find the labor necessary to plant the trees and the improved forages that are integral to sustainable practices (Calle, Montagnini, and Zuluaga 2009; Dagang and Nair 2003; Rao et al. 2015). For these reasons growth in part-time farming could be associated with a reluctance to adopt labor-intensive sustainable practices on farms or ranches.

How do we sort out the magnitude of these opposing, intersecting trends of globalization, part-time farming, and stewardship norms spreading among small-scale cattle ranchers? A case study of the influence of rental versus owner-occupied pasture management in a context marked by globalization and the spread of part-time farming might enable us to tease out the relative magnitude of these opposed influences and, in this light, assess the prospects for sustainable cattle ranching in Latin America. The case under study involves small-scale cattle ranchers in the Ecuadorian Amazon. Some

of these smallholders are *mestizo* migrants from the Andes whose families settled in the Amazon region forty to fifty years ago. Others are *Shuar*, lowland Amerindians, who, faced with encroachment and invasion of the Amazon lowlands by Andean migrants, converted from shifting cultivation to cattle ranching in the twentieth century in order to acquire secure titles to land. In the concluding section, after reporting on the opposed, intersecting trends toward more globalization, more part-time farming, and more stewardship on pasture management over a 30-year period among *Shuar* and *mestizo* cattle ranchers, I address the generality of these social and ecological dynamics across Latin America as a whole.

The Context: Small-Scale Cattle Ranching in the Ecuadorian Amazon

The people under study reside near Macas, in the upper reaches of the Amazon basin in Ecuador, just to the east of the front range of the Andes at about 1,000 meters of elevation (see figure 5.1). Tropical rainforest covers the unexploited portions of the landscape. It rains a lot! So much so that slash and burn methods of shifting cultivation do not work in this area because the forests are too wet to burn. “Slash and rot” rather than “slash and burn” described the pre-contact agricultural economy of the *Shuar*. Rivers run eastward into tributaries of the Amazon. The soils are acidic and infertile. The only people living in the region prior to 1950 were lowland Amerindians (the *Shuar*), a small number of Catholic missionaries who had labored to convert the *Shuar* to Christianity, and a few *mestizos* with homes around the missions. The *Shuar* lived in isolated homesteads in the rain forest. A small stream of *mestizo* migrants from the Andean highlands had begun to move downhill into the Amazon during the first half of the twentieth century. At first, the *mestizos* settled near the missions, but, as their numbers grew, they moved outward and displaced *Shuar* families from their ancestral lands.

To prevent the dispossession of the *Shuar* from their ancestral lands, the missionaries began to advocate for a change in *Shuar* settlement patterns. *Shuar* would resettle in villages and file, as communities (*centros*), for a collective title to the 4,000 to 5,000 hectare tracts of land around each of the newly created villages. The *Shuar* became quite adept during the 1970s and 1980s in creating new settlements and lodging claims to the surrounding land. *Mestizo* landholdings also expanded throughout the 1970s and

