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Technical Note 2.1 – Small-Scale Managed Forestry[1]

Chantal Line Carpentier[2]

Stephen A. Vosti

Julie Witcover

Abstract

Increasing the financial returns to forest activities is one proposed way to slow or even halt deforestation. But, will the levels of now higher expected returns be sufficient to alter deforestation rates, given the demonstrated profitability of annual crop and livestock production activities undertaken on cleared land? This Technical Note uses a farm-level bioeconomic model to assess the impacts on deforestation, land use and income of a new policy package (that includes technology and implicitly institutional changes) that allows and promotes sustainable, small-scale managed forestry. Results show that allowing sustainable off-take of timber products on farms would reduce, but not halt, smallholder deforestation, and would increase incomes. Moreover, the mechanisms for monitoring timber off-take are not in place; these will be needed to off-set the strong financial incentive to unsustainably harvest timber products.

This Technical Note is prepared as input into the OED's review of the World Bank's forestry policy, particularly the Brazil case study. This note is not for quotation or circulation, and its content does not necessarily reflect the views or opinions of the World Bank.

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[1]This is a numbered Technical Note series, with the potential for particular numbers in the series to have several versions; e.g., Note 2.1 may be followed by an updated discussion of small-scale managed forestry, which would be labeled Note 2.2.

[2]Author names appear in alphabetical order and no senior authorship is ascribed. Author affiliations and contact email addresses are, in order of listing: Research Fellow, H. A. Wallace Institute. Email address: **104723.2340@compuserve.com;** Visiting Research Fellow, IFPRI. Email address: **s.vosti@cgiar.org;** Research Analyst, IFPRI. Email address: **j.witcover@cgiar.org.** Vosti is the author for correspondence.

Introduction

Responses by resource users to technology and policy changes will determine the effectiveness of such changes. This is true for forestry and other policies that seek to influence deforestation and land use. This series of Technical Notes takes as axiomatic the need to focus on the whole farm, rather than on particular economic activities (in forests, on cleared land, or undertaken in the 'overlap' area linking the two). This series also focuses on small-scale agriculturalists at the forest margins, in part because of their sometimes impoverished state (which itself merits policy action), but more importantly because of their critical current and future roles in deforestation. These smallholders are pivotal to slowing deforestation in Brazil; failure to identify new combinations of forestry and other policies, technologies and institutional arrangements that effectively brake smallholder forest clearing will doom the Amazon.

This Technical Note presents the results of a specific policy experiment: allowing small-scale agriculturalists to sustainably harvest timber products from their own legal reserves. Several issues arise from this policy experiment that are relevant for the forestry (and other) policy review. First, will allowing smallholders to sustainably harvest timber products slow, or perhaps even halt, deforestation? Second, if deforestation is slowed or halted, why is that so -- i.e., is the braking effect due to the increased value of the forest that this policy change would induce, the on-farm competition for labor (man-days dedicated to timber extraction are not available for deforestation), or some combination of the two? Third, what are the implications for the use of cleared land, e.g., do livestock production systems still dominate the landscape if managed forestry is permitted? Finally, what are the implications for farm income – would smallholders be better off (as regards disposable income) if this policy were pursued?

A farm-level bioeconomic LP model, as described in Technical Note 1.1, is used to answer these and other questions.[3] This model contains a 25-year decision time horizon, explicitly accounts for on-farm competition among alternative agricultural and extractive activities for labor, capital and land, and assesses the impacts of policy and/or technological changes on deforestation, land use, and smallholder incomes. The model (its baseline land use and income results are included in this Note) was built for the western Brazilian Amazon, calibrated for those agronomic and economic conditions, and subject to extensive sensitivity analyses. We feel the model can predict the impacts of policy and technology changes on deforestation and land use by small-scale agriculturists in the western Amazon, and also believe that these results (especially the *directions* of farmer responses to policy/technology changes) are relevant for other frontier areas in the Amazon.

The next section briefly describes what the model does, and how, and then presents baseline land uses and the net present value (NPV) of income generated by these baseline land uses over a 25-year period. The following section describes the small-scale sustainable managed forestry policy experiment, and presents the results of the model simulation associate with it, with

[3] The model was laid out in great detail in the technical appendix circulated earlier.

special attention paid to land uses, deforestation, and household income. The Note ends with a brief discussion of policy implications of this policy experiment.

