The Logic of Livestock and Deforestation in Amazonia

Considering land markets, value of ancillaries, the larger macroeconomic context, and individual economic strategies

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Most cleared forest in Latin America's lowland tropics will eventually become pasture. This transformation is one of the most salient environmental changes of the last 25 years. The incineration of large areas of high-biomass forest in Amazonia currently generates 10–15% of the total carbon additions to the atmosphere (Dickensen 1987, Myers 1989). Forest conversion banishes from biological history several species every day. Local impact includes siltation of smaller creeks and rivers, sharp changes in microclimates, and shifts in the hydrological regimes (Salati and Vose 1984). Soil resources are also degraded (Fearnside 1979, Hecht 1985, Serrao and Toledo 1990).

The environment is not the only victim. Forest peoples routinely watch their livelihoods and complex agricultures and forestry be reduced to ashes when the forest is burned for pasture. Peasants are often displaced by cattle ranchers in violent conflicts (Martins 1984, 1990, Schmink and Wood 1992, Wagner 1990), though frequently peasants participate in short-term cropping of land on its way to becoming pasture.

This article analyzes the logic and the economics of livestock in Amazonia by evaluating the various means of making profits from land and natural-resource capital. I also elaborate how the Amazonian livestock sector is closely linked to virtually every other rural development activity. These links establish a framework for analyzing deforestation patterns. The analysis qualifies some of the current explanations of deforestation. Finally, I focus on current approaches to diminishing this destructive land use.

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Conversion of forest to pasture is a logical process for both large- and small-scale owners. However, to analyze the processes one must be aware of the deficiencies of many of the current explanations of deforestation into pasture and put into context the role of cattle in contemporary lowland tropical development. Although I focus on the Amazon of Brazil, my arguments are relevant to many areas of the lowland Latin American tropics.

Why forests fall: the hamburger connection?

By far the most common explanation of the logic of livestock focuses on market forces, particularly the international beef market. The so-called hamburger connection explanation proposes that the international commerce for beef stimulated the patterns of forest conversion for grassland. This perspective was informed by the work of Nigh and Nations (1980) for Central America, for which this model was persuasive for much of the 1970s and widely disseminated by a popular article by Norman Myers dealing with the "hamburger connection" (Lewis 1991, Myers 1981).

Nations and Komer (1983) analyzed the role of markets in grassland expansion within the context of Central America's land-tenure patterns, regional development strategies, and the relation of pasture to land speculation. These local features have been largely lost from the hamburger-connection story as it has been increasingly applied outside Central America, especially to Amazonia. International market dynamics have little to do with the expansion of livestock production in the Amazon lowland forests. Amazon herds are a small portion of national herds (usually less than 5%); aftosa (foot and mouth disease) is endemic to the region. Livestock from all areas in Latin America, tropical and temperate, represents a small proportion of the export portfolio of primary products—usually less than 5% (Jarvis 1986).

If deforestation were primarily a result of the workings of commodity markets, then the solutions would be straightforward: reduce demand. This strategy is proffered by those who subscribe to this model. But imports of Latin American beef are generally less than 5% of US total beef imports. Beef imports from Latin America are eclipsed by that purchased from Australia, New Zealand, and the European Economic Community. Interna-

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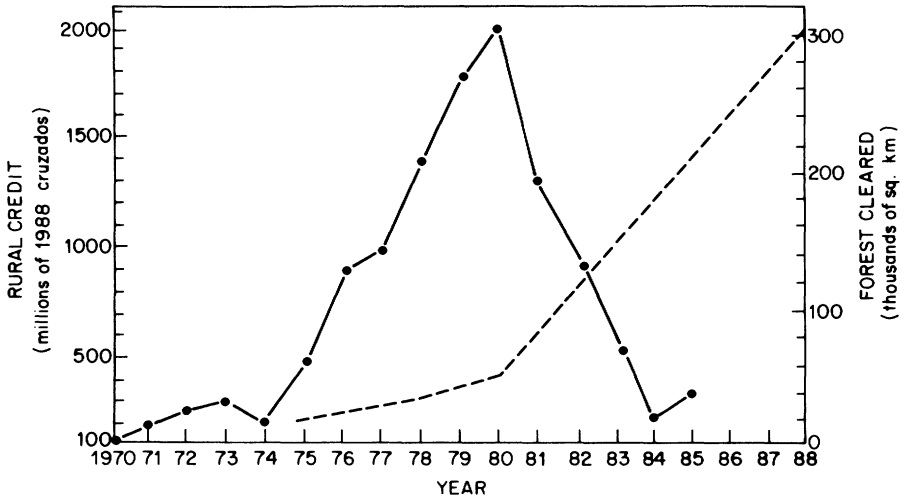

Figure 1. Average land prices in Rondonia, 1978–1986. (From Mahar 1989)

tional exports of beef from tropical areas have generally declined as a portion of market share, reflecting the surge in production by the European community. Demand for beef has also fallen in the Latin American economies as economic crises reduced domestic demand from the middle class, whose buying power has plummeted (Jarvis 1986). In spite of such contretemps in the livestock sector in Latin America, deforestation for pasture increased at dizzying rates.

