University of São Paulo
Luiz de Queiroz College of Agriculture

How well can smallholders in the Amazon live: an analysis of livelihoods and forest conservation in cacao- and cattle-based farms in the Eastern Amazon, Brazil

Daniel Palma Perez Braga

Thesis presented to obtain the degree of Doctor in Science. Area: Forest Resources. Option in: Conservation of Forest Ecosystems

Piracicaba
2019

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Bachelor in Forest Engineer

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versão revisada de acordo com a resolução CoPGr 6018 de 2011

Advisor:
Prof. Dr. **EDSON JOSÉ VIDAL DA SILVA**

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1. Desenvolvimento rural 2. Agricultura familiar 3. Bem-estar 4. Transamazônica 5. Cacau 6. Pecuária 7. Conservação florestal I. Título

Side-by-side, cacao agroforestry systems and cattle ranching are part of the rural development along the Transamazon highway…

To my parents and brothers.

For a better living in the Amazon.

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I should write another thesis just for the acknowledgments, given the importance of each person, among many people, that collaborated during this long journey. I would like to give my sincere acknowledgements to everyone who contributed, directly or indirectly, to this work. From the ideas, the planning, the fieldwork, the analysis, the writing… It wouldn't be possible to make this alone.

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Thank you very much!!!!!

Florestabilidade

"A nossa querida Amazônia
Com toda sua gradeza,
São florestas enormes
Cheias de vida e beleza,
Grandes variedades de árvores
Enriquecendo a natureza.

A Amazônia é uma região bela
Que devemos contemplar,
Florestas, rios, nascentes e a castanha-do-Pará
Muitas outras riquezas que podemos expolorar.
(...)

Existem várias alternativas que podemos implantar,
Usar as leguminosas como forma de adubar,
As culturas permanentes
E as roças-sem-queimar.

SAFs são alternativas que podemos implantar
Com muita vantagem na agricultura familiar,
Onde visa produzir alimento
E também reflorestar."
(...)

Manoel José Leite ("Manoel Alagoano") – Agricultor e poeta da Transamazônica. Pacajá – PA

SUMMARY

RESUMO

Quão bem os agricultores familiares podem viver na Amazônia: uma análise de meios de vida e conservação florestal de pequenos produtores de cacau e gado na Amazônia Oriental, Brasil

Desde que os primeiros colonos foram assentados ao longo da rodovia Transamazônica, Amazônia Oriental, no início da década de 1970, se discute como garantir os meios de vida dessas famílias. Ao longo do tempo, a produção de gado se tornou a principal opção. No entanto, o aumento da preocupação com os danos ambientais promovidos pela pecuária extensiva tem chamado atenção para os sistemas agroflorestais com cacau (*Theobroma cacao* L.) como potencial alternativa, capaz de conciliar a produção com a conservaçao florestal. No entanto, agricultores familiares continuam aderindo à pecuária. Ainda existe pouco conhecimento científico para entender se, e em qual grau, essas percepções e expectativas são realísticas, pois grande parte das pesquisas têm focado em aspectos estritamente técnicos. Diante desta problemática, este estudo investigou o que os agricultores familiares, que produzem cacau e/ou gado, podem esperar em termos do padrão de vida a ser alcançado e da conservação florestal como estabilidade natural da sua base de produção. Ao longo de sete munícipios, nós aplicamos 95 entrevistas em roteiros estruturados. Conforme indicado pela Análise de Componentes Principais, usamos a renda e a moradia para definir o bem-estar econômico e calcular o nível de sucesso para cada família. Então, calculamos as correlações e frequências e aplicamos testes de hipóteses (Spearman e Kruskall-Wallis). Os resultados revelaram que aproximadamente dois terços das famílias puderam alcançar um padrão de vida em níveis aceitáveis ou bons (com renda média em torno de 17.000 dólares por ano), mas também foram destacadas dificuldades a serem consideradas. Os fatores mais relevantes, positivamente relacionados com o sucesso, foram o tamanho da terra e o nível de tecnologia. Para os agricultores bem-sucedidos, a combinação de interações sociais, nichos de mercado e renda externa demonstrou-se relevante. Produtores de cacau puderam ser tão bem-sucedidos quanto produtores de gado, considerando que o cacau (em solos favoráveis) gerou, no mínimo, seis vezes mais renda por unidade de área que o gado. Quando as famílias adotaram os dois sistemas de produção a chance de sucesso aumentou, consequentemente ao custo de maior desmatamento. Sobre a conservação florestal, os sistemas agroflorestais relacionados com a diversificação da renda familiar, no melhor dos casos incluindo o uso de produtos não-madeireiros de árvores nativas, poderia ser uma alternativa factível à pecuária extensiva. No entanto, para difundir tais sistemas produtivos mais complexos seria necessário melhores políticas e efetivo suporte fundamentado por meio de cooperações institucionais com parcerias multilaterais, capazes de estabelecer logísticas efetivas e mercados atrativos para uma diversa gama de produtos. Estudos posteriores deveriam ampliar o foco em aspectos de contexto e em trajetórias individuais, usando métodos qualitativos complementares, além de apenas avaliações quantitativas.

Palavras-chave: Desenvolvimento rural; Padrão de vida; Pobreza; Transamazônica; BR 230; Cacau; Pecuária; Sustentabilidade; Sistemas agroflorestais.

ABSTRACT

How well can smallholders in the Amazon live: an analysis of livelihoods and forest conservation in cacao- and cattle-based farms in the Eastern Amazon, Brazil

Since the first colonists were settled along the Transamazon highway in Eastern Brazilian Amazon, in the early 1970s, it has been hotly debated how to guarantee their livelihoods. Over time, cattle ranching became the priority option. However, with increasing awareness about the socio-environmental drawbacks of this production system, the search for less damaging production systems was intensified. Cacao (*Theobroma cacao* L.) based agroforestry systems present one of the most promising land use options because they conciliate attractive yields with ecosystems conservation. Independent from this, many smallholders (small-scale households) continue seeing cattle ranching as their dedication. Whether and to what degree, these perceptions and expectations are realistic is not known, as most studies concentrate on technical aspects so far. Against this backdrop, this study invested in better understanding what small-scale farmers dedicated to cacao and/or cattle can realistically expect regarding living standard of their familiy and the forest conservation as stability of their natural production basis. Along seven municipalities, we applied structured interviews to 95 households. As suggested by Principal Component Analysis, we used the responses about income and housing to define the economic well-being and calculate success levels for each household. We then calculated correlations and frequencies, and applied hypotheses tests (Spearman and Kruskall-Wallis). The data showed for nearly two thirds of the visited families an acceptable to good living standard (with an average income higher than 17,000 USD/year), but also, concerning weaknesses for the rest. The most relevant factors, positively related to success, were land size and level of technology. For successful households, the combination of social interactions, market niches and off-farm income showed relevancy. Cacao farmers could be as successful as cattle ranchers, regarding cacao (on suitable soils) generated at least six times higher income per hectare than cattle. When households adopted both systems the chances of success were even higher, but on the cost of more deforestation. With regards to forest conservation, agroforestry systems related to a diversification of the household economic basis, at best including the use of non-timber products of native trees, could be feasible alternatives for extensive cattle ranching. However, to diffuse such more complex production systems requires better policies and effective support grounded in a thorough institutional cooperation of multilateral stakeholders able to establish effective logistics and attractive markets for the related diverse array of products. Further studies should increase focus on the aspects of context and personal pathways of households, using complimentary descriptive methods beyond just quantitative evaluations.

Keywords: Rural development; Living standard; Transamazon; BR 230; Poverty; Cocoa; Livestock; Sustainability; Agroforestry systems

1. INTRODUCTION AND OBJECTIVES

1.1. The Transamazon highway

In 1970, the General Emílio Garrastazu Médici, then president of Brazil, announced the construction of the emblematic Transamazon highway (Figure 1). It was the third longest road in the country, penetrating the core of Brazilian Amazon forest (Figures 2 and 3). The ambitious project aimed to connect the Atlantic and Pacific oceans, crossing the Amazon and expanding the agricultural frontier. Years before, the military's government (1964-1985) launched "Operation Amazonia" (BRASIL 1966; Hecht 1985; Mahar 1989) and, at that time, the National Integration Program – PIN (BRASIL 1970; Moran 1993), a set of policies to occupy the region for economic development, regarding the ideology of national security (Kleinpenning 1977, 1971).

Figure 1. Celebration of the Brazilian government projects in the Amazon (late 1960s and early 1970s): (a) event of national road planning, with the Ministry of Transports Mário Andreazza (left, white shirt) and the President General Emílio Garrastazu Médici (right, black shirt). Source: (JWS 2018); (b) inauguration of the Transamazon highway (BR 230), iron signal fixed at the stump of a Brazilian nut tree bark, slashed for that inauguration (Altamira municipality, Pará, 1970). Source: (Folha de São Paulo 2016)

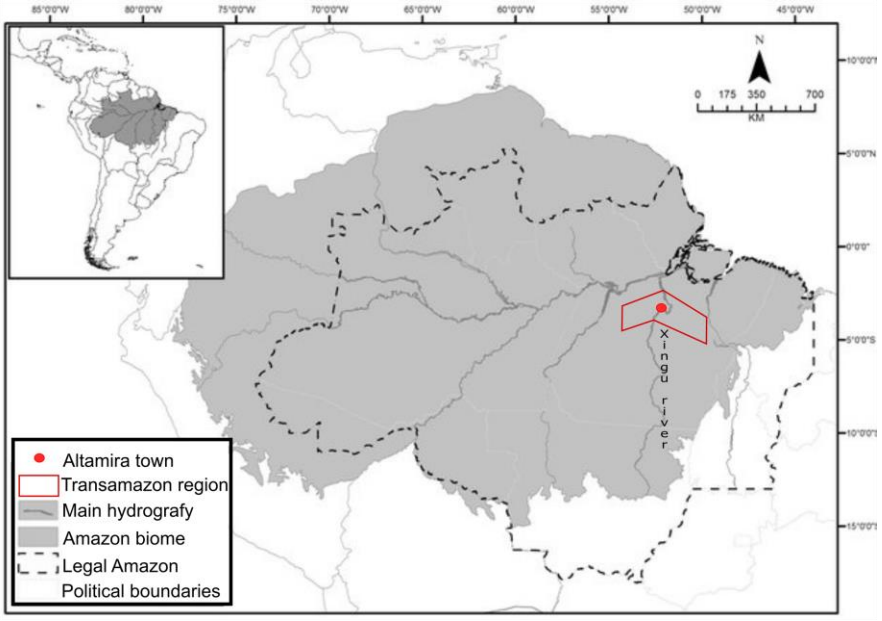

Figure 2. The Legal Amazon corresponds to the regulatory limits (political) of the Amazon in Brazil. What we call as Brazilian Amazon is the Amazon biome (natural vegetation) within Brazil. Besides, the map shows our study site, one of the main affected regions by the Transamazon highway in state of Pará, Eastern Amazon territory. Source: adapted from Leonardo Trevelin (Lopes and Mendes-oliveira 2015).

Other strategies were also at work to improve of infrastructure for rural activities, like the Amazon Development Plan (I and II) and the Amazon Program of Agricultural and Mineral Poles (POLAMAZONIA) (BRASIL 1974b, 1974a, 1974c; Schmink and Wood 1992). The main executive institutions were the Amazon Development Agency - SUDAM and the National Institute for Colonization and Agrarian Reform - INCRA, supported by the Bank of Amazonia - BASA and the Amazon Investment Fund - FIDAM (Hecht 1985; Kleinpenning 1977; Mahar 1989).

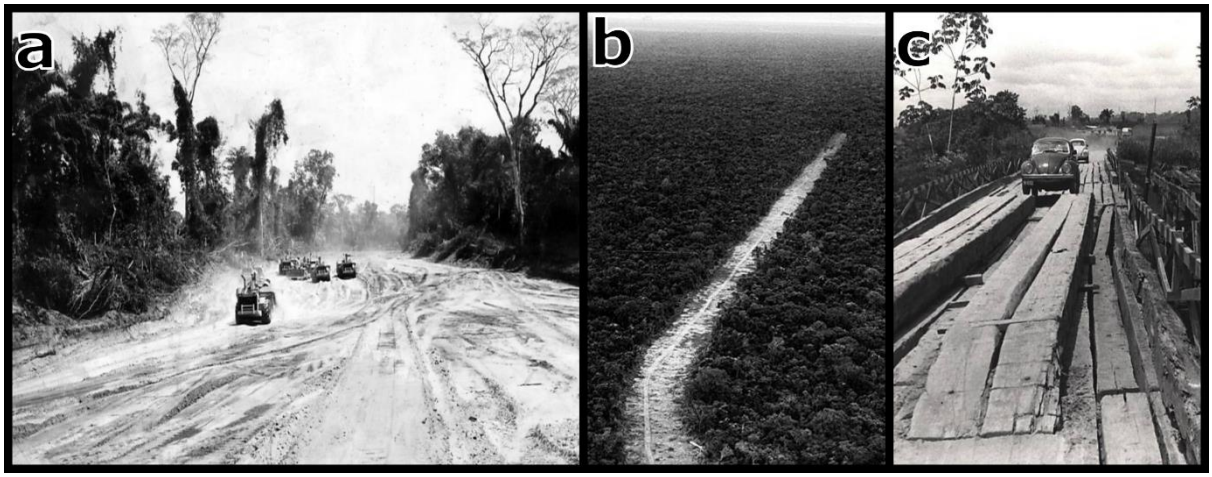

Figure 3. Transamazon highway under construction (early 1970s): (a) machinery working to make the backfill. Source: (Folha de São Paulo 2016); (b) opening the primary forest frontier. Source: (Folha de São Paulo 2016); (c) cars crossing the bridge made of wood. Source: (Folha de São Paulo 2016).

The government's geopolitical and mineral exploitation interests were softened by its discourse of social benefits through an enormous project of agrarian reform, promising to settle 100,000 colonist families, in five years, alongside the highway (Figure 4) (Fearnside 1984; Moran 2016). One of the most famous slogans for Amazonian colonization was "land without men to men without land", regarding the supposed demographic emptiness, which ignored the indigenous and other traditional long-term residents (Figure 5) (Ferreira et al. 2014; Schwartzman et al. 2013; Simmons 2002; Le Tourneau 2015).

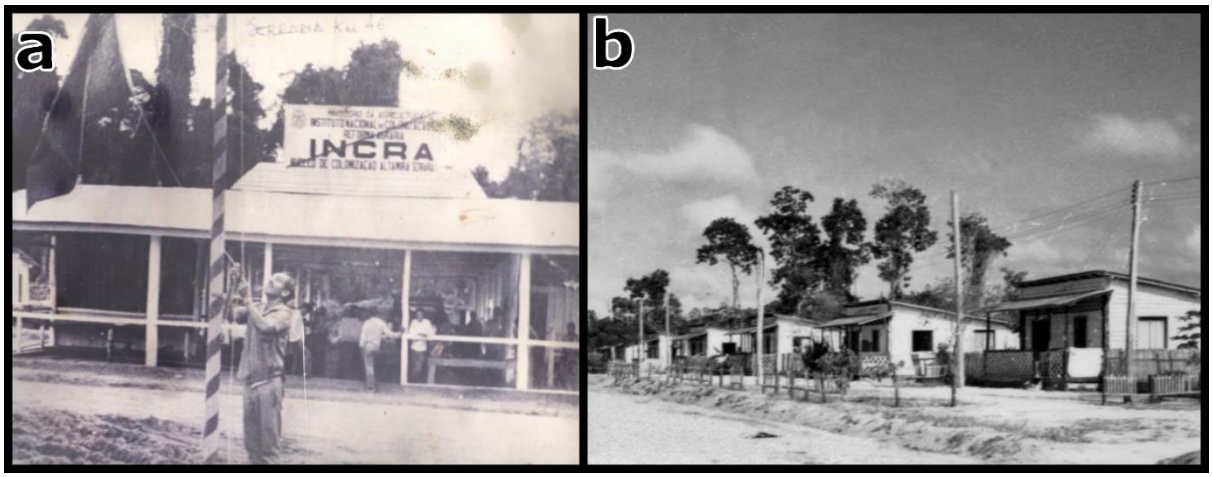

Figure 4. Colonization buildings in the old Agropolis of Brasil Novo (early 1970s): (a) INCRA's building. Source: (Uruará em Ação 2012); (b) standard wood houses, provided by the government, in the village of colonists. Source (IBGE n.d.).

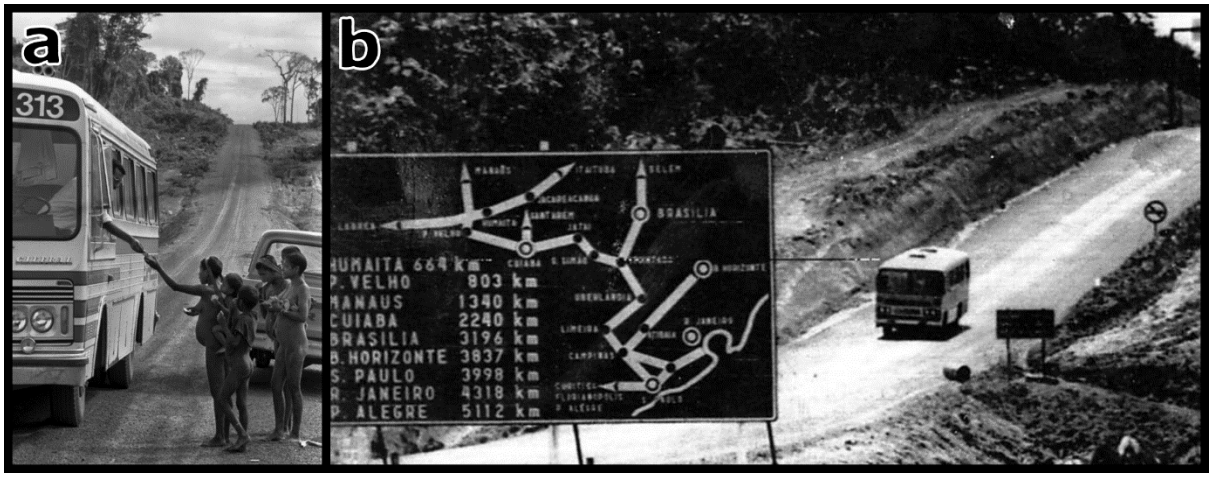

Figure 5. Transamazon transportation (mid 1970s and early 1980s): (a) Krain-a-Kore, indigenous people in the Cuibá-Santarém highway (BR 163), crossing the Transamazon highway. Source: Orlando Brito (Quarto Poder 2014); (b) old public bus and distances to major cities. Source: (Folha de São Paulo 2016).

Thousands of landless were encouraged and supported to colonize the humid forest (Figure 6), migrating from the Northeast dry lands. Also experienced farmers came from the Center-South. As part of the Integrated Colonization Projects, poor families received some temporary housing subsidies and 100 ha farm lots and were instructed to convert no more than 50% of the area for agriculture (Kleinpenning 1977; Smith 1978), at same time, the use of land would guarantee the possession.

Demographic growth boomed with spontaneous migrations (Caldas et al. 2010; Lisansky 1990). Within a few years, the Altamira municipality transformed into the "metropolis" of the Transamazon highway in Pará. At that time, Altamira counted on a thermoelectric power plant for energy and about four thousand masonry buildings in the town (Oliveira 1981). The regional situation of migration under the then "development model" of middle 1970s was well portrayed by the classic movie "*Iracema, Uma Transa Amazônica*" (Furtado 2013; Medeiros 2018).

Figure 6. Transamazon cultural activities (mid 1970s): (a) soccer team. Source: Cirineu Santos; (b) Catholic Mass by 70s; (c) children education at one of the first regional school, called "Melvin Jones". Source: Cirineu Santos (Uruará em Ação 2012).

In the first years of the highway's opening, the predominant economy was based on the collection of rubber (*Hevea brasiliensis* L.) and Brazil nut (*Bertholletia excelsa* Bonpl) (Oliveira 1981). Fishing and hunting were the main protein source (Oliveira 1981; Smith 1976). The colonization projects brought new possibilities for livelihoods through cash-crop production (Figure 7), including an industry for sugar-cane processing (Figure 8). By the end of the first decade, the most valuable agricultural crops were (in order of total income): banana, black-pepper, rice, maize, beans, manioc, coffee, cacao and sugarcane. Other less relevant crops were also introduced, such as watermelon, tomato, pineapple, orange, avocado, coconuts, and lemon. (Kleinpenning 1977; Oliveira 1981; Smith 1978). Despite the incipient economy of cacao and livestock, the suitable biophysical conditions (soil and climate) and the promising market propitiated an exponential growth of these two activities (mainly after 1980s), surpassing all the others (IBGE 2017; IPEA 2010).

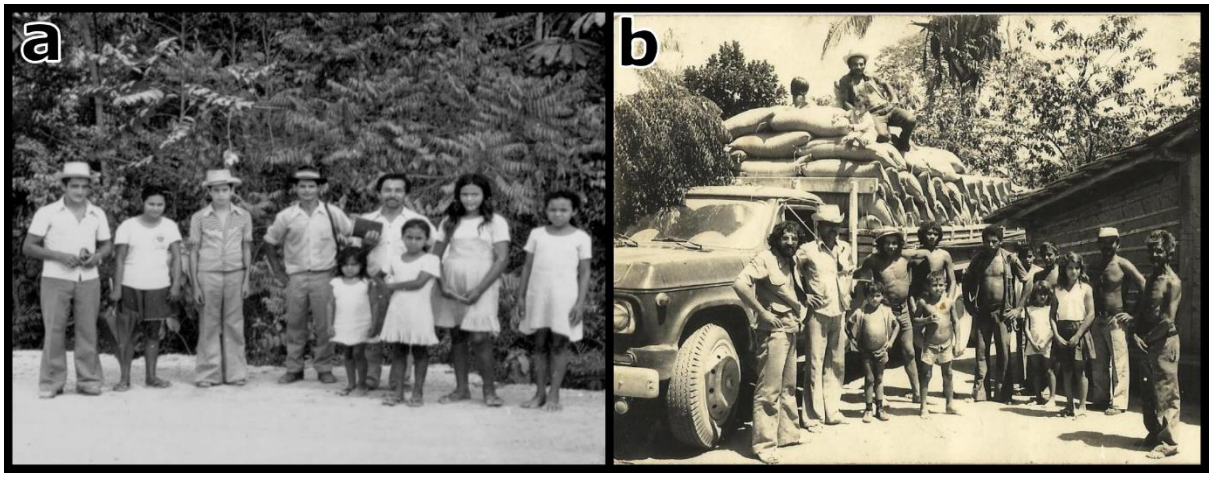

Figure 7. Transamazon colonists (mid 1970s): (a) family of colonists from Placas municipality; (b) first harvest of rice grains. Source: (IBGE n.d.).

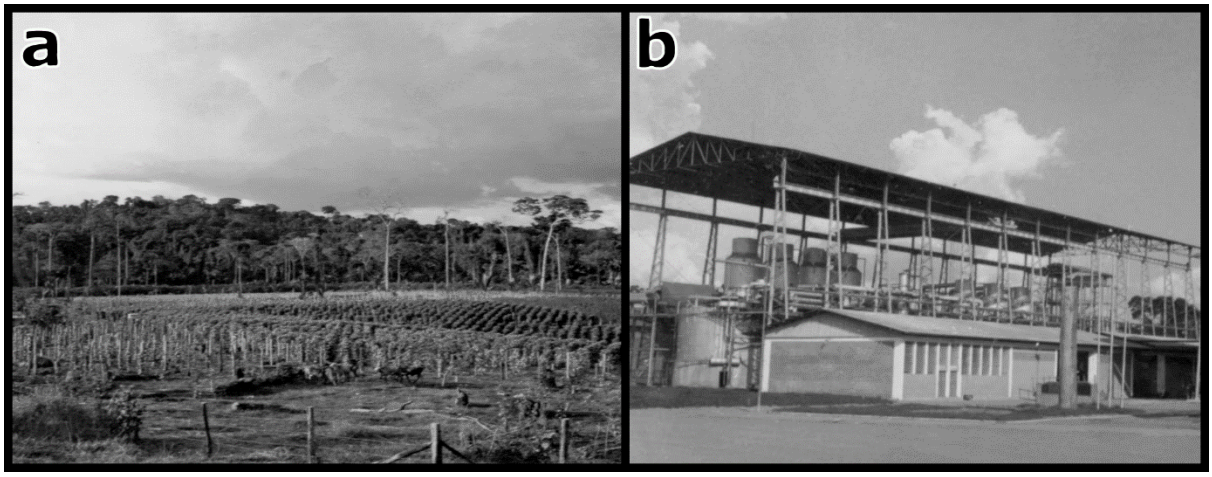

Figure 8. Transamazon agriculture, cash-crop market oriented (mid 1970s): (a) perennial pepper crop in Brasil Novo municipality; (b) Abraham Lincoln sugar plant from Medicilândia municipality. Source: (IBGE n.d.).

At same time, after 1973, the SUDAM began to provide larger plots of land, from 500 ha - 20,000 ha, to capitalized farmers or entrepreneurs, most with approved projects for livestock (Hecht 1993; Smith 1978). When the president Geisel assumed power in the mid 1970s, influenced by the lobby of São Paulo's entrepreneurs, the settlement scheme for smallholder along the Transamazon highway lost focus in the eyes of the government (Moran 2016). Gradually, the dynamics of territorial occupation increased and state actions no longer the exclusive drivers for the local land use change (Fraga and Gonçalves 2011; Margulis 2004). Inequalities of living standards increased quickly between smallholders/small-scale farmers ("agricultores", Figure 9) and largeholders/large-scale farmers ("fazendeiros", Figure 10).

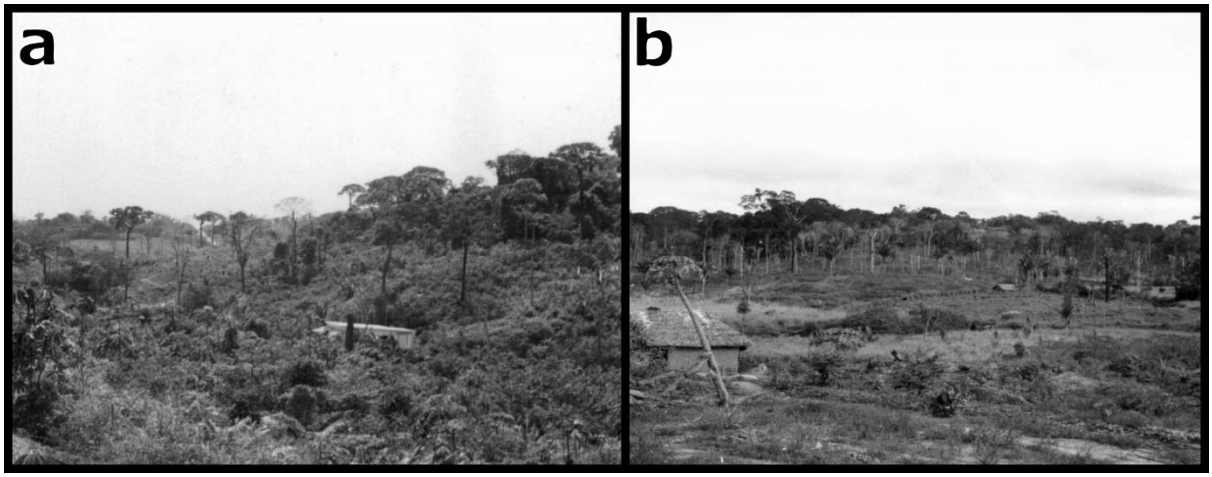

Figure 9. Transamazon small-scale farms with secondary forest "capoeira" (late 1970s): (a) standard wood housing of a smallholder colonist ("colono agricultor familiar") from Placas municipality, with annual crops. Source: (IBGE n.d.); (b) traditional cob wall housing ("taipa") near Transamazon, from Nova Ipixuna municipality, with pasture and annual crops. Source: (IBGE n.d.).

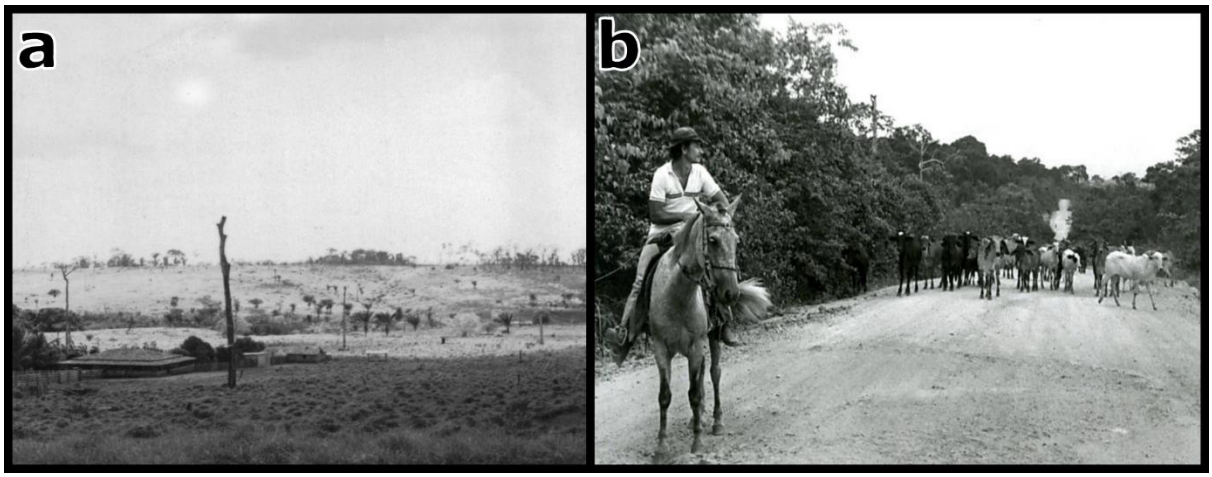

Figure 10. Transamazon large-scale production of bovine livestock (late 1970s): (a) housing of a largeholder rancher colonist ("colono fazendeiro") from Rurópolis municipality. Source (IBGE n.d.); (b) cattle herd transportation by own walking and the "cowboy" ("vaqueiro"). Source: (Folha de São Paulo 2016).

Evidently, the initial goals for infrastructure and settlements were not achieved. After one decade of the Transamazon's existence, about 8% of the announced number of families were settled, while 78% of the 5,400 km road was built but not paved (Mahar 1989). Traffic signs were almost non existent (until recently), and accidents became more and more common over time, mainly during the rainy season when the road suffered more damage, while increasing the traffic of vehicles (Figures 11, 12 and 13). Similarly, the minimum living conditions and farm needs for the households went unmet (Kleinpenning 1977). With no basic sanitation, precarious education and scarce medical care, disease was widespread, the most common being stomach worms, malaria, syphilis and tuberculosis (Oliveira 1981).

Figure 11. Transamazon dangerous (mid 1980s and early 1990s): (a) accidented truck.; (b) highway's secondary road destructed by the rain. Source: (Folha de São Paulo 2016).

Figure 12. Transamazon highway, slope and transportation hardships (1990s): (a) by animal; (b) by truck or walking; (c) by car; (d) by small airplane, commonly used by miners. Source: (Folha de São Paulo 2016).

The government lost control of the rapid expansion of cattle ranching, which "joined" with the timber sector to build and maintain unofficial roads (Almeida and Uhl 1995; E. Y. Arima et al. 2005; Merry et al. 2006; Perz et al. 2007; Uhl and Buschbacher 1985; R. Walker et al. 2013). The lack of governance resulted in several social conflicts and rural violence for land possession, hence marginalizing the peasants (Hecht 1985, 1993; Kleinpenning 1977; Poelhekke 1986; Schmink and Wood 1992), a process that has continued into the present (Bartholdson and Porro 2019; Mendes and Porro 2015). At the same time, the young municipalities experienced increased the deforestation, with some achieving the highest yearly rates of Brazilian Amazon (INPE 2017).

The democratic regime that followed the Brazil's military dictatorship allowed the national development plan to carry over, making some adaptations. However, traces of the military vision remained (Walker et al. 2011). Since 2011, the Transamazon underwent another wave of infrastructure, new migrations and social conflicts for the construction of Belo Monte hydropower dam, the third largest in the world, on the Xingu river in Altamira (Hall and Branford 2012; Moran 2016; Mota de Siqueira et al. 2017). Most of the farmers displaced by the dam intended to continue producing cacao or raising cattle (Randell 2016a).

Figure 13. Transamazon transportation (2018): (a) poor condition of a bridge made by wood, in Uruará; (b) traffic of vehicules and cattle in the paved stretch of the highway, in Pacajá. Source: author's personal collection.

Over almost five decades, cacao and ranching have become the strongest drivers of the regional economy as the most prevalent and highest income-earning rural activities (IBGE 2017; IPEA 2010; Mendes and Mota 2016; Moran 2016). Regarding the co-existence of distinct living strategies (Godar, Tizado, Pokorny, et al. 2012; Pacheco 2009), households have been transitioning their livelihoods from agricultural crops to cattle ranching, as well as from economic diversification to market-oriented specialization (Caviglia-Harris 2005; Walker, Moran, and Anselin 2000). Both activities (Figure 14) were strategically stimulated by the Brazilian government (and related institutions), to reduce poverty and increase financial stability (accumulation/capitalization/wealth) and economic well-being (Godar, Tizado, Pokorny, et al. 2012; Siegmund-Schultze et al. 2007; Veiga, Tourrand, and Quanz 1996; Walker et al. 1994).

Figure 14. Transamazonian smallholders, producers of cacao and cattle (2018): (a) farmers from the community working together to harvest the cacao seeds. Source: Raimundo Silva "Raimundinho Bié"; (b) young farmer working in the early morning to harvest the milk. Source: author's personal collection.