Baseline Simulation – Our Benchmark

Model Description – A linear programming (LP) model was developed to explicitly account for the biophysical and economic factors determining farmers' deforestation and land use decisions.[4] The archetypical farmer whose decisions are characterized by the model maximizes the discounted value of his family's consumption stream over a 25-year time horizon by producing combinations of products for home consumption and sale, subject to an array of constraints related to technologies for producing agricultural and extractive products, the impact of agricultural activities on soils, and the financial benefits associated with different activities, including the potential to sell household labor off farm for agricultural purposes.

Aside from a set of alternative economic activities (and their associated technical production coefficients), their financial returns, and the biophysical factors that constrain activity choices over time, the model contains a set of initial conditions, that is, an explicit set of farm and farm household characteristics that indicate both the model's starting point in terms of land already in use (for example, area in pasture), and farm- and household-specific constraints (for example, family size) that can influence the allocation of land, labor and cash to alternative land uses.[5] The model also limits certain input and product flows onto/off farms to reflect market imperfections, egs. milk sales are constrained by daily quotas, and the amount of hired labor that can be acquired in any given month is 15 man-days. Finally, the model includes an explicit policy 'package' to reflect realistically the policy setting in the western Brazilian Amazon, some elements of which influence land use, e.g., the prohibition on the extraction of timber products from

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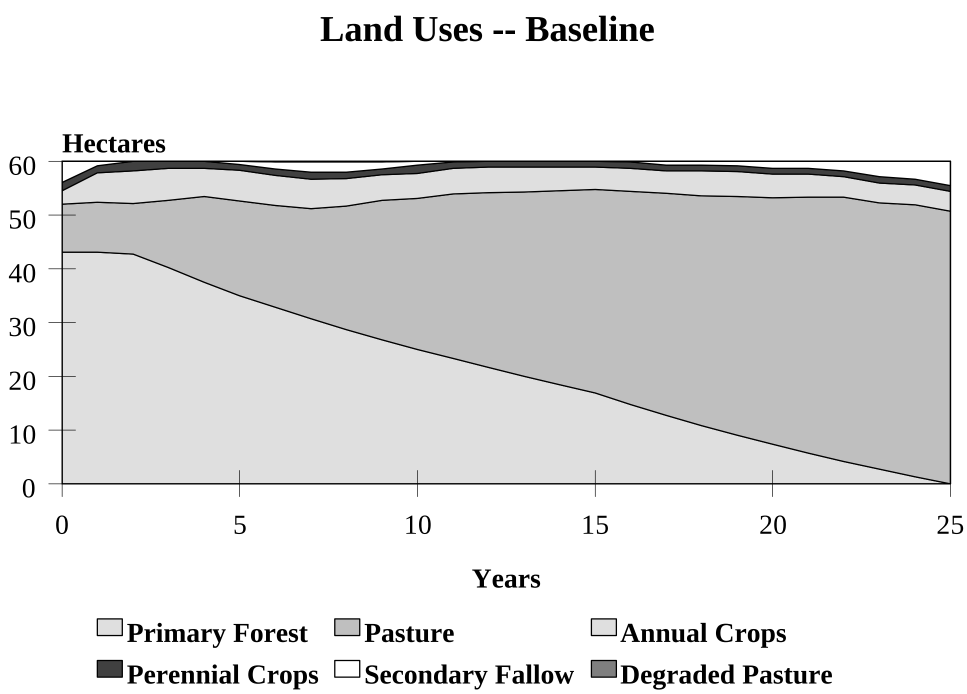
[4]Note that some potentially important factors influencing deforestation and use of cleared land have ***not*** been incorporated into this version of the model, most notably: the asset values of different types of land; land tenure; off-farm investments other than family labor hired out; and production risk due to unexpected weather shocks. Asset values will be the focus of future work. Land tenure and income diversification strategies involving non-agricultural activities are addressed in the regression work. We expect the explicit treatment of risks (weather, price, policy and other) to reinforce our results — that is, cattle production systems are dominant in virtually all model experiments, and the inclusion of risk would make these systems even more attractive. In future work, we intent to link the bioeconomic model with the Decision Support System for Agrotechnology Transfer (DSSAT) crop growth model, which contains a weather generator capable of simulating weather shocks and longer-term climate change.