The malthusian spector?

Another way of explaining the conversion of forest to pasture invokes population increase as the driving mechanism. Although overall rates of population increase have slowed somewhat, lowland tropical areas have witnessed a disproportionate increase in population numbers. This gain has been due to aggressive colonization programs, the advance of agricultural frontiers, infrastructure development (especially roads) in the service of economic integration, and national security concerns. More to the point, however, is that lowland tropical frontiers are generally more urbanized than people imagine and rely for much of their food on imports from more developed agricultural regions. Because of the ecological constraints of tropical zones (e.g., poor soils and pest problems) the lowland frontiers do not play a large role in food supply.

The movement of populations to these lowland areas has less to do with demographics per se than the factors that marginalize small farmers in Latin America. These factors include structural change in agriculture (which has reduced labor demand or changed demand to highly seasonal, short-term contracts and transformed access rights to land), expulsion of peasants by violence, excessively small holding sizes, and contraction of rural labor markets with increased mechanization—all of which make small farms less viable (Collins 1987, 1988, Graham et al. 1987, Millikan 1988, Schmink and Wood 1992).

Another powerful draw into the Andean Amazonian forests in recent years is the handsome returns (by peasant standards) to be made from the cultivation of coca. As agricultural and urban options contracted and as the regional economies faltered, illegal drug production on the Amazon flanks of the Andes attracted millions of migrants to the new growth sector. In a similar manner, dirt farmers also began to pursue the allure of the gold rush, as strikes abounded from the gold fields of the Gurupa in the Eastern Amazon to the Ecuadorian and Colombian jungles (Cleary 1990). It was not the increasing human numbers so much as the shifts in economic opportunity that began to make the Amazon a more appealing migration target than it had been in previous decades.

Current pasture-driven deforestation in the Amazon and other lowland tropical zones is the outcome of complex local processes, regional policy, and national economics in which cattle and their pastures have an economic flexibility and low risk unmatched by other, more ecologically appropriate, land uses. Attempts to control pasture expansion will be an arduous task.

Making money from land and resources

There are three main ways of capturing value through land and natural resources. The first is extraction, which can take two basic forms: renewable and nonrenewable. Both renewable and irrevocable extraction involve collecting some product of value to human society from the natural world. The materials being extracted can be primary products (ore, for example), in which numerous transformations transpire between the natural product and its forms of use. They can also be final products, like fish, which are generally processed little before they are finally consumed. Although labor and markets both figure in the way that value is generated with these natural commodities, there are also essential chemical or biological characteristics (perhaps one could call them inherent natural capital) that are the defining features of value.

Renewable exploitation approaches biological productivity for human uses in ways that do not undermine the basic viability of the resource. A vast literature in resource management and economics focuses on what are sustainable economic and biological levels of extraction and what pushes actors into overexploitation (c.f. Dasgupta 1984). The general classes of explanations can include population, lack of private property systems under market conditions (Hardin 1968), market-driven overexploitation (c.f. Blaikie and Brookfield 1987), misery-driven overexploitation (Sen 1984), prisoner dilemma models, and subsidy-driven exploitation (c.f. Repetto and Gillis 1988). Some of these models have been extrapolated to nonrenewable extraction, although the central focus of much of the analysis of nonrenewable resource extraction is concerned with optimal exploitation rates. An emerging body of Marxist scholarship also analyzes the historical patterns and determinants of exploitation is now gaining attention (Blaikie and Brookfield 1987, Bunker 1985).

Production, the second way to make

profits or accumulate capital, involves more direct intervention in the manipulation of biological processes through the application of energy, labor, and capital to generate products of use to human societies. Capital here can include the standard economic understanding of the term (e.g., machinery and money), but it also includes biological/environmental capital in the form of genetic resources or soil properties and human capital embodied in knowledge systems and individual skill. Production, compared to extraction, implies a far more complex and organized form of intervention in the natural world, and it incorporates the idea that energy and resources are applied to land to generate something of value not inherent in the land resource itself.

The third way to make money via land and natural resources relies on their ability to capture financial resources through speculation, their usefulness as means of capturing institutional rents (such as credits and subsidies), and as a means for claiming other assets. In this case, the value of the resource or land has little to do with its own characteristics or the labor and resources applied to it. The value of the resource or land is linked to its ability to generate returns through a variety of structural features in the larger economy. Bhagwati (1982) has called these activities directly unproductive profit-seeking activities. Value is determined less by inherent environmental characteristics (although these are not completely absent, as in the value of timber stocks) than by institutional factors, such as validity of title or political agility.

