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Analysis

Is It Possible to Make Rubber Extraction Ecologically and Economically Viable in the Amazon? The Southern Acre and Chico Mendes Reserve Case Study

Carolina Jaramillo-Giraldo [a,1], Britaldo Soares Filho [a,1], Sónia M. Carvalho Ribeiro [a,*,1], Rivadalve Coelho Gonçalves [b,2]

[a] Universidade Federal de Minas Gerais, Centro de Sensoriamento Remoto. Av. Antônio Carlos, 6627, Belo Horizonte, MG, CEP 31270-900, Brazil
[b] Laboratório de Fitopatologia, Embrapa-Empresa Brasileira de Pesquisa Agropecuária, Rio Branco, Acre, Brazil

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ABSTRACT

Rubber extraction in the Amazon faces enormous ecological and economic challenges. We modeled the ecology (tree density and forest yields) and the production chain, including rents of the three major rubber products: Pressed Virgin Rubber (PVR), Liquid Latex (LL), and Liquid Smoked Sheet (LSS) from native forests and from plantations in Southern Acre, including the emblematic Chico Mendes Reserve. Our estimates show that, in native forests, tree density ranges from 0 to 4 trees/ha (average = 1.67 trees/ha), while productivity varies from 1 to 3 l/tree/year (average = 2.26 l/tree/year) with yields between 1 and 6 l/ha/year. Our model estimates a potential annual production of 890 tons of dry rubber in the 2.5 million ha of forests of Southern Acre (average = 0.36 kg/ha/year). Rubber extraction in native forests is not economically viable without government subsidies. Mean Equivalent Annual Annuity (EAA) for LL is US$ 3.24 ha/year in a scenario with subsidies and of 75% of potential annual harvest. LSS from plantations reaches an EAA of US$ 270 ha/year if costs of formation are subsidized. Public subsidies or Payments for Ecosystem Services are essential to sustain, at least temporally, rubber tapper identity – an important Cultural Ecosystem Service of the Amazon.

1. Introduction

The Amazon is well-known for its diversity of living organisms (Lewinson and Prado, 2004; Hubbell et al., 2008; ter Steege et al., 2013; Fauset et al., 2015) as well as for the variety of livelihoods and cultures of its traditional communities that live in or by the forest (Gonçalves, 2005; McMichael, 2015). Despite Brazil's success in reducing deforestation (Nepstad et al., 2009), challenges to secure further reductions remain (Soares et al., 2014). In this respect, one key component for forest conservation policies continues to be the need to promote sustainable development, especially for traditional livelihoods (Arima et al., 2014). To meet this goal, the upgrading of sustainable production chains of timber and non-timber forest products (NTFPs) has been suggested as central (Delang, 2006; Schroth et al., 2004; WWF, 2014).

The consumption and trade of NTFP mirror well the Amazonian diversity. NTFPs encompass a variety of raw materials, such as food, fibers, resins, and animal products used and traded by local communities. NTFPs are also famed for their potential genetic pool for the future (Elisabetsky and Shanley, 1994; Coelho-Ferreira, 2009) and often linked to traditional knowledge and folk culture, hence regarded as "non-material" cultural ecosystem services (Gomes et al., 2012).

Yet, despite their reported potential to protect biodiversity and support traditional livelihoods, NTFPs market values are not sufficient to sustain economically viable, large-scale exploitation (Schroth et al., 2004; Shone and Caviglia-Harris, 2006; Gomes et al., 2012; Albers and Robinson, 2013). As a result, four decades of attempts to harness NTFPs production chains to further conservation goals and support traditional livelihoods have had mixed outcomes. While critics have questioned the limited potential of natural resource management of timber and NTFPs for reconciling

* Corresponding author.
E-mail addresses: cuduyari@gmail.com (C. Jaramillo-Giraldo), britaldo@csr.ufmg.br (B. Soares Filho), soniacarvalhoribeiro@cart.igc.ufmg.br, Sonia.carvalhoribeiro@gmail.com (S.M. Carvalho Ribeiro), rivadalve.goncalves@embrapa.br (R.C. Gonçalves).
[1] Tel.: +55 313409 5449, Fax: +55 31 3409 5410.
[2] Tel.: +55 54 3455 8015.

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conservation goals with local livelihoods (Shone and Caviglia-Harris, 2006), others have identified factors that could improve those production chains (MMA, 2009; Nunes et al., 2012; WWF, 2014).

Among the vast number of NTFPs from the Amazon, rubber is of particular importance due to its tie to the Amazon history and high potential for application in industry. It is the presence of the rubber tree (*Hevea* spp) that geographically defines the Amazon biome (Gonçalves, 2005). Rubber is one of the hyperdominant trees in the Amazon (ter Steege et al., 2013) with its ecology related to the long history of human occupation in the region. The rubber cycles in the late XIX century and from 1942 to 1965 boosted the Amazon economy, projecting it onto the world market (Hecht, 2013). Particularly, the early rubber boom was crucial for Brazil's scramble for the Amazon (Hecht, 2013). Rubber tappers' identity is still strong in some areas of the Amazon (Gomes et al., 2012). In addition, natural rubber has numerous applications with uses that go beyond 50 thousand objects (FNP, 2014) with high industrial applicability (Embrapa, 2015). Yet Brazil is not self-sufficient in rubber. As of 2011, rubber consumption in Brazil amounted to 400 thousand tons, of which 235 thousand tons, totaling US$ 1.1 billion, were imported mostly from Asian countries (FNP, 2014).