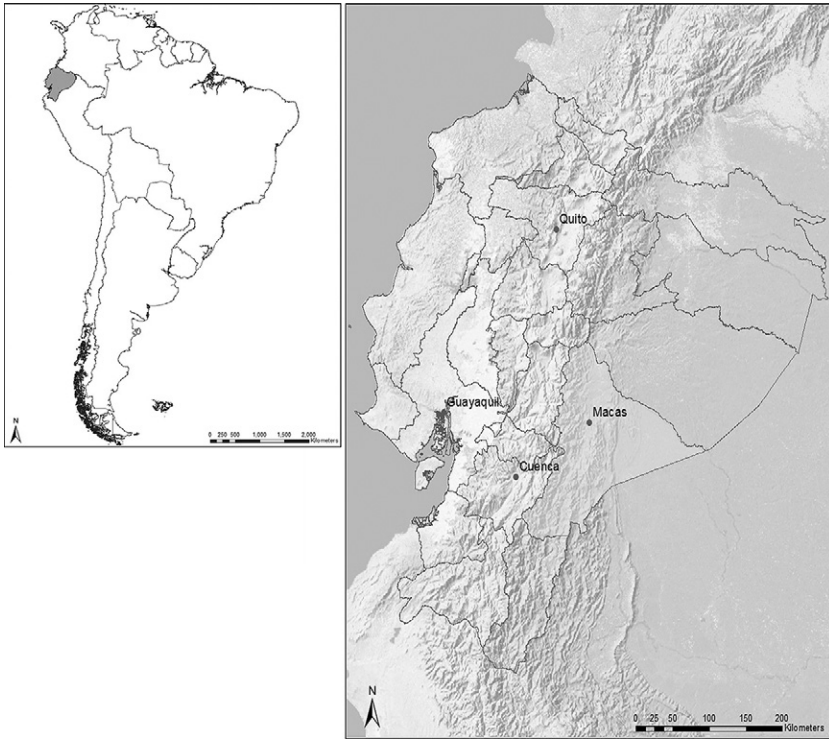


Figure 5.1

Ecuador study area: Morona Santiago

1980s. Mestizos too lodged claims to land, but as individuals. To strengthen their claims to forested land during the 1960s, 1970s, and 1980s, the Shuar followed the land-clearing practices of mestizos. The Shuar cleared patches of claimed land, planted pasture grasses, and acquired small herds of cattle (Rudel and Horowitz 1993).

By the end of the 1980s, the mestizos and Shuar had occupied almost all of the arable land in Morona Santiago. The Shuar had title to 42 percent of this land, and mestizos had title to the remaining 58 percent. While groups of Shuar had collective titles to blocks of land that contained village centers, individual Shuar households within each group took possession of particular tracts of land within their block of land. These tracts of land could be passed on to heirs, so in several vital respects Shuar households had acquired recognizable, individual agricultural smallholdings of 50 to 70 hectares by the 1980s.

In other respects, the position of the Shuar remained distinct from the mestizos, particularly in their access to credit. Because the Shuar did not have individual titles to land and because the *centros* would not allow individual Shuar to sell their landholdings to non-Shuar, the Shuar could not use their land as collateral to obtain loans from banks, so Shuar cattle ranchers found it impossible to take out loans to purchase cattle. In sum, by the late 1980s, both mestizos and Shuar had established small-scale cattle ranches throughout the valleys at the eastern base of the Andes, but their access to funds to finance cattle ranching remained unequal.

Over the past two decades, modest amounts of urbanization have occurred in Morona Santiago, especially around Macas, the provincial capital of the province. Growing employment in non-farm-related work in the provincial capital of Macas also created incentives for landowners with non-farm jobs to rent their lands to other cattle ranchers, so the extent of rented pastures would have been expected to grow with urbanization in the region. The province, about the size of the state of Vermont, had a population of 115,413 persons in 2010. The urban center of Macas had 19,176 persons in 2010 while the entire municipality, including extensive rural areas, had 41,155 persons (Censo del Ecuador 2011).

Local and provincial governments had no powers of taxation and remained dependent on the central government for funds to operate basic services like schools. After 2005, the central government focused its expenditures on upgrading the roads in the region. By 2015, newly paved roads connected most parishes with town centers in the valleys. Some people had begun to manufacture finished goods like furniture using wood from the forests of the region. Fertility rates had dropped significantly after 1980, first among mestizos and ten years later among the Shuar. Infestations of pests during the early 1990s reduced the size of the *naranjilla* crop (a citrus fruit) and, in so doing, reduced rural incomes substantially. In response, large numbers of young mestizos, but not young Shuar, left the region to look for work in urban areas or overseas. In most cases the emigrants left any lands they owned in the hands of their relatives.