1.2. Research question, hypothesis and objectives

Through our study, we aim to shed light on the role farming systems have on the conditions of rural development. The core of our research is aimed at gaining a better understanding of the degree to which rural Amazonian populations have attained economic well-being in frontiers areas, considering the issues of natural stability by forest conservation. Our major question was: **How well can smallholders in the Amazon live?** We conducted a survey sampling small-scale households dedicated to cacao and/or cattle from the region of Transamazon highway.

Our main hypothesis and respective objectives were:

I. Small-scale households can achieve good standards of living.
   - Define the living standard in the region of the Transamazon highway.

II. Cacao farmers can be more successful than cattle ranchers.
   - Compare the success of livelihoods between production systems: cacao vs. cattle

III. Successful households conserve less forests.
   - Reveal the relationship between success and forest conservation.

2. LITERATURE REVIEW

2.1. Cacao overview

Cacao (*Theobroma cacao* L., Malvaceae family) is a perennial tree native to the Northwestern Amazon (Clement et al. 2010; Monteiro and Ahnert 2012). It occurs, naturally in the lower-middle strata of forest and is distributed along alluvial soils with a high level of fertility (Somarriba and Lachenaud 2013). Its earliest recorded use dates back to about four thousand years among Pre-Colombian populations with widespread domestication across Mesoamerica (Clement et al. 2010; McNeil 2006; Ozturk and Young 2017).

Since the 16th century when Brazil's territory served as Portugal's colony, cacao was traded by indigenous people to Europeans in the present-day state of Pará in the Brazilian Amazon (Oliveira 1981). From the 17th century until the middle of 18th century, the Jesuit Order controlled the commerce of Amazon spices (Chambouleyron 2014; Walker 2007), through which cacao became a major export due to high demand for chocolate (Alden 1976). During that period, small-scale, experimental plantations were set up for cacao production (Chambouleyron 2014; Dean 1991). After 1750's, the Portuguese crown, empowered by the illuminist Marquis of Pombal, funded a monopolistic state-regulated trade firm that elevated cacao as most valuable crop of the Amazon (Alden 1976; Chambouleyron 2014; Walker 2007).

Right before the Brazil's independence (1823), cacao was planted in the Portuguese colonies of São Tomé and Príncipe in West Africa, which soon thereafter became the major zone of cacao production in the world (Walker 2007). Meanwhile, Brazil's center of cacao production relocated to the northeastern state of Bahia (Atlantic Forest biome) due to its more favorable socioeconomic conditions for cacao cultivation and commercialization (Walker 2007). Sure enough, the region yielded higher production compared to cacao extraction in the Amazon until the end of the 20th century. To support such production and attempt the crescent market demands, the federal government created the Executive Commission of the Cacao Agriculture Plan – CEPLAC in the end of 1950's.

The CEPLAC played an important role to consolidate the cacao crop, developing fundamental technologies and fomenting plantations (Oliveira 1981; Silva Neto 2001). When the Transamazon highway (BR 230) was underway in the 1970s, great institutional efforts were made to structure cacao cultivation in the land patches with fertile soil, and link cacao production in that "isolated" region to the existing cacao market chain (Oliveira 1981).

For instance, the federal government created the Plan for National Expansion of Cacao (PROCACAU), in 1976, with the initial goal of 170 thousand hectares of cacao plantations in the

Legal Amazon (CEPLAC 2019). Moreover, in 2008, the state government instituted the Program to Accelerate the Cacao Growing and Consolidation in Pará (PAC CACAU PARÁ) and created the Fund of Cacao Support in Pará (FUNCACAU) (PARÁ 2008). In the 1990s, Bahia's cacao fell victim to witches' broom disease (*Crinipellis perniciosa*) (Andebrhan et al. 1999; Lopes et al. 2011) which caused a devastating decline in the region's cacao supply and production. Thus, since the 1990s, the production of the Transamazonian cacao has made a strong push for the Pará lead the national production (Table 1) (IBGE 2018b; A. F. Silva et al. 2017).

Table 1. Indicators of cacao crop in the municipalites of Transamazon highway, study site, and state of Pará. Source: presentation of CEPLAC in São Paulo's Chocolat Festival 2019, accordingly to official data from MAPA/CEPLAC/SUPAM/SEFA/IBGE (2018).

Municipalities	State Production Ranking	Planted area (ha)	Production (t)	Productivity (kg/ha)
Medicilândia	1	44,538	51,423	1,190
Uruará	2	22,896	17,915	1,126
Novo Repartimento	5	11,904	7,051	795
Brasil Novo	6	11,023	5,289	778
Anapu	7	10,781	5,084	780
Pacajá	10	7,896	3,308	650
São Félix do Xingu	12	9,539	2,341	648
Total Pará		182,940	131,282	930
	Farmers (N)	Generated jobs		Funcacau (R$)
	24,004	304,900		5,306,000

2.2. Cattle ranching in the Amazon

During the 1970s, the history of cacao in the Brazilian Amazon converged with the history of cattle ranching along the Transamazon highway. A massive influx of cattle was introduced by governmental policies promoting colonization and rural development across the Brazilian Amazon.

Widespread livestock production served as one of the main methods of land occupation within the colonization strategy for the regions of agricultural frontier with the Brazilian Amazon (Becker 1988; Bowman et al. 2012; Carrero and Fearnside 2011; Hecht 1993; Poelhekke 1986). In the name of national "progress", the government offered several mechanisms that sanctioned colonization through development of livestock projects in these frontier zones. It created policies to provide fiscal incentive funds and financing facilities to support these projects (Fearnside 1979; Hecht 1993; Kleinpenning 1977; Mahar 1989); for example, tax liability discounts, duty-free

for imported machinery/equipment, subsidized rural credits, and other supports from the National Program of Livestock Development (PROPEC).

By 1980, the Brazilian Amazon had 16 million heads of cattle and more than 7.5 million hectares of pasture, all fomented by the government (Poelhekke 1986). Despite the then-considered economic risk of cattle production in the biophysical conditions of Amazon basin (Buschbacher 1986, 1987; Fearnside 1979; Hecht, Norgard, and Possio 1988; Smith 1978), the bovines presented a healthy response with good rates of animal growth (Veiga et al. 1996; Walker et al. 2009). Moreover, ranchers enjoyed minimal land prices and low costs to convert forest into pasture (Bowman et al. 2012). Further, they found that pasture maintenance demanded very little labor (Poelhekke 1986). Such conditions stimulated land speculation and attracted capitalized investors (Carrero and Fearnside 2011; Hecht 1993; Poelhekke 1986).

Over time, the evolution of ranching technologies, industrial facilities, basic public infrastructure, and the bovine market chain increased the industry's profitability and brought about the consolidation of livestock in the Brazilian Amazon (ABIEC 2017; Margulis 2004; Mertens et al. 2002; Santos et al. 2018; Walker et al. 2009). The size of cattle herds have grown exponentially over the last decades, which totaled about 1.5 million heads inside Legal Amazon in early 1970s to over 85 million heads in 2017 (IBGE 2017). This number is equivalent to four times the current human population in the same territory, and it represents 40% of the national herd.

Currently, the states of Legal Amazon with largest herd are Mato Grosso (35%), Pará (24%) and Rondônia (17%)(INPE 2017), constituting most of the so-called "arc of deforestation" along the frontier of the Amazon biome. The TerraClass Project revealed an area of 48 million ha of contiguous pasture, with one fifth of degraded pasture lands (INPE and EMBRAPA 2016). Considering the system of cattle production is the extensive livestock, Barreto et al. (2017), estimated the cattle industry has yet untapped potential for growth, suggesting implications of further deforestation. They approximated that if all of the 128 active slaughterhouses installed in the Legal Amazon were to operate at full capacity of almost 60,000 animals/day, this may create a demand for 69 million ha of pasture areas.

2.3. Consequences of ranching and alternatives

Many authors have identified bovine livestock, associated with road construction and rural population increase, as the main driver for forest conversion (Fearnside 2005; Kirby et al. 2006; Laurance et al. 2002; Moran 1993; R. Walker et al. 2013; N. F. Walker, Patel, and Kalif

2013). Livestock, predominantly practiced as extensive cattle ranching, has accounted for more than two-thirds of deforestation of the Legal Amazon (Mahar 1989; Margulis 2004; Nepstad et al. 2009; Ometto, Aguiar, and Martinelli 2011). A great portion of this situation is owed to largeholders (Fearnside 2005; Godar et al. 2014; Godar, Tizado, and Pokorny 2012; Moran 1993), however, smallholders also provoke a relevant deforestation effect at landscape scale (Aldrich et al. 2006; Brondízio et al. 2002; Godar et al. 2014; Walker et al. 2000).

Long announced (Buschbacher 1986; Shukla, Nobre, and Sellers 1990), the negative environmental impacts of deforestation induced by cattle ranching show reach not only at the local but also the global level (Fearnside 2005; Laurance et al. 2018). For instance, clearing the Amazon rainforest has direct impacts on climate change (Gedney and Valdes 2000; Malhi et al. 2008; Nobre et al. 2016; Werth and Avissar 2002), biodiversity loss, threats to human well-being (increased vulnerability) and decrease of ecosystem functions, goods and services to society (Le Clec'h et al. 2018; Díaz et al. 2006; Foley et al. 2007; Watson et al. 2005). Therefore, reduced ecosystem goods and services have serious implications on the ability to alleviate poverty (Fisher et al. 2014; Suich, Howe, and Mace 2015), and farm activities (livestock/agriculture) are become disrupted by the changes in hydrological regulation, soil conservation and pollination (Ometto et al. 2011).

Nowadays, the debate of sustainable rural development remains completely open. For example, on one hand authors have advocated for ranching intensification as solution to spare land for forest conservation (Bogaerts et al. 2017; Cohn et al. 2014; R. de O. Silva et al. 2017). On the other hand, this approach has been contested by others (Kreidenweis et al. 2018; Merry and Soares-filho 2017). Moreover, for small-scale farmers, the livestock business would not be profitable whether intensification was employed with sustainable/conservation practices (Garcia et al. 2017; zu Ermgassen et al. 2018). Even for conventional mono-crop agriculture, the land sparing approach has vulnerabilities without adequate support and strong local governance (Garrett et al. 2018).

On the other hand, a considerable portion of the literature has argued that agroforestry systems could better facilitate production with conservation practices (Porro 2009; Yamada and Gholz 2002) while promoting sustainable rural livelihoods (Porro et al. 2012). In the Transamazon context, cacao is predominantly cultivated within agroforestry systems, and next to livestock, it generates the second highest income among rural livelihood activities (IPEA 2010). However, it is still not clear whether cacao agroforestry systems could be a real alternative to cattle ranching for small-scale farmers, in the sense of promoting a better standard of living while attempting to conserve forests.

2.4. Smallholders, or small-scale household farmers

The concepts of smallholders, or small-scale farmers, or small-scale households, or even family farming ("agricultura familiar" in Brazilian Portuguese, Figure 15) are defined differently depending on the context (Harrison, Herbohn, and Niskanen 2002). Regardless the conceptual debate, for this study, we adopted the terms as similars but with slight preference for small-scale farmers, or simply households, to avoid the association of the strict criteria of Brazilian law commonly attributed to the terms "smallholders" or "family farming".

The Brazilian National Policy for Family Farming (BRASIL 2006) defined a smallholder family farm including specific criteria: (1) land size: do not possess an area of more than four fiscal modules (limits of 280-300 ha in our study site), under any tenure regime; (2) labor: predominant use of family labor; (3) income: most of family income generated from farming activities; (4) social interaction for family farm governance: farm managed by the family. More broadly, for example, Vliet et al. (2015) recognize family farming as an association of farming practices with use of family labor and to successive ownership of the land.

Figure 15. Small-scale household farmers (smallholders/family farming) dedicated to produce cacao, cattle and annual crops, from São Félix do Xingu, Pará, Brazil.

Transamazonian household farmers have been categorized by a combination of production system (strategy/farming activity) and economic degree (level of financial accumulation) (Castellanet, Simões, and Filho 1998; Ferreira 2001; Pacheco 2009; Veiga et al. 1996). Following the trend of farm specialization toward market-oriented production (Caviglia-

Harris and Sills 2005; Muchagata and Brown 2000), Pacheco (2009) stated that typologies "portray a somewhat linear trajectory for smallholders that begins with a farmer producing annual crops for subsistence purposes, and ends with a capitalized farmer engaged in somewhat specialized production, either of cattle or perennial crops". To assess the regional diversity of smallholders, the same author found seven types: (i) poor, diversified; (ii) poor, annual specialized; (iii) poor, perennial specialized; (iv) poor, cattle specialized; (v) wealthy, diversified; (vi) wealthy, perennial specialized; (vii) wealthy, cattle specialized.

Similarly, Godar, Tizado, and Pokorny et al. (2012) classified the Transamazon households (which they called as "colonists" due to the Amazon colonization process) by their type of production and level of capitalization, regarding the importance of land size to distinguish the cattle ranchers. Their results suggested the two predominant colonist types are largeholders practicing large-scale cattle ranching and smallholders practicing small-scale diversified family agriculture. In this sense, they found eight actor groups: (i) subsistence diversified farmers; (ii) subsistence farmers (annual crops); (iii) subsistence cattle ranchers; (iv) low-capitalized diversified farmers; (v) low-capitalized cattle ranchers; (vi) capitalized cocoa producers; (vii) capitalized cattle ranchers; (viii) large-scale cattle ranchers.

Despite regional distinctions and heterogeneity among Amazonian small-scale household farmers, Pokorny and Jong (2015) pointed out common aspects that they usually face in their given context, such as "integration into a market economy, ratio of market oriented versus household production, integration into a cultural social collective, and holding size and the property status, as well as availability and relative distribution of the productive factors land, labor, finances and technology" regarding the conditions of "forests and other natural resources, fertility of soil, water availability, access to public infrastructure including roads, energy, health, education and markets, as well as social organization.".

2.5. Livelihoods

The concept of livelihoods originated with Robert Chambers's studies, right after the Brundtland Commission Report in 1987 (Solesbury 2003). He was searching to increase the efficiency of development strategies and overcome the paradigm of poverty focused on income "only" (Chambers 1987; Chambers 1988). According to Chambers and Conway (1992), basically, livelihoods are the capabilities, activities and resources which combined allow the family support. The rural livelihoods approach aims to bring the households to the core of the analytical

understanding and, from this point of view, expand the knowledge about local living conditions with the purpose to facilitate a sustainable rural development.

The overall concept of livelihoods considers context interactions in which households are immersed, divided into vulnerability context (shocks, trends and seasonality) and transforming structures and process (levels of government, private sector, laws, policies, culture, institutions) (DFID 1999). The sustainability of livelihoods is evaluated by the resilience of households, their capacity to face or recover from an stress or impact, keeping able to increase their living standard, without prejudice the future of next generations, without destroying their base of natural resources (natural basis)(Pokorny et al. 2010).

The DFID (1999) systematized the above-mentioned logic building a useful framework, called as the "Sustainable Livelihood Framework" (SLF). They created a kind of checklist of key factors that influence the livelihoods, and, consequently, factors that influence the living standard (one of the outcomes) (Figure 16). The SLF consists of an analytical method by "the asset pentagon", supported by the five capitals: financial, human, social, physical and natural (DFID 1999, Bebbington 1999). Besides, the SLF brought in its conception the presumptiom of being flexible and adaptable to every kind of situations within rural development (DFID 1999). For example, Pokorny et al. (2010) applied this approach for diverse localities of the Amazon basin, including several communities from Bolivia, Brazil, Peru and Ecuador.

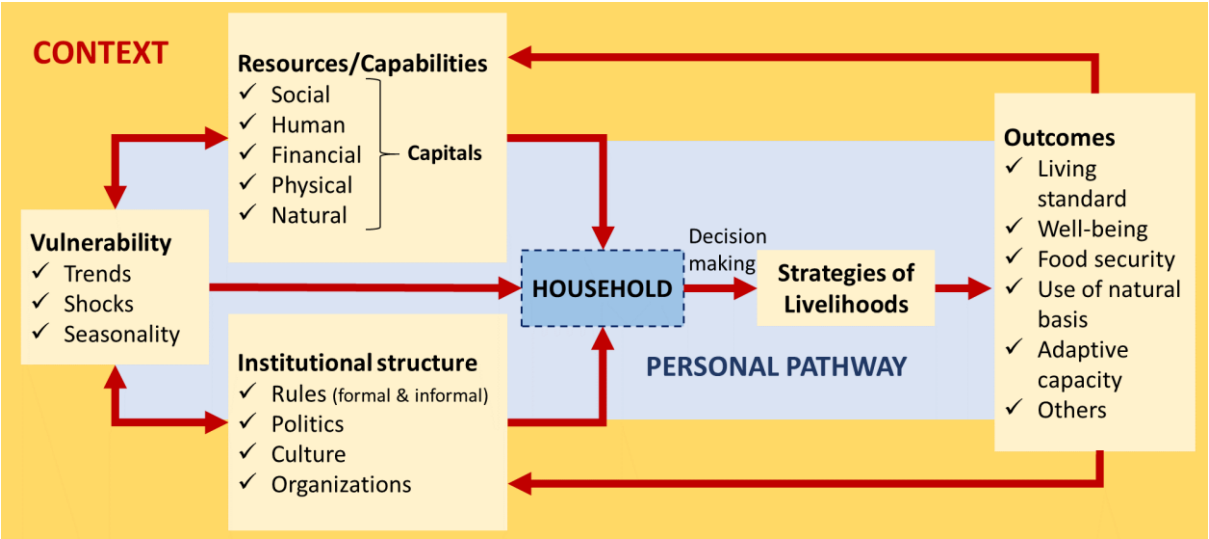

Figure 16. Conceptual framework of sustainable livelihoods approach adapted from Porkorny et al. (2010).

Looking deep into the concept of livelihoods, Scoones (2009) provided a clear description of the term:

"*A mobile and flexible term, 'livelihoods' can be attached to all sorts of other words to construct whole fields of development enquiry and practice. These relate to locales (rural or urban livelihoods), occupations (farming, pastoral or fishing livelihoods), social difference (gendered, age-defined livelihoods), directions (livelihood pathways, trajectories), dynamic patterns (sustainable or resilient livelihoods) and many more.*

Livelihoods perspectives start with how different people in different places live. A variety of definitions are offered in the literature, including, for example, 'the means of gaining a living' (Chambers 1995) or 'a combination of the resources used and the activities undertaken in order to live'. A descriptive analysis portrays a complex web of activities and interactions that emphasises the diversity of ways people make a living. This may cut across the boundaries of more conventional approaches to looking at rural development which focus on defined activities: agriculture, wage employment, farm labour, small-scale enterprise and so on. But in reality people combine different activities in a complex bricolage or portfolio of activities. Outcomes of course vary, and how different strategies affect livelihood pathways or trajectories is an important concern for livelihoods analysis. This dynamic, longitudinal analysis emphasises such terms as coping, adaptation, improvement, diversification and transformation. Analyses at the individual level can in turn aggregate up to complex livelihood strategies and pathways at household, village or even district levels." (Scoones 2009).

On the other hand, Scoones 2009 highlighted many relevant shortcomings about adopting the SLF, or any synthetic framework, for the analytical point of view. According to him, large part of these studies have failed on the expectation of contributing effectively to improve rural development in the fields, or even influence public policies. The mechanistic framework became limited to a momentary description of micro-scale realities, neglecting strong influence of factors which were addressed as mere context, such as politics and power (Scoones, 2009). Clay (2017) also reported the inconsistent application of that framework in research on human dimension of global environmental change. Scoones (2009) argued that livelihood frameworks should evolve to more assertive approaches for the new contemporary challenges, straightening the main issues to the questions of knowledge, dynamics, scale and politics.

Despite of the divergences on the use of analytical methods, such as the SLF, the conception of livelhoods itself is well recognized by literature (Donohue and Biggs 2015; Salazar et al. 2018; Manlosa et al. 2019). To our understanding, in general terms, livelihoods embraces the many possibilities of living within a given context of opportunities and adversities. It can be considered an intrinsic characteristic of every household in search of a way of life that best suits their survival skills, regarding their local living conditions. In this sense, each household adopts a set of strategies along their personal pathway, aiming to achieve better living standards. For instance, activities to generate income, such as production systems for rural households, are

strategies of livelihoods. The continuous adaptation, or transformation, of household strategies marks the personal pathway in distinct trajectories of life, which makes the livelihoods diverse and a dynamic process when seen over space and time.

2.6. Living standard and well-being

Living standard

Studies of poverty, inequality or general socioeconomic issues commonly employ the conception of living standard (Broda et al. 2009, Lewis et al 1998, Vanek et al 1978, Dwyer 2009). The legitimacy of this approach comes from a long inquiry of human thinking: "*The curiosity and interest that made Petty, Lavoisier, Lagrange, and others take up their investigations into real income and living standards were related to the assessment of the nature of people's lives."* (Sen 1985). For example, Hartwell (1961) described the rising standard of living in England between 1800-1850, analyzing changes in income distribution during the industrial revolution. Pamuk and van Zanden (2010) discussed the living standard analyzed by Friederich Engels when he published "The conditions of the working class in England in 1844", mentioning the poor conditions of proletariat lives, like consumption habits, income, criminal rate, health care, education, labor of child and women, etc.

According to Sen (1985, 1984), the meaning of living standard connected to well-being, but distinctions are worth highlighting. Standard of living approximates to economic well-being, not reduced to just monetary aspects but also not amplified to well-being in its broader sense. Thus, there is a partial independence between both conceptions, as overall well-being can be affected by factors that do not necessarily affect the standard of living and *vice-versa*. Considering many ways to see the living standard, Sen (1985) argued to define it in terms of functioning and capabilities, rather than just opulence, happiness or utility (pleasure, desire, choice, etc.):

"*A functioning is an achievement, whereas a capability is the ability to achieve. Functionings are, in a sense, more directly related to living conditions… Living conditions are, in a sense, states of existence - being this or doing that. Functionings reflect the various aspects of such states, and the set of feasible functioning bundles is the capability of a person. … Capabilities, in contrast, are notions of freedom, in the positive sense: what real opportunities you have regarding the life you may lead. … But among the beings and doings are activities of choosing, and thus there is a simultaneous and two-way relationship between functionings and capabilities*." (Sen 1985)

For instance, Rao and Min (2018) employed the conception of capabilities to propose a "decent living standard" supported by "basic material requirements that are instrumental (but not sufficient) to achieve physical, and to an extent social, dimensions of human wellbeing, whether

conceived as basic needs or basic capabilities, and independent of peoples' values or relative stature in society". Some authors aimed to encompass the broader sense of living standard using indicators of well-being and social aspects (Barrington-leigh and Escande 2016; Dowrick, Dunlop, and Quiggin 2003; Wai, Lau, and Bradshaw 2016).

Guedes et al. (2012), studying the Transamazon living conditions, built a framework to examine poverty and inequality of rural households. Their framework availed the synergy between income and well-being. For these authors "Rural wellbeing at the local level is thus a direct function of both the level (composition) and return (utility) to capital and an indirect product of exogenous constraints at higher scales (both temporal and spatial)". The same authors used multidimensional indices of well-being in contrast to income-only, attempting to incorporate the relation to social and natural assets. Following the conceptions of Sen (Sen 1999, 1985) and Bebbington (1999), Guedes et al. (2012) defined poverty and well-being without the intention to address subjective measures:

"We define rural poverty as the general lack of choices and opportunities that are reflected in low levels of income, portfolio of assets, land use choices, land tenure security, access to natural resources, and social networks. … we define wellbeing as the level of material conditions provided by a combination of livelihood strategies representing a portfolio of capital (financial and non-financial) and social relations structured and modified by their ability to increase household's satisfaction and security." (Guedes et al. 2012).

Well-being

Before getting too deep into living standard associated to economic well-being, we must step back to conceptualize the overall well-being. This will allow us to better define what would be the "influential" and "expression" factors in our evaluation of living standard. Following King et al. (2013), the concept of well-being is composed of two general categories: objective and subjective. Features of objective well-being embrace "many material and social attributes of people's life circumstances such as physical resources, employment and income, education, health, and housing … measured by quantitative statistics". The subjective features embrace "individual thoughts and feelings about one's life circumstances, and the level of satisfaction with specific dimensions. It is measured by psychological responses, such as life satisfaction, autonomy, mastery, social connectedness, and personal security".

Over time, studies document the evolution of well-being and "its multidimensional, dynamic, person-specific and culture-specific nature", gaining recognition "towards the assessment of quality life within a socioecological context." (King et al. 2013). Accordingly, Beauchamp et al (2018) built a human well-being framework highlighting two main principles: (i)

multidimensionality, composed of five feature groups (material, health, security, social relations, freedom of choice and action) across three dimensions (material, relational, and subjective); and (ii) heterogeneity, generated by local perceptions of their regional socioeconomic situation. We adapted this framework to our study of living standard analysis, adding the dimension of living conditions and its related features (Figure 17).

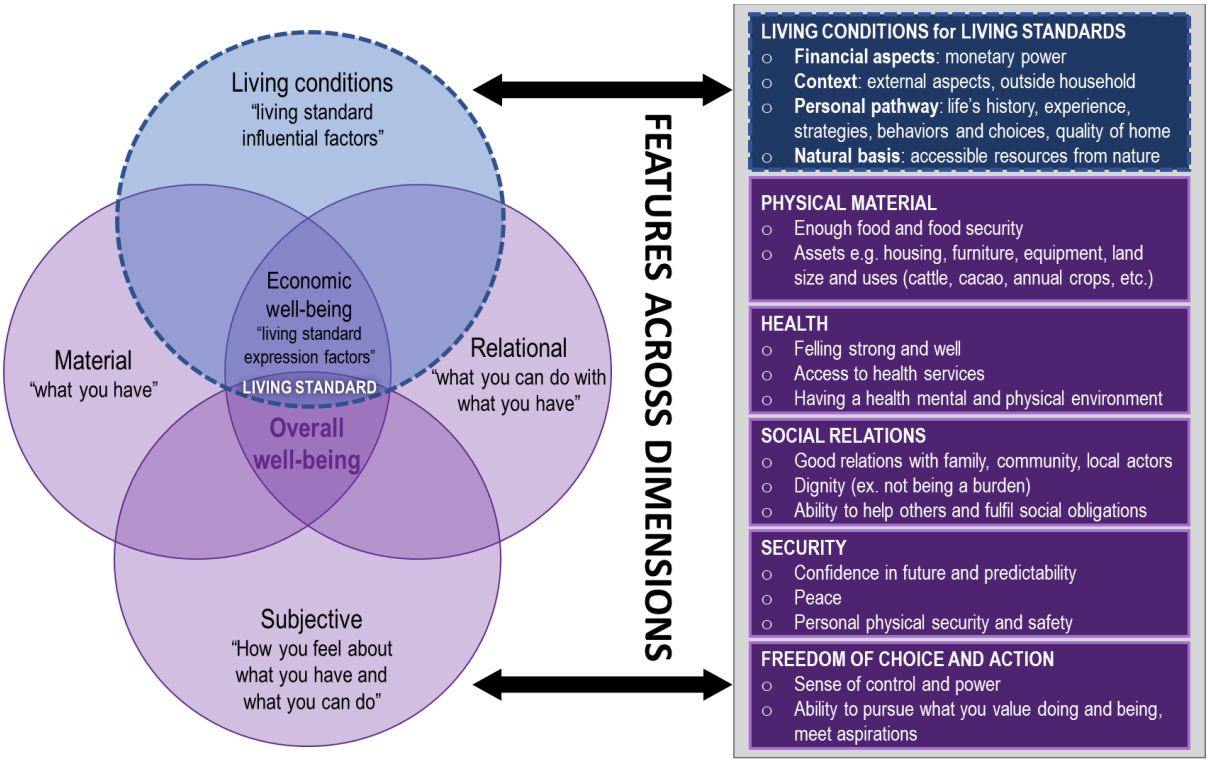

Figure 17. The intersection of living standard dimensions, encompassing household features (living conditions for living standards, physical material, health, social relations, security, freedom of choice and action) across dimensions of well-being (purple) and living conditions (blue). This framework was adapted from the study of Beauchamp (2018), which referred as "based on McGregor and Sumner (2010) and drawing on the World Bank's "Voices of the Poor" research (Narayan et al. 2000)".

Living standard *per se* is linked to each of the four dimensions (material, relational, subjective, and living conditions; Figure 17). Within living conditions, the intersection of material and relational dimensions resulted in a sub-dimension titled 'economic well-being'. The conceptual overlapping between dimensions reinforces the importance of not neglecting the relationships between them.

Therefore, our working understanding of living standard demands a multidimensional approach, expanding the more narrow conception of economic well-being (functioning and capabilities) to include other relevant factors that influence general well-being (living conditions). To encompass the diversity of living conditions in various regional contexts, factors contributing to determine the living standard are simply referred to as "influential factors". Additionally, factors that indeed express (versus influence) living standard are referred to as "expression

factors". Expression factors include those holding the potential to be indicators (or outcome variables) of living standard.

Evaluating standard of living by success levels

Considering all possible living conditions, living standard might not feasibly be fully captured by survey instrument measurements (Kakwani 1993). Facing the multiple factors that living standards could hold, despite its relevance, usability requires restraints (Sen 1985). Measurements of living standards often use financial indicators (Browne and Hood 2016; Cancian and Meyer 2004; Ravallion 1992; Thewissen, Stefan; Kenworthy et al. 2015; Weich and Lewis 1998), based on the evident correlations between economic aspects and well-being, social welfare or freedom (Rao and Min 2018; Sen 1999, 1984).

Following the economic logic of the Sustainable Livelihoods Approach, with assets defined into capitals (DFID 1999; Bebbington 1999), the World Development Report 2008 suggested a kind of progressive ("evolutionary") livelihoods for possible living trajectories, based on farming strategies and their close relation to financial aspects (World Bank 2007). Regardless of any controversy (Scoones 2009), these works stimulated a shift in approach to measuring livelihoods rooted in living standard performance or household's "success levels", capturing a more detailed understanding of livelihoods withing economic well-being/living standard.

Based on evidence that poverty is not always correlated with hardships, Cancian and Meyer (2004) combined indicators of success reflecting economic well-being. They measured financial independence, income above the poverty threshold and freedom from material hardships, and applied evaluations by success levels. Similar approaches of success were also used by Kakwani 1993 and King et al. 2013 constructing indices or models for evaluations.

Rather than limiting analysis to financial aspects, Sen (1985) emphasized the importance of multidimensionality of living standard and well-being, including the conception of living conditions: "…successes and failures in the standard of living are matters of living conditions and not of the gross picture of relative opulence…". Thus, even if financial aspects are selected as the core dimension of living standard evaluation (expression factors), it is fundamental to account for aspects of the surrounding dimensions (influential factors) of household's features that are contributing to the current state of living.

For these reasons, we opted to conduct an overview evaluation of living conditions, aiming to better understand the role of influential factors to the Transamazonian standard of living. This evaluation complements the evaluation of living standard itself, captured by economic well-being (which holds our "pool" of expression factors, e.g. income, housing, food, land, etc.).

Some determined expression factors are indeed our outcome variables, representing the living standard measured by levels of success. Remaining living conditions factors are analyzed by their potential of influence on success (e.g. market distance, soil fertility, farmer age, etc). To attempt this approach, it was necessary to investigate aspects of successful strategies of livelihoods/production systems playing a relevant role in rural development for the region of the survey.

2.7. Conceptual framework

Many of the literature about rural development in Eastern Amazon frontier describes the complexity of situations from the household level, showing the inter-relations between key factors regarding its major features of context, finance, natural basis and strategies (Brondízio et al. 2002; McCracken et al. 2002; Murphy et al. 1997; Pacheco 2009). Consistent with the presented backdrop, the history of cacao and cattle cultivation evolved parallelly in the region of Transamazon highway, with notable importance for the living standard, arising from the colonization process. Therefore, we built our conceptual framework (Figure 18) based on well-recognized aspects/factors that could be key in the search for better living standards, focused on the region of our study site or similar frontier contexts (Brondízio et al. 2002; Pokorny et al. 2010; Pokorny and Jong 2015).

