Agriculture and the Environment in the Brazilian Amazon

by

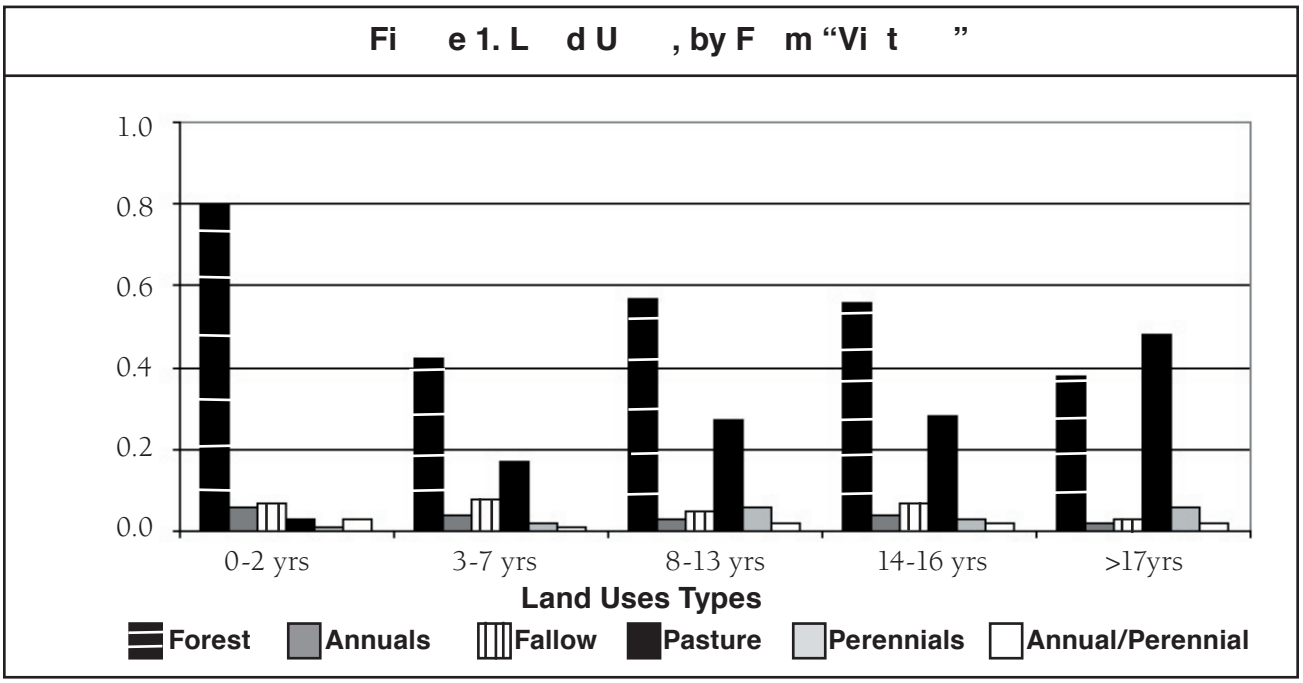
Stephen A. Vosti, Julie Witcover, Chantal Line Carpentier, Samuel Oliveira and Jair Santos

The profitability of agriculture is driving much of the deforestation in the Amazon, and labor scarcity is chiefly responsible for the establishment of pastures on cleared land. Deforestation can be slowed and non-pasture alternatives can be promoted, but doing so will be an expensive and slow process, which the international community should support.

Tropical ecosystems are under attack from two sides: deforestation rates are high and post-deforestation land uses provide virtually none of the environmental services once supplied by forests. This is especially true in Brazil, home to the world's largest remaining tract of tropical moist forests. Why is this happening? What can be done to slow deforestation? In particular, can the intensification of agriculture on already-cleared lands at the forest margin help slow deforestation? In this article, we use the results of field research on smallholder agriculture in the western Brazilian Amazon to address these issues. More specifically, we examine the potential tradeoffs between one important environmental objective (increasing and retaining carbon stocks) and farmer objectives (profitability and efficient labor use) across various land use systems (LUS) available to smallholders in that region today.

Trends in Land Use

Anyone who has visited the western Brazilian Amazon, or who has monitored the popular press regarding land use in that huge but remote area, will be aware of the large amount of deforestation taking place (it is estimated that an area about the size of Belgium is deforested, annually) and the marked trend toward converting deforested areas to pasture to support mixed cattle (beef and milk) production systems. Figure 1 confirms these trends by depicting land uses for several 'vintages' of farms, from those very recently established farms (0-2 years) to much older farms (more than 17 years) which comprised the first waves of migrant agriculturalists to this region beginning in the late-1970s. The decisions to decrease the amount of forest on farms and especially to increase the amount of pasture are clear.