The macroeconomic context in Ecuador remained volatile during the late twentieth century. In 1998, in the midst of an economic crisis, the country abandoned its own currency and adopted the U.S. dollar as the currency of choice for the Ecuadorian economy. An expansion in imported goods followed shortly thereafter as the stronger and more stable dollar

made goods like Argentine beef, produced in countries with currencies that were depreciating against the dollar, very inexpensive in Ecuador. To curry favor with urban consumers, beleaguered politicians in Ecuador's central government eliminated tariffs on imports of Argentine beef. The sudden access of low-cost Argentine beef to the Ecuador market created an economic crisis for Ecuadorian cattle ranchers. Given the low prevailing prices in markets for beef, ranchers in the Ecuadorian Amazon lost money on each cow that they raised and took to market. This circumstance led many small-scale ranchers to liquidate their herds in the early 2000s. Since then the prices for beef have recovered, and Ecuadorian landholders have tried to rebuild their herds. The economic and environmental consequences of these contextual changes are partially visible in the patterns of change captured in three surveys of cattle ranchers in Morona-Santiago between 1986 and 2011. I will outline these changes and explore their implications for land ownership and environmental stewardship in Amazonian pastures.

During the past twenty years, the cattle pastures in some portions of Morona Santiago appear to have changed in a fundamental way. The initial pattern of land clearing in the region during the mid-twentieth century involved clear cutting. Old photographs of these pastures show few trees, if any. Smallholders did not leave trees standing in fields that they sowed with pasture grasses for fear that the trees would fall on cattle and kill them during the violent thunderstorms that occur in the region. These treeless pastures have begun to give way selectively to silvopastures populated by large numbers of small trees in addition to the pasture grasses. By 2011 the numbers of trees in each hectare of pasture ranged from an average of 85 in one community to an average of 358 in another, nearby community. The communities with the highest densities of trees in pastures also had the largest proportion of small, recently germinated tree stems. This pattern suggests that the growth in the density of trees in pastures has occurred recently. By extension, the volume of GHG emissions associated with cattle ranching has begun to decline as the carbon sequestration of the trees in pastures has increased. What, then, has driven this trend towards a more silvopastoral landscape?

Three surveys of small-scale cattle ranchers conducted over a twenty-five-year period make it possible to answer this question, at least in part. Each survey contains subsamples of Shuar and mestizo cattle ranchers. The

ethnic composition of the respondents in each survey varied from approximately 33 percent Shuar in 1997 and 2011 to 50 percent Shuar in 1986. All of the data were collected in face-to-face interviews with respondents. The respondents were all asked the same questions, but in each survey the interviewing of people in different subsamples was done by different persons. Tensions between Shuar and mestizos made it important to use friends of Shuar or Shuar themselves in carrying out the interviews in Shuar villages. In effect, we carried out three repeated cross-sectional surveys of small-scale cattle ranchers in Morona-Santiago. By comparing the cross-sectional differences between the respondents in 1986 with those from 1997 and 2011, it becomes possible to trace out the socio-ecological changes occurring in this cattle ranching region of the Ecuadorian Amazon (Firebaugh 2008).

The Patterns of Change: Globalization, Urbanization, and Spontaneously Occurring Silvopastures

Continuity as well as change has marked the cattle economy of Morona Santiago over the past three decades. Of course households in the farming communities of Morona Santiago had other potential sources of income besides cattle ranching, especially in places like those surrounding Macas where some urbanization has occurred over the past thirty years. Perhaps because of the relative remoteness of the region from major centers of population in Ecuador and the corresponding absence of roads, cattle ranching has persisted as the most common source of income for a substantial number of households. Cows are a particularly attractive option for landowners with no direct access to roads because cows, unlike a crop, will walk out to a road before they are sold to a middleman and shipped to a market. In the interviews 58.7 percent of all households in 1986, 37.5 percent of all households in 1997, and 47.4 percent of all households in 2011 reported the sale of cattle as their chief source of income. In sum while the Shuar devoted more of their land than mestizos to cultivating root crops like taro and fruits like narangilla for sale in urban markets (2.1 versus 1.5 hectares, $p < 0.10$), cattle ranching has remained a mainstay in the household economies of the region throughout the post-settlement period.