[5] The model's point of departure was determined from field data collected in 1994. Farm households were clustered on the basis of characteristics deemed to be exogenous to farmers (for example, soil type). Several clusters emerged, each of which can be thought to represent a farm type. The average farm and household characteristics for a ***relatively well-situated farm type*** in terms of soil type and access to markets were used to generate the model baseline. All model simulations take as a point of departure the characteristics of one typical farm as identified from the Pedro Peixoto, Acre sample using this cluster analysis.

smallholder legal reserves is strictly enforced in the baseline (but not in this Technical Note).

Model Baseline – Figure1 depicts land uses (including forest, and therefore implicitly deforestation) generated by the model for a 25-year time span for a typical small-scale farm. Several results emerge from this baseline. First, the amount of forest retained is clearly declining over time, finally disappearing in about year 25, despite the small but positive revenue provided by the extraction of Brazil nuts (an activity currently undertaken by about 50% of sample farms). Second, in terms of area, cattle production is the dominant activity and pasture to support it eventually occupies about 85% of the farm. Third, annual crop production occupies about 8% of the farm throughout the 25-year time horizon. Finally, perennial tree crops (in this case, manioc, which has production cycle spanning more than one year) take up about a hectare of land over time, and secondary fallow weaves into and out of the baseline land use scenario, becoming significant as forests disappear completely.[6] Note that no degraded pasture appears in Figure 1, indicating that the archetypical farmer manages his pastures and herds under *this* baseline policy/technology scenario so as not to render them useless for supporting livestock production. In other scenarios, this is not the case.

Figure1 – Baseline land uses, by year



[6] Baseline simulations out to 35 years suggest that the area in secondary fallow continues to increase at approximately .20 ha every 2 years to reach 5.5 hectares in year 35.

The dominance of pasture on the archetypical farm merits special attention; two issues emerge. First, dairy production begins early on in the 25-year scenario, and continues to play an important role throughout — once the milking herd is established (say, by year 10) roughly 77% of income is derived from dairy operations, which occupy 42% of available household labor — averaged over the months with the exception of May. In May, pasture and animal care account for 128% of available household labor, implying that 15 man-days (the maximum allowed by the model) must be hired in May. Second, beef cattle production emerges as a second cattle activity in year 9, and it's contribution to income peaks in year 18 at which time it represents 25% of household income, but occupies just 4% of available household labor.

Extraction of Brazil nuts (allowed in the baseline policy 'package,' and practiced to one degree or another by about 50% of sample households) is a constant, but diminishing source of income to smallholders in the baseline run.[7] This activity is the only source of income from the forest in the baseline; previous experiments that dramatically increased the value of Brazil nuts only slightly slowed deforestation. Therefore, one of the prime objectives of this Technical Note is to see if increasing the flow of income from a *new* set of forest products will be more successful in slowing deforestation.

Financial flows from on-farm agricultural and extractive activities and off-farm sales of adult male labor are substantial. Savings during the first few years allow for subsequent investments that boost production (and, hence, consumption) in later years. Large investments (negative savings) are required in years 5, 9, and 11 to expand pasture areas. Farm profits plateau at about year 13, at a level of approximately R$9,000 per year.[8] The net present value (NPV) of the 25-year stream of the net value of total output (VTO) is R$50,635.[9]

Policy Experiment – Sustainable, Small-Scale Managed Forestry

This policy experiment simulates the removal (from the baseline scenario presented above) of the prohibition on the sustainable extraction of timber products from private forests. In this experiment, farmers are free to sustainably extract timber products from their privately held forests. Moreover, farmers can select the *amount* of forest they retain for this purpose (and for Brazil nut extraction), but not the per-hectare rate at which, or the species-specific way in which, timber is extracted, both of which are dictated by the imposed technology designed to maintain

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[7] The supply of Brazil nuts is directly linked to the amount of forest cover remaining on farms. The same survey data from 1994 used to identify farm types were also used to estimate Brazil nut off-take.

[8] All values are reported in terms of 1996 Brazilian reais; the model uses a constant set of 1993/94 input and product prices for the entire decision time horizon.

[9] A discount rate of 9% was used to calculate the NPV.

the ecological integrity of the forest.