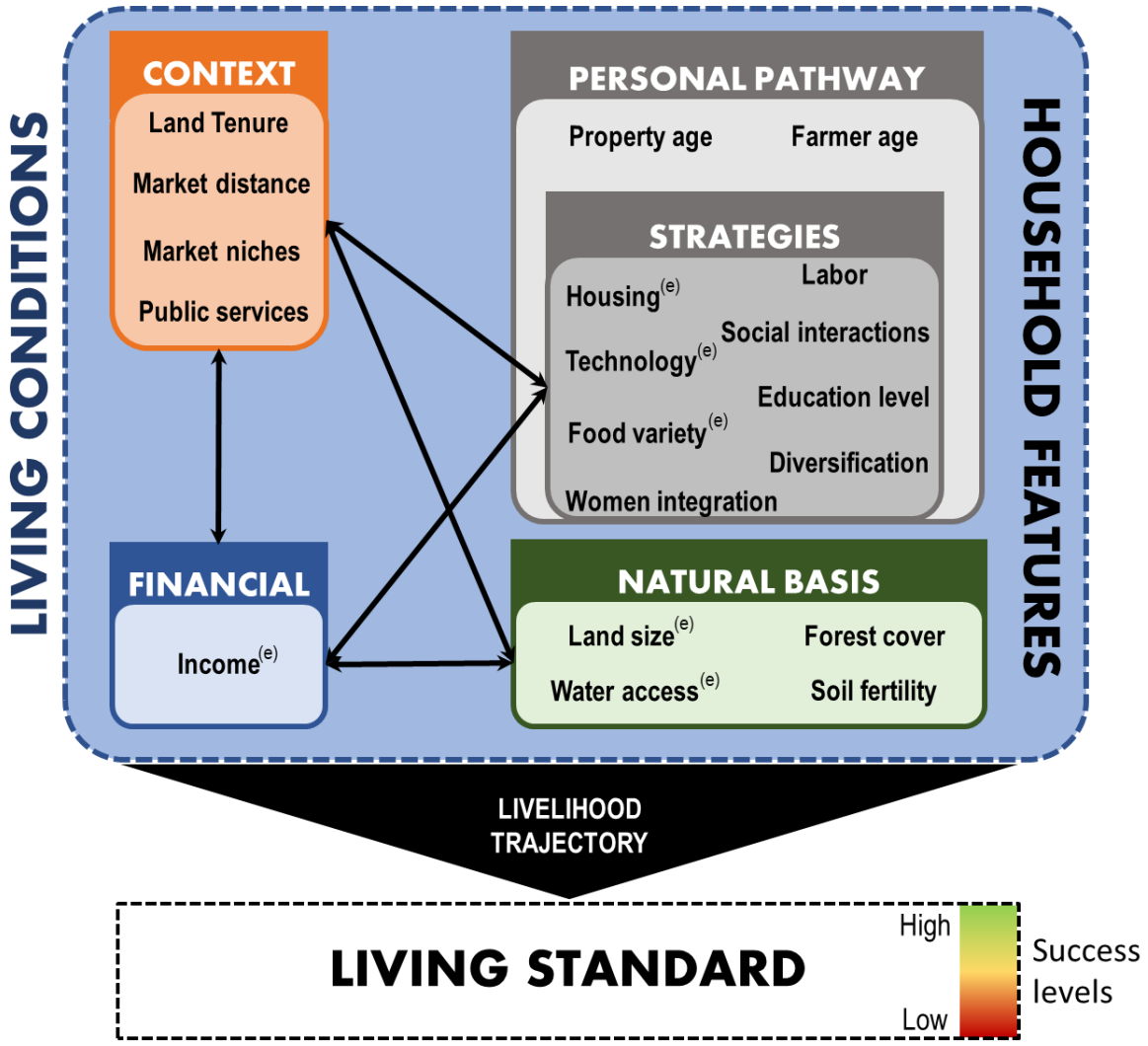

Figure 18. Conceptual framework for the regional situation of Transamazon, from household level (adopted in our analyzes). Factors of living conditions (influential factors), grouped by features, and its general interactions towards the individual livelihood trajectory (personal pathway) to achieve a living standard (outcome), regarding different levels of success. (e) means "expression factors" related to economic well-being.

Our main understanding is that, basically, living standard (outcome) can be expressed by economic well-being indicators (expression factors) but also is affected by other aspects (influential factors). All these aspects/factors compose the household features of the living conditions, regarding its multidimensional meaning. The interaction of these factors, during the individual livelihood trajectory/personal pathway, contributes to achieve the current standard of living, able to be measured by the success levels approach.

2.7.1. Key factors of living conditions for the living standard

In the Transamazon region, farming labor and exploration of land natural resources are the main activities contributing to financial growth of small-scale farmers (Godar, Tizado, Pokorny, et al. 2012; Perz 2005). This regional trend contrasts with worldwide trend of increased off-farm labor as a primary income-generating activity in rural areas (Ghimire, Wen-Chi, and Shrestha 2014; Reardon, Berdegué, and Escobar 2001). Studying the living standard and wealth accumulation among small-scale households from Transamazon, Walker et al. (1994) found that the type of farming system (activity/strategy) was related to success.

Similarly, Godar et al. (2012) demonstrated that actor groups from Transamazon region could be distinguished by type of production and level of capitalization, recognizing cacao and cattle as feasible strategies. Therefore, we found appropriated to use these production systems as sampling criteria to undertake our research question. Moreover, we needed to find out which relevant factors of living conditions (influential and expression factors) would be intrinsic common across the Transamazonian households.

First of all, **income** can be considered a fundamental factor of living conditions, an indicator of households' well-being (Guedes et al. 2012; King et al. 2013; World Bank 2007). It is key to liberation from poverty, guaranteed daily consumption, access to common goods and services, and to enjoyment of society (Browne and Hood 2016; Ravallion 1992; Thewissen, Stefan; Kenworthy et al. 2015). Linked to economic freedom, the value of income is sustained by the idea of access and accumulation of many basic needs or consumption items, such as food, cloths, health, education, housing, water, furniture, farming improvements, transportation, etc. (Murphy 2001; Sen 1999).

Moreover, **land size** and **labor** are close related to agrarian income (Medina et al. 2015; Murphy, Bilsborrow, and Pichón 1997). Regarding the use of **technologies**, these are four, so called, fundamental aspects of production, composing the household farming capacity (Costa 1995; Errington and Gasson 1994; Vliet et al. 2015). To better understand the importance of these aspects in the rural search for better living conditions, analytical procedures often stratify income, land and labor into more specific factors or variables.

Income is basically composed of farm and off-farm sources, including the sale of farming products, governmental benefits, payment for day-service "diárias", eventual employments, etc. (Godar, Tizado, and Pokorny 2012; Murphy 2001; Perz 2005). Land often is treated as land size, land use and land cover, but other qualitative attributes can also be relevant, such as slope, fertility, humidity, vegetation types, etc. (Aldrich et al. 2006; Guedes et al. 2014; Murphy 2001). Labor is commonly divided in family and hired work-farm, yet, characteristics

may distinguish the kind of labor such as participation of women, child work, farmer experience, age, skills, education level and others (Errington and Gasson 1994; VanWey, D'Antona, and Brondízio 2007; Verner 2004).

According to Hayami and Rutan (1971), "*success in agricultural growth, it is believed, is based on an ecologically adapted and economically viable agricultural technology which involves a continuous adaptation to available resources as well as a positive response by cultural, economic and political forces*.". In other words, they suggested that success would be related to the conditions of farming productivity associated wtih the management applied in the natural resources, considering the influence of context. For instance, taken the context of living conditions influenced by colonization in the Amazon, the primary assets of colonists would be provided by the attributes of their land, such as **soil fertility**, land size, forest cover, and water access.

Forests, represented by the '**forest cover**' metric, are the main source of timber, hunted meat, and plants for consumption and medicinal use to supply the newcomer households (Narel, Y Paniagua et al. 2007; Reyes-garcía et al. 2005; Smith 1976; Uhl and Kauffman 1990). Forests also have an important role of immediate low-cost input of soil fertilization, when burned for agricultural or livestock goals (Hecht 1985).

In contrary to those who showed the trend of specialized livelihoods (Caviglia-Harris and Sills 2005; Veiga et al. 1996; Walker et al. 2000), some authors have argued that **diversification** is essential for economic stability and well-being (Babatunde and Qaim 2009; Daud, Awoyemi, and Omotoso 2018; Godar, Tizado, and Pokorny 2012; Pellegrini and Tasciotti 2014).

Water access is another essential living condition for the permanence of colonists (McCracken et al. 2002; Pokorny and Jong 2015), but not crucial to Transamazonian production (Godar, Tizado, Pokorny, et al. 2012).

The living conditions necessary for farming yields, or productivity, also depend on personal pathways that contribute to the household's everyday decisions for livelihood strategies. The experience of households, influenced **farmer age** and duration of residence on the lot (**property age**), can exert significant effects on land uses (Pacheco 2009; Perz 2001; Perz and Walker 2002).

Moreover, experience and **education** can be strongly correlated to poverty in Pará (Guedes et al. 2012; Verner 2004), being critical for a successful living standard. Level of education exert influence on strategical choices of farm management, diversification or commercialization (Caviglia-Harris and Sills 2005; Daud et al. 2018), also affecting health, income

and general welfare of households (Medina et al. 2015; Ogundari and Abdulai 2014; Ogundari and Aromolaran 2014).

Similarly, the choice to invest in **housing** quality, compatible for the family size, also depends on a family's strategy; some may prefer to invest in farming rather than in shelter. Used as a socioeconomic indicator for the households displaced by Belo Monte dam in Transamazon (Randell 2017), housing is commonly observed in living standard evaluations (Sartre et al. 2016; Smeedin et al. 1993). Type of housing can impact health, comfort or satisfaction, and therefore an obvious indicator of a household's well-being and physical capital (King 2018; Perz 2005; Richards and VanWey 2015).

Investing time and energy in **social interactions** also can bring positive results to income, informal security, and well-being (Perz 2005; Sen 1985). Social interaction is a living condition derivative from livelihood strategies, which is often associated with farming success (Medina et al. 2015). Social network, cohesion, organization, and neighborhood relationship are some factors of poverty or livelihood studies (Guedes et al. 2012; Perz 2005). According to Fritz and Koch (2014), social inclusion forms part of a three-dimensional concept of prosperity, together with ecologic sustainability and quality life, in which responses are linked to economic development associated with levels of material living standard.

A debated aspect of social inclusion is the gender difference in rural activities. One specific issue would be the direct **women integration** in farming work. McCracken et al. (2002) described some individual behaviors present along the Transamazon frontier, including that women are less prone to join deforestation or weeding activities, but likely to be involved in harvesting and processing agricultural products. Depending on the availability of family labor, considering its structure and composition, integration of women would be a determinant strategy in obtaining a successful living standard. Moreover, women groups from Amazon frontier areas have demonstrated economic empowerment through access to decision-making positions, which reflects on sustainable livelihood practices and land cover and land uses (Mello and Schmink 2017). These effects may have a strong relationship with the economic and institutional context (VanWey et al. 2007; Verner 2004).

Strategic behaviors also can be evidenced by **food consumption**, which are commonly linked to health, social or environmental welfare, food security, and financial aspects (Ortiz et al. 2013; Pellegrini and Tasciotti 2014). Food is a good for direct personal use, wanted for desire or satisfaction, but essentially a daily need (Sen 1984). Easily measured, food count indicator, or dietary variety/diversity, is often used in nutrition or living standard surveys, with relationships to diet quality and anthropometric outcomes (Pellegrini and Tasciotti 2014; Ruel 2003; Tasciotti

2006). Hypothetically, it would be expected that a reduced food variety would be associated with less successful families.

In the context of living conditions from Transamazon, **land tenure** is a hotly debated issue, commonly associated to land accumulation and forest cover (Browder, Pedlowski, and Summers 2004; Carrero and Fearnside 2011; Godar, Tizado, and Pokorny 2012). It is more dependent on socioeconomic and political conditions - governmental institutions/actions, public polices or political organization - than on household wishes (Alston, Libecap, and Schneider 1996; Carr, Pan, and Bilsborrow 2006). Also measured as an asset of the land (Medina et al. 2015), tenure quality, formal or informal, is relevant to guarantee household rights and stimulate or maintain farming practices of land use systems, as well as technological adoptions, besides conservation of natural basis (Futemma and Brondízio 2003; Larson et al. 2008). Further, the security about land possession may influence diverse feelings or decisions, for instance, affecting household's strategies of to have children (Carr, Pa, and Bilsborrow 2007) or deforestation (Robinson, Holland, and Naughton-Treves 2011).

Another fundamental aspect of rural development studies would be the presence of basic **public services**, allowing people to access schools, health care and electricity, which improve quality of life (Bezerra et al. 2017; Brondizio 2004). Smallholders in the Amazon commonly lack these relevant services (Pokorny and Jong 2015). Education importance was presented above, as was the relationship of health to well-being and living standards. For instance, given electricity is a key factor for successful livelihoods, around 40% of rural populations in the Brazilian Amazon have access to this service (Medina et al. 2015). Despite of some governmental programs, such as "Luz para todos", complementary policies are needed to achieve better living standards for poor rural regions (Bezerra et al. 2017).

Commercialization also depends on contextual conditions. For example, **market distance** is correlated with poverty for many places in Pará (Guedes et al. 2014; Verner 2004), influencing land use/land cover, years of residence in the lot and labor (Pacheco 2009; Walker et al. 2002). Most roads in the region are unpaved, which makes travel conditions precarious and hampers transportation of farm products. Such conditions increase transportation costs and limit the ability to overcome poverty (Guedes et al. 2012; Perz and Walker 2002; Walker et al. 2002).

These constraints likely reflect on the scarcity of **market niches**, which could facilitate household success while promoting value aggregation to local products, better labor conditions, fair trade, environmental conservation and money circulation (Armengot et al. 2016; Ayuya et al. 2015; Scott 2016). For instance, certified cattle are a demand for international markets, expecting to consume beef from sustainable production systems (Ruviaro, Barcellos, and Dewes 2014).

3. METHODS

3.1. Study site

We carried the study in the Brazilian Eastern Amazon, state of Pará, region of the Transamazon highway (BR 230), in seven municipalities (Figure 19) including São Félix do Xingu (not accessed for BR 230 but has similar features of rural development) (Braga 2015; Mertens et al. 2002; Schmink and Wood 1992; Schroth et al. 2016). The climate is tropical humid, dry season around Jul-Nov, with annual rainfall varying between 1500-2200 mm and temperature average about 27°C (IBGE 2002; INMET 2017). The official dataset of soil (IBGE 2008b) was checked by field observations and categorized according to the fertility potential: high = eutrophic red Nitosol ("terra roxa"); moderate = dystrophic red-yellow Argisol or dystrophic red-yellow Latosol; low = dystrophic yellow Latosol. The original vegetation is ombrophilous forest, dense or open, with variations as submoutain (upland, "terra firme") or lowland (IBGE 2008a; Salomão et al. 2007). Most of the original vegetation inside household farms are mature forest (>60 years old) but not pristine, with some logging intervention.

The study site has a context of socio-economic poverty and migration (Guedes et al. 2014; Pokorny et al. 2013; Randell 2017) regarding to the Amazon colonization process (Hecht 1993; Kleinpenning 1977), with a population increase (Table 3) associated to high deforestation rates (INPE 2017; Tritsch and Le Tourneau 2016), accordingly to the introduction of this thesis.

Table 3. Socio-economic indexes for the the study site. GDP: Gross Domestic Product; HDI: Human Development Index; Gini: coefficient of wealth inequalities. (DATASUS and IBGE 2010; IBGE 2018a).

Region	Population (x1,000)	Population (x1,000)	Population (x1,000)	Demograp. density (hab./km2)	HDI	Gini per capita	GDP per capita
Year:	**2000**	**2010**	**2018***	**2010**	**2010**	**2010**	**2016**
Legal Amazon	21,039	25,474	28,659	5	0.683	0.618	20,879
Pará	6,190	7,581	8,513	6	0.646	0.626	16,690
Transamazon**	385	776	914	2	0.575	0.601	16,317
Municipalities							
Anapu	9	21	27	2	0.548	0.586	11,932
Brasil Novo	17	16	15	2	0.613	0.684	13,664
Medicilândia	21	27	31	3	0.582	0.614	20,857
N. Repartimento	42	62	75	4	0.537	0.596	10,443
Pacajá	29	40	47	3	0.515	0.663	9,471
S.F. do Xingu	35	91	125	1	0.594	0.614	10,481
Uruará	45	45	46	4	0.589	0.586	10,936

* estimated ; ** including São Félix do Xingu

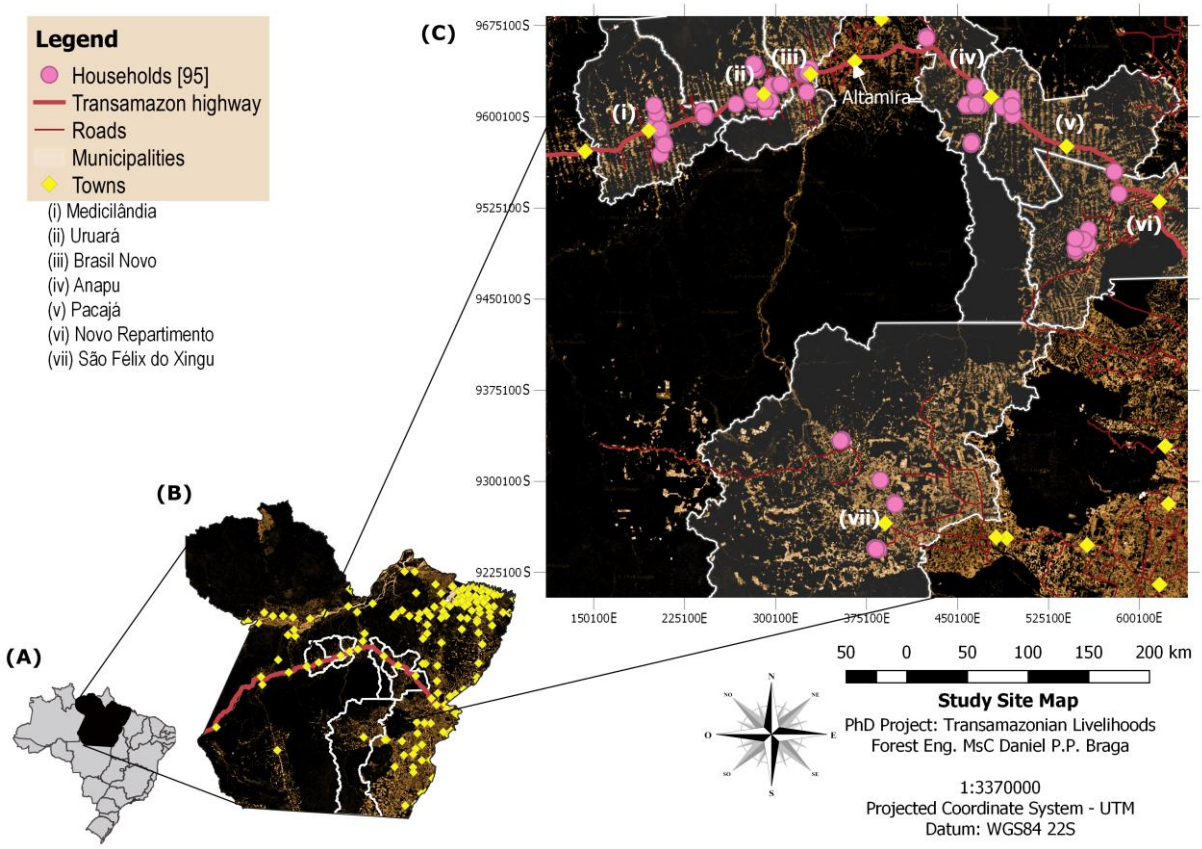

Figure 19. Study site map. (A) Brazil; (B) Pará and sampled municipalities of Eastern Amazon, colonization frontier (forest cover = black color); (C) sampling distribution (95 interviews) along the Transamazon highway (BR 230) and São Félix do Xingu.

3.2. Data collection

We used the Sustainable Livelihoods Framework (DFID 1999) as the basis for building our interview script, regarding its efficient method of data collection, with a multidimensional and interdiciplinary approach, widely published (Perz 2005; Urzedo et al. 2016; Zenteno et al. 2013). However, considering its deficiencies (Scoones 2009; Clay 2017) we opted to employ additional methods of analysis, which allowed us to better understand the variations of our sample, and explore the results in a broader sense.

The initial effort for a random sampling was not feasible because we could not access previous data about total number or location of farmers from the study site. In the fieldwork, it was not easy to find the farmer's housing from the roadside and farmers were not always available for the interviews. Similar hardships were reported by other studies in the Transamazon (Caldas et al. 2010; Pacheco 2009; Walker et al. 2002). In addition, our survey faced logistic limitations of transport and the lack of financial resources, being supported by one scholarship

and depending of rides, when local partners (such as NGOs, cooperatives, associations, syndicates) or local people (from sampled communities) were available.

Therefore, we opted to find the first farmers by indication of local partners and people, then, following the snow-ball method for the vicinity around (Cohen and Arieli 2011). This procedure of data collection, is similar to the "opportunistic" sampling, conducing the interviews with available farmers. Other researchers applied similar method (Caldas et al. 2010; Pacheco 2009; Walker et al. 2002). From each locality, we looked for small-scale households (smallholders/family farmers) dedicated to the production systems of cacao and/or cattle – as their main income source -, regardless their financial condition or economic well-being.

The first interviewed farmers, indicated by local partners, usually presented a relatively good economic well-being. However, we observed a minimization of this bias on the subsequent interviewees from vicinity (indicated by previous interviewees), which presented an aleatory variation of economic well-being (Figure 20).

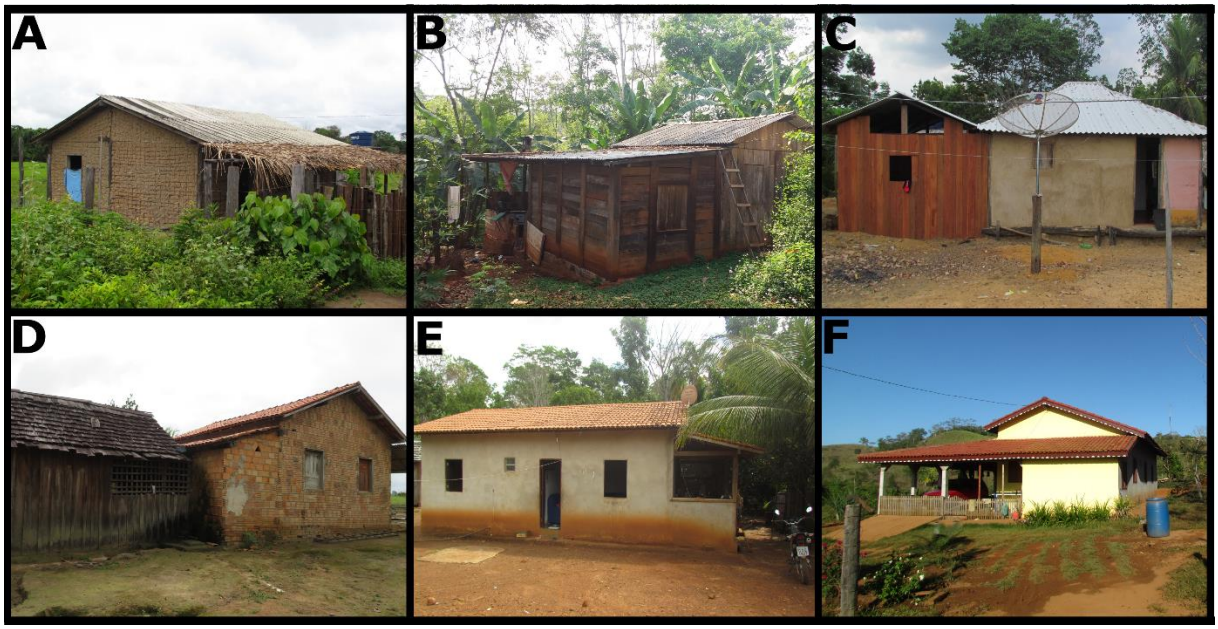

Figure 20. Diversity of household's economic well-being expressed by their housing structure: (a) cob wall, "taipa"; (B) wood; (C) mixed cob wall and wood; (D) mixed wood and masonry; (E) masonry not finished; (F) masonry complete.

During the fieldwork period, we were hosted by households from each locality of our study site, observing their daily routine. The first three months were dedicated to preliminary site recognition, for network contacts, visit communities, check the areas of pasture and cacao and execute the pilot questionnaire. In sequence, we applied 95 structured interviews (Jan 2017 to May 2018).

Descriptive analysis showed the top five income were outliers, being removed of posterior statistical analysis. Outliers were included only in the result section "4.4" for probability and qualitative descriptions. The 90 remained households composed our sampling with 26 cacao farmers, 28 cattle ranchers and 36 both, cacao and cattle (Table 4).

Table 4. Field sampling with number of interviews per production system and municipality (N=95). [3] three outliers: 2 Cacao and 1 Cacao+Cattle; [2] two outliers: 1 Cacao and 1 Cacao+Cattle

Municipality	Production system	Nº interviews	Total
Anapu	Cacao	7	18
	Cattle	6	
	Cacao+Cattle	5	
Pacajá	Cacao	3	12
	Cattle	5	
	Cacao+Cattle	4	
Brasil Novo	Cacao	4	10
	Cattle	2	
	Cacao+Cattle	4	
Medicilândia	Cacao	8	15[3]
	Cattle	3	
	Cacao+Cattle	4	
Uruará	Cacao	4	18[2]
	Cattle	9	
	Cacao+Cattle	5	
Novo Repartimento	Cacao	5	13
	Cattle	2	
	Cacao+Cattle	6	
São Félix do Xingu	Cacao	0	9
	Cattle	1	
	Cacao+Cattle	8	

The interviewed farmers represented the head of the family living in the land, owner of 3 to 350 ha, with clear engagement to the farm management. Hired labor, or extra-familiar labor, were not used as criteria to define small-scale households (Errington and Gasson 1994). As requirement, household's productive areas had at least 8 years of use for cacao agroforestry systems or pasture.

Interviews were recorded (when allowed) and households mapped using Garmin GPSMAP 64s and QGIS Desktop 3.0.3. The questionnaire (see Appendix 1) contained 185 questions in five thematic divisions: personal identification; land composition; production systems and farm activities; other livelihoods; perceptions about assets and capital indicators (subdivided in financial, physical, natural, social and human) (DFID 1999).

Collection of additional data – Local perception of success

We used an additional survey to better understand the local perception of success. We asked two open-ended questions to 28 local actors from our study site (farmers, technicians, teachers, professors, NGOs, cooperatives, associations, syndicates and community leaderships): (i) what would be the main personal qualities of a successful small-scale farmer?; and (ii) what would be the material goods owned that indicate a successful household?. The most frequent responses were grouped in three categories (Table 2).

Table 2. Indicators of successful smallholders (positive features), perceived by local people (N=28) from the Transamazon region. Relative frequency (%) of mentioned item with >20% answers.

Economic well-being: financial achievements	
Housing structure, comfortable home	46%
Own vehicle for transportation	25%
Apparent high yield and income, with economic stability	21%
Economic well-being: farming yields	
Diversification of farming and products	57%
Land infrastructure, possession of equipment (technology)	54%
Evidence of better farming practices, good management	46%
Farmer's personal qualities (subjective)	
Creative, innovative, prepared for future changes	46%
Good manager, planner and administrator	43%
Leadership attitude, communicative, active and pushful	43%
Perseverance and dedication to the enrolled activities	32%
Desire to achieve good income, aiming economic stability	25%
Honesty, humility, honour, good reputation and business credibility	21%
Enjoy farming and be happy about living in his land	21%

Consistent with the living standard conceptualization, local perception revealed that aspects of financial achievements and farming yields are appropriate indicators of success. The sense of economic well-being was frequently mentioned in the responses. Additionally, individuals cited several personal skills, cultural aspects, and behaviors were reported as important qualities to achieve success. Therefore, given the proximity of understandings (academic and local), we considered success levels an appropriate proxy to understand the living standards of the Transamazon region, and successful households would be those with higher level of economic well-being.

3.3. Data analysis

We conduced our data analysis at the household-level, selecting 19 factors (Table 5) based on the conceptual framework. These factors were constructed from the variables extracted from the interview script, in which, the qualitative factors were scaled into values of 0 to 1. Some of the factors (land size, forest cover, diversification, education, farmer age, food variety, labor, land tenure, market distance, property age and soil fertility) were generated by single variables. The other factors (income, housing, market niches, public services, social interaction, water access, women integration and technology) were calculated, systematically, from the sum or mean of their set of variables (see Appendix 2).

In general, the factors were analyzed as categoric variables, using absolute and relative frequency, and as numeric variables, using descriptive statistics, Principal Component Analysis - PCA, correlations with Spearman's tests and non-parametric hypothesis tests (Kruskall-Wallis). The monetary values were converted by the rate of R$ 3.45 per USD, average price for the fieldwork period. Data was manipulated using Microsoft Excel 2013 and R Studio version 3.5.1 (R Core Team 2018).

For the objective one (I), we used various analyzes. First, we adopted descriptive statistics and calculated the average income per household and per individual household member, confronting with the minimum wage and the poverty thereshold. Second, we defined categories for each factor to calculate the absolute frequency. Third, we applied the PCA to find the most contributing variables that explain the data variation and interpret the axes/components of the PCA as the dimensions of our study, which represent the regional situation from the household level.

We used the two variables with higher contribution to PCA as determinant factors to define the living standards by success levels, accordingly with our conceptual framework and the suggestions of local perception of success. These two variables were scaled (0 to 1) and united by the average into one factor, representing the individual living standard, taken as the success of each household. By organizing this living standard factor in crescent order, we built a "success ranking" and, then, we made a systematic categorization of three levels of success: low $\leq$0.33; intermediate 0.34-0.65; high $\geq$0.66, in agreement to the range of our sample.

To better characterize the distinction of success levels, we plotted the data in a histogram for the above mentioned two most contributing variables and, also, applied hypothesis tests for all variables. To describe the possible drivers of success and reasons of the living standard, we applied correlations with Spearman's tests for all variables. Besides, to better understand critical aspects in the regional situation of the study site, we consensued a parameter

of "relatively good living condition" for each analyzed factor, based on the variation of our sample, and calculated the relative frequency by success levels.

In addition, according to our statistical results, we employed the two most relevant factors – potential drivers of success – combined to find the probability of success. We used the parameters of "relatively good living condition" to define "good" and "bad" conditions for both factors. Then, the relative frequency of households by success levels was calculated in function of both factors combined, corresponding to four possibilities: (A) Factor-I good x Factor-II good; (B) Factor-I good x Factor-II bad; (C) Factor-I bad x Factor-II good; (D) Factor-I bad x Factor II-bad). The results allowed to identify the households in two major groups: (i) within the expectation of success; (ii) out of the expectation of success. Against this probabilistic backdrop, we used a qualitative analysis of our dataset, associated to field observations and personal communications, to describe the living standard through some personal pathways (including the income outliers) which were enlightening.

Table 5. Selected factors/variables for the study site, suggested by our conceptual framework as influential factors for the living standard in the Transamazon region or similar contexts. (e)expression factors, related to economic well-being; *output variables, suggested by PCA. The respective units for each variable are in parentheses, when the factor corresponds to a categorical variable it was transformed into 0-1 scale for statistical analysis.

Factor - Variable (*Unit*)	**Description**	**Reference**
Diversification *(products)*	Number of farm products commercialized.	(Godar et al. 2012; Medina et al. 2015; Pacheco 2009; Pellegrini and Tasciotti 2014)
Education *(0-1 scale)*	Degree of study, educational level.	(Caviglia-Harris and Sills 2005; Medina et al. 2015; Ogundari and Abdulai 2014; Verner 2004)
Farmer age *(years)*	Age of the family's head.	(Perz 2001; VanWey et al. 2007; Verner 2004)
Food variety(e) *(ingredients)*	Number of ingredients eaten at one day.	(Ortiz et al. 2013; Pellegrini and Tasciotti 2014; Piperata et al. 2011)
Forest cover *%*	Proportion of land size covered by total forest vegetation, primary plus secondary.	(D'Antona, VanWey, and Hayashi 2006; Ludewigs et al. 2009; Pacheco 2009; Walker et al. 2002)
Housing(e)* *(0-1 scale)*	House building quality, size, quality of bedrooms and bathrooms.	(Perz 2005; Richards and VanWey 2015; Sen 1999)
Income(e)* (*USD/year)*	Gross income, on-farm plus off-farm, monthly estimated.	(Godar, Tizado, Pokorny, et al. 2012; Medina et al. 2015; Guedes et al 2012; World Bank 2007)
Labor *(family members)*	Number of family members.	(Medina et al. 2015; Verner 2004; Vliet et al. 2015; Walker et al. 2002)
Land size(e) *(ha)*	Total size of the rural property.	(D'Antona et al. 2006; Godar et al. 2012; Medina et al. 2015; Vliet et al. 2015)
Land tenure *(0-1 scale)*	Document type of land possession.	(Carr et al. 2006; Futemma and Brondízio 2003; Larson et al. 2008; Medina et al. 2015)
Market dist. *(km)*	Distance from the nearest city.	(Guedes et al. 2014; Pacheco 2009; Walker et al. 2002)
Market niches *(0-1 scale)*	Access to specific market niches, getting better prices.	(Medina et al. 2015; Pokorny and Jong 2015; Scott 2016)
Property age *(years)*	Period of residence in the lot.	(Murphy et al. 1997; Pacheco 2009; Perz and Walker 2002)
Public services *(0-1 scale)*	Electricity, health and education access.	(Medina et al. 2015; Pokorny and Jong 2015; Walker et al. 2011; Weil 1981)
Social interactions *(0-1 scale)*	Enrollment to organizations, community and relations with family/neighborhood.	(Guedes et al. 2012; Medina et al. 2015; Ostrom 2000; Perz 2005)
Soil fertility *(0-1 scale)*	Classes of soil typology.	(Browder et al. 2004; Godar, Tizado, Pokorny, et al. 2012; Guedes et al. 2014; Pokorny and Jong 2015)
Technology(e) *(0-1 scale)*	Farming equipment required for cacao and/or ranching	(Angelsen and Kaimowitz 2001; Lipton 2010; Medina et al. 2015; Pokorny and Jong 2015)
Water access(e) *(0-1 scale)*	Water quality and where and how it is collected	(Godar et al. 2012; McCracken et al. 2002; Pokorny and Jong 2015)
Women integration *(0-1 scale)*	Direct participation in cacao and/or ranching activities	(Carr et al. 2006; McCracken et al. 2002; Mello and Schmink 2017; VanWey et al. 2007; Verner 2004)

For the objective two (II), we categorized the households by production systems (cacao, cattle or cacao+cattle), as their main strategy of livelihoods. We used the production systems as our treatments for comparison and calculated the relative frequency according to the levels of success. We applied the hypothesis test (Kruskal-Wallis) to find significant differences between the success levels of the livelihoods, also to better characterize the factor which could define the profile of the households dedicated to the studied production systems. In this sense, we calculated the averages of income and production per unit area and analyzed the monthly income distribution over one year. To find potential drivers of success, we applied correlation tests.