The changes in landholdings and cattle herds in the region over the course of twenty-five years are outlined in table 5.1. Several trends are readily apparent. First, the mean size of the landholdings declined from 60 to

Table 5.1

Trends in landholdings and cattle herds, 1986–2011: Three surveys

		1986	1997	2011
Landholdings (hectares)	Mean size	60.5	50.7	30.7
	Kurtosis	2.1	2.9	28.3
Head of cattle	Mean size	14.3	11.0	17.9
	Kurtosis	0.9	1.1	7.7

Source: Interviews with rural household heads: 1986, 1997, and 2011.

30 hectares while the herds of cattle remained approximately the same. Stocking rates of cattle in pastures went up. The subdivision of lands that occurs with the retirement or death of the first generation of landowners accounts for most of the observed changes. The decline in the size of landholdings was more pronounced among the Shuar than among mestizos. Over the twenty-five-year period the mean size of mestizo landholdings declined from 57 to 42 hectares while the mean size of Shuar landholdings declined from 66 to 22 hectares.

Differences in migration patterns among young mestizos and young Shuar may account for these different trajectories of change. Many of the younger mestizos migrated elsewhere to work in the 1990s, and they had little interest in inheriting land, so often there was only one heir to land, and in that circumstance the land passed from one generation to the next without being subdivided. Fewer of the younger Shuar migrated elsewhere to work in the 1990s. Staying closer to the homestead, they were more interested in receiving their “fair share” of land at the time of inheritance. The persistence of higher fertility among the Shuar into the 1990s also meant that there were more heirs in Shuar households than in mestizo households, so at the time of inheritance Shuar lands often had to be divided in more ways than did mestizo lands.

The other dramatic change in cattle and landholdings occurs after 1997 and is signaled by the dramatic increases in kurtosis in both the distribution of land and in the distribution of cattle between 1997 and 2011. Kurtosis measures the length of the tail in any distribution of values, so the increase in its size after 1997 signals an increase in the inequality of landholdings and cattle herds. A small number of ranchers began to work more

than two hundred hectares of land and maintained herds of more than one hundred cattle. During the initial period of settlement, restrictions on the size of landholdings set by the Ecuadorian state's agrarian reform and new land settlement agency, *el Instituto Ecuatoriano de Reforma Agraria y Colonizacion* (IERAC), limited the variance in the size of landholdings both among and between mestizo and Shuar landowners. This restraint on the accumulation of land and cattle disappeared in 1994 when the agrarian reform agency was absorbed into an institute for agricultural development and for all practical purposes ceased to operate (Immigration and Refugee Board of Canada 1999).

The change in currency in the Ecuadorian economy in 1998 disturbed the cattle economy in Morona Santiago. To curb rampant inflation in the Ecuadorian currency, caused in part by a slump in oil prices during the late 1990s, the government decided to abandon the *sucre* and adopt the dollar as Ecuador's currency. As noted, this shift from a weak (the *sucre*) to a strong (the dollar) currency altered the goods that Ecuador could import. In particular, the adoption of a stronger currency in Ecuador at the same time that Argentina's government leaders abandoned their attempt to peg the value of the Argentine peso to the dollar made it possible to import previously unaffordable Argentine beef into Ecuador at a price that significantly undercut the price of Ecuadorian beef. In this context the Argentine beef quickly captured a major share of the urban market for beef in Ecuador. In this circumstance the prices for Ecuadorian beef in local markets declined to the point, as noted earlier, where Ecuadorian cattle ranchers lost money on each cow that they sold. To prevent these losses, Ecuadorian producers, both Shuar and mestizo, liquidated their herds. In effect they "destocked" their lands and turned to other pursuits to make money. This cross-border dynamic drove small Ecuadorian ranchers out of business, which further opened up market opportunities for larger Argentine ranchers to export their beef. It resembles on an international scale the agglomeration that occurred in the Chinese pork industry during the last two decades of the twentieth century (see chapter 4).