In directly unproductive profit-seeking activities, land and resources become objects of strategies conditioned by the larger economy (Bhagwati 1982). They represent ways of making a profit but produce little by way of goods and services through increased production. In Bhagwati's initial formulation, he focused on tariffs, where the use of such activities would not, in principle, carry with them large externalities. When the directly unproductive profit-seeking strategy is transferred into the tropical forest, the activities can use up resources. Livestock ranching is not a pure case, because it is possible to capture a return on animals in some circumstances (c.f. Browder 1988, Hecht et al. 1988), but more of the benefits are characteristic of directly unproductive profit-seeking activities than of productive resource use.

Livestock and wealth

A discussion on extractive, productive, and profitable but largely unproductive forms of appropriating value from land resources is helpful for understanding how cattle and their pastures are not limited to producing wealth as commodities generated through productive activities. In Brazil, pastures and livestock have served as a means of claiming land and providing tax breaks and have been vehicles to a variety of other forms of financial benefits, such as subsidies, cheap credits, and immense speculative gains (Browder 1988, Hecht 1982, 1985, Hecht et al. 1988, Mahar 1989, Repetto and Gillis 1988).

Pastures and livestock have played a seminal role in the conversion of forest to pasture because they are among the best ways in which all three forms of capturing value—extractive, productive, and directly unproductive profit-seeking—can be achieved, especially in the lowland tropics where environmental and economic risk are high. Moreover, both large- and small-scale landholders can participate. The underlying logic of livestock investment varies at different scales of production: the biological flexibility of the animal that permits it to harvest land whose quality is declining; the economic flexibility of animals allows the owner to decide the moment of sale; cattle can occupy large areas with little labor; and the range of institutional benefits associated with livestock all combine to expand land use that produces few calories, little protein, and little direct monetary returns compared with other forms of agriculture while producing maximal environmental degradation.

The logic of livestock

Large-scale ranching in the Amazon has been the subject of a great deal of analysis. Most of the literature on cattle production in Amazonia has focused on the eastern Amazon (Browder 1988, Gasques and Yokomizo 1986, c.f. Hecht 1982, 1985, Mahar 1979, 1989). The focus on corporate ranches was facilitated by the relative ease of obtaining information, because the documentation of these enterprises could be tracked through public materials held in the Superintendency for Amazon Development (SUDAM). There were 579 ranch projects according to 1987 data (SUDAM 1987). This number includes 276 projects in modernization and 303 in reformulation and amplification, that is, redefining the terms of the project in terms of activities, size, and finances.

This data contrasts with that of Gasque and Yokomizo (1986), who say there are 621 projects, and Browder (1988) who indicates 470. The disagreement is due to the reformulation of parts of projects: does a ranch with several reformulations counts as one or many projects? The high percentage of abandoned projects (30%; Gasques and Yokomizo 1986) imply that we have no idea how many SUDAM ranches there are currently. The studies produced from the project information gave the impression that only highly subsidized livestock operations were involved in the tremendous transformation of forests to grasslands. SUDAM rances tended to be well over 10,000 ha in size, whereas the usual size for non-SUDAM ranches was often much lower. There is no question that the SUDAM jumbo ranches, many of which exceed 20,000 ha, formally control approximately 8,763,000 ha. In areas where they dominate, such as northern Mato Grosso and Southern Para, they have been responsible for 30% of the clearing, according to figures from INPE, the Brazilian Institute for Space Studies (Tardin et al. 1982). However, recent data suggest new trends: the explosive deforestation in Rondonia, Mato Grosso, and Para suggest several other patterns. Areas dominated by middle size holdings, with few SUDAM ranches such as those in Paragominas Para, are currently experiencing deforestation rates greater than 1.5% per year (Woodell et al. 1988).

These SUDAM ranches were highly subsidized in several ways. SUDAM ranches received grants of up to 75% of the ranch development costs to encourage corporate groups to invest

in the region. These incentives have totaled close to 600 million dollars. Up to 100% of a corporation's tax bill would be forgiven if those monies were invested in holdings in the Amazon region or the dry Northeast. The net effect of these incentives was to permit corporations to use their monies as though they were venture capital or simply to divert them into other, more lucrative activities. In addition, no import taxes were exacted for equipment used on these ranches.