For the objective three (III), basically, we calculated the average of forest cover (%) for our sample and made the stratified analyzes by the levels of success and by the production systems, employing relative frequency, hypothesis test and correlation test. We confronted our responses with the legal requirements (Law nº 12,651/2012) using the minimum criteria of 50% of forest cover as the basic reference. The results this objective III were presented while describing the results for objective I and II, once we considered the forest conservation one intrinsic issue of success.

4. RESULTS

4.1. Living standard of small-scale households

Our interviews revealed, beyond diverse livelihoods, a standard for nearly two thirds of the visited households, evidencing the acceptable good living but also relevant weaknesses to be concerned (Table 6). By average, we found a gross income around 17,000 ±9,400 USD/year, 24% from off-farm, and each family member (regardless age) disposing of 5,350 ±4,600 UDS/year, which corresponds to 1.6 times the minimal salary of Brazil (Decree-Law nº 9,255/2017). On the other hand, 41% of households were under the minimal salary per family member, while about one third was under the poverty line of 1.90 USD/day.

Table 6. General living conditions expressed by frequency of households (%) for categories of factors, and by average for income, land size and forest cover. When the factor corresponds to a discrete variable, its respective unit and threshold parameters are in parentheses.

Factors *(Unit of variable)*	**Categories**			
Housing *(categoric)*	Comfortable or Suited 40	Fair 27	Unsuited or Bad 33	
Market distance *(Km)*	Near *(≤30)* 61	Far *(>30)* 39		
Market niches *(categoric)*	Considerable 10	None or few relevant 90		
Soil fertility *(categoric)*	High 16	Moderate 50	Low 34	
Diversification *(commercialized products)*	High-specialized (1) 24	Specialized (2) 24	Diversified (3-4) 27	High-diversified (>4) 24
Social interactions *(categoric)*	Strong 20	Moderate 46	Weak 34	
Land tenure *(categoric)*	Title 32	Other federal 34	Non-federal or zero 33	
Education *(categoric)*	Zero or basic incomplete 66	Basic complete 16	High school complete 12	Superior study 7
Labor *(family members)*	Good *(≥4)* 60	Few *(<4)* 40		
Water access *(categoric)*	Good 34	Some hardship 66		
Food variety *(ingredients)*	Rich *(>20)* 7	Moderate *(16-20)* 45	Poor *(<16)* 48	
Women integration *(categoric)*	High 42	Moderate 46	Low 12	
Technology *(categoric)*	High 34	Moderate 52	Low 13	
Public services *(categoric)*	High 90	Moderate 9	Low 1	
Farmer age *(years)*	Young *(<30)* 1	Adult *(30-50)* 50	Old *(>50)* 49	
Property age *(years)*	Newbie *(<15)* 10	Experient *(5-15)* 23	Senior *(>15)* 67	
Income *(USD/year)*	Average 17,000 ±9,400			
Land size *(ha)*	Average 90 ±63			
Forest cover *(%)*	Average 37 ±24			

The attainable standard of living comprised moderate-income families, who could make low risk investments. Accordingly, they could purchase minimal inputs required for the agricultural production and, at same time, contribute to the local economy by consuming and selling basic products in local markets. Their housing was fair or suited and could be made by

good quality wood, sometimes by masonry or "half-half". The family size could be regularly accommodated and there are eventual signs of improving the building or furniture. The number of family members was reasonable for labor, making a moderate women integration into farming tasks. Most of them had access to the basic public services and their diet had relatively good food variety, rarely more than 23 ingredients per day, with modest breakfast. The education level of family's head varied from zero to undergrad degree, children accessed school, but young not always concluded undergrad.

Generally, land conditions were also reasonable. Households commonly presented title tenure or some federal official document for the land, between 50 and 150 ha, eventually smaller or larger, with around 40% of original forest cover, which 81% was the original vegetation. It was possible to identify farm planning and efforts to make an appropriate management and organization of the property, showing heterogeneous strategies for commercial production. In addition, there were few equipment demands for the main farming activities.

On the other hand, despite general positive level of living observed for many families, the survey also exhibited considerable shortfalls for our sampling. For instance, by far not all families have managed to achieve an adequate level of economic well-being, also there were notorious deficits for many aspects of a successful living standard. Next sections are dedicated to better understand the regional situation, looking the aspects that may lead to success.

4.2. Regional situation and reasons for the living standard

The visited farmer families expressed a wide range regarding living conditions. The Principal Component Analysis showed that local aspects could be structured into five Dimensions, which together explained 52.6% of total data variance (Figure 21). Each Dimension represents a main feature group, resultant of the understanding based on the most important factors. Dimensions were interpreted with complementary role, supported by factor's correlations also by factor's multifunctionality (same variables contributing to explain more than one dimension). At the end, the result was a "web of linkages", with a dynamic perspective, favoring the comprehension about the complexity of regional situation from the household level.

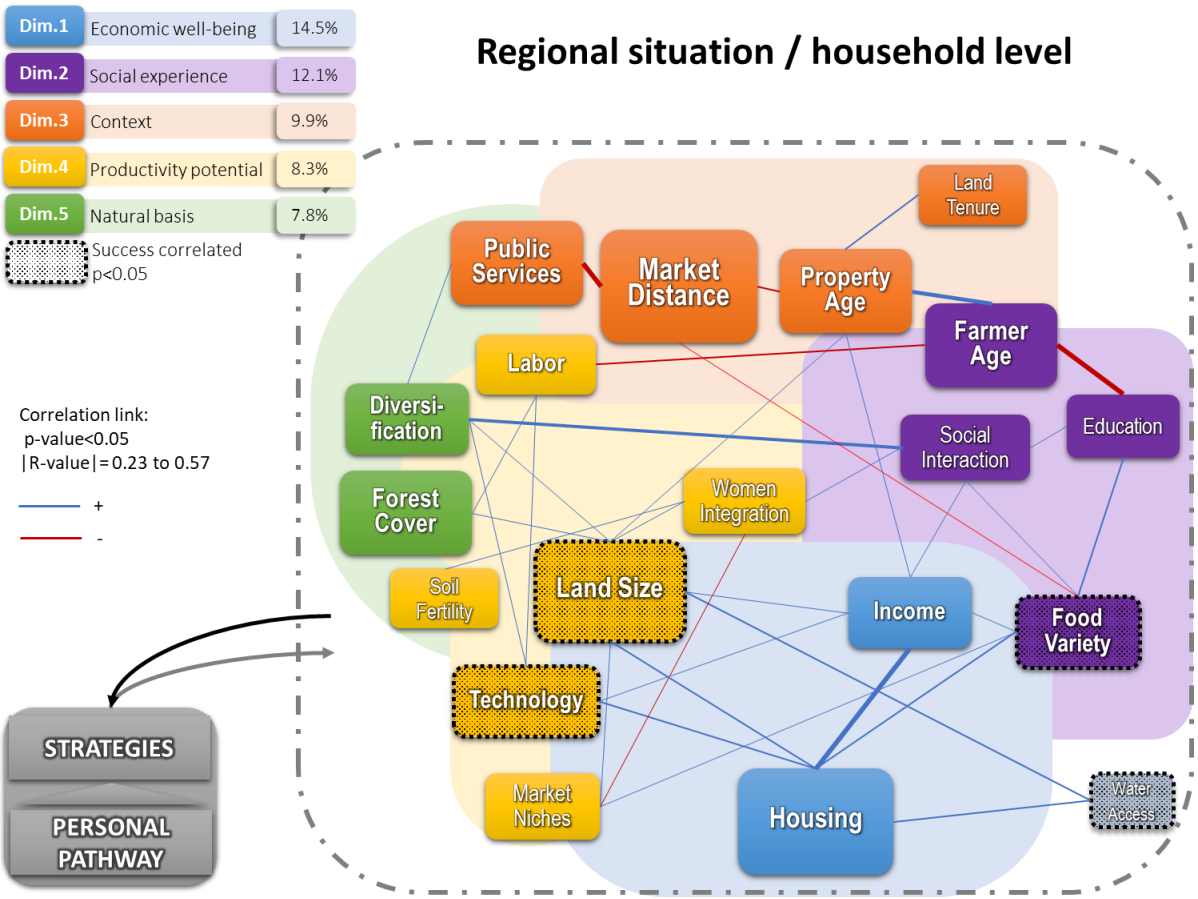

Figure 21. Variable correlations and its contribution to explain the regional situation from household's perspective, following the PCA structure, composed of five Dimensions related to strategies/personal pathway. Variables are colored and allocated inside the areas from the Dimension which they have a higher and meaningful contribution. Variable's box and text are sized according to its absolute contribution. The link width is in function of the correlation, R-value, and its color is blue when positive or red when negative. Water is the unique not representative (contribution <5%) for the five Dimensions.

4.2.1. Dimension 1 – Economic well-being success

According to the regional diversity of households, the PCA and the survey supported income and housing as the main determinants to define three levels of success (Figure 22) regarding notable distinctiveness (Table 7). Half of the households (50%) fell into the intermediate success level, widely representing the living standard stated above. The other part of households, 32.2% were categorized as low (32.2%) and high (17.8%) as high success.

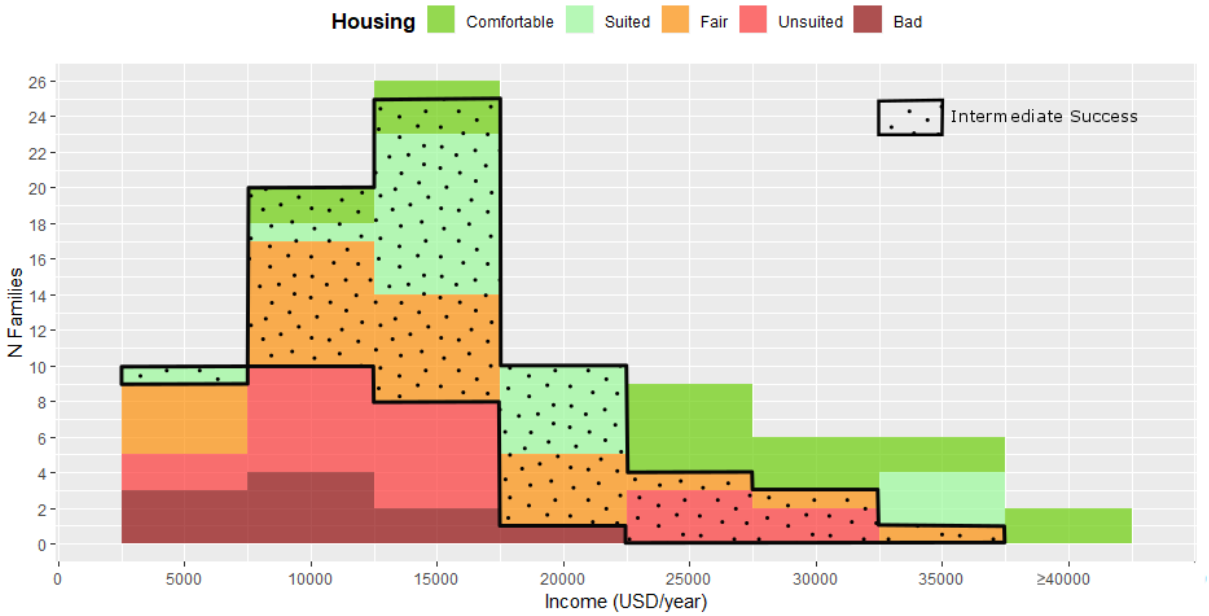

Figure 22. Number of families counted for 5,000 USD/year intervals, showing the housing categories and highlighting the standard of intermediate success. The low and high Success are below and above the Intermediate, respectively.

Taken the intermediate success level as the living standard, households attributed to the lower level showed major shortcomings. Generally, low success farmers can be considered as survivals from the environmental conditions and market challenges, living a hard rural life, with a lack of facilities and evident hardships for transport and communication. Their houses often are made by rustic material building, such as wood or cob wall, "taipa", usually without adequate accommodation for the family size and presenting no signs of improving the building or furniture. Their lower income (with average of 28% off-farm income) makes them to avoid new investments, considering the risk to not resist and break when facing market crises (low resilience).

At the same time, households categorized as high success were significantly better off regarding some major aspects. As first impression, they look evident successful, showing a rural life more stable, above the living standard expectative, presenting facilities and less hardships for transport and communication. Normally, their houses are made by masonry or mixed with good quality wood, with adequate accommodation for the family size, presenting excellent house building and furniture (in comparison to the neighborhood). Their higher income (with average of 16% off-farm income) propitiates the possibility of investments, with less risk to break when facing crises (greater resilience).

Table 7. Significant factors to distinguish between levels of success (variables with $p<0.05$, Kruskall-Wallis). Different letters ([a, b, c]), as well as different categories, means statistical difference between numerical values of success levels.

	Success levels		
Factors	**Low**	**Intermediate**	**High**
Income (USD/year)	9,794 ±4,294 [a]	16,606 ±6,460 [b]	31,151 ±7,618 [c]
Land size (ha)	74 ±48 [a]	84 ±61 [ab]	137 ±74 [b]
Housing	bad or unsuited	fair or suited	suited or comfortable
Technology	low	moderate	high
Water access	moderate or bad	moderate or good	moderate or good
Labor	most family, few hired	family and hired	few family, most hired
Food variety	poor or moderate	moderate or rich	moderate or rich

Success was close related to better conditions of farming. Families with better housing have more land and better technology, food variety and water access. In addition, level of housing considerably increased when families owned more than the intermediate's income average, having higher chance to possess suited or comfortable home.

Income stratification revealed that on-farm income had a stronger correlation to success ($p<0.05$) than off-farm income. Moreover, on-farm income also was significantly related to social interaction, land size and technology, which reinforces the understanding that social network may propitiate partnerships and technical assistance for farming production, indirectly leading to success.

Regarding the off-farm income importance as complementary budget, it is correlated ($p<0.05$) to: farmer age ($R=0.26$), property age ($R=0.26$), labor ($R=0.24$) and market distance ($R=-0.22$). These variables together expressed the meaning of income generation related to personal pathway and context, elucidating some common income sources by retirements, daily works in rural vicinity, jobs in the commercial center and payments by the federal programme "bolsa família".

4.2.2. Dimension 2 – Social experience

This Dimension gather aspects that express opportunities of people's interaction, regarding an accumulative sense of shared experiences over time. Households with intermediate success had similar chances to achieve good conditions of living as the high success, except by the factor of social interactions (Figure 23). Correlations supported our understanding that success was linked to social experience, generated by the opportunities of communication (from farmer age, food variety, education and social interactions) below described.

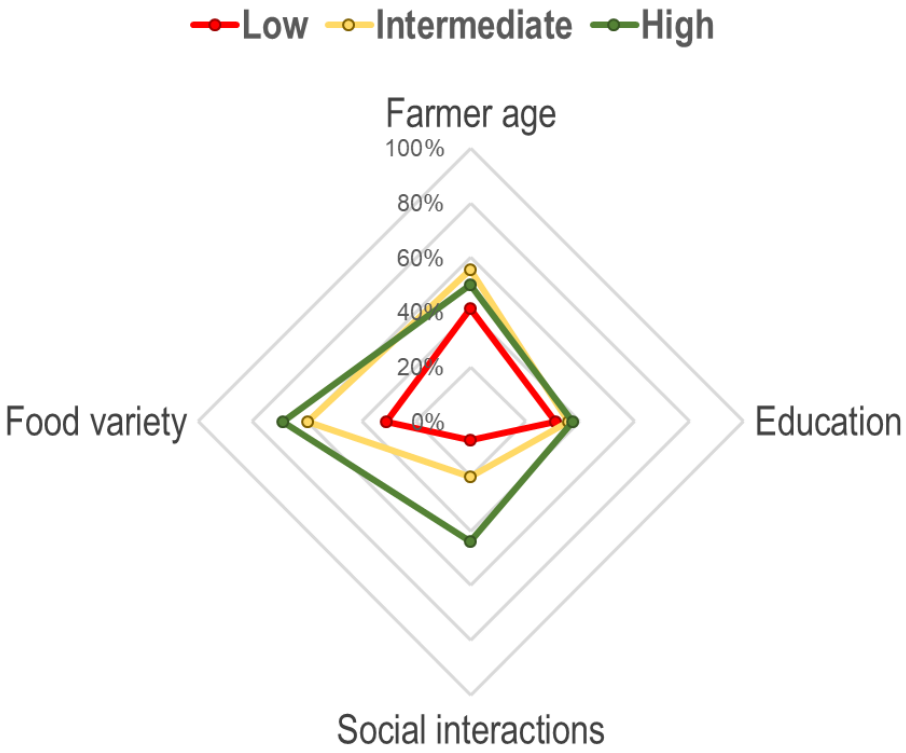

Figure 23. Relative frequency (%) of households that achieved relatively good living conditions for the aspects of social experience, comparing the success levels. Consensual parameter: Farmer age 25-50 years old; Education ≥ basic complete; Social interactions = strong; Food variety ≥ 16 ingredients.

Composing the social interaction variable, our survey detected specific situations, from the family to external institutions:

(i) About family/neighborhood relationship, only six households reported some uncomfortable situation. Nevertheless, we observed some problems of acquaintanceship not exposed during the interview, presumably hidden to avoid conflicts.

(ii) Participation on informal communitarian groups, supporting mutual farming interest (e.g. "multirão"), showed higher frequence by high success households. Still, this kind of collective work was not a common practice in our sampling. Interactive moments were seasonally pushed by specific farming demands. Once or twice yearly, cacao harvesting joined people of all ages and gender with a lot of conversations during the seeds collection, sited under cacao shade. For cattle, mainly the vaccination moment got together some men from vicinity.

(iii) Not a precondition for success, households often were registered as official members of some local organization, such as cooperatives, associations, syndicates or similar. However, one fourth of the farmers are not affiliated to any of these organizations, mainly the cattle ranchers.

(iv) We found a major gap for non-local partnerships, grasping external institutions focused on rural development or farming productive goals, including research institutes, universities, NGOs, banks, technical assistance companies, factories or corporations in general. Most of the interviewed complained about missing this kind of collaboration, while only 40% had some access.

Besides social interactions, food variety could be pointed as central indicator of success. Also, playing an important role for this dimension of social experience. Connection between food and social relationships were noticed by observations of daily rural life. For example, while food was being bought or harvested, while cooking and while eating or sharing to visitors, employees or neighbors. Moreover, common feeding behaviors supported a cultural connection along the site, like consumption of similar basic ingredients. Despite reasonable number of daily eaten ingredients, farmers rarely were concerned about healthy diet, regarding nutrition richness or quality of ingredients for cooking.

Correlations showed households tending to eat more ingredients when there were better social interactions but also better education, access to market niches or when resided near to commercial center. Market distance correlated to food variety was easily explained because farmers bought around 70 ±15% of the daily ingredients. Education degree possibly influences food consumption because of information access. Yet, relationship of market niches and food may be due to cattle ranchers that incorporate cheese or milk into the family's diet, instead of cacao farmers which rarely consume chocolate or fruit pulp in their meals.

At last, regarding farmer age and education linkage, more than a half of the interviewed farmers have more than 50 years old, while just few have more than basic studies complete. Young farmers use to have higher degree of schooling, possible due to relatively good access to basic education besides parents commonly encouraged them to study.

4.2.3. Dimension 3 – Context

Expressing the aspects that are somehow independent of households, the context dimension means conditions imposed more by local situation and less by farmer's control. Despite no relevant discrepancies between levels of success (Figure 24), households living longer time in the same land have slightly better chance to be successful. Correlations revealed the positive linkage of longer time of residency to income and land size, in addition, to better conditions of land tenure and market proximity, which provided better access to basic public services.

Even though, public education and basic sanitation had precarious conditions. For instance, households have no sewage or water treatment. Also, experiencing some rural schools, we observed the shortage of teachers regarding their deficient capacity, with bad classrooms or buildings, missing scholar equipment/materials, etc. Access to basic education is feasible, but the logistics of student's transportation is another hardship, mainly in the rainy season.

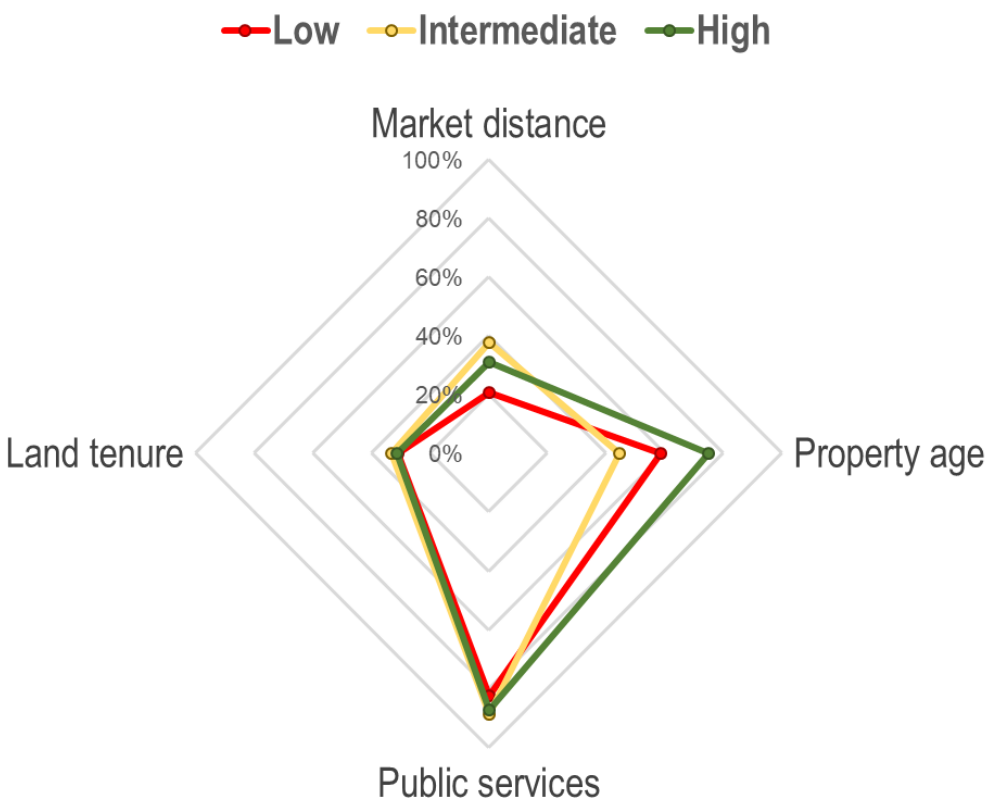

Figure 24. Relative frequency (%) of households that achieved relatively good living conditions for the aspects of context, comparing the success levels. Consensual parameter: Market distance ≤15 km; Property age ≥20 years of residency; Public services >66% of access (high); Land tenure = titled land.

Market distance strongly explained the household's diversity, showing a relevant contribution to the dimension of economic well-being success. In average, households were placed 36 ±31 km far from the nearest city. When they were closer to commercial centers, family members had higher probability to obtain an off-farm job. Further, distance also had relation to farmer's perception about transportation hardships. Regarding long routes of narrow tracks (generally more than 15 km) plus the bad condition of their motorcycles, the main vehicle, to transport products and people. The precarious maintenance of public transportation system increases the danger using it.

From outside their gate, farmers perceived the context factors that are most hampering their commercialization. Road infrastructure, cooperatives (building, facilities or administration) and better prices were the main demands (Figure 25). Besides, technical assistance was relevant

for low-intermediate success households. Other subjects were less mentioned, but generally showed important concerns for improvements of transport logistics, rural credits and trade relationship.

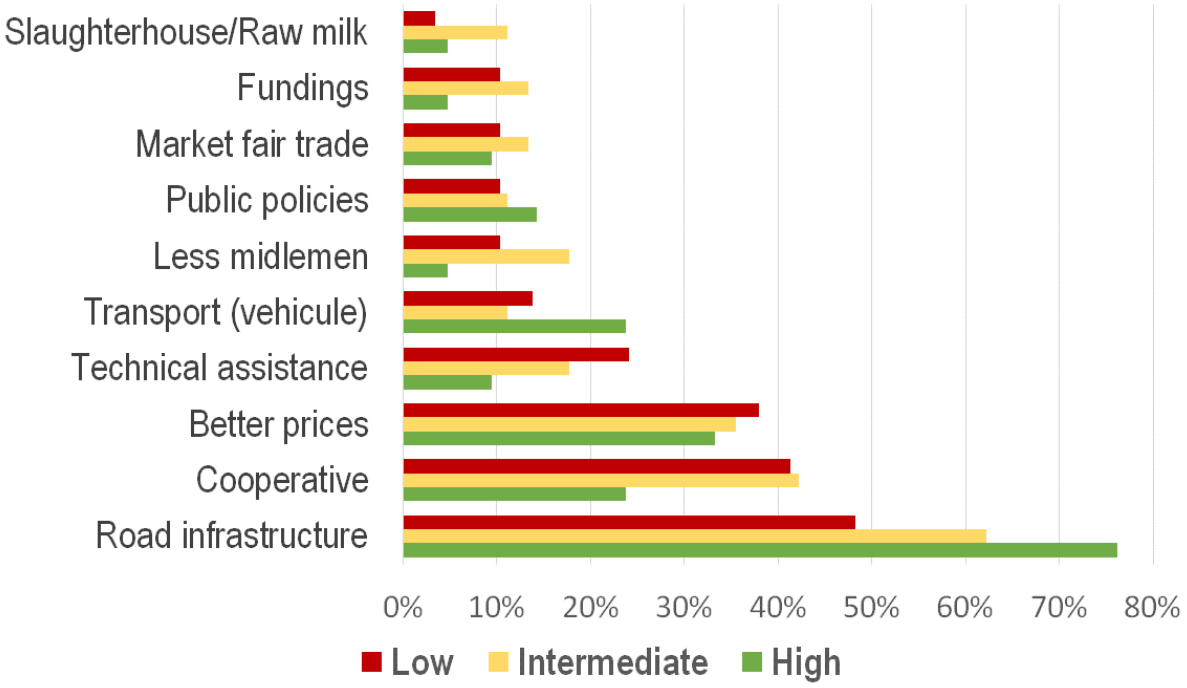

Figure 25. Relative frequency of contextual demands (>10%) for a better commercialization, per success level.

4.2.4. Dimensions 4 and 5 – Productivity potential related to natural basis

Dimensions 4 and 5 shared contributions of same variables: forest cover, soil fertility, land size, labor and diversification. This similarity made the meaning of productivity potential closer to natural basis, or vice-versa. Towards an understanding of production as a land use investment supported by resources of land and labor.

The comparison between levels of success exposed that low/intermediate households more often have better conditions for the aspects of labor and forest cover (Figure 26). On the other hand, while women integration and diversification were similar across the levels, the factors of market niches, technology, land size and soil fertility probably impose shortcomings.

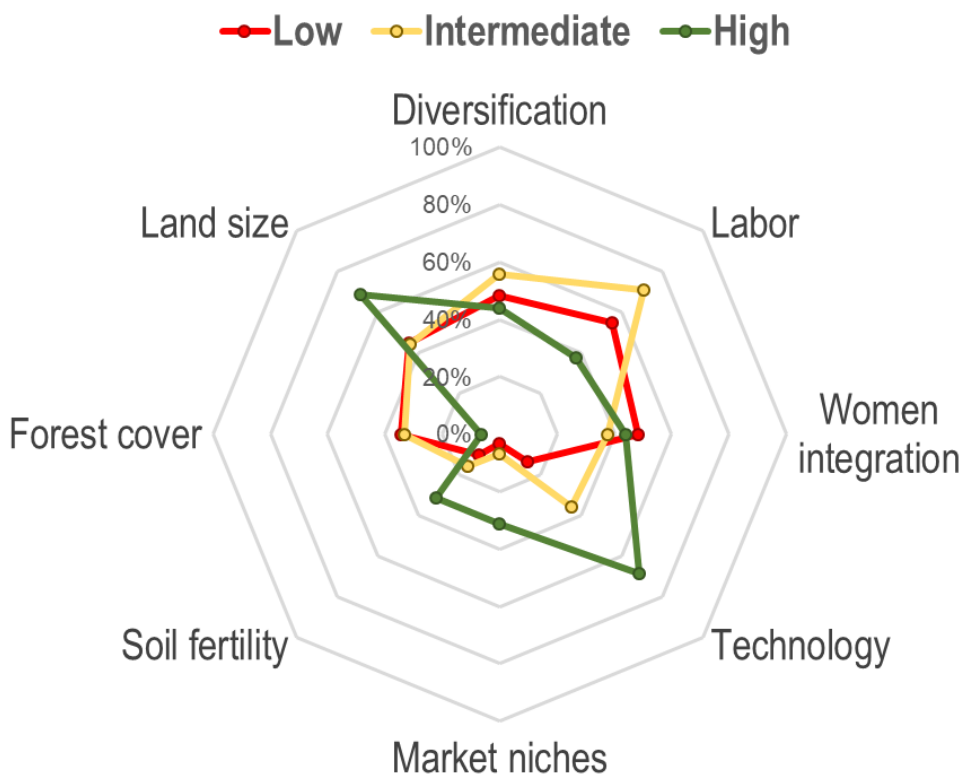

Figure 26. Relative frequency (%) of households that achieved relatively good living conditions for the aspects of productivity potential and natural basis, comparing the success levels. Consensual parameter: Diversification ≥3 products commercialized; Labor ≥4 family members; Women integration = high participation on farming activities; Technology = enough basic equipment for farming; Market niches = considerable access to better prices; Soil fertility = high potential (NVe); Forest cover ≥50%; Land Size ≥90 ha.

Attempt to overcome the bottleneck of land size, when feasible, households acquired more land over time. Simultaneously, farmers persisted longer having larger lands. Thus, their chances to achieve a successful living standard increased, as well as access to water and capability to answer market niches, as showed by the correlation linkages.

On the other hand, family labor decreases following farmer age, evidencing the weakness of household succession. With better access to education, young people expressed less interest on keep farming, leaving the household when became adults. In addition, most of farmers complained that young do not want to work "anyway", like they were "lazy" or "carefree".

By the natural basis perspective, our sampling revealed that being high success probably implies in less forest (Figure 27). In average, the high success farmers held an original forest cover of 26 ±19%, while low success have 39 ±23%. However, this investment of land use change was not a guarantee of better economic well-being. Deforestation did not always result in

higher success, once most of the families (79%) which cleared more than 50% of the land (overpassing the limit by law) are still intermediate or low success.

Correlations suggested this disability would be less impacted by soil fertility and more by personal pathway/strategy related to management conditions. Once, forest cover presented a positive relation to land size and labor, at same time, secondary forest cover had a negative relation to technology and diversification. Soil fertility did not present relevant correlations. So, not a rule, when households had adequate farming area plus work force and equipment, they could intensify their management, conservating more the original forest, while searching for success.

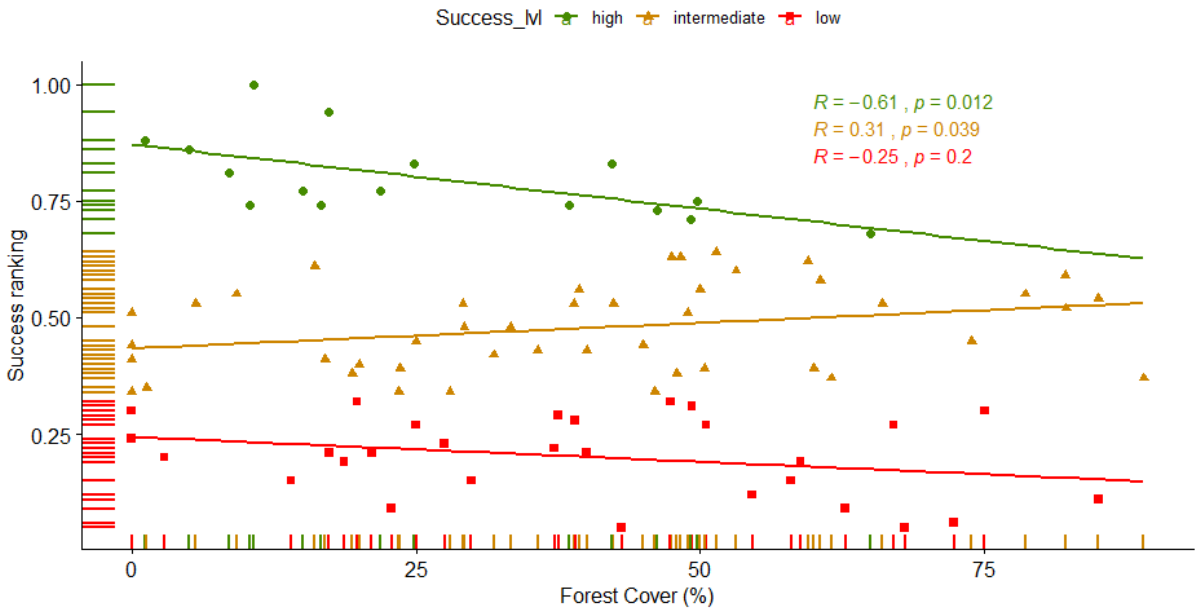

Figure 27. Success ranking in function of forest cover. Households grouped by success levels and correlation by the regression line with Spearman's test (R-value, p-value).