Several years later, when it again became profitable to raise cattle and sell them locally, landowners began to raise money to reestablish their herds. Of course access to capital to restock pastures varied, sometimes dramatically, from landowner to landowner. Those landowners with sufficient capital sought to distinguish themselves from neighboring ranchers by

emphasizing the higher quality breeds of their cattle. By 2011 some growers had taken to importing bulls from the United States to improve the quality of their herds. Others boasted that their cattle had caught the attention of cattle breeders from more economically established areas like the coast of Ecuador. In sum, landowners were not only restocking their pastures after 2000, they were also seeking to distinguish their cattle from those of their neighbors with the expectation that their brand of cattle would attract higher prices in a more globalized market for beef. These trends in restocking pastures accentuated the growing inequality in the size of farms and herds that is visible in table 5.1.

Mestizos had decided advantages over the Shuar in the restocking of pastures in Morona Santiago after 2000. Because larger numbers of young mestizos had gone overseas to work, they remitted more money to their elders, and these funds could be used to purchase more cattle. The other crucial difference between mestizo and Shuar landowners involved access to credit from banks. Mestizos mostly had fee simple “pre-titles” to their land that enabled them to get state-subsidized loans from the agricultural development bank (*Banco de Fomento*) in which they put their land up as collateral to secure the loan.¹ If they fell behind on the loan repayments, the bank could foreclose on the loan and take possession of the land. Individual Shuar, with only collective titles held by entire village, could not use their *centro*-designated tract of land as collateral for a bank loan. Furthermore, the legal prohibition on the sale of Shuar lands to non-Shuar persons or entities meant that state banks could not take possession of a Shuar borrower’s lands in the event of a foreclosure. Aware of the deleterious effects that restrictions on credit imposed on economic development (De Soto 1989), the Salesian (Catholic) missionaries had created a revolving fund for bank loans for the Shuar in the 1970s, but the amount of money available to Shuar borrowers through this source remained small in the late twentieth century. These differences in access to capital made it possible for mestizos, but not for Shuar, to rebuild their herds of cattle fairly quickly after 2000. By 2011 mestizo herds averaged 20.4 head of cattle while Shuar herds averaged only 2.8. With land but no cattle, the Shuar had incentives to rent their pastures to mestizos with cattle and earn at least a small sum of money (in 2013 around \$15 per month per hectare of pasture).

The changing incidence of rented land among Shuar and mestizos in table 5.2 testifies to the diverging trajectories of these two groups of

small-scale cattle ranchers and suggests economic and environmental differentiation between mestizos and Shuar. The relative ease with which people could acquire land during the immediate post-settlement period of the 1980s had depressed the market for rented land. Why rent land when you could, with some effort, acquire your own land by occupying unclaimed lands several hours' walk from a road? For these reasons the demand for rented lands during the 1980s was low, and few landowners among either Shuar or mestizos rented out their pastures to others.

By 2011 a new pattern of land rentals had emerged (see table 5.2). More people were renting their pastures to others, particularly among Shuar landholders. The ethnic differences in the incidence of renting are statistically significant. Almost three-fourths of all Shuar landholders were renting their pastures to other people with herds of cattle and insufficient pasture to maintain them. These differing incidences of rented land had important environmental consequences for the two groups of smallholders.

With primary and secondary forests adjacent to many of the Amazonian pastures, seed rain from the nearby patches of forest tends to be heavy, so seedlings sprout spontaneously in the pastures. Owners or renters first encounter the seedlings when they "clean" the pastures after the cattle have eaten the forage. The cleaning consists of cutting down any weeds, brush, or low-value trees that have sprouted in the pasture since the last cleaning, which may have occurred a year earlier, right after the cows last grazed an area. The cleaning enhances the productivity of pasture grasses in the next season by eliminating other plants that would compete with the pasture grasses for sunlight, water, and soil nutrients.