Subsidized credits were widely available at essentially negative interest rates. Thus, while inflation leaped ahead to more than 50% per year, the credits were granted at 8–12%. Because these credit lines were largely granted by public banks and were initially designed to favor small farmers, the kinds of loans for land development (*investimento*) unlike those for short-term costs (*custieo*) or marketing, often had 6–8 year grace periods under a 12–15 year amortization period. Many of the contracts signed in the early 1970s were not adjusted when policies shifted, resulting in a so-called founders rent for early borrowers. Under the prevailing inflation rates, such funds were often diverted into short-term financial markets (speculative stocks or currency markets) or other kinds of investments with a rapid and high return.

Land concessions were provided in many areas or lands were provided at nominal cost. Indeed, EMBRAPA (the Brazilian Ministry of Agriculture) economic analyses generally do not incorporate a land price. The ensemble of benefits directly tied to the clearing of forest ostensibly for cattle ranching made this activity enormously attractive, and indeed the benefits were designed to lure investors and capital into the region. The dynamic entrepreneurs from Southern Brazil were given extraordinary favors in part because they helped craft the terms of the incentives and because they were to take on the *mission civilizatrice* of taming the Amazon. As Mahar (1979, 1989) suggested in his studies of Amazonian frontier policy, livestock became a vehicle for capturing these kinds of extraordinary financial benefits. Whether the land use itself was sustainable, economic, or appropriate made little difference in this context.

Subsidies and land

The SUDAM cases could probably be argued on the basis of subsidies and tax waivers alone, and indeed this line of argument has become central in policy circles. Here, it is argued, the distortions caused by SUDAM subsidies drive virtually all pasture expansion with predictably dire results (c.f. Repetto and Gillis 1988). And getting the prices right—reducing or eliminating subsidies and credits—would bring the producer cost in line with the real costs and make the heedless conversion of immense areas less likely.

The subsidy for deforestation has its roots in a long history of gentlemen's agreements between the cattle sector and government policy makers (c.f. Hecht 1982, Pompermeyer 1979) and were revoked in a "policy triumph" under President José Sarney's 1989 *Nossa Natureza* program only when subsidy contracts of 15 to 20 years had largely terminated for most of the establishments that enjoyed them.

The point of the immense subsidies was to develop regional breeding herds, and for this reason cow-calf and steer-fattening operations were always included, and indeed they were an important justification for the incentives. Cow-calf operations are costly: they require more labor, more fencing, more management, and more medicine. The fodder demands of lactating and pregnant cows are often 25% higher than those of steers. Fattening operations, on the other hand, require minimal labor, perfunctory vaccinations, and far less fencing and management. Losses are less likely, because young steers are robust.

Importing steers from producer areas (Goias in the case of the Southern Amazon flanks, the Island of Marajo in the Paragominas area, and the Roraima grasslands and the riparian zones for the Manaus region) drastically reduces the production costs for many livestock operations. Overgrazing and maximizing production in the first few years after deforestation when pasture quality is better often makes these operations profitable, albeit for fairly short periods of time.

The focus on a few hundred megaranches has obscured the fact that there are more than 50,000 livestock operations in Amazonia at all scales of production. But state subsidies do not explain the dynamics of deforestation for other cattle operators in Amazonia. Clearing forest for pasture was economically attractive even if one did not have the luxurious benefits of SUDAM affiliation. In addition to the emphasis on fattening steers, the economic impact of regional development strategies, subsidized credits, inflationary pressures in the Brazilian economy that place premiums on real property, the potential revenues from timber, and the possibility of gold strikes set into play an intense rise in the speculative value of lands (Figure 1; Fearnside 1982, Hecht 1985, Mahar 1979, Schmink and Wood 1992). The rise in land values also reflects specific large-scale infrastructure investment patterns: the development of extensive highway systems and the clear commitment by the Brazilian government to sustain investment in Amazonia through its development strategy and jumbo projects such as the Carajas area and Tucurui hydropower dam in the Carajas area (Hall 1989, Hebette and Colares 1990, Hecht and Cockburn 1989).

An industry has developed around clearing land for pasture and then selling that land as quickly as possible, pocketing the gains and moving on into new forest zones, the famous *industria de posse*. The value of land as a commodity itself rather than as an input into production helped fuel the murderous land conflicts that now characterize the Brazilian Amazon (Hecht and Cockburn 1989, Martins 1990, Schmink and Wood 1992).

Land ownership in Amazonia has been characterized by extensive fraud and overlapping and competing claims. Land fraud stories verge on the folkloric, with archives ablaze and state governors selling title to areas that exceed the areas of their states (c.f. Asselin 1982, Martins 1990, 1984 Santos 1984), but there are several fundamental problems that reflect the existence of colonial titles, use rights from the state for particular resources (emphyteusis rights), squatters rights, the exceptionally rapid creation of capitalist land markets in Amazonia, and a rather chaotic, often corrupt, transmission of definitive title (Bun-

ker 1985, Hecht 1986, Pompermeyer 1978, Santos 1984).