Even though women integration was not pointed as key to success, it was clear that female work was not only complementary but essential to the living standard maintenance. Their main responsibilities were cooking, housekeeping, washing, kids-care and homegarden (vegetables, small animals, etc.). Not always, but some women took part of farming management decisions and some were the head of the family. Situations of divorce, women leaving the household, showed their importance by the clear falling of the farm "business". Men looked for another partner quickly. Nevertheless, we did not find a reasonable explanation for the negative correlation between women integration and access to market niches.

The slight contribution of market niches for the success probably due to existence of few niches' opportunities in the study site. When existed, handful families were prepared to

attend such eventual demand. In contrast to the high success, the low success household were not well integrated to markets, still missing appropriate knowledge, structure or technology to make products with better quality or for primary processing. They also presented more hardships for land organization, without appropriate management or land use planning, lacking adequate farming equipment.

At last, water access did not contribute to explain the regional situation. Despite not being a relevant problem, the general conditions were moderate-bad, once it had no specific treatment and many households collected far from home, from water springs, small river or were dependent of the neighbor availability.

4.3. Personal pathways

Among other aspects, the analysis of PCA and correlations supported technology and land size as relevant conditionals for the household's living standard. We used this result to explore the success levels probability (Figure 28) and find factors that additionally explained that probability, by the perspective of personal pathways. Our findings confirmed expectations that good conditions of technology and land size together can increase the chances of better living standards, given 11% of households were low and 53% were high success. In opposition, bad technology and bad land size showed 42% low and 9% high success households.

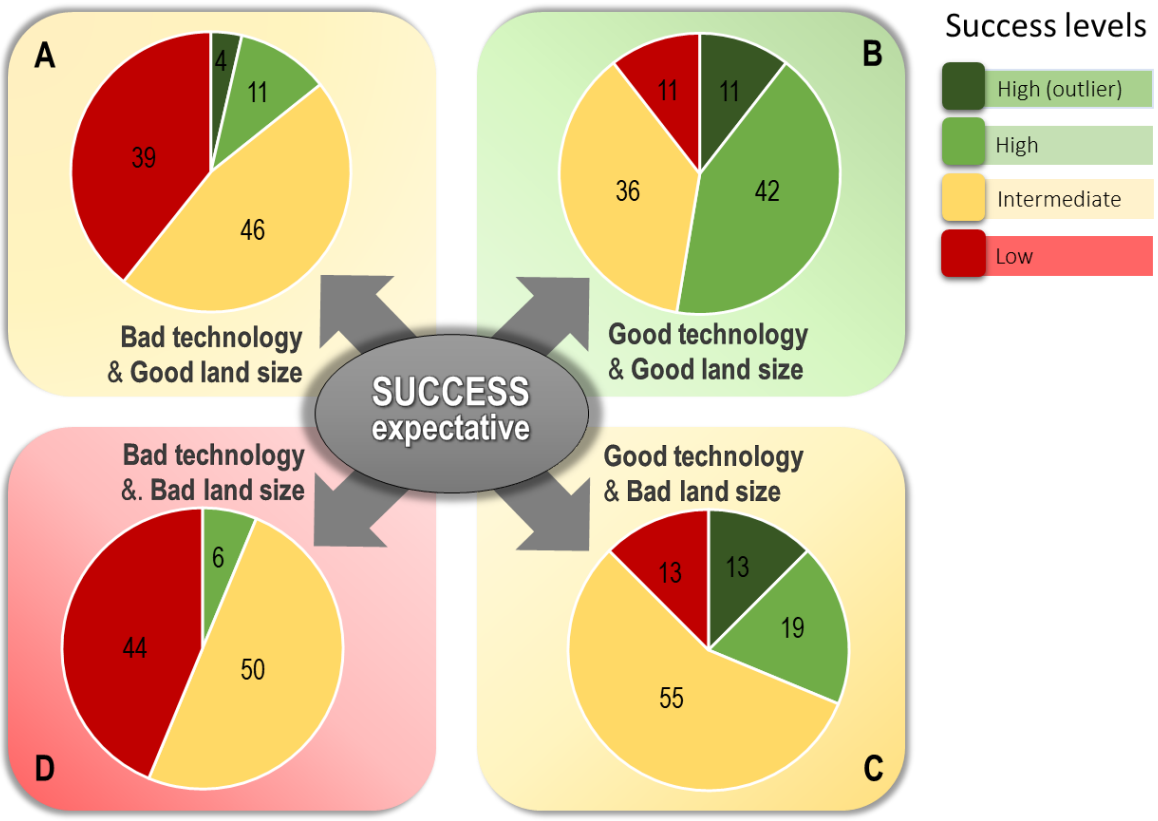

Figure 28. Expectative of success levels regarding the conditioning factors of technology and land size. Chance calculated by relative frequency (%) of sampled households for each condition: (A): N=28; (B): N=19; (C): N=33; (D): N=15. Parameter of good conditions: technology: appropriated farm equipment (>0.66); land size: ≥ 90 ha.

Hereafter, we use qualitative descriptions to expose real particularities of cases (Table 11) that corroborate the presented statistics (subsection I), also cases that were exceptions, with lower probability (subsection II) and cases that highlighted factors which were obscured or missed by the quantitative analysis (subsections III, IV, V and VI). From these cases, our main findings revealed: (i) the factors contributing to the living standard presented a wide variation, case-by-case, regarding the diversity of sampled households; (ii) besides land size and technology, other factors supported good standards of living, mainly whether combined, such as social interaction, market niches and regular off-farm income; (iii) factors not included in our statistical analysis were important for some cases, like initial capital with cumulative experience, but mainly the role of familiar stability.

Table 11. List of households used for descriptions of personal pathways, ordered by order of citation in text. * income outliers.

Farmer	Success level	Income (USD/year)	Off-farm income	Tech	Land size (ha)	Soil fertility	Market dist.	Social inter.	Market niches
A cacao	low	4,707.61	18%	inter.	5.2	inter.	Near	-	eventual
B cacao	low	11,165.22	19%	inter.	45.8	inter.	Near	±	none
C both	inter.	12,147.83	53%	high	100	inter.	Near	-	eventual
D cacao	inter.	27,486.56	1%	high	100	inter.	Far	-	none
E cattle	inter.	34,254.93	0%	inter.	362.25	Poor	Near	±	eventual
F both	high	33,484.35	20%	high	91	Fertile	Near	+	constant
G cattle	low	16,144.35	27%	high	200	inter.	Near	-	eventual
H both	low	7,991.01	3%	high	90	inter.	Near	-	eventual
I both	high	41,719.13	6%	inter.	84	inter.	Near	+	constant
J cattle	high	31,360.00	69%	inter.	86.5	Fertile	Near	±	constant
K cacao	low	10,999.17	4%	high	3.4	Fertile	Near	±	none
L cattle	low	6,045.51	57%	inter.	97.5	inter.	Near	-	eventual
M cattle	high	34,162.32	1%	inter.	197.5	inter.	Far	±	eventual
N both	high	47,785.69	12%	high	140	inter.	Far	+	constant
O both	high	25,937.25	42%	high	110	inter.	Near	+	eventual
P cacao	inter.	16,150.22	72%	inter.	11	Fertile	Near	+	eventual
Q both	inter.	29,457.78	64%	inter.	50	inter.	Far	+	constant
R both	inter.	14,830.64	59%	low	132.5	inter.	Near	+	constant
S both	inter.	21,886.38	50%	inter.	96	inter.	Near	+	eventual
T cattle	inter.	11,925.80	83%	inter.	79	inter.	Near	±	eventual
U cacao	high	67,783.04*	17%	inter.	21.5	Fertile	Far	+	eventual
V cacao	high	145,329.71*	19%	high	83	Fertile	Far	+	constant
X both	high	114,884.06*	24%	high	97.4	Fertile	Near	±	constant
Y both	high	90,063.99*	32%	inter.	354.2	Fertile	Near	±	constant
Z1 both	inter.	12,654.78	0%	inter.	49.74	Moderate	Near	+	eventual
Z2 both	inter.	14,998.07	11%	high	59	Moderate	Near	+	eventual
Z3 both	low	8,604.83	4%	inter.	52.5	Moderate	Near	±	eventual

I. Typical households

Around five years ago, the young farmer "A" spent all his savings to buy a very small piece of land (5.2 ha), full of cacao plantation, to live with his wife and two little daughters. Their main social interaction was the activities of the local church. Despite to be near market and have a relatively good quality of soil, the scarce farm equipment hampered their production. Besides cacao crop, the small benefit of "Bolsa família", a federal program for poor families, was their only income source, showing few options to surpass the low standard of living.

From another location but similar living conditions, the farmer "B" possessed a land size nine times larger than "A", however, even being more experienced by age and years of property, she could not manage to be more successful. The low technology was

an important hardship, but in her case, it was probably amplified by the motorcycle accident of her husband, years ago, reducing significantly his activities for farming.

On the other hand, having appropriated land size (100 ha) and enough access to farm equipment, "C" and "D" could surpass their difficulties and achieve an acceptable living standard. "C" invested his farm income to buy and rent a house in the city, while his wife worked as housekeeper. After five years of this livelihood, they were in process of migration to the city, where they built a well-structured house, near the job of their daughter in the gas-station. "D" was a recent colonist placed in a settlement with stronger restrictions of land use by environmental law. He had an organized work routine and became intermediate level of success by managing just 15% of his land, with income from cacao crop plus receiving the benefit of "Bolsa família" program (yearly UDS 278).

Another pathway that achieved a satisfactory standard of living was the case of farmer "E". His parents were pioneers of the Transamazon, with wide farming experience coming from the south of Brazil. After his father death, he abandoned studies at high school to invest on family farming business, following his passion by cattle ranching. Living near city in poor soils, he took bank credits from the Constitutional Fund of North (FNO) to expand the pasture area, buying land from his brothers. Despite bad quality of housing plus missing corral structure, he had a truck to commercialize the cattle and often reformed his pasture with mechanization. His livelihood showed a trade-off between well management and well-being.

Even better off, with adequate land size and technology, many other living conditions favored the colonist "F" and his family to achieve their current high standard of success. Transamazonian residents since 1992, they also migrated from the south and were placed near the city in fertile soil. Their family trajectory was based on good practices of farm management. With basic education, the couple had four children, which concluded the high school and one became agronomist. Exceptionally, they all remained in the region, farming or working for rural demands.

The farm tenure of household "F" was titled, with careful composition planning - 30 ha of organic cacao, 12 ha of pasture for milk, 6 ha of sugar-cane and 1 ha of annual crops –which allowed them to become autonomous chocolate producers. Stability of income was achieved as well as market niches accessibility. In addition, they presented an entrepreneurial vocation. "F" had been the president of local organic cooperative and his wife learned how to make extra-money commercializing homemade bread and chocolate. Their last acquisition was a large and modern kitchen.

II. Exceptional households

The middle age "G" and the old "H" were farmers expected to be more successful according to their main living conditions (probabilities of Figure 28), but they still did not achieve a satisfactory living standard. Land size and technology were not a problem for them, as well as other factors such as market distance, soil fertility, access to public services, family labor and experience by property age. Their similar hardships converged by food variety, social interaction, women integration, forest cover and educational level.

Differently from "H", the farmer "G" looked slightly better because he received off-farm income for retirement. "G" had two lots of land, specialized on cattle ranching, and was owner of a small commerce in the village, where his wife worked. Their three children completed high school, one became the farmer successor, the other owned a business of moto-cross track and the only daughter suddenly died by unknown disease.

Despite some signs of improvements, like house expansion with better building (masonry), they were economically weak. After losing their daughter, their commerce was almost failing without profits. In addition, they lost considerable part of their herd by a severe drought, which targeted many places from that locality in 2015-16 (public employees estimated the death of 5,000 cattle and 1,000 ha of cacao plantations). At last, a cattle buyer defaulted his payments to "G", stealing his cattle evaluated in almost USD 8,000.

The few cases of high success under bad conditions of land size and technology revealed that these farmers had not so bad living conditions as commonly found for the low success households. For instance, "I" and "J" had a considerable amount of land (>80 ha) and - regardless their demand for corral or equipment for cacao primary processing - both farmers owned enough farm equipment for basic managements like fences, brush cutter, costal sprayer and other required tools.

III. Adversities hampering strategies

As showed by the case of "G" (subsection II), unpredictable adversities could affect the familiar stability, the core of household's organization, changing the personal pathway. For instance, the poor farmer "K" was 52 years old, with incomplete basic study, living in a bad housing with his wife and two young daughters, placed 4 km near city, in a very small-hold (3.4 ha) with few technologies but high fertility soil. Ten years ago, they had moved to this property, cultivating chicken and annual crops for

subsistence. He worked as sharecropper to invest income converting all his land (secondary forest) into cacao crop, aiming to acquire more land.

After some time, he suffered a remarkable familiar tragedy. His older son crashed on a motor-cycle, while driving home in its dangerous route. Disabled to farm, the young engaged on drugs trafficking, got sick and ended up being killed. In addition, "K" had no access to market niches and his main social interactions were promoted by the syndicate of rural workers, the local church and rarely community work by "multirão".

Other low success households presented resembling hardships, including situations of illness, father-son contest, recent divorce and alcoholism. For example, the farmer "L", which had been sick and his daughter had mental deficiency, depending on medicines. Like "K", farmer "L" had few possibilities of increasing his living standard, mainly engaged on church rather than other institutions for farm strengthening.

On the other hand, households which did not suffer with those kinds of adversities generally could achieve better success, like the cases of "M" and "N". Farmer "M's" wife concluded high school and, together, they manage the farm as a business to invest on their well-being. Placed in poor soils, livestock was their straight focus, tending to expand the land size as much as they could, as well as ranching technologies. With similar thinking and family organization, "N" built a well-structured corral and was irrigating their cacao.

IV. Highlighting important factors

The case of "C" (subsection I, above) showed an important contribution of off-farm income on the household's pathway. In this sense, the job of rural teacher fitted for "O" as livelihood strategy to keep the financial stability while living on farm with her farmer husband. Moreover, for some living trajectories, the off-farm income expressed relevant connections between social interactions and access to market niches, as showed by "F" (subsection I, above).

For instance, "P" and her husband were very socially active, as well as their two sons. She became municipal councillor, while her husband the president of local cooperative and their sons were enrolled to student movements. Besides accessing market niches by the social interactions, the off-farm income became the main financial source being invested on farming. However, it was remarkable their trade-off between investments in land or housing, like mentioned for "E" (subsection I, above), an aspect also presented for the following farmer "Q".

Farmer "Q" had been the president of the local cooperative, long-time engaged with social movements, with a wide social network. Collaborating to organize the commerce for organic cacao, he had eventual access to better prices. Nowadays, while his two sons worked in the family farm, most of the household income came from off-farm - two retirements, one teacher's salary of his daughter and "Q's" sales of newborn fishes "alevinos" -.

Similarly, the farmers "R", "S" and "T" had a wide social network by working as health agents for their communities, at same time, they accessed market niches. Another case that presented convergence of these factors was the farmer "U" and her husband, strongly engaged on cooperative for market niches, but also getting off-farm income by working with land mechanization. These above-mentioned farmers expressed a clear prospection of improving their living standards for the next few years.

V. The backstage of outliers

In addition, we found farmers evidently over the living standard expectative for the Transamazon situation. These were the top five income, the outliers, which reinforced the findings of subsection III, highlighting the association between off-farm income, social interactions and market niches.

Farmer "V" was one of them. His father carefully chose a fertile land when was being settled by INCRA, bringing all the family from the south. At that time, they had a car and became socially important collaborating to stablish other colonists. When young, his brother worked for regional companies of topography. His family had many hardships while settling, traveling to outside the Transamazon, but always coming back to help "V" on farming.

At the time of the interview, "V" had become a high specialized cacao farmer, with appropriated technology and land size. Also, president of local association of farmers, member of the cooperative owning a small chocolate factory, and acting intensively for the cacao commercialization. His wife makes chocolate, cacao liquor and other artisanal products. Stimulating the education for their children, the older son had a job in the city besides helping some farming activities.

Also income outliers, the farmers "X" and "Y" enjoyed distinct livelihood trajectories regarding evident familiar engagement on parallel social activities. Following the pioneer colonist history of "V", Farmer "Y" was an important actor for the local development, helping in the construction of the city buildings and acting for the rural

syndicate of smallholders. Despite some technological demands, his intere family worked well integrated in the farm activities, but two of his sons have an external job. One drives the car of rural school, transporting local kids for the municipal education, and the other was a city councilor, before engaged on organic cacao market.

The farmer "X" presented some similar features. Daughter of colonists, with strong social interactions, she was member of the same cooperative as "V" and had worked for the regional cooperative for organic cacao. She was bachelor's degree and got a job for the government but kept managing the farm from the city together with her son's family that stayed living in the land. They used all required farm equipments to support their production.

Moreover, "U" followed the "outlier's pattern" of social interaction, off-farm income and market niches in addition to family stability and technology. She and her husband could surpass the hardships of their small land and even facing a situation of fire that burned considerable part of their cacao plantation. With good organization of family labor, they explored their productive potential with extreme high technology, relatively to the region, regarding their fertile soil. They have a tractor which allows them to make an extra money to be, gradually, expanding their land size and cacao crop.

VI. Each case is one case

Regarding the above-mentioned households (subsections I, II, III, IV and V) we found diverse possibilities of pathways, case-by-case, that resulted on distinct living standards. In this sense, we looked at households aiming to explore factors that could lead farmers towards different standards of living. We choose three farmers, relatives and neighbors, with similar living conditions, such as income, land size, social interactions, soil fertility and farming system strategies. Technology was equivalent accessible because they shared farm equipment.

But the younger farmer "Z1" might be considered slightly better off ("intermediate-high") than his two uncles "Z2" and "Z3", because he owned one of the best housings of our sampling. Another reflection of their living standard could be saw by their transportation vehicles. While "Z1" owned an old motorcycle plus a second-hand popular car, "Z2" had a new motorcycle plus an old second-hand Hilux pickup and "Z3", the poorest one, possessed just an old second-hand motorcycle.

When compared, the family members of "Z1's" household had a higher education level than the members of his relatives. Born in that locality, the young farmers

could learn from "try-error"/success of their parents, relatives and friends from vicinity. In addition, "Z1" received land from heritage, being able to better prepare the farm composition, manage money, plan his family structure and invest on housing. The prominent aspects that could have given some advantages to "Z1" highlighted education levels and pointend to factors out of our framework, like initial capital and cumulative experience.

4.4. Comparative success analysis of Cacao and Cattle

Farmers of cacao (based agroforestry systems) can be as successful as the cattle ranchers. However, when both production systems are adopted together, the chance to be high success is slightly better off (Figure 29). From the high success households, the relative frequency revealed that 63% choose Cacao+Cattle as the main economic activity, while 37% choose just Cattle and 25% just Cacao. When compared, the Cacao+Cattle was significatively more successful than Cacao ($p<0.1$) but not than Cattle.

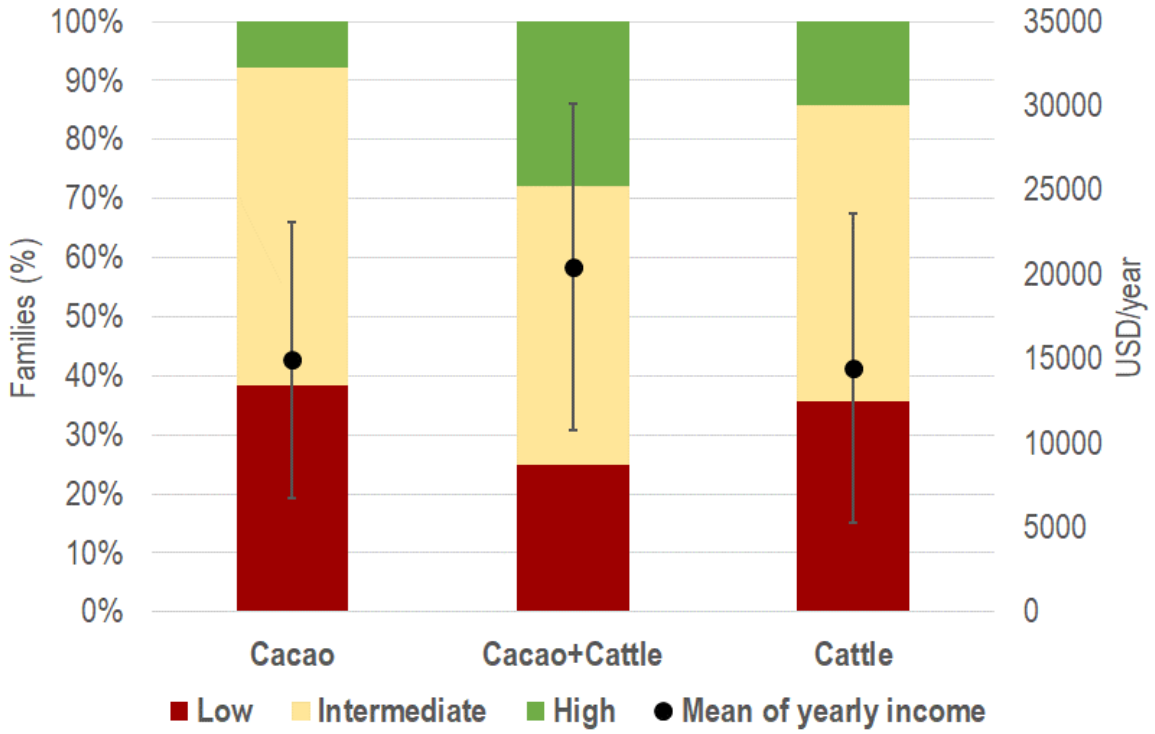

Figure 29. Frequency of families for the success levels and production systems.

The two production systems, cacao and cattle, presented distinct role for the family yearly income. Cacao could guarantee money in hands almost every week or month. Still, farmers could

not properly plan their budget or administrate their expenses because yield was seasonal and the local market prices was almost unpredictable for them. Our results evidenced that cacao propitiated higher income per unit area (Table 8) and highlighted the seasonal pattern of income availability (Figure 30).

Table 8. Yearly production and income per unit area for the two production systems, according to interviews.

	ha	Kg/ha.year	USD/ha.year
Cacao	15 ±14	630 ±300	1020 ±580
	ha	**Heads/ha**	**USD/ha.year**
Cattle	63 ±55	1.5 ±1	142 ±110

The climax of production used to last about three to four months, after the rainy season, depending on the geographic locality. The decreasing yield on the remainder months fell to around 20% of the highest apex, bringing a handful amount of income enough for basic needs, only. When the crop was old, or suffers with bad environmental conditions, commonly, the yield was zero for 1 to 3 months. During this period, cattle income could be an alternative. The months with higher cattle income fitted in the same period of less cacao income, suggesting the complementarity of both production systems.

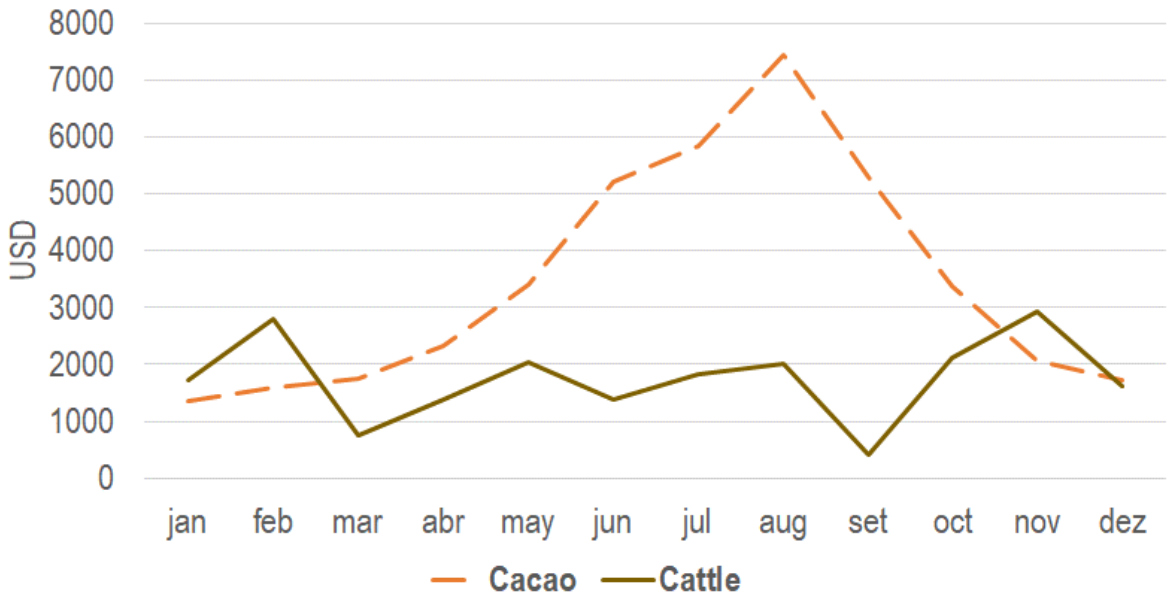

Figure 30. Seasonality of average income per month, comparison between production systems.

On the other hand, cattle ranching presented no pattern of monthly income other than milk yield, which few families (18%) were engaged. The vast majority of farmers produced the

animals for the beef chain, which the commercialization amount and period seemed to be totally dependent of personal reasons. Farmers commonly used the cattle as their living savings, selling determined number of heads one, two or three times per year, rarely more than this, according to the money required for some eventual need or specific investment.

Cacao for chocolate and cattle for beef were easily commercialized at Transamazon region. Both had some transportation hardships during the rainy season, mainly for those who were far from the market because of the precarious conditions of the routes "travessões". The buyers commonly came to take the production at the farm by order. For the cacao, this option was less available, but farmers managed to organize alternative transportation logistics, by cooperatives, community friendship or private/public transportation. For the cattle, farmers manifested less safe for the commercialization, some considerable level of insecurity to receive the payment, counting many stories of debts and middlemen "atravessadores" opportunists.

We summarized the distinctions found between the production systems at Table 9, evidencing the higher income achieved by households who adopted both production systems.

Table 9. Main factors that distinguished the production systems. ***p<0.01; **p<0.05; *p<0.1 Different letters ([a, b, c]), as well as different categories, means statistical difference (Kruskall-Wallis) between numerical values of production systems. Categorical variable's comparisons were calculated through indexes.

	Production System		
Variables	**Cacao**	**Cacao+Cattle**	**Cattle**
Income (USD/year)***	14,930 ±8,164 [a]	20,449 ±9,688 [b]	14,476 ±9,169 [a]
Land size (ha)***	52 ±48 [a]	87 ±40 [b]	130 ±77 [c]
Forest cover*	47 ±31 [a]	31 ±17 [b]	36 ±21 [ab]
Soil fertility**	high or moderate	moderate, low or high	low or moderate
Diversification***	specialized	diversified	specialized
Market niches***	moderate	low	low
Social interaction**	moderate	moderate	low
Women integration***	high	moderate	low

The cacao farms used to be smaller and located at better soil fertility conditions. Cacao farmers were better off to access market niches, mainly the organic, and to promote social interactions and women integration. It means that they have better relations with family and neighborhood, more participation on the community activities and on external meetings, events or partnerships. Besides, women participated more on cacao farming activities, mainly harvesting and drying the seeds.

As main drivers of success for cacao farmers, we pointed land size and technology (Table 10). Regarding the natural basis, cacao households still conserve more native forest when compared to those who additionally adopted cattle. At the same time, when soil fertility was

higher, the cacao farmers tended to convert more forest into cacao crop (R=-0.57; p<0.01). However, even the high fertility or less forest cover did not necessarily result in higher levels of success for the cacao farmers.

Table 10. Factors with significative correlations to success (R-values), per production system. Significance level of p-values by Spearman's test: ***p<0.01; **p<0.05; *p<0.1

	Cacao	Cacao+Cattle	Cattle
Income	0.78***	0.71***	0.77***
Housing	0.91***	0.95***	0.93***
Technology	0.51***	0.34**	
Land size	0.45**	0.34**	
Food variety		0.5***	0.38**
Property age			0.35*
Forest cover			-0.32*
Market niches			0.32*
Farmer age		-0.32*	
Water access		0.28*	
Diversification		-0.32*	

In contrast, the cattle farms used to have larger areas and be located at worst soil fertility conditions. Besides, ranching required less farm equipment and less labor than cacao crop. Cattle ranchers depended on large areas of forest conversion into pasture (Figure 31), showing the land use change as a promising investment, from ranchers' perspective. Property age, in this sense, represented the time farmers had to convert more forests into pasture. Another significant factor was the access to market niches, like cheese, milk or a better breed such as nelore cattle.

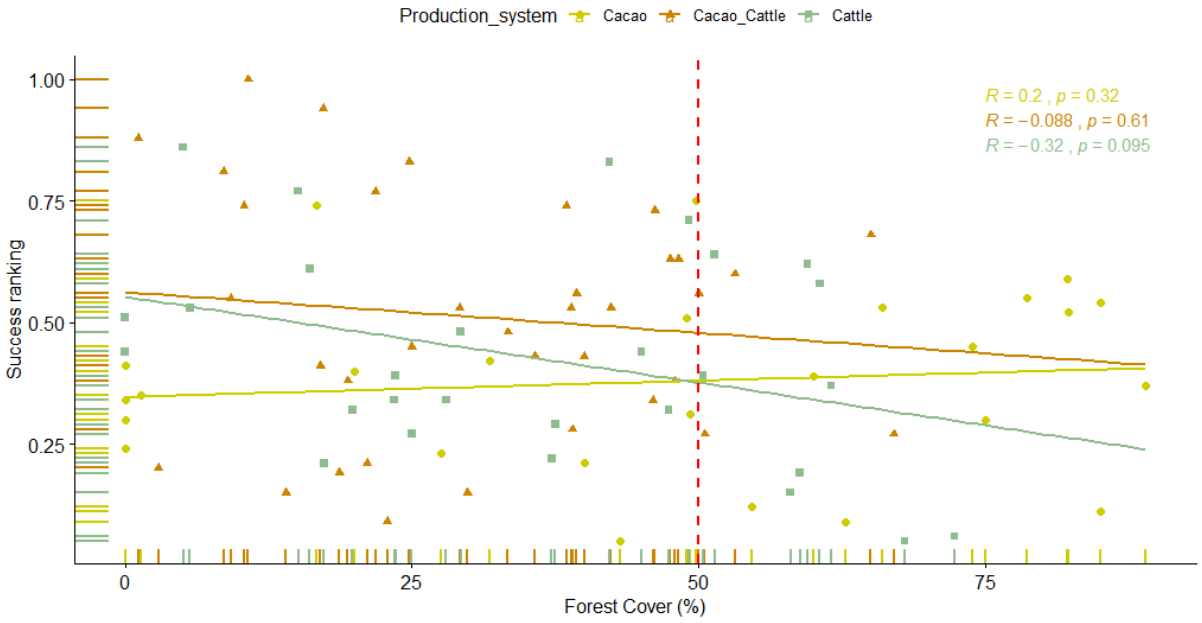

Figure 31. Household success by production system related to forest conversion (R-value, Spearman). Cattle ranchers presented a significative negative correlation between forest cover and success, while other production systems did not. Red line means percentual minimum of forest cover, required by the Brazilan forest law (12.651/2012).

The farmers who strategically adopted both production systems, cacao plus cattle, also tended to be more diversified in general, commercializing higher number of products. However, when diversification was too much, the success was negatively affected. In this case, young farmers had the advantage of health and energy for work to achieve success. Despite the higher chance to be successful, the union of cacao and cattle increased the chance of higher impact on natural basis, having less originally native forest cover. Regarding only 14% of cacao+cattle households maintained ≥50%, while this percentual of forest cover was achieved by 32% of cattle ranchers and by 46% of cacao farmers.

At last, the food variety and water access correlations to success were significantly associated ($p<0.05$) to income and housing, respectively, being understood as consequence of economic well-being improvements instead of drivers. Some variables could not distinguish the production systems, and neither were related to success, such as: land tenure, market distance, education and public services.

5. DISCUSSION

5.1. Diverse sample

Our methods of sampling did not follow a randomized survey design, generally employed by socioeconomic or land use studies (Browder et al. 2004; Caviglia-Harris 2005; D'Antona et al. 2006; Perz 2005). Despite challenging conditions when collecting field-based data in the Transamazon (see methods' section), similarly experienced by other field researchers in this region (e.g. Caldas et al. (2007) and Pacheco (2009)), we successfully employed the "first opportunity" method for a household-level data collection (Caldas et al. 2010; Pacheco 2009; Perz et al. 2007; Perz and Walker 2002). Considering these fieldwork challenges, studies suggests a sample of around 80-150 interviews is appropriate for survey studies in Amazon frontier regions (Caviglia-Harris 2005; D'Antona et al. 2006; Godar, Tizado, Pokorny, et al. 2012; Walker et al. 1997), thus our number of 95 interviews was adequate for our analysis.

The variation in our data indicated household diversity, underlined by descriptions of personal pathways (e.g. households from low to high economic well-being, regarding very different trajectories of livelihoods). Such diversity across households is not unique to our study site; rather, it occurs across the Amazon basin (Graeub et al. 2016; Vliet et al. 2015). Pokorny et al. (2010, 2013) described dozens of livelihoods along the Amazon basin, showing the household diversity across the regionality of multiple socio-economic contexts. Besides, Medina et al. (2015) revealed the socio-economic heterogeneity of family farming by regions of Brazil. And further, Muchagata et al. (2000) described diverse farming systems across individual households in Marabá, a municipality near our study site.

Acknowledging this household diversity, typology studies in the Transamazon region have tended to broadly categorize farmers in terms of production systems, wealth, and land area (Godar, Tizado, Pokorny, et al. 2012; Pacheco 2009); however, publications about land use and land cover similarly have portrayed the diversity of households (Perz and Walker 2002; Veiga et al. 1996; Walker et al. 2002). In addition, Perz (2005) analyzed colonists from Uruará and argued that diversity of personal assets influenced the household diversity and well-being. Regarding our results, aspects of economic well-being could accordingly distinguish households in the Transamazon region.