Despite its importance, rubber tapping from native forests in the Amazon has steadily declined due to its low profitability (Embrapa, 2015). In face of the threats posed to this traditional extractive system (Gomes, 2009; Gomes et al., 2012; Hecht, 2013), there are but few studies that address in an integrated way the ecological, economic and cultural aspects of rubber tapping. A particular challenge of such studies is to overcome the shortage of geographically distributed data on productivity (forest yields) and profitability (prices and costs) of NTFPs. In this regard, spatially-explicit assessments are key to help design and put in place policies aimed at valuing the multiple services provided by the Amazon forests, as these policies need reliable estimates of current and expected forest yields and rents under a set of ecological and socioeconomic conditions (Maes et al., 2012; Maes et al., 2013).

As rubber is a raw material traded in markets, conventional economic approaches use market prices to value this product (Turner et al., 2015). There are two major ways whereby rubber enters the market. One is through community industry partnerships (Morsello, 2006) and the other is through NTFPs product market chains (MMA, 2009). While the former occurs through scattered initiatives, *e.g.* The Body Shop Foundation initiative (BodyShop, 2015), the latter is a mainstream practice. However, Ecosystem Services (ES) from standing rubber trees (*e.g.* biodiversity, carbon storage, and rubber tapper's identity) are seldom incorporated in market values. Knowledge of the production chain, including environmental, socio-institutional and economic aspects, is therefore key for orienting policy interventions and investment programs, such as Payment for Ecosystem Services (PES) projects that could ensue sustained and equitable benefits to all those involved (MMA, 2009).

Here, we combine spatially-explicit ecological modeling with economic valuation of three rubber products – Pressed Virgin Rubber (PVR), Liquid Latex (LL), and Liquid Smoked Sheet (LSS) – from native forests as well as from plantations to inform policies aimed at safeguarding the tradition of rubber tapping that has had so much meaning to the ecology and history of the Amazon. To this end, our study focuses on the rubber production chain in Southern Acre including the emblematic Chico Mendes Reserve (CMR).

2. Case Study Area

In Acre, one of the nine states of the Brazilian Amazon, the traditional NTFPs are rubber (*Hevea* spp.) and Brazil nut (*Excelsa bertholletia*). These NTFPs have well-established production chains involving cooperatives that receive support from various government agencies and non-governmental associations (MMA, 2009; WWF, 2014). Southern Acre was included in the national plan for socio-biodiversity (MMA, 2009) as the target region for promoting the rubber chain. The consolidation of rubber chain in the state is moving forward based on three major rubber products, namely PVR, LL, and LSS. LL is produced in Acre since 2005 when the state government set up a condom factory in Xapurí, named Natex Condoms. This was the first factory in the world to produce condoms from LL extracted from native rubber trees (Tollefson, 2015). LSS technology was developed by the department of chemistry of the Federal University of Brasilia to generate thin sheets of pure rubber. Since 2006, various municipal initiatives have supported different associations to produce LSS used, for example, as shoe soles (WWF, 2014).

Rubber extraction in the state is supported by a government agency named System of Incentives for Environmental Services (SISA), which advances market consolidation strategies and provides subsidies to rubber tappers through PES programs (CIFOR, 2014). These subsidies are paid to rubber tappers which receive per kilo of dry rubber (paid at an affiliated institution), in addition to the market price, a share of subsidy to reach a minimum price. These subsidies from SISA are welcomed by pro-rubber tapping movements that emerged after the murder of Chico Mendes – a celebrated rubber tapper leader. In 2012, the subsidies amounted to US$ 1.75 per kg for PVR, and US$ 3.90 and 3.75 for LL and LSS, respectively (Table 1).

Moreover, as a means to become self-sufficient in rubber production and to reduce deforestation, rubber plantations in agroforestry systems have been proposed as a an economic alternative to cattle raising as in the case of Brazilian Extractive Reserves (Schroth et al., 2004). To this end, the state government has supported since 2010 reforestation on degraded pastures with different native trees, such as *Hevea* spp. In addition to restoring degraded lands, rubber plantations are envisaged as a way to improve efficiencies of scale (Line Carpentier et al., 2000; Schroth et al., 2004). In native forests, one person may extract 500 to 600 kg of latex a year, whereas in rubber plantations the same workforce may extract as much as 20 tons a year (SEAPROF, 2014).

Our study area, the southeast part of Acre state, comprises 3.88 million hectares (ha) of which 2.5 million ha consist of forests and 0.9 million ha of pasture and croplands. The study area encompasses the 11 largest municipalities of Acre on a population basis, including the Chico Mendes Extractive Reserve situated alongside the BR-317 highway that connects Brazil to the Pacific Ocean *via* Peru (Fig. 1).

CMR is emblematic for many reasons. It was one of the first protected areas in Brazil designated as an extractive reserve (RESEX) category, which allows sustainable human occupation inside. Its designation was pressed by popular movements (*i.e.* rubber tappers and nut gatherers) resisting the appropriation of forest areas by large farmers (Salisbury and Schmink, 2007). Rubber tapping has been the main economic activity in CMR guided by its Management Plan and Advisory Council Utilization Plan (MMA, 2009).

Table 1
Total production costs and sale prices (US$/kg) for Pressed Virgin Rubber (PVR), Liquid Latex (LL) and Liquid Smoked Sheet (LSS) in scenarios of full (FC) and partial (PC) cycles and with (PS) and without subsidies (AS).

Economic variables	Presence of subsidies			Absence of subsidies		
Products	PVR	LL	LSS	PVR	LL	LSS
Total cost in full cycle	2.58	3.08	3.35	2.82	3.80	5.32
Total cost in partial cycle	1.66	1.97	2.27	1.98	2.94	4.78
Sale price	1.75	3.90	3.75	0.81	1.89	2.49

Conversion factor (*Fn*): 1 kg of latex extracted: 0.9 kg LSS, for other products *Fn* = 1. US$ 1 = R$ 2.