But what motivates smallholders to clear forest? Surely they are aware of the environmental effects of forest clearing. And, of all the alternative LUS available to smallholders in that region, why is pasture so predominant?

The answers to these and related questions lie in the relative private financial returns to alternative LUS in this region and the acute shortage of labor available to establish and manage LUS. Research results based on systematic measurements of the profitability of LUS explain why smallholders routinely pick up their chainsaws, and the enormity of the challenge faced by policymakers seeking to dissuade them from doing so. Systematic measurements of selected environmental characteristics of LUS explain why policymakers should continue to try to meet this challenge.

Evaluation of Land Use Systems

Table 1 presents summary results of field research undertaken in the western Brazilian Amazon. The rows of Table 1 represent LUS (with labels appearing in the first column of Table 1), paired so as to highlight the costs/benefits of LUS intensification. In order of presentation, the LUS rows represent:

- •Forest–traditional Brazil nut extraction
- •Managed Forestry–the sustainable, low-impact extraction of timber products from privately held forests on farms
- •Coffee/*Bandarra*–a coffee-based system that includes a fast-growing native tree species
- •Coffee/Rubber–coffee and rubber, intercropped
- •Traditional Pasture–a low-technology, mixed cattle production system
- •Improved Pasture–a more intensive and higher-producing cattle and pasture system
- •Annual/Fallow–a slash-and-burn agriculture system involving annual crops
- •Improved Fallow–a legume-based fallow system involving annual crops.

Beginning in column two, the columns of Table 1 represent selected LUS characteristics of interest to the international community (ability to sequester carbon) and those of interest to farmers (returns to land, returns to labor and labor requirements). Comparing the profitability of traditional forest extraction activities (forest) with that of alternative LUS can shed light on deforestation issues, examining LUS labor requirements can help explain the use of cleared land, and reviewing carbon sequestration results highlights the environmental costs associated with LUS change.

Land Use Systems Compared—Farmer Concerns

In the relatively labor-scarce setting of the western Brazilian Amazon (about three inhabitants per square kilometer), the returns to labor outweigh returns to land in farmers' LUS decisions. Table 1 presents both profitability measures for comparison. Clearly, the returns to labor dedicated to traditional forest extraction activities are by far the lowest among all alternative LUS, yielding about U.S.$1 per person-day; this is the fundamental reason why forests continue to fall in the region.

Among the non-forest-based LUS alternatives, systems at or below the average rural daily wage for unskilled labor, approximately U.S.$6.50 per day, are probably not attractive to farmers; hence, the annual/fallow system is not practiced. Traditional pasture/cattle production systems, the most prevalent in the study area, yield slightly better returns than wage labor. All of the remaining systems yield even higher returns to labor. For example, the improved pasture/cattle system brings in about three times more per person-day than the traditional cattle system.

Analysis of returns to land (column three of Table 1) shows that all intensified systems appear relatively attractive, and the two traditional systems (forest and annual/fallow) are below average. Farmers who are more interested in returns to labor than to land would likely select improved pasture/cattle systems, while those more concerned with per hectare (ha) asset values might prefer systems scoring high on both counts, such as improved fallow and coffee/*bandarra*.

Adoptability of Intensive Agricultural Systems

But a LUS with high returns to labor may simply be out of reach of many small farmers in the area, given the current labor scarcity and poorly performing labor markets. Labor required to manage LUS are reported in column 5 of Table 1. The coffee/rubber system demands the most labor by far, nearly 60 person-days per hectare per year. At the other end of the spectrum lies traditional forest extraction, which requires only about one person-day per ha per year to manage. Traditional pasture requires the least labor of any system other than the forest-based

Table 1. Carbon Sequestration and Profitability of Selected Land Use Systems

	Global Environmental Concerns	Farmer Concerns		
	Carbon Sequestration	Profitability		Labor Requirements
	Above-ground Carbon t/ha (time-averaged)	Returns to land R$/ha (1 ha=2.471 ac)	Returns to Labor R$/ person-day	Labor person-day/ ha/yr
Forest	148	-2	1	1
Managed Forestry	148	416	20	1
Coffee/*Bandarra*	56	1955	13	27
Coffee/Rubber	56	872	9	59
Traditional Pasture	3	2	7	11
Improved Pasture	3	710	22	13
Annual/Fallow	7	-17	6	23
Improved Fallow	3-6	2056	17	21

Notes to Table: Prices are based on 1996 averages, and expressed in December, 1996 reais, R$ (U.S.$=R$1.04).

systems, approximately 11 person-days per ha annually; its intensified version, improved pasture, needs just slightly more than this. Clustered at 1.5-2.0 times the labor requirements of these systems are coffee/*bandarra* and improved fallow, as well as the vanished shifting cultivation (annual/fallow) system.