At least in theory, renters and owners might adopt somewhat different stances toward the cleaning of pastures. Renters primarily will be concerned

Table 5.2

The changing ethnic profiles of people who rent out pastures to others

	1986	2011
Mestizo	16%	35%
Shuar	13%	74%

Source: Interviews with rural household heads: 1986 and 2011.

with the productivity of the pasture for the next year, the typical length of a rental contract, so they will eliminate all seedlings from the pasture in order to enhance the regrowth of the pasture in the following months. Owners, who operate with a longer time horizon, will identify the species of the sprouting tree. If it looks to be commercially valuable, they will allow it to grow in place, anticipating that ten to fifteen years later, they will be able to harvest the tree and sell it to a sawmill or to a furniture maker for a considerable sum of money. In other words, renters and owners have different discount rates. Renters have high rates, and owners have low rates. Because the seedlings appear spontaneously, the creation of these spontaneously generated silvopastures entails considerably less labor from farmers than most silvopastoral systems in which farmers plant the trees in the pasture.

As noted, these silvopastures have emerged more frequently in some communities than in other communities. In addition, they seem to have appeared recently, with the highest densities of trees occurring in communities that have a high proportion of recently germinated, relatively small trees. Higher stem densities are most likely to occur on farms where a “son changes the cows” and cleans the pastures.² Stem densities averaged 366 per hectare where the sons changed the cows and 200 where they did not ($p \leq 0.001$). The higher level of involvement of the younger generation in management of these silvopastures would be consistent with the observation that the silvopastures have emerged recently.

The ecological effects of these different patterns of pasture management by owners and renters can be considerable, as indicated by the data in table 5.3. It indicates the density of three types of tree seedlings in owner-occupied versus rented pastures. The left column indicates the density for

Table 5.3

Stem densities of tree seedlings in cattle pastures, Ecuadorian Amazon, 2011

	All stems: Densities per hectare in pastures	Small stems: Densities per hectare in pastures	Palm trees: Densities per hectare in pastures
Owner-occupied pastures	262.4	124.6	17.9
Rented pastures	119.8	81.7	9.2

Source: Interviews with rural household heads: 1986, 1997, and 2011.

all kinds of seedlings that achieve chest high size. The middle column indicates the density of just the youngest seedlings, and the right hand column indicates the density of palm tree seedlings. Palms are included as a separate category of tree because their thick trunks make them so difficult to chop down that farmers frequently leave them standing. The same pattern of regeneration runs across all three types of seedlings. Owner-occupied pastures have many more seedlings than rented pastures. All of the mean differences across the different types of seedlings are statistically significant.

The carbon-sequestering effects of these differences in seedling density can be significant. Calculations of the carbon sequestered, above and below ground, in the owner-occupied fields indicate an increment of about one ton of carbon per hectare per year compared with the carbon sequestered in rented pastures. At the July 2018 price of carbon offsets, the smallholders with high densities of trees in their pastures would receive \$12 to \$14 per hectare per year. The \$200 to \$300 annual increment in income from carbon sequestration would provide a noticeable increase in income for smallholders whose total annual income might approximate \$5,000. In addition, the trees in pastures provide nutrient-rich litter for the pastures and protection for water sources for the cattle. Because the predominant pasture grass in the region, *gramalote* (*Axonopus scoparius*), is a shade-tolerant grass, the productivity of the pasture does not decline under trees. As a result, the stocking rates for cattle in shaded pastures was no different than the stocking rates for sun-filled pastures.

The fields with few trees show some signs of soil exhaustion. The pasture grasses mature more slowly than they did in the past, sometimes taking a full year before they flower rather than the eight months that it took when the fields were first planted with pasture grasses. Bare spots and inedible scrub growth have colonized sections of these fields. Because rental agreements typically last for only one year, the renters who pasture their cattle on these lands have no long-term investment in them and no incentive to address issues of pasture degradation. Taken together, the association of negative environmental outcomes with rented lands and positive environmental outcomes with owner-occupied lands seems supportive of Netting's argument about the affinity between owner-occupied lands and the practice of small-scale sustainable agriculture.