Because those who clear land have a stronger legal claim to a parcel than those who do not, there is ample incentive to clear as much land as possible. Moreover, legal claim to an area six times the size of the clearing is permitted under the laws of the Institute of Agrarian Reform. Thus, should there be interesting timber on adjacent sites or potential mineral finds, these rights, too, can be secured through clearing. Finally, under the threats of agrarian reform, land in effective use—that is to say cleared—cannot be expropriated under the terms of the new 1988 constitution.

Table 1. Comparative production costs on corporate Amazonian ranches.

Costs (per hectare)	This study	Kitamura	Browder
Capital costs			
Land costs	$10–15	—	$31.70
Land clearing	$87–130	$150	$55.00
Pasture formation	$49–68	$64–100	$26.36
Infrastructure costs	$17–25	$23.51	$20.63
Total	$163–238	$235	$133.37
Animal purchase	$150	$154.60	$150.00
Variable costs			
Pasture brush control	$10–65	$45–75	0
General maintenance	$15	$9.00	$14.87
Animal maintenance	$10–16.50	$11.00	$11.90
Total	$35–96	$65	$26.77

Production

Cattle ranching as a productive economic activity is tenuous. A study carried out by the Brazilian Institute for Economic Analysis on SUDAM ranches showed that the actual production and sale of livestock was a mere 15% of projected productivity (based on the general stocking rate of one animal unit per hectare) in large operations that were running at capacity, whereas those ranches that were still developing generated a mere 8% of estimated production (Gasques and Yokomizo 1986). Take-off rates have hovered at approximately 10%, one of the lowest herd cull rates in the world. Formation and management of pastures is quite expensive, pastures are not usually sustainable, and the value of the final animal product often does not repay the investment costs. Browder (1988) suggests that cattle repay approximately 25% of their production costs based on a 15% take-off rate, based on SUDAM ranches.

In a simulation study of livestock economics under various price regimes, with and without subsidies, with and without speculation, and with different types of technologies, Hecht et al. (1988) showed that the economic returns to cattle production alone (no credits, overgrazing, or land appreciation) were only economically viable under specific conditions (Table 1) in the cattle cycle. Overgrazing improved the economic scenario somewhat, but the real gains to the enterprise were realized through capital gains linked to the rise in land values and the subsidies. The returns to production of cattle are overshadowed by the spectacular returns that obtain to land speculation and the rents associated with subsidies. This is not to say that the revenue derived from the sale of cattle is unimportant, only to point out that in certain economic scenarios the largest portion of the revenue associated with livestock will not be generated by returns to production but rather through financial or directly unproductive profit-seeking machinations.

Extraction

Irreversible extraction can also have a role in livestock expansion in two ways. The first, already mentioned, involves using livestock as a way to claim lands. A recognized land claim permits the holder to assert royalty rights on subsurface minerals technically owned by the national states. Areas adjacent to gold strikes frequently experience vigorous clearing. Cattle claim what is under their feet. The other main way that extraction is linked to pasture expansion is through the use of valuable timber to subsidize pasture development costs (Uhl and Buschbacher 1985). This more recent phenomenon is due to the improved infrastructure, expanding timber markets, and relatively recent policy changes, and it is more widely used by smaller ranching operations.

Larger-scale livestock operations appropriate value from natural resources through their ability to capture financial resources and to claim extractive ones. They can generate revenue as producers of beef, but this revenue rarely covers the costs of production. The fusion of all three forms of accumulation through a given land use is not limited to cattle ranching, but it does have special appeal: the low cost of pasture compared to developing agriculture or perennial crops like cacao, its low labor demands, and, most important, rapid and extensive occupation of land.

The logic of livestock for peasants

The discussion of large-scale livestock operations has dominated the analysis of cattle and deforestation, and indeed the impact of big operators is probably more important for deforestation patterns in the basin as a whole. Currently, the highest rates of deforestation occur in the state of Rondonia, where colonists and small producers are also intimately involved in the expansion of livestock. Rondonia's herd increased 30-fold in the period between 1970 and 1988, and it has come to dominate the cleared areas (see Table 2).

Why should livestock figure so prominently in the strategy of small farmers? There are several reasons that pertain to the biological flexibility of the animals and their unusual economic features within the context of rural and national economies. Cattle, and livestock more generally, have been one means of evening out risk in agriculture. As part of a household income portfolio, they provide an income supplement in the form of milk or calves; if there are agricultural disasters, as is often the case in the Brazilian Amazon, cattle provide a

Table 2. Herd size in the north region. Source: IBGE Censo Agropecuario.