Tradeoffs Between Farmer Concerns and Environmental Concerns

Will the search for higher profitability in general, and higher returns to labor in particular, come at a high environmental cost? One environmental service of critical concern is the ability of LUS to retain and sequester carbon. CO_2 emissions from forested areas make up about 25% of total global emissions, and therefore can substantially impact atmospheric quality and global warming. Available evidence shows that the trade-off between returns to labor (column four) and carbon stocks (column two) is stark. Forests are by far the best way to store carbon, but extracting Brazil nuts from them yields far less per person-day than manual labor. Managed forestry looks promising as an intensive system that retains a large amount of carbon. However, the most attractive system along the returns-to-labor spectrum, improved pasture/cattle, is one of the *worst* ways of storing above-ground carbon. The coffee-based systems occupy intermediate positions. Moving from coffee/rubber to the coffee/*bandarra* system (the more attractive in terms of labor requirements as well) improves returns to labor without sacrificing carbon stocks.

Summary, Conclusions and Policy Messages

This article has examined the financial and environmental consequences of changes in selected LUS in the western Brazilian Amazon, concentrating on smallholder concerns and carbon sequestration. With one exception, we uncovered no 'win-win' systems that boosted farm profits and sequestered large amounts of carbon.

Since labor returns from traditional extractive forest activities remain *far below* those from any alternative non-forest-based LUS examined, the prospect of continued deforestation looms large; unless the financial returns to forest-based activities can be increased, forests will continue to fall.

Labor scarcity, rather than LUS profitability, seems to be driving the use of cleared land. Small patches of very profitable non-pasture LUS do appear on farms, but the labor-saving pasture/livestock systems dominate the agricultural landscape.

More intensive, non-forest-based LUS can affect deforestation in conflicting ways. On the one hand, these LUS use much more labor, and hence can

Small-scale farmers removing forest to earn a living and ensure food security. Photo: Steve Vosti

deflect labor from deforestation activities. However, these systems are more profitable and hence can generate cash to cover the costs of hired labor for deforestation. The second effect is likely to overwhelm the first, leaving severe regional labor shortages as the only 'brake' on deforestation.

But what of managed forestry that seems to be a 'win-win' system? Managed forestry holds great promise for retaining carbon stocks and increasing farm income. But, this LUS remains experimental and may not be suitable for smallholders who face depleted forest reserves or who are too poor to make needed up-front investments. Moreover, third party monitoring will be required to ensure sustainable timber off-take, and institutions for doing so are not currently in place.

What can and should national policymakers do to reduce deforestation and improve farmer welfare at the forest margins? To be most effective, strategies should work both sides of the forest margin, increasing the intensity of use of cleared land while either pushing up the costs of deforesting or increasing the value of standing forest. For example, policy changes can improve incentives for the formation of farmers' groups capable of managing small-scale managed forestry systems that do not now exist. Almost all intensive systems require rural credit; this credit will not flow from commercial sources, so policy action is needed. Reducing transportation costs will also be key to intensifying agriculture, so again, policy action is required. Finally, direct subsidies may be needed to promote some systems; chemical fertilizers for establishing some systems are an example. To reiterate, policies that boost incentives to maintain forests must complement these efforts.

Investing in the most promising land use systems is possible and worthwhile if done with the awareness that intensification *per se* of a given land use may have unintended consequences; that is, in the absence of other measures, policies can establish a profit motive for accelerated deforestation. When this occurs, policymakers must redouble their regulatory and other direct interventions to manage deforestation.

Finally, what role should the international community play in reducing deforestation? First, sponsoring research on issues of global interest is essential. Second, paying some of the costs of establishing and monitoring LUS that generate large amounts of environmental (and other) services of importance to the global community is appropriate.

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Stephen A. Vosti is an assistant adjunct professor in the Department of Agricultural and Resource Economics at UC Davis. He can be reached by telephone at (530)752-8097 or by email at vosti@primal.ucdavis.edu. Julie Witcover is a Ph.D. candidate in the ARE department at UC Davis. She can be reached by email at witcover@primal.ucdavis.edu. Chantal Line Carpentier is a researcher for the Commission for Environmental Cooperation. Samuel Oliveira and Jair Santos are researchers for the Empresa Brasileira de Pesquisa Agropecuaria (Embrapa) in Brazil.