The patterns in these data also suggest trends associated with globalization, in particular that the growing inequality in landholdings contributes

to environmental degradation at the lower end of the size distribution of landholdings. Owner-occupied landholdings in Morona Santiago averaged 25.2 hectares of pasture compared to 16.0 hectares of pastures on farms that rented pastures to others (differences in means, $p = .046$). As landholdings decline in size through subdivision or sale, landowners seem more likely to become passive owners, renting their land out to others and doing little to improve the long-term sustainability of their pastures. At the other end of the size distribution of landholdings, large operators can most easily increase the scale of their operations, and enjoy the advantages of increased scale by renting additional lands from other smallholders.

As noted, these patterns of cattle pasture management have a pronounced ethnic dimension. Table 5.4 compares the stem densities of trees in mestizo- and Shuar-owned pastures. Contrary to the stereotypical notions about the *ecological noble savage* (Redford 1991), the mestizos in Morona Santiago, not the Amerindian Shuar, practice the more sustainable regimen of pasture management. All of the mean differences in this table are statistically significant. The Shuar in fact are caught up in a natural-resource-degrading poverty trap. They are forced, because of a lack of palatable economic opportunities, to degrade their chief asset, their pasture lands, through rental contracts year after year in order to earn their subsistence. In this sense their poverty induces them to practice a strategy of pasture management that over time will diminish their returns from the land even further (Lerner et al. 2015; Rudel, Katan, and Horowitz 2013). A natural-resource-degrading poverty trap really represents an impoverished, rural form of environmental injustice that is meted out to rural peoples without enough wealth to escape the trap.

Table 5.4

Stem densities of tree seedlings in cattle pastures, Ecuadorian Amazon, 2011

	All stems: Densities per hectare in pastures	Small stems: Densities per hectare in pastures	Palm trees: Densities per hectare in pastures
Mestizo-owned	269.8	129.7	19.3
Shuar-owned	84.8	64.2	5.0

Source: Interviews with rural household heads: 1986, 1997, and 2011.

Conclusions: How General Is This Pattern? What Are Its Policy Implications?

What do these patterns tell us about the link between landownership and the ecology of small-scale, sustainable cattle ranching? The emergence of these silvopastoral landscapes on owner-occupied lands but not on rental lands suggests a logic that resembles Netting's (1993) premise about the sources of sustainability. It has occurred in a setting with two countervailing forces, a globalizing market for beef and a rise in part-time farming, so its presence in this setting testifies to the robustness of the connections among small-scale agricultural operations, landownership, and sustainable practices. The particulars of the sustainable practice may be important in assessing the significance of the Morona Santiago case. Most, but not all, sustainable agricultural practices are labor-intensive activities. Terracing lands, manuring fields, and maintaining home gardens all require additional inputs of labor when introduced. The conversion of a pastoral to a silvopastoral landscape usually follows this pattern because the landowner has to plant the trees, oftentimes along the edges of fields. In the case of the spontaneous silvopastoral landscapes of Morona Santiago the additional inputs of labor are insignificant. The person who cleans the pasture with a machete after the cattle have grazed it just leaves the seedlings of valuable tree species in place. The absence of additional labor inputs makes it possible to create this type of silvopastoral landscape even in places where the growth of non-farm employment opportunities in nearby towns has increased the opportunity costs of work on the farm. Because the trees create another income stream for landowners through the sale of wood to sawmills, their presence in pastures counteracts, to some degree, the episodes of extremely low prices for beef like those that occurred in the early 2000s when the Ecuadorian beef market experienced globalization and the entry of extremely inexpensive beef from overseas. In this sense the emergence of a silvopastoral landscape in cattle ranching areas makes these places more food secure by making small, local producers more resilient in the face of market volatility because they have more diverse sources of income.