Description of Technology – Farmers are allowed to extract up to 10 cubic meters of timber from selected trees species per hectare, per year, a rate and method judged by local foresters to be sustainable over a 30-year forest production cycle.[10] Low-impact harvesting methods are deployed, e.g., sawn logs are hauled using oxen to the roadside for processing into planks. Labor requirements for every phase of the production process (felling, on-farm transport, sawing of planks, etc.) are explicitly accounted for.

Details of the Policy Experiment – 1996 market prices are used to determine the values of timber products, purchased inputs (including labor) and transportation costs involved in this activity.[11] Investments (saws, log hauling materials, etc.) are required to begin harvesting operations, and these made and paid for by farmers, who experience negative cash flows from timber operations during the first couple of years. Markets are assumed to exist for and be able to absorb all timber products produced over the entire 25-year decision time horizon, at constant 1996 prices. The volume of sales required to reduce transportation costs, combined with the relatively small legal reserves held by most smallholders, likely requires that groups of farmers combine forested areas and capital to engage in the sustainable harvesting of timber products. Expertise regarding how to select species, fell trees, and produce and market timber products is assumed to exist, perhaps via technical assistance during the initial phases. Finally, farmers are always expected to follow the very specific rules regarding species selection and felling, and do so at zero supervision cost *to farmers* when the activity is undertaken.[12]

Results of Model Simulation – Land uses resulting from the simulation of this policy experiment appear in Figure 2; two important differences emerge vis-a-vis the baseline scenario (which did not permit sustainable managed forestry). First, land held in forest in year 25 is approximately ten hectares, as compared to zero area in forest in year 25 of the baseline. Second, area in secondary forest fallow is reduced to zero, and there is a slight reduction in the amount of pasture land, though this continues to be the predominant land use. Land in annual and perennial crop production is quite similar to that the baseline. So, over this time horizon and vis-a-vis the baseline simulation, deforestation is slowed, secondary fallow is eliminated, and pasture remains

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[10]Details of extraction rates and methods, and labor requirements were provided by Evaldo Braz (Embrapa, Acre) and based on his collaborative research on sustainable management of forests in the western Brazilian Amazon.

[11]Constant 1993/94 prices are used for all other activities.

[12]No effort has been made here to assess the financial wisdom of adhering to these constraints. However, logic suggests that in an unconstrained world farmers would select and harvest according to a von Thunen-type algorithm; all of the most valuable species (controlling for on-farm transport costs) wold be harvested first, then farmers would move on to harvest the less valuable species. Ecological integrity of the forest would be quickly undermined by this harvesting algorithm. Work by Steve Stone and others has confirmed the selective harvesting of high-valued species in the eastern Amazon. Future work may focus on this issue.

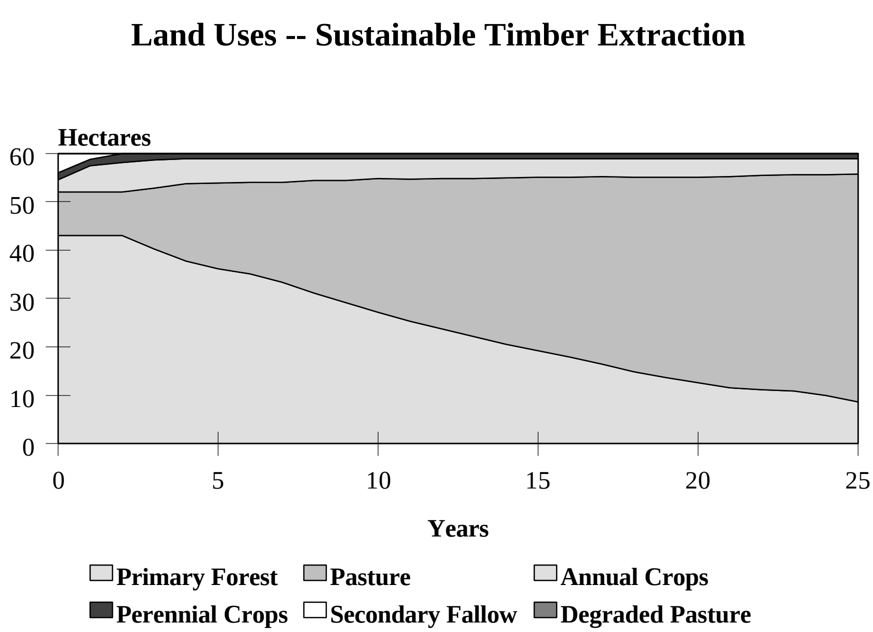
the predominant (though slightly reduced) land use.