	1970	1975	1980	1985	Percent increase 1970–1985
Acre	72,166	120,143	292,191	333,457	362
Amazonas	283,362	415,457	455,584	420,940	48
Para	594,313	777,660	2,729,796	3,485,368	486
Rondonia	23,126	55,392	248,558	768,411	3227
Roraima	238,761	246,126	313,069	303,501	27
Amapa	64,990	62,660	46,069	46,901	−38

large lump of income when sold. Thus, livestock cushion the viscisitudes of agriculture.

The ability of animals to move between use and exchange values is important for small holders, as is the ready local market for animal products, where beef fetches the highest price of any source of protein and the highest per-kilo value of any basic food commodity. Cattle provide these market benefits with less labor cost than rice, beans, corn, or manioc or tree crops. Labor time for each activity is shown in Table 3. Animals are capable, unlike crops, of transporting themselves. The timeliness of animal harvest is determined by household need or market opportunity and not by the biological demands of crop production, which often work against small farmers because all bring their main crops to market simultaneously.

Cattle production also extends the economic life of a given cleared area. Sites that have been planted to crops go out of production within three years and are usually planted to grass. This land is grazed until it becomes choked with weeds or so degraded that no forage will grow. Although the productivity of these pastures is among the lowest in the Amazon, they provide marginal return on a piece of land that would otherwise be generating nothing for the colonist household. This return may be a minor increment, but for poor households its importance should not be dismissed, especially because labor costs are relatively low and returns on output quite respectable.

In highly inflationary economies such as those of most Amazon countries, investing in animals is a way of protecting assets for peasants, as it is for large owners. For people who may not be comfortable with banks, and where interest rates do not lag behind inflation, such a strategy is completely reasonable.

Colonization projects have frequently produced credit lines for small-scale producers of cattle. In this case, there are obvious benefits of using borrowed money whose value is evaporating to buy an animal whose value is at least maintaining if not exceeding that of inflation.

The role of cattle as a means of claiming land is well developed for small-scale holders and follows roughly the same logic as that of large-scale owners. Throughout the Amazon, pasture is the cheapest and easiest way to claim occupation rights. If, as often happens, peasant households inhabit a parcel of questionable title, and this land is adjudicated, the larger the cleared area the greater the indemnification if land is expropriated. Because areas that have been cleared for pasture have a value that is approximately one-third greater than that of forest, peasants' ability to speculate with these lands is also enhanced. Among colonists, land speculation and indemnification by the state or larger landowners occurs with some frequency. Finally, given the nature of windfall profits in Amazonia, a lucky gold strike or generous profits in coca production may produce immense surpluses for a rural household. In this case, one of the few means of diversification in the regional economy involves investing in land with cattle. For example, in the Guaviare areas of Colombia, famed for its coca production, only approximately 5000 ha are given over to coca cultivation, whereas most of its forests fall for the creation of pasture, which now occupies some 100,000 ha. Another argument that is advanced to explain the widespread use of cattle by small farmers is a cultural one: peasants attempt to emulate their richer ranching neighbors and to capture some of the prestige associated with this activity.

The diversity of economic ends that can be served by cattle make them compelling for colonists without the symbolic overlay. Whether these advantages center on their convenience for the household as it struggles along day to day, or in the way livestock can be used to mitigate larger macroeconomic pressures, cattle have extraordinary benefits vis-a-vis what many consider more appropriate land uses, such as perennial crops. It is not surprising that peasants everywhere clamor for cattle and are intent on clearing pasture for the day when they can add to their humble herds. Livestock are important in helping to guarantee the livelihoods of peasants by reducing risk, protecting assets and biological flexiblity, extending land parcel life, all with a minimum of effort, and they are a relatively inexpensive and accessible investment. Within the wider economic dynamics, they once again capture financial benefits.

Cattle must be seen in the context of the numerous roles they fill in these uncertain rural economies. For both large and small operators, their advantages are unescapable. Unfortunately, these private benefits have quite disastrous public costs in terms of their environmental costs and their implications for the regional economy.

The ecological dimensions of pastures

Pastures in the Amazon do not remain productive for long (Fearnside 1979, Hecht 1982, Serrao and Toledo 1990). The high-biomass forests survive on the poor acid soils because they have complex systems of nutrient cycling. Most of the ecosystem nutrients are held in the biomass itself, not in the soil, so physiological and structural features of the plants and symbiotic relationships with other organisms keep nutrients circulating within the living materials. When forests are cleared for pasture, there is a nutrient flush as elements held in the biomass are released to soils. However, with leaching, runoff, uptake by the pasture plants, and incorporation into the cattle soil nutrients decline rapidly to levels below those necessary for maintaining pasture production. The nutrient value of the grasses falls off, and shrubby weeds begin to invade the pasture. Soils become compacted. Cleaning the pastures by chopping

Table 3. Summary of returns from agricultural production and sale of colonization plot (resident owner). Source: FAO–CP 1987.