The generality of a case is always open to question in assessing the policy implications of a case study. Pastures are the most common category of land use in the world, so enhancing the sustainability of pastoral land

uses through measures like the ones described here should be a high priority in global efforts at sustainability. More particularly, are spontaneously generated silvopastoral landscapes a common enough occurrence in the tropics to warrant promotion through some sort of payments for environmental services (PES) program (Wunder 2005)? Silvopastures occur in a wide range of settings in the tropics, in Central America in Costa Rica (Harvey and Haber 1999) and in sub-Saharan African settings like Cameroon (Carriere et al. 2002). The extensive Babassu palm forests of the southeastern Amazon basin in Brazil spread spontaneously after deforestation and, typically, fires (Anderson, May, and Balick 1991). Interestingly, the presence of fires and their role in propagating the Babassu silvopasture contrasts with the humid, fire-absent silvopastures in the Ecuadorian Amazon. Certainly, the absence of fire in Morona-Santiago does not seem to be a condition that limits the generality of the lessons that one can draw from this case.

The ongoing globalization of the beef industry evident in the history of cattle ranching in Morona Santiago has several contradictory implications for sustainability initiatives in the cattle industry. Global trends in crop production over the past two decades underscore the growth in the production of oil seeds like soybeans and the relative stagnation in the production of basic grains like wheat. These trends testify to the growing influence of urban consumers and their growing demand for more animal protein, sometimes produced in very specific ways (Rueda and Lambin 2013). In this context Brazilian cattle ranchers have been able to secure a high-end market for "grass fed" beef overseas, in Europe in particular. Cattle produced in silvopastures would appear to provide a similar opportunity in Ecuador. Certification schemes could focus, conceivably, on the sustainability of pasture management routines, a dimension along which the Ecuadorian silvopastures described here would score well. Entry into this type of high-end market for beef would provide a further financial supplement to PES schemes that could pay for sequestering carbon in silvopastures.

While globalization can promote sustainability through the growing influence that affluent, distant, and environmentally concerned consumers can play in shaping production practices (discussed in chapter 9), globalization has a contrary effect through its impact on landownership and rental practices in the Morona-Santiago region. The political activities during the 1970s and 1980s of Shuar and mestizo settlers, channeled by the agrarian

reform and new land settlement legislation of the 1960s, created a relatively equitable, owner-occupied cattle ranching landscape by the end of the twentieth century. Globalization, with its destructive impact on local cattle herds, its promotion of growing inequalities in the size of farms and cattle herds, and its encouragement of land rentals, has undermined the social bases for silvopastoral agricultural sustainability among the cattle ranchers of the Ecuadorian Amazon.

To date, both the environmentally curative effects of the new silvopastures and the environmentally degrading effects of the continuous pasture rentals have occurred without meaningful interventions by either the state's agricultural extension agents or environmental NGO personnel. In this respect, Morona-Santiago represents a *rural backwater*, largely untouched by agricultural policy initiatives of any kind. The central government of Ecuador could provide an infusion of capital, but the political calculus that would lead a government to invest in a rural backwater like Morona Santiago does not seem self-evident. For that reason, there is little reason to believe that government assistance will be forthcoming for the Shuar smallholders with degraded lands or for the mestizo smallholders whose pastures merit carbon sequestration payments. In this sense, the dynamics described here have occurred in the absence of a concerted effort to improve Morona-Santiago's coupled human-and-natural system of cattle ranching through improved governance. It may take a large-scale, internationally funded effort to encourage the spread of these spontaneously generated silvopastures and arrest the degradation of the rented pastures. In sum, the currents of change in cattle ranching described here present opportunities for mobilization around new policies that would have important ramifications for global-scale issues like climate change and biodiversity conservation.

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1. "Pre-titles" are, as the name implies, not full titles to land. Smallholders can avoid the full expense of titling by acquiring only the pre-title, which is sufficient to transfer the ownership of land and to put the land up as collateral in order to obtain a bank loan.

2. People "change the cows" daily. Pastures are not fenced. Rather, cows are tethered in a patch of mature grass. Over the next twelve hours they eat all of the grass within reach. Then someone comes along and pulls the cow into another patch of mature grass before tying it down again. Water in the predominant pasture grass in the region is sufficient to keep the cows hydrated.

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