However, land use patterns do not stabilize by year 25 in this policy experiment, so even though 25 years is a long time horizon, it is insufficient to judge the full and long-term impacts of allowing small-scale managed forestry. When land use patterns *do* stabilize, after about 35 years, only .12 has. of forest is left, and of the cleared land 49 has. are in pasture, 2.8 has. are dedicated to annual crop production and fallow land returns to the landscape after year 25, stabilizing at 7.5 has. in year 35.

Therefore, over the long term, even though deforestation is slowed by allowing small-scale managed forestry, it does not stop and the end result is the virtual elimination of the forest. The predominant land use, in this policy experiment as in the baseline scenario, remains livestock.

The managed forest scenario also generates differences in other parameters of interest (again, vis-a-vis the baseline scenario). First, both seasonal labor hiring patterns and the absolute numbers of man-days hired change; much more labor is hired generally (but still subject to the 15 man-day per month limit), and forest extraction activities concentrated in July and August boost labor demand in those months. Second, as expected, seasonal labor use patterns adjust to reflect large increases in manpower dedicated to timber extraction activities over the May-September period (dry season), thereby increasing the on-farm competition for labor during the deforestation season, and providing another source (aside from the profitability of sustainable managed forestry) of downward pressure on deforestation.

Figure 2 – Land Uses with Sustainable Managed Forestry



Finally, engaging in small-scale managed forestry increases farm income, especially during years 5 through 9, prior to which substantial start-up costs reduce cash flow. The NPV of the value of total output under this policy experiment was approximately R$55,000; the baseline figure was R$ 50, 635, about 10% lower.

Conclusions and Implications for Forestry (and Other) Policy

Several conclusions emerge from this policy experiment that are relevant for forestry and other policies in Brazil.

Adding value to forests held by small-scale farmers will be fundamental to slowing deforestation. Attempting to do so via increases in Brazil nut prices will not suffice; new types of forest products need to be added to the list of legally extractable products. Current legal restrictions on sustainable timber extraction from forest reserves and the bureaucratic obstacles to overcome them are costly to farmers. Legal restrictions were eliminated in this policy experiment; deforestation slowed and farm incomes rose. Forestry policy prohibiting the extraction of timber products by small-scale farmers should be reviewed and modified.

But, allowing small-scale timber extraction, even *if* practiced sustainably by smallholders, will not halt deforestation. Indeed, over the long term, the amount of forest retained on small farm will be the same whether or not farmers are allowed to practice this activity -- practically zero in both cases. Therefore, the real gains from changing this particular forestry policy is the slowing of deforestation, and the gaining of time to devise other solutions to the deforestation problem.

But, the likelihood that smallholders *will* extract timber products sustainably is not high for several reasons, all of which are relevant to policymakers. First, profitability of these schemes may encourage the development or practice of unsustainable or excessively damaging extraction techniques; no farm-level or community-level mechanisms are currently in place to ensure sustainable harvesting. Therefore, important institutional investments (such as timber extraction monitoring and verification systems) will need to be made to ensure that the extraction of timber products is done sustainably.

Second, preliminary assessments suggest there are economies of scale in sustainable timber extraction, suggesting that this activity will be more profitable for groups of farmers working together than for individual smallholders. This may offer benefits and complications; benefits include the potential for pooling capital to cover start-up costs and the potential for farmers to monitor one another; complications include the establishment and implementation of long-term agreements regarding off-take, cost sharing and monitoring in frontier areas with high transactions costs for such activities. Research is needed to identify effective, self-enforcing and self-financing mechanisms of monitoring mechanisms for all schemes aiming to increase forest value, perhaps especially small-scale timber extraction.

Finally, although much progress has been made over the past decade, sustainable timber extraction schemes are still experimental, i.e., the long-term integrity of the forest under these schemes is still unknown, and large and perhaps species-specific modifications to harvesting volumes and harvesting methods might be needed; these changes may affect profitability and hence the attractiveness of these schemes generally to smallholders. Long-term, participatory research is required to clearly define and ‘fine tune’ these schemes.