	Units	Year*				Total US$
		1	2	3	4	
Area cleared	ha/yr	6.0	6.0	6.0	6.0	—
Area planted						
Annuals	ha/yr†	—	6.0	6.0	6.0	—
Perennials	ha/yr	—	—	3.0	2.0	—
Cash costs incurred	Cz$‡	9.6	17.9	35.8	35.4	7.2
Gross value of production	Cz$	—	39.2	39.2	39.2	8.5
Net return on production	Cz$	(9.6)	21.3	3.4	3.8	1.3
Household labor required	man days	156.0	432.0	50.0	559.0	—
Net return to labor from production	Cz$/man day	(61.0)	49.0	7.0	7.0	0.8
Sale of plot	Cz$	—	—	—	205.3	14.9
Net return after sale of plot	Cz$	(9.6)	21.3	3.4	209.1	16.2

*Agricultural year, beginning in September.
†Hectares of land used (mixed and relay cropping during the year produces more than 6 ha of annual crops per year).
‡Cz$ 1000 = US $72.62.

down the bush, burning, and fertilizing can give pastures a new, albeit short lease on life, although the economics of maintaining pastures versus clearing new ones works against managing existing cleared land (Serrao and Toledo 1990). Thus, new areas are constantly being cleared as old ones go out of production. Pastures in the Amazon are degraded, and they are frequently abandoned in ten years (Hecht 1982, 1985). Some, such as Buschbacher (1986), have described this process as "shifting ranching."

These degraded lands are exceedingly difficult to rehabilitate. As the size of clearings get larger, it is increasingly difficult for forest seeds to establish themselves (c.f. Nepsted et al. 1990). There are several reasons for this. First, fire is an integral part of pasture formation and maintenance. Tropical forest trees are rarely able to tolerate fire, and seed in the soil or stump sprouts are thus regularly killed. Next, many forest seeds are large and need to be carried by animals. If the dispersal agents are killed or flee because of habitat destruction, the number of seeds that enter a field is also reduced. If, by some lucky chance, seeds somehow arrive in a field, they are often subject to extensive predation by leafcutter ants. The environmental conditions of pastures (high heat, low humidity, and compacted soils) make it hard for a seedling to establish itself, let alone survive the various onslaughts of fire, drought, and ravaging predators. These factors also make pasture areas difficult and expensive to recuperate (Nepsted et al. 1990). Thus, clearing for pasture in the end often condemns land to waste, and more than 50% of the areas cleared in the past have been abandoned.

In terms of regional economies, cattle generate ephemeral employment in the clearing phase and for brush management, but they do not absorb much labor at any scale of production. This situation is a private advantage for both peasants and large landowners, but for the regional economy it is a disaster because livestock occupy vast areas but generate little employment. The standard *fazenda* uses one cowboy for every 1500 ha cleared. The links to other parts of the regional economy are weak. Implements, seed, wire, animal supplements, and veterinary products all come from southern Brazil. Local urban centers do consume Amazon beef, and some employment is generated in the small slaughterhouses and butcher shops, but the bulk of the labor linked to pasture development is in the clearing stage for casual labor, with little permanent employment. Tax revenues generated from the sales of animal is low. In the case of the SUDAM ranches, taxes of approximately 2% of the value of the incentive money they received were produced (Gasques and Yokomizo 1986).

What is to be done?

Policy and politics. One of the current emphases in international policy arenas is to reduce cattle subsidies and their wider economic distortions; then pastures would lose their attractiveness as an investment. This view constitutes the major analytic contributions of World Resources Institute (c.f. Repetto and Gillis 1988) and the World Bank (Binswanger 1989, Mahar 1989). This perspective views development processes as largely mechanistic and underemphasizes the fact that economic processes that accompany livestock development take on a life of their own and interact with a number of economic currents within the local economy.

The irony, of course, is that deforestation rates have increased as subsidies to the sector have declined. One of the central problems with this model has been the excessive focus on super subsidies to a relatively small set of producers and the extrapolation of this view to all cattle operations in the Amazon. Even in SUDAM, between 60% and 70% of the total fiscal incentive resources were concentrated in 35 large corporate groups that often had more than one SUDAM project. Although these ranches were important in initiating a regional clearing dynamic, the withdrawal of subsidies now comes too late.

The regional economy responds synergistically to a number of factors that are now beyond the control of one set of policies. What drives land speculation now are high inflation rates, the relatively low entry costs for land in Amazonia, the clear commitment to infrastructure development, colonization programs, the nonrenewable resource potential, the threat of disappropriation of uncleared land, and the concerted promulgation of doctrines of national security, national integration, and manifest destiny (Hecht and Cockburn 1989, Olivera-Filho 1990).