5.2. Quantification gaps suggest additional approaches

Given the results we obtained, one could try to systematize the influential factors of living standard through a mechanist logic, or framework. For example, by the analogy to the agronomic framework of soil fertility, the well-known "Law of the Minimum" by Justus von Liebig.

The Liebig's diagram is understood like building a barrel with wood, which will be full of some fluid. Applied to the topic of soil fertility, each piece of wood represents the nutrients, the fluid represents the yield. In our case of living standard at household level, each wood would represent one living condition and the fluid would represent the living standard. If some piece of wood was shorter than the others, it would provoke a leak, limiting the barrel to be full. We then proposed an hyphothetical framework based on results of our survey (Figure 32).

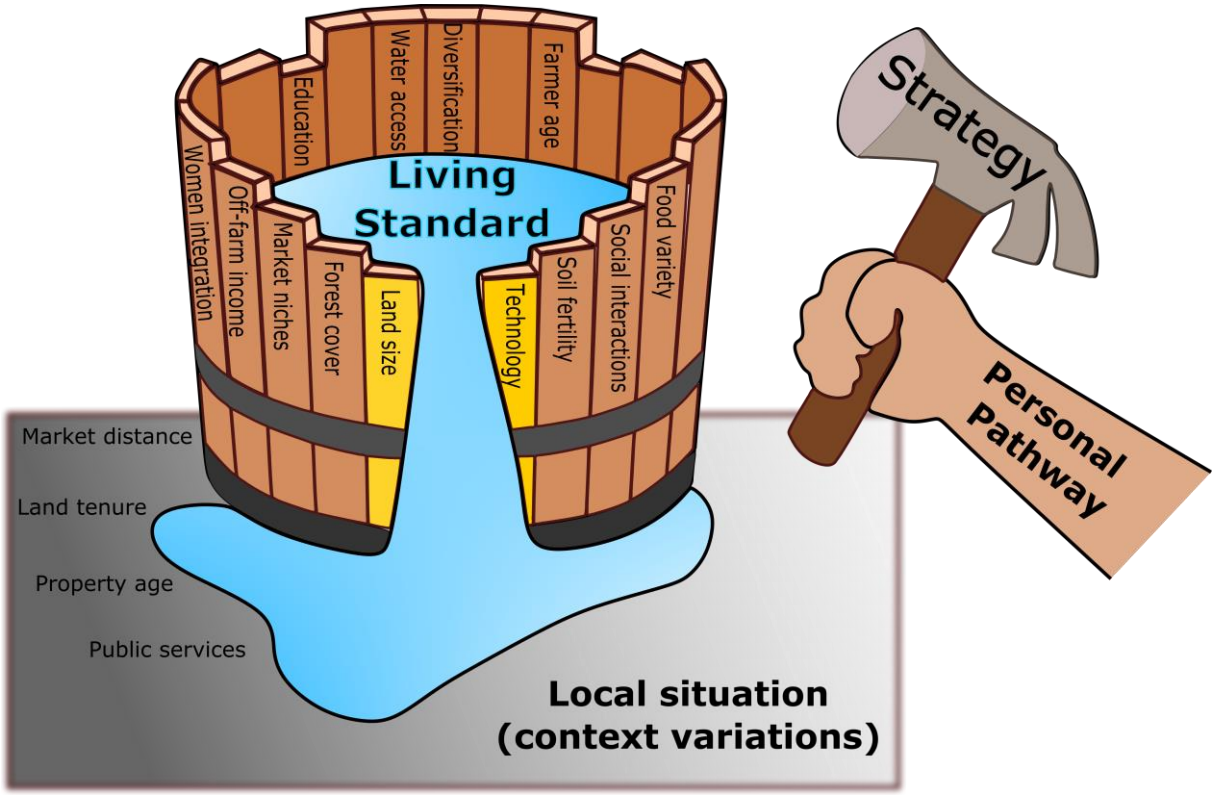

Figure 32. Hypothetical framework representing the household's living standard adapted from the "Law of the Minimum", by Justus Von Liebig.

The "Law of the Minimum" states the amount of the scarcest nutrient may proportionally limit the yield. Plants require greater amounts of certain essential nutrients (macronutrients) (Rajasekar, Nandhini, and Swaminathan 2017) and lesser quantities of other nutrients (micronutrients); nevertheless, micronutrient intake must be sufficient for healthy plant

growth (Dimkpa and Bindraban 2016; Hafeez, Khanif, and Saleem 2013) considering an adequate nutrient interaction (Fageria 2001; Rietra et al. 2017). Also, each specie requires different amount of each nutrient, which is influenced by environmental factors (Fageria, Baligar, and Li 2008). Similarly, households would need some key factors to increase their chance of success, at same time, other factors required in combination should not be deficient for an acceptable living standard. The contribution of each required factor varies household to household (by strategy/personal pathway), and depends on the influence of contextual factors.

This framework-based logic can be useful, but partially. Responses of PCA revealed that almost half of our analysis were not explained by the analyzed factors. Despite our effort to carefully select a considerable number of factors representing the living conditions of the study site, the quantitative findings were limited. One reason could be the absence of some influential factors, e.g. farmer origin or previous farming experience (Garrett et al. 2017; Godar, Tizado, Pokorny, et al. 2012; Murphy 2001; Pacheco 2009), access to agricultural policies, assistance or rural credits (Medina et al. 2015; Murphy et al. 1997) or initial wealth (Murphy et al. 1997; Perz 2005). Moreover, Scoones (2009) also underlined the importance of context, embracing governance, power ralations, etc., that influence the living standard.

The complex interactions makes the outcome of living standard not fully predictable, neither easily equationated. Despite the Figure 32 may help to partially understand the individual living standard, it could not be taken as a rule. Such logic could be too simplistic or reductionist whether not considering the dinamics of many perspectives, coming from varying specificities (e.g. personal pathaways, individual strategies and local context), including the variation of correlated factors across households.

In this sense, while we were able to link certain factors to success in our sample (e.g. land size and technology), those factors did not necessarily determine the living standard for many families. For instance, when we compared households with similar living conditions but different living standards, we found that small distinctions in the personal pathway could drastically change the living standard for some cases. From our understanding, the effect of key factors (e.g. technology) and how they interact with other factors (living conditions) varied in ways unknown across individual cases (highlighting the importance of diversity and, perhaps, subjectivity).

Therefore, we evidenced the household's living standard could not be fully explained only through quantitative modelling or simply by mathematical evaluations. Our research approach engaging participatory and local-level fieldwork was useful to reveal the complex interactions at the household level. However, a different type of field survey would be necessary

to achieve more holistic results, aiming to "fill" that gap of understanding about the variation in living standard across households. For instance, the use of methods to enhance qualitative analysis, rather than mechanical or numerical approaches, could capture the important role of institutions and organizations (contextual aspects) that mediate livelihood strategies and pathways (Scoones 2009). In this sense, we highlight that additional approaches would help to expand the living standard understanding, underlining that more focus should be given to the role of three main aspects: (i) context; (ii) strategies/personal pathways; (iii) subjective well-being: e.g. family stability.

5.2.1. Personal pathway through context

From the personal pathway perspective, individual behaviors should be considered to better comprehend the households's diversity within living standard. Our results showed that factors attributed to strategies and personal pathways were common for the data variance explanation, with contributions to the five dimensions of PCA. Variables with strategical meaning seemed to be guided by individual reasons, in turn, influenced by the context.

Despite the rural development context in Transamazon strongly facilitated the adoption of cattle ranching (Carrero and Fearnside 2011; Hecht 1993, 1985), at same time, famers had individual reasons to diverge on strategies, beyond livestock (Hoelle 2014; Siegmund-Schultze et al. 2007), investing in perennial or annual crops as their main activity (Godar et al. 2014; Godar, Tizado, Pokorny, et al. 2012). For example, studying the adoption of the farm diversification strategy supported by policy makers in Netherlands, Maraner et al. (2015) concluded that younger farmers, with more family labor and larger agricultural output, were more disposed to diversify their farming.

Decisions usually are based on relevant trade-offs (Steffan-Dewenter et al. 2007; Wainaina, Tongruksawattana, and Qaim 2014; Wale 2012). Those trade-offs possibly were considered by farmers during the decision-making process. Exemplifying, our field observations showed some families with savings, whether in cash or cattle, they needed to choose one investment option: if that monetary capital should be spent on farming, housing, health, transpotation (vehicle), or their children's education. In this sense, for example, rural child labor versus education is a trade-off hardly debated for Latin America situations (Emerson and Souza 2008; Kruger 2007; Psacharopoulos 1997). Another daily example we observed regarded the management routine, when the resource shortages forced the farmer to either prune the cacao or "clean" the pasture. Besides financial resource limitations, studies have demonstrated that

management decisions include trade-offs regarding sustainable agriculture practices (Jaleta, Kassie, and Shiferaw 2013; Steffan-Dewenter et al. 2007) or even the farmer's health (Antle and Pingali 1994).

Our field observations also suggested that behaviors/decisions of personal pathways could be based on a wide range of subjective reasons, including linkages from the past (culture, life history, education, farming experience, etc.), of the present (immediate needs or priorities, such as hunger, children education, habitation, etc.) or aspirations for the future (search for status, economic stability, well-being, etc.). Supporting the existence of subjectivity in the process of choices, Meraner et al. (2015) recognized that farmer's personal attitude probably has a mix of motives, regarding the psychological influence.

For example, Garret et al. (2017) pointed out that subjective well-being embedded in one's lifestyle – more so than income – was a reason for households to be farmers in two regions of Eastern Brazilian Amazon. Kastner and Stern (2015) made a review to show that household decisions for energy-relevant investments were frequently related to beliefs about consequences for and beyond the household. These examples reinforce how difficult it is to explain the reasons for the standard of living based only on quantitative methods.

Another way of analyzing the influential factors would be to look at the relationship between agency and structure. These two terms are widely debated by sociologists and anthropologists in scientific literature, presenting many different points of view (Gardner 2016; Jessop 1996; Sewell Jr. 1992). Here, we simply mean what agency would be people's individual ability to act freely, according to one's own desire or creativity. Structure would be related to culture and the factors that influence people's behavior, limiting the agency and shaping the society.

The personal pathway of some farmer or household naturally brings personal experiences accumulated along their own history of life, being affected by cognitive structure of beliefs. For example, the influence of marriage, religion, market, political relationships or even the culture promoted by the processes of pecuarization or colonization. In this sense, the importance of the context emerges from the role of the institutions present in a certain locality, as well as its focus of influence. The degree of influence of the institutions for the agency of the actors is difficult to measure, or even to define, but its existence is evident (Abdelnour, Hasselbladh, and Kallinikos 2017).

Moreover, much of our explanation gap, statistically pointed by PCA, could be embedded in the lack of linkages to broader macro-structural issues (a bias of our analysis). This issues were pointed out by Scoones (2009) while discussing about the "sustainable livelihoods

approach". According to Scoones (2009), it would be extremely important to not ignore structural forces of class and capital and deeply study the aspects related to power, politics, institutions and markets. He further argues for better linkages to governance debates in development, regarding long-term shifts in rural economies and the need to deal with climate change at a global level.

The literature supports that context strongly influences the trajectory of livelihoods, which has implications on a household's strategic decisions (DFID 1999; Scoones 2009; Singh, Singh, and Singh 2008). For example, studies have shown that given a context of environmental adversities, insecurity, or risks, migration decisions are taken on a household level but affected by individual attitudes (Comoé and Siegrist 2013; Dustmann et al. 2017; Giles and Mu 2018). Looking at the case of Belo Monte's dam, most of the displaced households decided to invest in cacao or cattle as livelihood strategies (Randell 2016b). Suggesting, individual behaviors are associated to local context, with considerable contribution to the regional diversity.

Therefore, the subjectiveness of behaviors/decisions or agency/structure toward strategies of personal pathways, in the given living conditions, could be other relevant factors to be added in the gap of living standard's explanation.

5.2.2. Subjective well-being: family stability

Our qualitative analysis of personal pathways enriched our interpretation of the statistical results and evoked insights about non-evaluated factors that may explain part of the data variation, not captured by PCA. For example, familiar stability, which could represent one aspect of subjective well-being. In our sample, households with higher living standards generally had healthy family members and stronger family union and organization for farming, which drastically contrasted with that of outliers; meanwhile, less successful households commonly presented evidence of familiar hardships. Other research has described the importance of family structure regarding the core of labor for farming, narrow farm interests, and the interaction of households with the farm business (Errington and Gasson 1994).

Errington and Gasson (1994) argued that organization of family members and health are essential aspects to achieve the production objective, which supported the idea of living standard related to family stability for the household's success. In addition, Vliet et al (2015) and Pokorny et al. (2013) pointed out the role of family labor in family farming, which responds efficiently in the limited economic situation due to their flexibility and motivation to work, and with better knowledge of the site conditions.

Guedes et al. (2012) expanded the understanding of familiar stability when they used family social network as one dimension of their well-being framework for Altamira, including the variable "relatives living in the region". According to Loeber et al (2000), the family structure/composition and the age of mothers when they have their children can impact on the development of juvenile offending. In addition, Fowler et al (2015) found the influence of housing mobility to the dynamic household composition. These studies suggest the important role of family stability for the general well-being of households. The adversities that families suffered, described by the personal pathway of our sampling, had a considerable contribution to their livelihood trajectories and therefore to regional diversity. This adversities woulbe embraced by the concept of shocks in the context of household vulnerability, summarized by the conceptual framework of DfID (1999).

5.3. Key factors of the living standard

Despite that market distance was not correlated to success, it expressed relevant contributions for the PCA, probably affecting the household's diversity. This contradiction is comprehensible considering the literature review presented by Walker et al. (2002), about variables from empirical household-level analyses in the Amazonian and the Neotropical Americas. These authors showed negative but also positive correlations of market distance and land use/investment outcomes, with significant and non-significant results. In line with our results, Guedes et al. (2014) did not find a significant relationship between distance from urban Altamira and the household's poverty level. In addition, the precarious conditions of roads, which may influence decisions and profits, have been reported by other authors (Perz and Walker 2002).

Among the four success correlated variables, technology and land size were highlighted, but water access and food variety were not. Water access was considered an important factor by the literature (McCracken et al. 2002; Pokorny and Jong 2015), but, in contrary, other authors did not find significant results (Brondízio et al. 2002; Garrett et al. 2017) similarly we did not find relevant contribution to the PCA's dimensions. Probably this result is due to the common availability of water by water springs, small rivers or soil perforations also the high levels of rainfall.

Like our findings, Pelegrini and Tasciotti (2014) found positive correlations between food variety and household income in developing countries; however, they do not discuss causal relationship, whether food affected income or *vice-versa*. Our observations suggest that food

variety seemed to be more influenced by other factors rather than the driver of success. Ortiz et al., (2013) showed that Amazon populations commonly buy around 80% of their food for consumption, which may depend on diversity of ingredients accessible in local markets. Therefore, the diversity of ingredients consumed may be a good indicator of a consequence of living standard, but not a cause.

Hayami and Rutan (1971) stated that farming success depends on the use of well adapted technology, which is consistent with the global understanding of rural development for the smallholders from tropical Americas (Pokorny and Jong 2015). In the case of Brazilian farmer strategies, Medina et al. (2015) revealed high correlations between technological factors and income. The conclusions of Cattaneo (2001), showed that technological changes in the Amazon, mainly if applied for livestock, would imply in desirable effects on smallholder's economic well-being regarding conditions of labor, capital and productivity. Moreover, the modelling analysis of poverty (of settlers along the Transamazon) made by Guedes et al (2012) pointed out significative results of agricultural technology to multidimensional indices of well-being.

In contrast to our findings, Garret et al. (2017) and Cattaneo (2001) found that technology was a significant factor in the success of cattle ranchers from the Amazon. In our results, the household technology was generally in good condition, but it is important to consider that our data analysis included only the basic farm equipment used in cacao and livestock management, which demand few intensive activities (Hecht 1993; Silva Neto 2001; Veiga et al. 1996). Similarly, in the municipality of Santarém in Pará, D'antona et al. (2006) found that farming systems usually employed very basic technology, mainly manual practices. For example, farmers from our sample rarely owned machinery or used fertilizers, which is typical in Brazil's norther region, and confirmed by Medina et al. (2015)'s research.

Studies have related technology to farm size, demonstrating that higher investment in intensive technology is more common among largeholders compared to smallholders (Hazell et al. 2007; Mazoyer and Roudart 2010). Generally, land size is associated with wealth or the capitalization level for productivity (Vliet et al. 2015).

The contribution of land area to the success of our sampled households was consistent with the findings of Murphy et al. (1997) and Siegmund-Schultze et al (2007), which found positive correlations between farm size and income for Amazon farmers. Similarly, the size of farms in Brazil generally present a significant positive correlation with income (Medina et al. 2015). The statements of Godar et al. (2012) suggested that the relationship between land size and farming success along the Transamazon should consider other decisive living conditions

together, which is supported by our results showing land size having the highest number of correlations.

5.4. Land size of small-scale households

Pokorny et al (2013) demonstrated that small farmers are important actors for the rural development of Amazon basin, improving the local well-being while attempting to meet the demands of poverty alleviation, food security and climate change. Research has assigned different property sizes to the group 'smallholders' in the Amazon basin, usually up to 100 ha (Godar et al. 2014; Godar, Tizado, Pokorny, et al. 2012; Margulis 2004; Siegmund-Schultze et al. 2007). But the definition of smallholders by the farm size or land area is controversial (Pokorny and Jong 2015; Vliet et al. 2015). For example, Godar et al. (2014) considered large properties those with >500 ha for the Brazilian Amazon.

A unique land area would imply unfair categorizations whether neglecting the biophysical conditions of the site (Pacheco 2009; Wood 2002) associated with infrastructural and institutional conditions (Perz and Walker 2002; Pokorny and Jong 2015). Attempting to address this issue, the Brazilian law defined a range of land sizes according to "fiscal modules", which incorporate the general conditions of land productivity for each municipality (BRASIL 1979). In order to benefit from public policies, smallholder households must have less than 4 fiscal modules (limits of 280-300 ha in our study site) and criteria of family farming features, according to national legislation (BRASIL 2006).

However, even the definition of family farming is hotly debated by academics (Errington and Gasson 1994; Vliet et al. 2015). For example, for the region of Transamazon, these rules neglect that small-scale cacao farmers commonly need to hire labor, or employ the system of sharecroppers "meeiros" (Brondizio 2004; Randell 2017), when their crop area is above 10-15 ha. For instance, if they fail to meet the smallholder criteria by law, they would be excluded from rights related to land use/forest cover by the Federal Law 12,651/2012 (BRASIL 2012), or from commercialization priority for farming products by the National Program of Scholar Food "PNAE" (BRASIL 2009).

According to Medina et al (2015) we observed that land size commonly restricts the household production, mainly when associated to precarious infrastructural and institutional conditions of context. These unfaroble conditions were also pointed out by Brondízio et al. (2002) like relevant conditions affecting the household's behavior for land use and land cover (Perz and Walker 2002). From the living standard perspective, Guedes et al (2012) found greater

inequality between groups with different property sizes, smaller properties being poorer than larger ones. As expected, Guedes et al (2014) statistically demonstrated that "larger properties and older households are associated with better-off smallholders".

Based on the land size average of our sample of households with intermediate/high success, we observed that, small-scale cacao farmers placed on fertile soils would be able to achieve an acceptable living standard with 50 ha, while cattle ranchers in poor soils would need 160 ha. With moderate soil fertility, where cacao and livestock could be adopted, a land area of 100 ha would be sufficient. However, these observations did not account for the minimal conditions in which smallholders would be able live considering forest conservation under current legal requirements.

Our sample, including the income outliers, presented just 2% of small-scale households slightly over the legal area-limit for smallhoders in their municipalities, and just 5% of households (all cacao farmers) presented more hired/sharecropper labor than family labor. Which means that only exceptions overpassed the limitant criteria of Brazilian law. Moreover, it is known that Transamazonian smallholders still preserve more than largeholders (Godar, Tizado, and Pokorny 2012).

5.5. Better living standard and contradictions of rural development

For the main question of our research, about what living standard would be expected for small-scale farmers in the Transamazon region, we confirmed Moran (2016)'s descriptions that say: over the years, many colonists "built ever better homes, their children studied in the city, and many own homes in town while still continuing to manage their rural properties. In other words, over a generation, a not insignificant number of them moved from being landless to being middle class". Known that most families had migrated in conditions of great poverty (Kleinpenning 1977, 1971; Mahar 1989), our results showed that it is now possible to reach a standard of living at acceptable or good levels.

Guedes et al. (2012) revealed that poverty and inequality decreased among smallholders from Transamazon over time but suggested a certain limit by structural bottlenecks. Nevertheless, Moran (2016) underlined that not all households succeeded, in accordance with our results. We found from very bad to comfortable housing, also a large discrepancy between income thresholds (around 2,000 to 145,000 USD/year), since it is more common to find worst than better conditions of living. In this sense, the scope of our sample indicated the presence of

aspects of poverty and inequality in the standard of living, especially whether considered the outliers.

Taking the infrastructure to exemplify the contradictions of the context, since 2014, the BR-230 had 400 km of paved road between Novo Repartimento and Medicilândia, where concrete bridges are currently being installed (later than announced by managers). The non-paved roads "travessões" usually receive maintenance of machines once or twice a year (being more harmed in places where there is frequent extraction of wood). Despite, improvement of roads still one of the greatest demands of smallholders from our sample.

There were also improvements in the access to basic public services, such as light, education and health, considering these demands were rarely accessed by the population at the first decades. However, access does not mean quality. We experienced these public services in rural zones, observing they are all basic and deficient. For example, electricity was very unstable and education and public health were precarious, lacking trained professionals and appropriated equipment or resources. These shortcomings were described by Pokorny and Jong (2015) and Moran (2016) in general terms.

Therefore, when observed throughout the period of colonization, the model of progress seems to have brought few improvements, or less than expectations. With almost a half of a century since the opening of Transamazon highway, in 1970, the evolution of living conditions and the living standard have grown at a slow pace. On the other hand, rates of deforestation (INPE 2017) reveal a very fast process of land use conversion (Wood and Porro 2002). As we reported, the literature about Transamazon relates rural development to ecological implications, mainly to deforestation (Becker 1988; Guedes et al. 2012; Moran 2016). Recent studies have highlighted the socioeconomic and environmental contradictions of Transamazon "progress" (Bro and Moran 2018; Simmons et al. 2019; Simmons, Walker, and Perz 2016).

5.6. Cacao farmers can be successful as well as cattle ranchers

The rural economy of the Transamazon has grown, driven by cacao and beef commodities (IPEA 2010; Margulis 2004; Moran 2016; Oliveira 1981), the smallholder playing a key role on both value chains (Godar, Tizado, Pokorny, et al. 2012; Godar, Tizado, and Pokorny 2012; Pokorny et al. 2013). At the household level, we demonstrated that small-scale cacao farmers and cattle ranchers could be successful as well, and both together could be slightly better off.

Yearly income per unit area of cacao crop was estimated to be superior than that of cattle. For tropical America, studies have shown a cacao yield of about 250 kg/ha.year (Deheuvels et al. 2012; Somarriba et al. 2013; Somarriba, Villalobos, and Orozco 2009; Whelan et al. 2007), estimated at around 500 USD/ha.year. Our results showed more than double estimation, which is compatible with the findings of other studies for the Pará and Transamazon regions (Mendes and Mota 2016; Mendes and dos Reis 2013; Schroth et al. 2016).

The productivity of bovine livestock (heads/ha) of our sample was similar to the Amazon average and around the double the Pará average (R. Walker et al. 2013). The income values found by Buschbacher (1987) on the first decades of Transamazon colonization, between 50 to 104 USD/ha, were less than those in our results. On the other hand, our average income was less than half of the 372 USD/ha found by Garret et al (Garrett et al. 2017), but his calculations considered some largeholders "outliers", with more than 2000 USD/ha.

Comparing the profitability of the farm systems, regardless the costs of land and initial plantation, the net revenue of cacao was estimated to be, at least, more than six times greater than cattle ranching per unit area. The results of Arima, Barreto and Marky et al. (2005) for the Brazilian Amazon and Siegmund-Schultz (Siegmund-Schultze et al. 2007) for smallholders from Pará showed a net revenue of about 19 and 18 USD/ha of pasture, for the respective authors. While for cacao net revenue in Pará, including the costs stated by Mendes and Mota (Mendes and Mota 2016) and the cacao price at 1.5 USD/kg, it could be estimated at more than 1000 USD/ha.year for the average of cacao productivity in Pará (dos Reis and Silva Neto 2013), and about 120 USD/ha.year for our sample.

However, scaled up cacao plantations would be restricted by favorable biophysical conditions (Pacheco 2009; Schroth et al. 2016) regarding the predominant poor soils of Amazon basin (IBGE 2008b; Sombroek 1984). This is not a problem for cattle ranching (Buschbacher 1987; Walker et al. 2009). Moreover, the adoption of livestock rather than cacao has other economic and cultural reasons besides just biophysical conditions.

For instance, Garret et al (2017) unveiled that livestock colonists perceived a better well-being than those with other land uses. In this sense, Siegmund-Schultz et al. (2007) deduced that livestock have a functional quality beyond productivity, also being a tool of land occupation and status increase. Therefore, the adoption of ranching may fall into the personal behaviors, discussed above, regarding aspects of culture, tradition or status (Hoelle 2014, 2018). But Pedelahore (2014) showed that farmers also associate the cacao plantation with social status. Still, many small-scale farmers choose to cultivate both cacao and cattle, when feasible.

Our findings suggested that households have a common behavior of carefully choose their farming systems according to the local biophysical conditions, but also considering the opportunities of context, for example that both cacao and cattle received institutional and infrastructural support in Transamazon (Hecht 1993; Mahar 1989; Mendes and Mota 2016; Oliveira 1981; Schroth et al. 2016). This behavior is related to the potential of Amazon smallholders to adapt to the local conditions, which was elucidated by the Pokorny et al (2013) and Pokorny and Jong (2015).

5.7. The dilemma between strategies for success and forest conservation

Comparing the household's living standard by strategies, successful cattle ranchers provoked higher deforestation than successful cacao farmers. Consistent with the findings of Walker (2002), we showed that when farmers adopted cacao and cattle in the same property, the deforestation was even higher, following a slight increase of the chances of success. Supported by Pacheco (2009) and Garret et al (2017), we argue that increase of economic well-being to high levels probably implies higher deforestation, especially when adopting extensive ranching. Accordingly, Wunder (2001) expressed that income increases demand for agricultural land, impacting negatively on natural areas across landscapes.

Murphy, Bilsborrow, and Pichón (1997) said that "*over time, more successful and experienced frontier households are likely to accumulate wealth and increase productivity*", regarding "*fertile soil*". This means that colonists have tended to make trade-offs between forests and cultivated products, often resulting in the sacrificing of forest-based benefits for cultivation, reducing plant diversity while expanding the area of converted land (Fujisaka and Escobar 1995; Fujisaka and White 1998; Veiga 1996). Farmers converting forests to fields generally do so aiming to achieve a better living standard through farming systems compatible with the natural basis of soil fertility (Godar et al 2012; Browder 2004).

Cacao plantations used to be one of these investments requiring forest clearing (Clay 2004; Piasentin and Saito 2014), albeit at a much lower scale than bovine livestock, which is pointed out as the main cause of Amazon deforestation (Fearnside 2005; N. F. Walker et al. 2013). Furthermore, it is well described by literature the manifold advantages of cacao agroforestry systems about the maintenance of important ecosystem services (Mortimer, Saj, and David 2018), highlighting the carbon stocks and biodiversity (Barrios et al. 2018; Somarriba et al. 2013)

For the farmers perspective, forest cover offers a kind of savings like a stock of soil fertility for production (Hecht 1985). But with short-term benefits after burned (Buschbacher, Uhl, and Serrao 1988; Jordan and Herrera 1981). Therefore, the conversion of forest into another land use would be a kind of investment with promising cost-benefits from an economic point of view (Andersen 1997; Margulis 2004). However, we showed a considerable risk of land use change does not lead households toward an acceptable living standard, as demonstrated by the low success farmers from our sample.

Our finding of a negative relationship between larger ranchers and forest cover is well documented in the literature (Fearnside 2005; Margulis 2004; Pacheco 2009; Walker et al. 2009). Beyond degradation of forests, authors have argued that capital accumulation by extensive ranching has contributed very little to alleviate the Amazon social and economic inequalities (Guedes et al. 2014; Margulis 2004; Verner 2004; Walker et al. 2009). In addition, market regulation and policies for beef trade can strongly influence the amount of deforestation or even the quality of land management at property level (Barreto et al. 2017; Faria and Almeida 2016; Gibbs et al. 2016; N. F. Walker et al. 2013). For the Transamazon, Schon et al. (2019) found "greater marginalization, longer land tenure and transitions to cattle grazing, but not agricultural rents, are major contributors to forest clearance and incentives not to comply with the Forest Code.".

Lastly, we did not find negative correlations between forest cover and other factors of living conditions. In contrast, other authors linked market distance to deforestation (Walker et al. 2002). The positive correlation between forest cover and land size is controversial. For instance, in similar frontier contexts of Pará, D'Antona et al. (2006) demonstrated that small-scale farmers with larger areas can retain more forests; in contrast, Ludewing et al. (2009) showed the opposite.

5.8. Future perspectives from the household level to the regional level

5.8.1. Synergy between strategies for success and forest conservation

Whether general economic well-being has improved over time, environmental drawbacks have increased so far (INPE 2017). To avoid the negative environmental impact of small-scale households, public policies should be diversely compatible with household diversity (Davidova 2014; Godar, Tizado, Pokorny, et al. 2012; Graeub et al. 2016; Pacheco 2009) regarding their protagonism for rural development (Pokorny et al. 2013). Given the importance of policies for command and control or payments for environmental services, for example, it is

needed to move forward the tradeoffs in mixed "rewards and punishments" approaches (Börner, Marinho, and Wunder 2015; Börner, Mendoza, and Vosti 2007; Gebara and Agrawal 2017). Household economic stability at local level should be targeted, side-by-side with policies for natural stability.

One way would be stimulating farm systems with "better-and-stable" financial return in smaller areas than extensive livestock, promoting the the so-called land-sparing. However, it is well known this "isolated" approach wouldn't be effective to conservation of forests (Gasparri, Grau, and Gutiérrez Angonese 2013; Morton et al. 2006). The ideal would be a combination of strategies, also mixing with land-sharing (Kremen 2015), regarding the support of institutions with good arrangements of governance (Ceddia et al. 2014; Garrett et al. 2018; Thaler, Viana, and Toni 2019) and specific policies for better agricultural practices associated to natural stability in compliance to the current Forest Law n° 12.651/2012 (Cohn et al. 2014; Matson and Vitousek 2006; Thaler 2017; zu Ermgassen et al. 2018).

For example, the intensification of extensive ranchings associated sustainable/conservation practies would require specific support to guarantee the farm system profitability for small-scale households (Barreto, da Silva, and Ellinger 2013; Garcia et al. 2017; Latawiec et al. 2014; Marcuzzo 2015; zu Ermgassen et al. 2018). Moreover, on the one hand, perennial crops were shown to provide better economic well-being (Siegmund-Schultze et al. 2007), on the other hand, biophysical conditions for production would be the major shortcomings to the widespread adoption of a couple alternatives (Pacheco 2009). In this sense, it would require more than just sustainable intensification of the same agricultural crops/commodities.

We argue that Amazon development should conciliate the household diversity to the biodiversity from each locality, building a broader portfolio of economic alternatives using, at best, agroforestry systems. Following the proposed "Amazonia Third Way" (Nobre et al. 2016; Nobre and Nobre 2019), an innovative way of development should include the most recent technologies, regarding the fourth industrial revolution, and rest on well organized institutions able to absorb a diversified production. Small-scale farming systems should be improved with the use of naturally adapted native species (Clement et al. 2010; Lima, Coelho–Ferreira, and Santos 2016; Maia and Andrade 2009; Shanley, Luz, and Swingland 2002), towards diversification with nontimber tree products, as suggested by Caviglia-Harris et al (2005) and Shanley et al. (2016).

First steps could reinforce the consolidated markets for açai and Brazil nut. Given the richness of useful species, for example, listed by Salomão et al. (2007) in the Transamazon, we underline some already locally extracted products, such as the oils of copaiba and andiroba, the

almond of cumaru, the fruits of cajá and cupuassu or the palms of bacaba, buriti and babassu, among others. Most of these plants already exist in the areas of cacao agroforestry systems or disperse on pastures (Braga 2015; Braga, Domene, and Gandara 2018). Despite the existence of some market niches and limited local value, farmers are cutting them off because little to no existing commercialization efforts or incentives. Moreover, many native products are being wasted in the fields or lost to deforestation, degradation or logging (Shanley et al. 2016; Shanley and Luz 2003).

Facing the general hardships of native nontimber forest product extraction (Wunder 2015) and cultivation (Hoch, Pokorny, and Jong 2009), rural livelihood alternatives require broader institutional support, based on the local knowledge and experiences (Hoch et al. 2009; Pokorny et al. 2013), while improving their commercialization (Shanley et al. 2016). Beyond the better management of trees inside areas of cacao and pasture, farmers could be encouraged to use various arrangements of profitable agroforestry systems (Cardozo et al. 2015; Yamada and Gholz 2002) designed for specific biophysical conditions including the rehabilitation of degraded lands (Lavelle et al. 2016; Rêgo et al. 2017; Schroth et al. 2016) or alternatively to slash and burn practices (Tremblay et al. 2014).