As the rest of the Brazilian economy goes into a tailspin, the Amazonian development is seen as an important means of resolving internal social tensions and assuring continued accumulation for entrepreneurs who are not able to participate advantageously in urban investments (c.f. Hall and Goodman 1990, Schmink and Wood 1992). Given the difficulty of the other land uses in Amazonia and the high rates of failure, livestock is a relatively secure investment (Fearnside 1990, Hecht in press, Martins 1990, Millikan 1988).

Technological fix. A popular line of argument suggests that environmental problems in Amazonia could be substantially mitigated if better pasture and livestock practices were implemented (Serrao and Toledo 1990). If each area cleared stayed in production, then the need for deforestation would diminish. Research institutes throughout the Amazon engage in careful field testing, fertilizer trials, and germplasm selection to find the combination that permits sustainable pasture production. Although certainly a laudable goal, the assumption is that pasture management problems reflect improper technologies and that the desultory and destructive pasture management is largely the outcome of poor existing technologies.

Better management could make a difference, but only part of the logic underlying the regional livestock economy is based on production per se. It is the other things that cattle do besides grow meat that make them of singular fascination. In our simulation (Hecht et al. 1988), we showed that improved technologies do not yield returns that can compete with overgrazing. Because the ancillary benefits not linked to production will accrue under good or bad management, and because the returns are higher to bad management under the time frame of many ranchers, technological solutions are likely to have little impact on deforestation.

In the case of Paragominas, Para, where extensive research has been under way for more than a decade and where the best pasture technology systems are tested and subsidized, the new technology adoption is minimal and deforestation rates have increased above the prevailing rates of the 1970s.[1] If technologies could make a difference, they would be expected to do so there, because those ranches are near the large Belem market.

Social movements. Rainforests will ultimately survive because those who make their livings from them have organized to protect them from destruction. Tropical forests are not empty of people. They are and have been home to more than a million people in the Amazon, from indigenous people to petty extractors of many kinds. Based on systems of renewable extraction and some small-scale agriculture, informed by complex systems of local environmental knowledge, these populations have been able to generate large revenues that have maintained the Amazonian elites in fine style for centuries.

As forest peoples increasingly find themselves threatened by livestock enterprises and government infrastructure development, their resistance has become increasingly politicized and environmentalized. These movements are frail, but their concerns about forest conservation represent the aspirations of indigenous social movements. Moreover, they have been able to stop some deforestation. The Rubber Tapper Union of Acre for example, claims that 1.2 million ha of forests have been saved by their direct actions. In southern Para, where gold mining, timber mining, and ranching have obliterated one of the richest forests and its fauna, the only areas that have not been routinely ravaged have been within the Kayapo and Xingu reserves. Indigenous peoples and their urban and international allies have formed concerted and well-argued resistance to development plans that impinge on their territories.

There is often a romantic frisson associated with the emergence of resistance movements, but these movements are frail and the history of Amazonia has been written in crushed aspirations (Hecht and Cockburn 1989). Nonetheless, these types of movements, beleaguered though they may be, have managed to form alliances within the national political context and with international environmental groups to bring pressure to bear at many levels. This method is not without consequences, as the death of rubber-tapper leader Chico Mendes in 1988, makes clear.

Final comments

In this article, I have demonstrated how value can be extracted from natural resources via extractive, productive, and fiscal economies. The ideas have been framed within an analysis of the logic of livestock for both large- and small-scale producers. By concentrating on strategies and rationales, I have shifted emphasis away from the usual ways of explaining deforestation in Amazonia: Malthusian pressures, commodity markets, and policy mistakes. At least in the case of Brazil, the demographic model of deforestation is not valid because population densities are low, and more than half the population is urban (IBGE 1987). The so-called hamburger connection, that is, the influence of international beef markets, simply does not operate in the current Amazonian context. Amazonian beef is rife with aftosa and prohibited into US markets, even if the Amazon were not a net beef importer.

The current emphasis on policy and subsidy distortions incorporates more complexity, but the application of these ideas relatively late in the process means that other forces can continue the deforestation pressure, even when specific parts of the economic incentives change. The empirical data show that, as credits have contracted, deforestation has increased. Models that focus on beef commodities cannot capture the broader dynamics of livestock-stimulated deforestation throughout the humid Latin American tropics. Land markets, value of ancillaries, and the larger macroeconomic context and individual economic strategies must also be included. Livestock are an unusual commodity in terms of their biological, market, and ancillary features, quite unlike those of coffee or rice.

The destiny of the region will be shaped through national politics to a greater degree than international pressure. The logic behind livestock is immensely compelling and likely to become more so, particularly since the alternatives—forestry, agriculture, and agroforestry—lack the variety of mechanisms (extractive, productive, and fiscal) through which value can be captured.

[1] T. Stone, Woods Hole Amazon Remote Sensing Project, Woods Hole, MA, 1993. Personal communication.

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