In opossition of the wake of the trend away from diversified to specialized livelihoods, household's diversification could be a good strategy to achieve success, increasing market independence, income, food security and well-being (Babatunde and Qaim 2009; Daud et al. 2018; Godar, Tizado, and Pokorny 2012; Pellegrini and Tasciotti 2014). For instance, Batistella, Bolfe and Moran (2012) poited out agroforestry systems as alternative to pasture. However, according to Porro et al (2012), the consolidation of a novel combination of production systems, using agroforestry systems as a pathway ("balancing development and conservation"), would require a "multichain" market approach supported by multilateral stakeholders in consonance with public policies and social organizations (Resque et al. 2019; dos Santos et al. 2015; Schmink et al. 2014). Moreover, in order to establish more complex production systems, it would be essential to improve the conditions for access to rural credit for small-scale farmers, through the National Program for Strengthening of Family Farming (PRONAF), and the technical assistance (Filho, Rowsy, and Castro 2016b).

In this sense, we observed a successful case of household with diversified livelihood and strong social interactions, harnessing the partnership of multiple stakeholders, who currently achieved a well living standard (Figure 33). From their poor beginning, they migrated to Transamazon in 1990s, like many other households, they accessed the PRONAF to buy a dozen of cattle for milk/meat subsistence; also, planted the cacao crop with their own labor but

supported by CEPLAC. Over time, they followed the technical assistance of Sister Dorothy Stang, from church, and diversified their farm production. Nowadays, besides a productive homegarden, they adopted agroforestry systems with cacao, açaí, cupuaçu, cajá and other perennial crops, as well as areas for annual crops in monoculture (e.g. pineapple, rice and maiz) and cattle ranching with rotated pasture management. Recently, with institutional support of an NGO, the Amazon Environmental Research Institute (IPAM), this household farmers could build a mini bio-industry to produce their own fruit pulp and sell it to the city demand, with guaranteed commercialization by the National Program of Scholar Food (PNAE).

Figure 33. Transamazon household colonists over time (1990s to 2010s): (a) Family of newcomer colonists in the middle of 1990s, from Anapu, with the Sister Dorothy Stang (1931-2005). Sister Dorothy worked for smallholders toward sustainable livelihoods and ended murdered as consequence of conflicts for land tenure and logging; (b) The couple of same family after 20 years of farming. Source: author's personal collection.

5.8.2. Socio-institutional organizations for a better rural development

Given the strong influence of contextual factors (e.g. governmental and market incentives, local economy, and institutional arrangements) in the process of decision-making for land-use change and livelihoods (Deadman et al. 2004; Margulis 2004; Richards and VanWey 2015; VanWey et al. 2007), the issues of rural development in parallel with forest conservation could not be thought without reinforce such factors. Aubertin (2015) argued that positive effects of Amazon forest conservation in the past were due to the major government's efforts. Assunção et al (2015) showed that both prices and polices were fundamental to improve conservation practices in the Amazon.

The local presence of market niches, concerned to environmental issues and fair trade, would be essential to demand smallholder's products in frontiers like the Transamazon (Vronski

and Olimpio 2016). Moutinho, Guerra and Azevedo-Ramos (2016) stated for a "new development paradigm" with the consolidation and expantion of sustainable commodities, with appropriate infrastructure, in accordance to the national legislation of forest protection. However, as already mentioned, expanding bovine livestock with sustainable/conservation practices would require better technical assistance with complentary policies and better governance (Garcia et al. 2017; Latawiec et al. 2014; zu Ermgassen et al. 2018).

In this sense, the study of Jones et al. (2016) at local level, suggested that Amazonian smallholders would decide to invest in conservation practices if alternative livelihoods were incentivated by economic strategies, regarding an institutional organization with hybrid public-private governance approach. On the other hand, Pacheco et al. (2017) showed that public policies and private initiatives combined with effective governance could reduce deforestation in the Brazilian Amazon, but not really stimulated a transition to more sustainable production systems. These same authors argued for new intensified models of production adapted to the local biophysical and sociotechnical conditions. They suggested that governance options should be designed in coordination with multiple stakeholders, from private to public, targeting alternative production systems.

For example, public policies as the National School Meal Program (PNAE) and the Food Procurement Program (PAA) are important to absorb part of the small-scale productions and to stimulate the community organization for agricultural diversification (Resque et al. 2019). Still, according to Filho, Calvi and Castro (2016a), such Programs "depends on the participation of farmer organizations, buying agents and especially on the political will of the managers". So, to attempt the issues of rural development in consonance with forest conservation, social and institutional organization in local would be required to build a base with good governance conditions (Ceddia et al. 2014).

We agree with Nobre and Nobre (2019) about harnessing the current technologies to develop new ways of production, adapted to the various contexts of Brazilian Amazon. We underline the favoring of bio-industries based on small-scale production of native nontimber products, at best provided by agroforestry systems. The aspects of social organization, farming systems and infrastructure for product processing should follow some successful examples of cooperatives from Amazon frontiers (Nobre and Nobre 2019).

For instance, Nobre and Nobre (2019) mentioned some big social organizations with bio-industries, processing products from agroforestry systems, such as the Tomé-Açu Mixed Agricultural Cooperative (CAMTA) in Pará (Batistella et al. 2012; Piekielek 2010), the Joint Venture and Dense Reforestation Project (RECA) in Rondônia (Vasconcelos et al. 2016), the

central cooperative of extractivism commercialization of Acre (COOPERACRE) in Acre (Castro et al. 2014; Schmink et al. 2014). Also, example of community organizations to produce native non-timber products like the women breakers of babassu, in the states of Maranhão and Tocantins (Pinto, Machado, and Kreutz 2018; Porro, Veiga, and Mota 2011).

Curiously, none of the many cooperatives, or similar social organizations, from the Transamazon evolved like those above mentioned. Administrative constraints were commonly observed during the fieldwork, but many hardships hampered the development of those institutions. For example, the organic cacao cooperative COPOAM suffers from people's individualistic culture, low capitalization, few accesses to agricultural inputs and technical assistance (Trzeciak et al. 2018). Similar difficulties were faced by other cooperatives, such as the agroextractivist association "Seeds of Forest" (ASFLOR) from Uruará, dedicated to agricultural and non-timber forest products and the cooperative of organic cacao products (COOPCAU) from Pacajá.

Parallelly, in the study site, NGOs have developed important projects broader than just extension, heading multilateral partnerships to improve the local well-being, food security, basic sanitation, economic stability and bringing the producers closer to consumers. For example, managing multiple stakeholders, IPAM has executed projects that helped households with their farming systems and structure, providing technical assistance and stimulating the accomplishment of the environmental laws, among many other benefits. Similarly, IMAFLORA and SOLIDARIDAD have worked in São Félix do Xingu and Novo Repartimento, respectively, reinforcing the smallholder's commercialization and well-being with successful achievements.

About those projects, we observed positive responses of visited households which indicate favorable outcomes for the actuation of NGOs. Experients and trusted institutions should have greater support/funds for long-term work, regarding the role of institutional context for land use decisions at household level (Perz 2001). Moreover, it highlights the importance of social organizations under the perspective of political dimensions of governance frontiers, as reported by Thaler et al (2019).

6. CONCLUSION

Our present study demonstrated that small-scale households could achieve acceptable or good levels of living standard, in terms of economic well-being. The great diversity of households presented considerable scope for success, despite the relevant shortcomings of the Transamazon region. Land size and technology were pointed as the most relevant factors contributing to success. But correlations and personal pathways highlighted that they could not be taken as a rule of decisive drivers of success, without considering other influential factors (from living conditions to living standard), suggesting that each case is one case.

Cacao farmers were successful as well as cattle ranchers. When both activities were adopted in the same farm there was a slight increase of the chance of success. However, the desirable living standard at high level of success is likely to transform forests into other more profitable land uses. This investment probably results in less forest conservation than the limits required by the Brazilian law, especially when employed extensive cattle ranching. Cacao agroforestry systems are economic alternatives, commonly with less impact on forest conservation. But the scope of cacao is limited mainly by conditions of soil fertility.

To reduce pressures on the environment and continue increasing the economic well-being, households would need higher efforts to find sustainable livelihoods, aiming to produce in smaller areas while conserving the forest reserve. Accordingly, we detected that specific production systems were not the core of success. This indicates that any profitable activities could be economic alternatives, provided they are feasible under the local living conditions (regarding biophysical site, market and socio-institutional context).

In this sense, we suggest the reinforcement of current agroforestry systems and the experimentation of new arrangements including, at best, non-timber products of native trees. However, to diffuse such more complex production systems requires better policies, focused on family farming, and effective support grounded in a thorough institutional cooperation of multilateral stakeholders able to establish effective logistics and attractive markets for the related diverse array of products.

REFERENCES

Abdelnour, Samer, Hans Hasselbladh, and Jannis Kallinikos. 2017. "Agency and Institutions in Organization Studies." *Organization Studies* 38(12):1775–92.

ABIEC. 2017. *Perfil Da Pecuária No Brasil: Relatório Anual 2018*.

Alden, Dauril. 1976. "The Significance of Cacao Production in the Amazon Region during the Late Colonial Period: An Essay in Comparative Economic." *American Philosophical Society* 120(2):103–35.

Aldrich, Stephen P. et al. 2006. "Land-Cover and Land-Use Change in the Brazilian Amazon: Smallholders, Ranchers, and Frontier Stratification." *Economic Geography* 82(3):265–88.

Almeida, Oriana Trindade D. E. and Christopher Uhl. 1995. "Developing a Quantitative Framework for Sustainable Resource-Use Planning in the Brazilian Amazon." *World Development* 23(10):1745–64.

Alston, Lee J., Gary D. Libecap, and R. Schneider. 1996. *The Determinants and Impact of Property Rights: Land Titles on the Brazilian Frontier*.

Andebrhan, Teklu, Antonio Figueira, Milton M. Yamada, Julio Cascardo, and Douglas B. Furtek. 1999. "Molecular Fingerprinting Suggests Two Primary Outbreaks of Witches' Broom Disease (Crinipellis Perniciosa) of Theobroma Cacao in Bahia, Brazil." *European Journal of Plant Pathology* 105:167–75.

Andersen, Lykke E. 1997. *A Cost-Benefit Analysis of Deforestation in the Brazilian Amazon*. 65. Brasília: Institute for Applied Economic Research.

Angelsen, A. and D. Kaimowitz. 2001. *Agricultural Technologies and Tropical Deforestation*.

Antle, John M. and Prabhu L. Pingali. 1994. "Pesticides, Productivity, and Farmer Health: A Philippine Case Study." *Amer. J. Agr. Econ.* 76:418–30.

Arima, Eugenio, Paulo Barreto, and Marky Brito. 2005. *Pecuária Na Amazônia: Tendências e Implicações Para a Conservação Ambiental*. Belém-PA: Imazon.

Arima, Eugenio Y., Robert T. Walker, Stephen G. Perz, and Marcellus Caldas. 2005. "Loggers and Forest Fragmentation: Behavioral Models of Road Building in the Amazon Basin." *Annals of the Association of American Geographers* 95(3):525–41.

Armengot, Laura, Pietro Barbieri, Christian Andres, Joachim Milz, and Monika Schneider. 2016. "Cacao Agroforestry Systems Have Higher Return on Labor Compared to Full-Sun Monocultures." *Agronomy for Sustainable Development* 36(70).

Assunção, Juliano, Clarissa Gandour, and Rudi Rocha. 2015. "Deforestation Slowdown in the Brazilian Amazon: Prices or Policies?" *Environment and Development Economics* 20:697–722.

Aubertin, Catherine. 2015. "Deforestation Control Policies in Brazil: Sovereignty versus the Market." *Forests, Trees and Livelihoods* 37–41.

Ayuya, Oscar I. et al. 2015. "Effect of Certified Organic Production Systems on Poverty among Smallholder Farmers: Empirical Evidence from Kenya." *World Development* 67:27–37.

Babatunde, Raphael O. and Matin Qaim. 2009. "Patterns of Income Diversification in Rural Nigeria: Determinants and Impacts." *Quarterly Journal of International Agriculture* 48(4):305–20.

Barreto, Paulo, Ritaumaria Pereira, Amintas Brandão Jr., and Sara Baima. 2017. *Os Frigoríficos Vão Ajudar a Zerar o Desmatamento Da Amazônia?* Imazon and Instituto Centro Vida.

Barreto, Paulo, Daniel Silva da Silva, and Paula Ellinger. 2013. *Como Desenvolver a Economia Rural Sem Desmatar a Amazônia?* Belém-PA: Imazon.

Barrington-leigh, Chris and Alice Escande. 2016. "Measuring Progress and Well-Being: A Comparative Review of Indicators." *Social Indicators Research*.

Barrios, Edmundo et al. 2018. "Contribution of Trees to the Conservation of Biodiversity and Ecosystem Services in Agricultural Landscapes." *International Journal of Biodiversity Science, Ecosystem Services and Management* 14(1):1–16.

Bartholdson, Örjan and Roberto Porro. 2019. "Brokers – A Weapon of the Weak: The Impact of Bureaucracy and Brokers on a Community- Based Forest Management Project in the Brazilian Amazon." *Forum for Development Studies* 46(1):1–22.

Batistella, Mateus, Édson Luis Bolfe, and Emilio F. Moran. 2012. "Agroforestry in Tomé-Açu: An Alternative to Pasture in the Amazon." Pp. 321–42 in *Human-Environment Interactions*, edited by B. E. and M. E. Springer, Dordrecht.

Beauchamp, Emilie, Emily Woodhouse, Tom Clements, and Eleanor Jane Milner-gulland. 2018. "'Living a Good Life': Conceptualizations of Well-Being in a Conservation Context in Cambodia." *Ecology and Society* 23(2).

Bebbington, Anthony. 1999. "Capitals and Capabilities: A Framework for Analyzing Peasant Viability, Rural Livelihoods and Poverty." *World Development* 27(12):2021–44.

Becker, Bertha. 1988. *Fronteiras*. edited by U. de Brasília. Paris: ORSTOM.

Bezerra, Paula Borges da Silveira et al. 2017. "The Power of Light: Socio-Economic and Environmental Implications of a Rural Electrification Program in Brazil." *Environ. Res. Lett.* 12.

Bogaerts, Meghan et al. 2017. "Climate Change Mitigation through Intensified Pasture Management: Estimating Greenhouse Gas Emissions on Cattle Farms in the Brazilian Amazon." *Journal of Cleaner Production* 162:1539–50.

Börner, Jan, Eduardo Marinho, and Sven Wunder. 2015. "Mixing Carrots and Sticks to Conserve Forests in the Brazilian Amazon: A Spatial Probabilistic Modeling Approach." *Plos One* 1–20.

Börner, Jan, Arisbe Mendoza, and Stephen A. Vosti. 2007. "Ecosystem Services, Agriculture, and Rural Poverty in the Eastern Brazilian Amazon: Interrelationships and Policy Prescriptions." *Ecological Economics* 64:356–73.

Bowman, Maria S. et al. 2012. "Persistence of Cattle Ranching in the Brazilian Amazon: A Spatial Analysis of the Rationale for Beef Production." *Land Use Policy* 29(3):558–68.

Braga, Daniel Palma Perez. 2015. "Cacao Agroforestry Systems for Reclamation of Degraded Lands in Sao Felix Do Xingu, Pará." University of São Paulo / Luiz de Queiroz Agricultural College.

Braga, Daniel Palma Perez, Frederico Domene, and Flávio Gandara. 2018. "Shade Trees Composition and Diversity in Cacao Agroforestry Systems of Southern Pará, Brazilian Amazon." *Agroforestry Systems*.

BRASIL. 1970. *Decreto Lei n 1.106 de 16 de Junho de 1970: Cria o Programa de Integração Nacional, Altera a Legislação Do Impôsto de Renda Das Pessoas Jurídicas Na Parte Referente a Incentivos Fiscais e Dá Outras Providências.* Brasil.

BRASIL. 1974a. *Decreto Nº 74.607, de 25 de Setembro de 1974: Dispõe Sobre a Criação Do Programa de Pólos Agropecuários e Agrominerais Da Amazônia (POLAMAZÔNIA).* Brasil.

BRASIL. 1974b. *II Plano Nacional de Desenvolvimento (PND) Para o Período de 1975 a 1979*.

BRASIL. 2006. *Lei n 11.326, de 24 de Julho de 2006: Política Nacional Da Agricultura Familiar e Empreendimentos Familiares Rurais*.

BRASIL. 2009. *Lei n 11.947, de 16 de Junho de 2009: Atendimento Da Alimentação Escolar e Do Programa Dinheiro Direto Na Escola Aos Alunos Da Educação Básica e Dá Outras Providências.*

BRASIL. 2012. *Lei n 12.651, de 25 de Maio de 2012: Dispõe Sobre a Proteção Da Vegetação Nativa e Dá Outras Providências.*

BRASIL. 1966. *Lei n 5.174, de 27 de Outubro de 1966: Dispõe Sobre a Concessão de Incentivos Fiscais Em Favor Da Região*

Amazônica e Dá Outras Providências.

BRASIL. 1974c. *Lei n 5.727, de 4 de Novembro de 1971: Dispõe Sobre o Primeiro Plano Nacional de Desenvolvimento (PND), Para o Período de 1972 a 1974*.

BRASIL. 1979. *Lei n 6.746, de 10 de Dezembro de 1979: Altera o Estatuto Da Terra e Dá Outras Providências.*

Bro, Aniseh S. and Emilio Moran. 2018. "Market Participation in the Age of Big Dams: The Belo Monte Hydroelectric Dam and Its Impact on Rural Agrarian Households." *Sustainability* 10.

Brondizio, Eduardo S. 2004. "Agriculture Intensification, Economic Identity, and Shared Invisibility in Amazonian Peasantry: Caboclos and Colonists in Comparative Perspective." *Culture & Agriculture* 26(1–2):1–24.

Brondízio, Eduardo S. et al. 2002. "The Colonist Footprint: Toward a Conceptual Framework of Land Use and Deforestation Trajectories among Small Farmers in the Amazonian Frontier." Pp. 133–66 in *Deforestation and land use in the Amazon*, edited by C. H. Wood and R. Porro. University Press of Florida.

Browder, John O., Marcos A. Pedlowski, and and Percy M. Summers. 2004. "Land Use Patterns in the Brazilian Amazon: Comparative Farm-Level Evidence From Rondônia." *Human Ecology* 32(2).

Browne, James and Andrew Hood. 2016. *Living Standards, Poverty and Inequality in the UK : 2015-16 to 2020-21*. London: Institute for Fiscal Studies.

Buschbacher, R., C. Uhl, and E. A. S. Serrao. 1988. "Abandoned Pastures in Eastern Amazonia . II. Nutrient Stocks in the Soil and Vegetation." *Journal of Ecology* 76(3):682–99.

Buschbacher, Robert J. 1987. "Cattle Productivity and Nutrient Fluxes on an Amazon Pasture Author (S):" *Biotropica* 19(3):200–207.

Buschbacher, Robert J. 1986. "Tropical Deforestation and Pasture Development." *BioScience* 36(1):22–28.

Caldas, Marcellus et al. 2007. "Theorizing Land Cover and Land Use Change: The Peasant Economy of Amazonian Deforestation." *Annals of the Association of American Geographers* 97(September 2005):86–110.

Caldas, Marcellus M. et al. 2010. "Settlement Formation and Land Cover and Land Use Change: A Case Study in the Brazilian Amazon." *Journal of Latin American Geography* 9(1):125–44.

Cancian, Maria and Daniel R. Meyer. 2004. "Alternative Measures of Economic Success among TANF Participants: Avoiding Poverty, Hardship, and Dependence on Public Assistance." *Journal of Policy Analysis and Management* 23(3):531–48.

Cardozo, Ernesto G. et al. 2015. "Species Richness Increases Income in Agroforestry Systems of Eastern." *Agroforest Syst* (July).

Carr, David L., William K. Y. Pa, and Richard E. Bilsborrow. 2007. "Declining Fertility on the Frontier: The Ecuadorian Amazon." *Popul Environ* 28(2006):17–39.

Carr, David L., William K. Y. Pan, and Richard E. Bilsborrow. 2006. "Declining Fertility on the Frontier: The Ecuadorian Amazon." *Population and Environment* 28(1):17–39.

Carrero, Gabriel C. and Philip M. Fearnside. 2011. "Forest Clearing Dynamics and the Expansion of Land Holdings in Apuí, a Deforestation Hotspot on Brazil's Transamazon Highway." *Ecology and Society* 16(2).

Castellanet, C., A. Simões, and P. C. Filho. 1998. *Diagnóstico Preliminar Da Agricultura Familiar Na Transamazônica Indicações Para Pesquisa e Desenvolvimento. Documentos, 105*. Belém-PA.

Castro, M. J., M. S. CARVALHO, K. X. O. ORMOND, A. P. A. FARIAS, and D. M. MACEDO. 2014. "Análise Da Logística de Beneficiamento de Castanha, Borracha e Frutas: O Caso Cooperacre." *A Revista Eletrônica Da Faculdade de Ciências Exatas e Da Terra Produção/Construção e Tecnologia* 3(5):110–26.

Cattaneo, Andrea. 2001. "A General Equilibrium Analysis of Technology, Migration and Deforestation in the

Brazilian Amazon." Pp. 69–90 in *Agricultural Technologies and Tropical Deforestation*, edited by A. Angelsen and D. Kaimowitz. Costa Rica: CIFOR; CABI Publishing.

Caviglia-Harris, Jill L. 2005. "Cattle Accumulation and Land Use Intensification by Households in the Brazilian Amazon." *Agricultural and Resource Economics Review* 34(2):145–62.

Caviglia-Harris, Jill L. and Erin O. Sills. 2005. "Land Use and Income Diversification: Comparing Traditional and Colonist Populations in the Brazilian Amazon." *Agricultural Economics* 32(3):221–37.

Ceddia, Michele Graziano, Nicholas Oliver Bardsley, Sergio Gomez-y-Paloma, and Sabine Sedlacek. 2014. "Governance, Agricultural Intensification, and Land Sparing in Tropical South America." *PNAS* 111(10):7242–47.

CEPLAC. 2019. "Evolução Da CEPLAC Na Região." *Ministério Da Agricultura Pecuária e Abastecimento*. Retrieved February 25, 2019 (http://www.ceplacpa.gov.br/site/?page_id=9).

Chambers, R., 1987. "Sustainable rural livelihoods: a strategy for people, environment and development. Sustainable rural livelihoods: a strategy for people, environment and development." *Institute of Development Studies* (UK).

Chambers, Robert. 1988. "Sustainable livelihoods, environment and development: putting poor rural people first." Agriculture and Rural Problems, *Institute of Development Studies* (UK).

Chambers, Robert, and Gordon Conway. 1992. "Sustainable rural livelihoods: practical concepts for the 21st century." *Institute of Development Studies* (UK).

Chambouleyron, R. 2014. "Cacao, Bark-Clove and Agriculture in the Portuguese Amazon Region in the Seventeenth and Early Eighteenth Century." *Luso-Brazilian Review* 51(1):1–35.

Clay, J. 2004. *World Agriculture and the Environment*. Washington, DC: Island Press.

Clay, Nathan. 2018. "Integrating livelihoods approaches with research on development and climate change adaptation." *Progress in Development Studies* 18.1: 1-17.

Le Clec'h, Solen et al. 2018. "From Field Data to Ecosystem Services Maps: Using Regressions for the Case of Deforested Areas Within the Amazon." *Ecosystems* 21(2):216–36.

Clement, Charles R., Michelly de Cristo-Araújo, Geo Coppens D'Eeckenbrugge, Alessandro Alves Pereira, and Doriane Picanço-Rodrigues. 2010. "Origin and Domestication of Native Amazonian Crops." *Diversity* 2:72–106.

Cohen, Nissim and Tamar Arieli. 2011. "Field Research in Conflict Environments: Methodological Challenges and Snowball Sampling." *Journal of Peace Research* 48(4):423–35.

Cohn, A. S. et al. 2014. "Cattle Ranching Intensification in Brazil Can Reduce Global Greenhouse Gas Emissions by Sparing Land from Deforestation." *Proceedings of the National Academy of Sciences* 111(20):7236–41.

Comoé, Hermann and Michael Siegrist. 2013. "Relevant Drivers of Farmers' Decision Behavior Regarding Their Adaptation to Climate Change: A Case Study of Two Regions in Côte d' Ivoire." *Mitig Adapt Strateg Glob Change*.

Costa, Francisco de Assis. 1995. "O Investimento Na Economia Camponesa: Considerações Teóricas." *Revista de Economia Política* 15(1):18.

D'Antona, Álvaro O., Leah K. VanWey, and Corey M. Hayashi. 2006. "Property Size and Land Cover Change in the Brazilian Amazon." *Population and Environment* 27(5–6):373–96.

DATASUS and IBGE. 2010. "Índice de Gini Da Renda Domiciliar per Capita Segundo Município." *Ministério Da Saúde*. Retrieved November 28, 2018 (http://tabnet.datasus.gov.br/cgi/ibge/censo/cnv/ginibr.def).

Daud, Adebola Saidat, Taiwo T. Awoyemi, and Abeeb Babatunde Omotoso. 2018. "Human Capital and Income

Diversification among Crop Farmers in Rural Oyo State, Nigeria." *Journal of Agribusiness and Rural Development* 49:1–10.

Davidova, Sophia. 2014. *Small and Semi-Subsistence Farms in the EU: Significance and Development Paths*. Vol. 13.

Deadman, Peter, Derek Robinson, Emilio Moran, and Eduardo Brondizio. 2004. "Colonist Household Decisionmaking and Land-Use Change in the Amazon Rainforest: An Agent-Based Simulation." *Environment and Planning B: Planning and Design* 31:693–709.

Dean, Warren. 1991. "A BotâNica e a Política Imperial: A Introdução e a Domesticação de Plantas No Brasil." *Revista Estudos Históricos* 4(8):216–28.

Deheuvels, Olivier, Jacques Avelino, Eduardo Somarriba, and Eric Malezieux. 2012. "Vegetation Structure and Productivity in Cocoa-Based Agroforestry Systems In." *Agriculture, Ecosystems and Environment* 149:181–88.

DFID. 1999. *Sustainable Livelihoods Guidance Sheets Framework*. Vol. 2.

Díaz, Sandra, Joseph Fargione, F. Stuart Chapin III, and David Tilman. 2006. "Biodiversity Loss Threatens Human Well-Being." *Plos Biology* 4(8).

Dimkpa, Christian O. and Prem S. Bindraban. 2016. "Fortification of Micronutrients for Efficient Agronomic Production: A Review." *Agronomy for Sustainable Development* 36:7.

Donohue, Caroline, and Eloise Biggs. 2015. "Monitoring socio-environmental change for sustainable development: Developing a Multidimensional Livelihoods Index (MLI)." A*pplied Geography* 62: 391-403.

Dowrick, Steve, Yvonne Dunlop, and John Quiggin. 2003. "Social Indicators and Comparisons of Living Standards." *Journal of Development Economics* 70:501–29.

Dustmann, Christian, Francesco Fasani, Xin Meng, and Luigi Minale. 2017. *Risk Attitudes and Household Migration Decisions*. 423.

Emerson, Patrick M. and André Portela Souza. 2008. "Birth Order, Child Labor, and School Attendance in Brazil." *World Development* 36(9):1647–64.

Errington, Andrew and Ruth Gasson. 1994. "Labour Use in the Farm Family Business." *Sociologia Ruralis* 34(4):293–307.

Fageria, N. K., V. C. Baligar, and Y. C. Li. 2008. "The Role of Nutrient Efficient Plants in Improving Crop Yields in the Twenty First Century." *Journal of Plant Nutrition* 31:1121–57.

Fageria, V. D. 2001. "Nutrient Interactions in Crop Plants." *Journal of Plant Nutrition* 24:1269–90.

Faria, Weslem Rodrigues and Alexandre Nunes Almeida. 2016. "Relationship between Openness to Trade and Deforestation: Empirical Evidence from the Brazilian Amazon." *Ecological Economics* 121:85–97.

Fearnside, Philip M. 1984. "Brazil's Amazon Settlement Schemes: Conflicting Objectives and Human Carrying Capacity." *Habitat International* 8(1):45–61.

Fearnside, Philip M. 1979. "Cattle Yield Prediction for the Transamazon Highway of Brazil." *Interciencia* 4(4):220–25.

Fearnside, Philip M. 2005. "Deforestation in Brazilian Amazonia: History, Rates and Consequences." *Conservation Biology* 19(3):728–33.

Ferreira, Diego Cardoso Ferreira, Gisele do Socorro dos Santos Pompeu, Jhonatas Ramalho Fonseca, and Joabe Costa dos Santos. 2014. "Sistemas Agroflorestais Comerciais Em Áreas de Agricultores Familiares No Município de Altamira , Pará Commercial Agroforestry Systems in Small Farms Areas in Altamira , Pará." *Revista Brasileira de Agropecuária* 9(3):104–16.

Ferreira, L. A. 2001. "Le Rôle de l'élevage Bovin Dans La Viabilité Agroécologique et Socio-Économique Des Systemes de Production Agricoles Familiaux En Amazonia Brésilienne—Le Cas d'Uruará (Pará, Brésil)."

Institut National Agronomique Paris-Grignon.

Filho, Galdino Paula, Roberta Rowsy, and Amorim De Castro. 2016a. "Institutional Markets for Family Agriculture: Analysis of the Food Acquisition Program (PAA) and the National School Feeding Program (PNAE) within a Territory in the Brazil." *International Journal of Research Studies in Agricultural Sciences (IJRSAS)* 2(4):12–23.

Filho, Galdino Paula, Roberta Rowsy, and Amorim De Castro. 2016b. "Socioeconomic Analysis of Rural Credit and Technical Assistance for Family Farmers in the Transamazonian Territory, in the Brazilian Amazon." *Journal of Agricultural Science* 8(10).

Fisher, Janet A. et al. 2014. "Understanding the Relationships between Ecosystem Services and Poverty Alleviation: A Conceptual Framework." *Ecosystem Services* 7:34–45.

Foley, Jonathan A. et al. 2007. "Amazonia Revealed: Forest Degradation and Loss of Ecosystem Goods and Services in the Amazon Basin." *Frontiers in Ecology and the Environment* 5(1):25–32.

Folha de São Paulo. 2016. "Acervo de Fotos: Transamazônica." *UOL*. Retrieved October 12, 2018 (https://fotografia.folha.uol.com.br/galerias/7568-transamazonica#foto-146731).

Fowler, Patrick J., David B. Henry, and Katherine E. Marcal. 2015. "Family and Housing Instability: Longitudinal Impact on Adolescent Emotional and Behavioral Well-Being." *Social Science Research* 53:364–74.

Fraga, Nilson Cesar and Thiago de Oliveira Gonçalves. 2011. "On the Road of Transamazônica (BR 230), Territory and Occupation of Amazon: An Overview of Two Influenced Cities – Balsas (Maranhão State) (MA) and MedicilâNdia (Pará State) (PA)." *Brazilian Geographical Journal* 2(1):132–45.

Fritz, Martin and Max Koch. 2014. "Potentials for Prosperity without Growth: Ecological Sustainability, Social Inclusion and the Quality of Life in 38 Countries." *Ecological Economics* 108:191–99.

Furtado, Gustavo Procopio. 2013. "The Borders of Sense: Revisiting Iracema, Uma Transa Amazonica (1974)." *Journal of Latin American Cultural Studies: Travesia* 22(4):399–415.

Futemma, Célia and Eduardo S. Brondízio. 2003. "Land Reform and Land-Use Changes in the Lower Amazon: Implications for Agricultural Intensification." *Human Ecology* 31(3):369–402.

Garcia, Edenise, Fábio Sampaio Vianna Ramos Filho, Giovanni Matheus Mallmann, and Francisco Fonseca. 2017. "Costs, Benefits and Challenges of Sustainable Livestock Intensification in a Major Deforestation Frontier in the Brazilian Amazon." *Sustainability (Switzerland)* 9(1).

Gardner, Andrew. 2016. *Agency Uncovered: Archaeological Perspectives on Social Agency, Power, and Being Human*. edited by A. Gardner. New York: Routledge.

Garrett, R. D. et al. 2018. "Intensification in Agriculture-Forest Frontiers: Land Use Responses to Development and Conservation Policies in Brazil." *Global Environmental Change* 53(September):233–43.

Garrett, Rachael D. et al. 2017. "Explaining the Persistence of Low Income and Environmentally Degrading Land Uses in the Brazilian Amazon." *Ecology and Society* 22(3).

Gasparri, N. I., H. R. Grau, and J. Gutiérrez Angonese. 2013. "Linkages between Soybean and Neotropical Deforestation: Coupling and Transient Decoupling Dynamics in a Multi-Decadal Analysis." *Global Environmental Change* 23(6):1605–14.

Gebara, Maria Fernanda and Arun Agrawal. 2017. "Beyond Rewards and Punishments in the Brazilian Amazon: Practical Implications of the REDD + Discourse." *Forests* 8(66):1–27.

Gedney, Nicola and Paul J. Valdes. 2000. "The Effec of Amazonian Deforestation on the Northen Hemisphere Circulation and Climate." *Geophysical Reasearch Letters* 27(19):3053–56.

Ghimire, Raju, Huang Wen-Chi, and Rudra Bahadur Shrestha. 2014. "Factors Affecting Nonfarm Income

Diversification among Rural Farm Households in Central Nepal." *International Journal of Agricultural Management and Development* 4(2):123–32.

Gibbs, Holly K. et al. 2016. "Did Ranchers and Slaughterhouses Respond to Zero-Deforestation Agreements in the Brazilian Amazon?" *Conservation Letters* 9(1):32–42.

Giles, John and Ren Mu. 2018. "Village Political Economy, Land Tenure Insecurity, and the Rural to Urban Migration Decision: Evidence from China." *Amer. J. Agr. Econ.* 0(February):1–24.

Godar, J., T. A. Gardner, E. J. Tizado, and P. Pacheco. 2014. "Actor-Specific Contributions to the Deforestation Slowdown in the Brazilian Amazon." *Proceedings of the National Academy of Sciences* 111(43):15591–96.

Godar, Javier, Emilio Jorge Tizado, and Benno Pokorny. 2012. "Who Is Responsible for Deforestation in the Amazon? A Spatially Explicit Analysis along the Transamazon Highway in Brazil." *Forest Ecology and Management* 267:58–73.

Godar, Javier, Emilio Jorge Tizado, Benno Pokorny, and James Johnson. 2012. "Typology and Characterization of Amazon Colonists: A Case Study Along the Transamazon Highway." *Human Ecology* 40:251–67.

Graeub, Benjamin E. et al. 2016. "The State of Family Farms in the World." *World Development* 87:1–15.

Guedes, Gilvan R. et al. 2012. "Poverty and Inequality in the Rural Brazilian Amazon: A Multidimensional Approach." *Human Ecology* 40(1):41–57.

Guedes, Gilvan R., Leah K. Vanwey, James R. Hull, Mariangela Antigo, and Alisson F. Barbieri. 2014. "Poverty Dynamics, Ecological Endowments, and Land Use among Smallholders in the Brazilian Amazon." *Social Science Research* 43:1–30.

Hafeez, B., Y. M. Khanif, and M. Saleem. 2013. "Role of Zinc in Plant Nutrition- A Review." *American Journal of Experimental Agriculture* 3(2):374–91.

Hall, Anthony and Sue Branford. 2012. "Development, Dams and Dilma: The Saga of Belo Monte." *Critical Sociology* 38(6):851–62.

Harrison, Steve, John Herbohn, and Anssi Niskanen. 2002. "Non-Industrial, Smallholder, Small-Scale and Family Forestry: What's in a Name?" *Small-Scale Forest Economics, Management and Policy* 1(1):1–11.

Hartwell, M. 1961. "The Rising Standard of Living in England, 1800-1850." *The Economic History Review*.

Hayami, Y. and V. W. Ruttan. 1971. *Agricultural Development: An International Perspective*. Baltimore, Md/London: The Johns Hopkins Press.

Hazell, P., C. Poulton, S. Wiggins, and A. Dorward. 2007. *The Future of Small Farms for Poverty Reduction and Growth. 2020 Discussion Paper 42*. Washington, DC: International Food Policy Research Institute.

Hecht, Susanna B. 1985. "Environment, Development and Politics: Capital Accumulation and the Livestock Sector in Eastern Amazonia." *World Development* 13(6):663–84.

Hecht, Susanna B. 1993. "The Logic of Livestock and Deforestation in Amazonia." *BioScience* 43(10):687–95.

Hecht, Susanna B., R. Norgard, and G. Possio. 1988. "The Economics of Cattle Ranching in the Eastern Amazon." *Interciencia* 13:233–40.

Hoch, L., B. Pokorny, and W. D. E. Jong. 2009. "How Successful Is Tree Growing for Smallholders in the Amazon?" *International Forestry Review* 11(3):299–310.

Hoelle, Jeffrey. 2014. "Cattle Culture in the Brazilian Amazon." *Human Organization* 73(4):363–74.

Hoelle, Jeffrey. 2018. "Quantifying Cultural Values Associated with Deforestation in the Brazilian Amazon." *Journal of Land Use Science* 13(1–2):166–81.

IBGE. n.d. "Biblioteca." *Instituto Brasileiro de Geografia e Estatística*. Retrieved October 12, 2018

(https://biblioteca.ibge.gov.b).

IBGE. 2018a. "Censo Demográfico 2017." *Instituto Brasileiro de Geografia e Estatística*. Retrieved November 29, 2018 (https://cidades.ibge.gov.br/pesquisas).

IBGE. 2002. "Mapa de Clima Do Brasil."

IBGE. 2008a. "Mapa de Vegetação Do Estado Do Pará."

IBGE. 2008b. "Mapa Esquemátido de Solos: Pedologia Do Estado Do Pará."

IBGE. 2018b. "Produção Agrícola Municipal." *Instituto Brasileiro de Geografia e Estatística*. Retrieved January 7, 2018 (https://www.ibge.gov.br/estatisticas-novoportal/economicas/agricultura-e-pecuaria/9117-producao-agricola-municipal-culturas-temporarias-e-permanentes.html?edicao=9118&t=resultados).

IBGE. 2017. "Sistema IBGE de Recuperação Automática - SIDRA." *Instituto Brasileiro de Geografia e Estatística*. Retrieved November 28, 2018 (https://sidra.ibge.gov.br).

INMET. 2017. "Instituto Nacional de Agrometeorologia." Retrieved November 29, 2018 (http://www.inmet.gov.br).

INPE. 2017. "Projeto Prodes Monitoramento Da Floresta Amazônica Brasileira Por Satélite." *Instituto Nacional de Pesquisas Espaciais: Divisão de Processamento de Imagens (DPI)*. Retrieved (http://www.dpi.inpe.br/prodesdigital/prodesmunicipal.php).

INPE and EMBRAPA. 2016. *TerraClass 2004-2014: DinâMica Do Uso e Cobertura Da Terra No Período de 10 Anos Nas Áreas Desflorestadas Da Amazônia Legal Brasileira*. Brasília.

IPEA. 2010. "Instituto de Pesquisa Econômica Aplicada: Agropecuária." Retrieved November 29, 2018 (http://www.ipeadata.gov.br).

Jaleta, Moti, Menale Kassie, and Bekele Shiferaw. 2013. "Tradeoffs in Crop Residue Utilization in Mixed Crop-Livestock Systems and Implications for Conservation Agriculture." *Agricultural Systems* 121:96–105.

Jessop, Bob. 1996. "Interpretive Sociology and the Dialectic of Structure and Agency." *Theory, Culture & Society* 13(1):119–28.

Jones, Kelly W. et al. 2016. "Forest Conservation Incentives and Deforestation in the Ecuadorian Amazon." *Environmental Conservation* (August):1–10.

Jordan, Carl F. and Rafael Herrera. 1981. "Tropical Rain Forests: Are Nutrients Really Critical?" *The American Naturalist* 117(2):167–80.

JWS. 2018. "Portal Memória Brasileira: Depois de Quase Meio Século a Transamazônica Ainda Não Está Pronta." *José Wille*. Retrieved October 12, 2018 (https://www.jws.com.br/2018/10/depois-de-quase-meio-seculo-a-transamazonica-ainda-nao-esta-pronta/).

Kakwani, N. 1993. "Performance in Living Standards." *Journal of Development Economics* 41:307–36.

Kastner, Ingo and Paul C. Stern. 2015. "Examining the Decision-Making Processes behind Household Energy Investments: A Review." *Energy Research & Social Science* 10:72–89.

King, Anita. 2018. *Living Standards Analysis Model: The First Prototype*. New Zealand Treasury Working Paper.

King, Megan F., Vivian F. Renó, and Evlyn M. L. M. Novo. 2013. "The Concept, Dimensions and Methods of Assessment of Human Well-Being within a Socioecological Context: A Literature Review." *Social Indicators Research* 116(3):681–98.

Kirby, Kathryn R. et al. 2006. "The Future of Deforestation in the Brazilian Amazon." *Futures* 38(4):432–53.

Kleinpenning, J. M. G. 1977. "An Evaluation of the Brazilian Policy for the Integration of the Amazon Region (1964-1974)." *Tijdschrift Voor Econ. En Soc. Geografie* 68(5):297–311.

Kleinpenning, J. M. G. 1971. "Road Building and Agricultural Colonisation in the Amazon Basin." *Tijdschrift Voor Economische En Sociale Geografie* 62(5):285–89.

Kreidenweis, Ulrich et al. 2018. "Pasture Intensification Is Insufficient to Relieve Pressure on Conservation Priority Areas in Open Agricultural Markets." *Glob Change Biol* 24(March):3199–3213.

Kremen, Claire. 2015. "Reframing the Land-Sparing/Land-Sharing Debate for Biodiversity Conservation." *Annals of the New York Academy of Sciences* (The Year in Ecology and Conservation Biology Reframing).

Kruger, Diana I. 2007. "Coffee Production Effects on Child Labor and Schooling in Rural Brazil." *Journal of Development Economics* 82(August 2004):448–63.

Larson, Anne M., Peter Cronkleton, Deborah Barry, and Pablo Pacheco. 2008. *Tenure Rights and Beyond-Community Access to Forest Resources in Latin America*. Vol. 1.

Latawiec, A. E., B. B. N. Strassburg, J. F. Valentim, F. Ramos, and H. N. Alves-Pinto. 2014. "Intensification of Cattle Ranching Production Systems: Socioeconomic and Environmental Synergies and Risks in Brazil." *Animal* 8(8):1255–1263.

Laurance, William F. et al. 2018. "An Amazonian Rainforest and Its Fragments as a Laboratory of Global Change." *Biological Reviews* 93:223–47.

Laurance, William F. et al. 2002. "Predictors of Deforestation in the Brazilian Amazon." *Journal of Biogeography* 29(5):737–48.

Lavelle, Patrick et al. 2016. "Unsustainable Landscapes of Deforested Amazonia: An Analysis of the Relationships among Landscapes and the Social, Economic and Environmental Profiles of Farms at Different Ages Following Deforestation." *Global Environmental Change* 40(September):137–55.

Lima, Pedro Glécio Costa, Márilia Coelho–Ferreira, and Ronize Santos Santos. 2016. "Perspectives on Medicinal Plants in Public Markets across the Amazon : A Review." *Economic Botany* (February):1–15.

Lipton, Michael. 2010. "From Policy Aims and Small-Farm Characteristics to Farm Science Needs." *World Development* 38(10):1399–1412.

Lisansky, J. 1990. *Migrants to Amazonia: Spontaneous Colonization on the Brazilian Frontier*. Boulder, Colo.: Westview Press.

Loeber, Rolf et al. 2000. "Stability of Family Interaction from Ages 6 to 18." *Journal OfAbnormal Child Psychology* 28(4):353–69.

Lopes, Maria Aparecida and Ana Cristina Mendes-oliveira. 2015. "A Amazônia Brasileira e Os Pequenos Mamíferos Não-Voadores." Pp. 15–20 in *Os Pequenos Mamíferos Não Voadores da Amazônia Brasileira*, edited by A. C. Mendes-Oliveira and C. Miranda. Sociedade Brasileira de Mastozoologia.

Lopes, Uilson Vanderlei et al. 2011. "Cacao Breeding in Bahia, Brazil - Strategies and Results." *Crop Breeding and Applied Biotechnology* (S1):73–81.

Ludewigs, Thomas, Alvaro de Oliveira D'antona, Eduardo Sonnewend Brondízio, and Scott Hetrick. 2009. "Agrarian Structure and Land-Cover Change Along the Lifespan of Three Colonization Areas in the Brazilian Amazon." *World Development* 37(8):1348–59.

Mahar, Dennis J. 1989. *Govemment Policies and Deforestation in Brazil's Amazon Region*. Washington, DC: The World Bank.

Maia, J. G. S. and E. H. Andrade. 2009. "Database of the Amazon Aromatic Plants and Their Essential Oils." *Quim. Nova* 32(3):595–622.

Malhi, Yadvinder et al. 2008. "Climate Change, Deforestation, and the Fate of the Amazon." *Science* 319:169–73.

Manlosa, Aisa O., et al. 2019. "Livelihood strategies, capital assets, and food security in rural Southwest Ethiopia." *Food Security* 11.1: 167-181.

Marcuzzo, Silva Franz. 2015. *Programa Novo Campo: Estratégia de Pecuária Sustentável Na Amazônia*. Alta Floresta-MT: ICV.

Margulis, Sergio. 2004. *Causes of Deforestation of the Brazilian Amazon*. World Bank.

Matson, Pamela A. and Peter M. Vitousek. 2006. "Agricultural Intensification: Will Land Spared from Farming Be Land Spared for Nature?" *Conservation Biology* 20(3):709–10.

Mazoyer, Marcel and Laurence Roudart. 2010. *História Das Agriculturas No Mundo: Do Neolítico à Crise ContemporâNea*. Editora UNESP.

McCracken, Stephen D., Andrea D. Siqueira, Emilio F. Moran, and Eduardo S. Brondízio. 2002. "Land Use Patterns on an Agricultural Frontier in Brazil: Insights and Examples from a Demographic Perspective." Pp. 162–92 in *Deforestation and land use in the Amazon*, edited by C. H. Wood and R. Porro. University Press of Florida.

McNeil, Cameron. 2006. *Chocolate in Mesoamerica Maya Studies*. Gainesville: University Press of Florida.

Medeiros, Carlos Gabriel Sardinha de. 2018. "Iracema: Representations and Allegories of a Brazilian Screw." *Faces Da História* 5(2):209–25.

Medina, Gabriel, Camila Almeida, Evandro Novaes, Javier Godar, and Benno Pokorny. 2015. "Development Conditions for Family Farming: Lessons From Brazil." *World Development* 74:386–96.

Mello, Denyse and Marianne Schmink. 2017. "Amazon Entrepreneurs: Women's Economic Empowerment and the Potential for More Sustainable Land Use Practices." *Women's Studies International Forum* 65:28–36.

Mendes, Fernando Antonio Teixeira and Jay Wallace da Silva Mota. 2016. *O Cultivo Do Cacaueiro No Estado Do Pará*.

Mendes, Fernando Antônio Teixeira and Sylvan Martins dos Reis. 2013. "ImportâNcia Socioeconômica e Ambiental." Pp. 12–19 in *Manual técnico do cacaueiro para Amazônia Brasileira*. Belém-PA: CEPLAC/SUEPA.

Mendes, Josilene Ferreira and Noemi S. Miyasaka Porro. 2015. "Social Conflicts in Times of Environmentalism: Living Law Rights to Land in Settlements with a Conservationist Focus." *Ambiente & Sociedade* XVIII(2):93–110.

Meraner, Manuela, Wim Heijman, Tom Kuhlman, and Robert Finger. 2015. "Determinants of Farm Diversification in the Netherlands." *Land Use Policy* 42:767–80.

Merry, Frank et al. 2006. "Industrial Development on Logging Frontiers in the Brazilian Amazon." *International Journal of Sustainable Development* 9(3):277–296.

Merry, Frank and Britaldo Soares-filho. 2017. "Will Intensification of Beef Production Deliver Conservation Outcomes in the Brazilian Amazon?" *Elem Sci Anth* 4(24).

Mertens, Benoit, R. Poccard-Chapuis, M. G. Piketty, A. E. Lacques, and A. Venturieri. 2002. "Crossing Spatial Analyses and Livestock Economics to Understand Deforestation Processes in the Brazilian Amazon: The Case of São Félix Do Xingú in South Pará." *Agricultural Economics* 27(3):269–94.

Monteiro, Wilson R. and Dário Ahnert. 2012. "Melhoramento Genético Do Cacaueiro." Pp. 11–30 in *Ciência, tecnologia e manejo do cacaueiro*. Bahia: CEPLAC/CEPEC/SEFIS.

Moran, E. F. 1993. "Deforestation and Land Use in the Brazilian Amazon." 21(93).

Moran, Emilio F. 2016. "Roads and Dams: Infrastructure-Driven Transformations in the Brazilian Amazon." *Ambiente & Sociedade* XIX(2):207–20.

Mortimer, Róisín, Stéphane Saj, and Christophe David. 2018. "Supporting and Regulating Ecosystem Services in Cacao Agroforestry Systems." *Agroforestry Systems* 92(6):1639–57.

Morton, Douglas C. et al. 2006. "Cropland Expansion Changes Deforestation Dynamics in the Southern Brazilian Amazon." *PNAS* 103(39).

Mota de Siqueira, Juliana et al. 2017. "The Middle and Lower Xingu." *Revista Brasileira de Estudos Urbanos e Regionais* 19(1):148–63.

Moutinho, Paulo, Raissa Guerra, and Claudia Azevedo-Ramos. 2016. "Achieving Zero Deforestation in the Brazilian Amazon: What Is Missing?" *Elementa: Science of the Anthropocene* • 4(2):1–11.

Muchagata, Marcia and Katrina Brown. 2000. "Colonist Farmers' Perceptions of Fertility and the Frontier Environment in Eastern Amazonia." *Agriculture and Human Values* 17:371–84.

Murphy, Laura, Richard Bilsborrow, and Francisco Pichón. 1997. "Poverty and Prosperity among Migrant Settlers in the Amazon Rainforest Frontier of Ecuador." *The Journal of Development Studies* 34(2):35–65.

Murphy, Laura L. 2001. "Colonist Farm Income, Off-Farm Work, Cattle, and Differentiation in Ecuador's Northern Amazon." *Human Organization* 60(1):67–79.

Narayan, D., R. Chambers, M. K. Shah, and P. Petesch. 2000. *Voices of the Poor: Crying out for Change*. edited by The World Bank. New York: Oxford University Press.

Narel, Y Paniagua, Zambrana, Anja Byg, Monica Svenning, Jens-christian Moraes, Cesar Grandez, and Henrik Balslev. 2007. "Diversity of Palm Uses in the Western Amazon." *Biodivers Conserv* 16:2771–87.

Nepstad, Daniel et al. 2009. "The End of Deforestation in the Brazilian Amazon." *Science* 326(5958):1350–51.

Nobre, Carlos A. et al. 2016. "Land-Use and Climate Change Risks in the Amazon and the Need of a Novel Sustainable Development Paradigm." *PNAS* 113(39):10759–68.

Nobre, Ismael and Carlos A. Nobre. 2019. "The Amazonia Third Way Initiative: The Role of Technology to Unveil the Potential of a Novel Tropical Biodiversity-Based Economy." in *Land use. Assessing the Past, Envisioning the Future.*, edited by L. C. Loures. IntechOpen.

Ogundari, Kolawole and Awudu Abdulai. 2014. "Determinants of Household's Education and Healthcare Spending in Nigeria: Evidence from Survey Data." *African Development Review* 26(I):1–14.

Ogundari, Kolawole and Adebayo B. Aromolaran. 2014. "Impact of Education on Household Welfare In." *International Economic Journal* 28(2):345–64.

Oliveira, Edvaldo. 1981. *Pará: O Retorno Do Cacau à Sua Origem*. Cadernos d. CEPLAC.

Ometto, Jean Pierre, Ana Paula Dutra Aguiar, and Luiz Antonio Martinelli. 2011. "Amazon Deforestation in Brazil: Effects, Drivers and Challenges." *Carbon Management* 2(5):575–85.

Ortiz, Rodomiro, Andreea Nowak, Angela Lavado, and Louis Parker. 2013. "Food Security in Amazonia: Report for Global Canopy Programme and International Center for Tropical Agriculture as Part of the Amazonia Security Agenda Project." (March 2015).

Ostrom, Elinor. 2000. "Collective Action and the Evolution of Social Norms." *Journal of Economic Perspectives* 14(3):137–58.

Ozturk, Gulustan and Glenn M. Young. 2017. "Food Evolution : The Impact of Society and Science on the Fermentation of Cocoa Beans." *Comprehensive Reviews in Food Scienceand Food Safety* 16:431–55.

Pacheco, P. et al. 2017. *Beyond Zero Deforestation in the Brazilian Amazon: Progress and Remaining Challenges to Sustainable Cattle Intensification*. CIFOR.

Pacheco, Pablo. 2009. "Smallholder Livelihoods, Wealth and Deforestation in the Eastern Amazon." *Human Ecology* 27–41.

Pamuk, Şevket and Jan-luiten van Zanden. 2010. "Standards of Living." Pp. 217–34 in *The Cambridge Economic History*

of Modern Europe, edited by Broadberry, Stephen, and K. H. OíRourke. New York: Cambridge University Press.

PARÁ. 2008. *Institui o Programa de Aceleração Do Crescimento e Consolidação Da Cacauicultura No Estado Do Pará - PAC CACAU-PA e Cria o Fundo de Apoio a Cacauicultura Do Estado Do Pará*. Brazil.

Pédelahore, Philippe. 2014. "Farmers Accumulation Strategies and Agroforestry Systems Intensification: The Example of Cocoa in the Central Region of Cameroon over the 1910 – 2010 Period." *Agroforestry Systems* 88:1157–66.

Pellegrini, Lorenzo and Luca Tasciotti. 2014. "Crop Diversification, Dietary Diversity and Agricultural Income: Empirical Evidence from Eight Developing Countries." *Canadian Journal of Development Studies* 35(2):211–27.

Perz, S. G. 2001. "Household Demographic Factors as Life Cycle Determinants of Land Use in the Amazon." *Population Research and Policy Review* 20(3):159–86.

Perz, Stephen G., Marcellus M. Caldas, Eugenio Arima, and Robert T. Walker. 2007. "Unofficial Road Building in the Amazon: Socioeconomic and Biophysical Explanations." *Development and Change* 38(3):529–51.

Perz, Stephen G. L. 2005. "The Importance of Household Asset Diversity for Livelihood Diversity and Welfare among Small Farm Colonists in the Amazon." *Journal of Development Studies* 41(7):1193–1220.

Perz, Stephen G. and Robert T. Walker. 2002. "Household Life Cycles and Secondary Forest Cover among Small Farm Colonists in the Amazon." *World Development* 30(6):1009–27.

Piasentin, Bonazzi and Carlos Hiroo Saito. 2014. "The Different Methods of Cocoa Farming in Southeastern Bahia, Brazil: Historical Aspects and Perceptions." *Bol. Mus. Para. Emílio Goeldi. Cienc. Hum.* 9(1):61–78.

Piekielek, Jessica. 2010. "Cooperativism and Agroforestry in the Eastern Amazon: The Case of Tomé-Açu." *Latin American Perspectives* 37(175):12–29.

Pinto, Rosyjane P. F., Neli T. G. Machado, and Marcos R. Kreutz. 2018. "Movement and Learning Spaces in Brazil: The Case of Coconut Breakers from Imperatriz in Maranhão." *Rev. Ens. Educ. Cienc. Human., Londrina* 19(3):336–43.

Piperata, Barbara A. et al. 2011. "Nutrition in Transition: Dietary Patterns of Rural Amazonian Women during a Period of Economic Change." *American Journal of Human Biology* 23(4):458–69.

Poelhekke, Fabio G. M. N. 1986. "Fences in the Jungle Cattle Raising and the Economic and Social Integration of the Amazon Region in Brazil." *Revista Geográfica* (104):33–47.

Pokorny, B. and W. De Jong. 2015. "Smallholders and Forest Landscape Transitions: Locally Devised Development Strategies of the Tropical Americas." *International Forestry Review* 17(S1):1–19.

Pokorny, Benno et al. 2010. *Smallholders, Forest Management and Rural Development in the Amazon*. edited by B. Pokorny. CIFOR.

Pokorny, Benno, Wil de Jong, Javier Godar, Pablo Pacheco, and James Johnson. 2013. "From Large to Small: Reorienting Rural Development Policies in Response to Climate Change, Food Security and Poverty." *Forest Policy and Economics* 36:52–59.

Porro, Noemi, Iran Veiga, and Dalva Mota. 2011. "Traditional Communities in the Brazilian Amazon and the Emergence of New Political Identities: The Struggle of the Quebradeiras de Coco Babaçu - Babassu Breaker Women." *Journal of Cultural Geography* 28(1):123–46.

Porro, Roberto et al. 2012. "Agroforestry in the Amazon Region: A Pathway for Balancing Conservation and Development." Pp. 391–428 in *Agroforestry - The Future of Global Land Use*. Vol. 9, edited by P. K. R. Nair and D. Garrity. Springer Science+Business Media Dordrecht.

Porro, Roberto, ed. 2009. *Alternativa Agroflorestal Na Amazônia Em Transformação.* Brasília, DF: Embrapa Informação

Tecnológica.

Psacharopoulos, George. 1997. "Child Labor versus Educational Attainment Some Evidence from Latin America." *J Popul Econ* 10:377–86.

Quarto Poder. 2014. "O Cerco Aos Índios Na Ditadura e Na Democracia." *Marcos Santos*. Retrieved October 12, 2018 (http://www.blogquartopoder.com.br).

R Core Team. 2018. "R: A Language and Environment for Statistical Computing."

Rajasekar, M., D. Udhaya Nandhini, and V. Swaminathan. 2017. "A Review on Role of Macro Nutrients on Production and Quality of Vegetables." *International Journal of Chemical Studies* 5(3):304–9.

Randell, Heather. 2017. "Forced Migration and Changing Livelihoods in the Brazilian Amazon." *Rural Sociology* 82(3):548–73.

Randell, Heather. 2016a. "Structure and Agency in Development-Induced Forced Migration: The Case of Brazil's Belo Monte Dam." *Population and Environment* 37(3):265–87.

Randell, Heather. 2016b. "The Short-Term Impacts of Development-Induced Displacement on Wealth and Subjective Well-Being in the Brazilian Amazon." *World Development* 87:385–400.

Rao, Narasimha D. and Jihoon Min. 2018. "Decent Living Standards: Material Prerequisites for Human Wellbeing." *Social Indicators Research* 138(1):225–44.

Ravallion, Martin. 1992. *Poverty Comparisons: A Guide to Concepts and Methods*. Washington, DC: LSM Working Paper No. 88.

Reardon, Thomas, Julio Berdegué, and Germán Escobar. 2001. "Rural Nonfarm Employment and Incomes in Latin America: Overview and Policy Implications." *World Development* 29(3):395–409.

Rêgo, Lyvia Julienne Sousa, Juliana Galvão de Sousa Magalhães, Liniker Fernandes da Silva, Márcio Lopes da Silva, and João Ricardo Vasconcellos Gama. 2017. "Economic Analysis of the Cumaru Almond Production in Agroforestry Systems in Alenquer, Pará State." *Reflexões Econômicas* 1(3):38–56.

dos Reis, Sylvan Martins and Paulo Júlio da Silva Neto. 2013. "Índices de Produtividade." Pp. 199–200 in *Manual técnico do cacaueiro para Amazônia Brasileira*. Belém-PA: CEPLAC/SUEPA.

Resque, Antonio Gabriel L. et al. 2019. "Agrobiodiversity and Public Food Procurement Programs in Brazil: Influence of Local Stakeholders in Configuring Green Mediated Markets." *Sustainability* 11(1425).

Reyes-garcía, Victoria, Vincent Vadez, William Leonard, and David Wilkie. 2005. "Knowledge and Consumption of Wild Plants: A Comparative Study in Two Tsimane' Villages in the Bolivian Amazon." *Ethnobotany Research & Applications* 207:201–7.

Richards, Peter D. and Leah K. VanWey. 2015. "A Second Act in Rural Migration in Western Pará: Rural Out-Migration and the Legacy of Amazon Colonization." *Journal of Latin American Geography* 14(2):53–75.

Rietra, René P. J. J. et al. 2017. "Communications in Soil Science and Plant Analysis Effects of Nutrient Antagonism and Synergism on Yield and Fertilizer Use Efficiency." *Communications in Soil Science and Plant Analysis* 48(16):1895–1920.

Robinson, Brian E., Margaret B. Holland, and Lisa Naughton-Treves. 2011. *Does Secure Land Tenure Save Forests? A Review of the Relationship between Land Tenure and Tropical Deforestation*. Copenhagen, Denmark.

Ruel, Marie T. 2003. "Operationalizing Dietary Diversity: A Review of Measurement Issues and Research Priorities." *American Society for Nutritional Sciences* 133(11):3911S–3926S.

Ruviaro, Clandio Favarini, Otávio Júlio Jardim Barcellos, and Homero Dewes. 2014. "Land Use Policy Market-Oriented Cattle Traceability in the Brazilian Legal Amazon." *Land Use Policy* 38:104–10.

Salazar, Oswaldo Viteri, Jesús Ramos-Martín, and Pedro L. Lomas. 2018. "Livelihood sustainability assessment of coffee and cocoa producers in the Amazon region of Ecuador using household types." *Journal of Rural Studies* 62: 1-9.

Salomão, Rafael de Paiva et al. 2007. "The Forests of Belo Monte on the Great Curve of the Xingu River, Eastern Amazon." *Bol. Mus. Para. Emílio Goeldi. Ciências Naturais* 2(3):57–153.

dos Santos, Leonilde Rosa, Carlindo Silva Raiol, Thiago Almeida Vieira, and Guimarães Pinheiro. 2015. "Factors for the Adoption of Agroforestry Systems in the Eastern Amazon , Brazil." *Revista de La Facultad de Agronomía* 113(2014):140–46.

Santos, Marcos Antônio Souza dos et al. 2018. "Quantitative Analysis of the Beef Cattle Industry in the State of Pará, Brazil." *Semina: Ciências Agrárias* 39(2):747.

Sartre, Xavier Arnauld De et al. 2016. "Sustainable Development Policies and the Spread of Land-Sharing Practices. A Statistical Assessment in a Frontier Region of the Brazilian Amazon." *Journal of Rural Studies, Elsevier* 46:66–76.

Schmink, M. et al. 2014. "Forests Citzenship in Acre, Brazil." Pp. 31–49 in *Forests under pressure: Local responses to global issues*, edited by P. Katila, G. Galloway, W. De Jong, P. Pacheco, and G. Mery. Vienna.: International Union of Forest Research Organizations (IUFRO).

Schmink, M. and C. Wood. 1992. *Contested Frontiers in Amazonia*. New York, NY, USA: Columbia University Press.

Schons, Stella Z., Eirivelton Lima, Gregory S. Amacher, and Frank Merry. 2019. "Smallholder Land Clearing and the Forest Code in the Brazilian Amazon." *Environment and Development Economics (2019),* 24:157–79.

Schroth, Götz, Edenise Garcia, Bronson Winthrop Griscom, Vinceslau Geraldes Teixeira, and Lucyana Pereira Barros. 2016. "Commodity Production as Restoration Driver in the Brazilian Amazon? Pasture Re-Agro-Forestation with Cocoa (Theobroma Cacao) in Southern Pará." *Sustain Sci* 11:277–93.

Schwartzman, Stephan et al. 2013. "The Natural and Social History of the Indigenous Lands and Protected Areas Corridor of the Xingu River Basin." *Philosophical Transactions of the Royal Society B: Biological Sciences* 368(1619).

Scoones, Ian. 2009. "Livelihoods Perspectives and Rural Development." *Journal of Peasant Studies* 36(1):171–96.

Scott, Gregory J. 2016. "Growing Money on Trees in Latin America: Growth Rates for Cocoa 1961-2013 and Their Implications for Industry." *& Environ. Sci* 16(1):1–19.

Sen, Amartya. 1999. *Development as Freedom*. edited by O. U. Press. Oxford.

Sen, Amartya. 1985. *Standard of Living*. Clare Hall, Cambridge University.

Sen, Amartya. 1984. "The Living Standard." *Oxford Economic Papers* 36:74–90.

Sewell Jr., William H. 1992. "A Theory of Structure: Duality, Agency, and Transformation." *American Journal of Sociology* 98(1):1–29.

Shanley, Patricia and Leda Luz. 2003. "The Impacts of Forest Degradation on Medicinal Plant Use and Implications for Health Care in Eastern Amazonia." *BioScience* 53(6).

Shanley, Patricia, Leda Luz, and I. A. N. R. Swingland. 2002. "The Faint Promise of a Distant Market: A Survey of Belém's Trade in Non-Timber Forest Products." *Biodiversity and Conservation* 11:615–36.

Shanley, Patricia, Alan R. Pierce, Sarah A. Laird, and Manuel R. Guariguata. 2016. *From Lifelines to Livelihoods: Non-Timber Forest Products into the 21st Century*. edited by S.-V. B. Heidelberg. Tropical Forestry Handbook.

Shukla, J., C. Nobre, and P. Sellers. 1990. "Amazon Deforestation and Climate Change." *Science* 247:1322–25.

Siegmund-Schultze, M., B. Rischkowsky, J. B. da Veiga, and J. M. King. 2007. "Cattle Are Cash Generating Assets for Mixed Smallholder Farms in the Eastern Amazon." *Agricultural Systems* 94(3):738–49.

Silva, Adriana Ferreira, Arlei Luiz Fachinello, Margarete Boteon, Nicole Rennó Castro, and Leandro Gilio. 2017. "Estrutura e Renda Da Cadeia Produtiva Do Cacau e Chocolate No Brasil." *Revista de Economia e Agronegócio - REA* 15(3).

Silva Neto, Paulo Júlio da. 2001. *Sistema de Produção de Cacau Para a Amazônia Brasileira*. Belém: CEPLAC.

Silva, Rafael de Oliveira et al. 2017. "Sustainable Intensification of Brazilian Livestock Production through Optimized Pasture Restoration." *Agricultural Systems* 153:201–11.

Simmons, Cynthia S. et al. 2019. "Discipline and Develop : Destruction of the Brazil Nut Forest in the Lower Amazon Basin Discipline and Develop: Destruction of the Brazil Nut Forest in the Lower Amazon Basin." *Annals of the American Association of Geographers* 109(1):242–65.

Simmons, Cynthia S. 2002. "The Local Articulation of Policy Conflict: Land Use, Environment, and Amerindian Rights in Eastern Amazonia." *Professional Geographer* 54(2):241–58.

Simmons, Cynthia, Robert Walker, and Stephen Perz. 2016. "Spatial Patterns of Frontier Settlement : Balancing Conservation and Development." *Journal of Latin American Geography* 15(1).

Singh, Manpreet, Parvinder Singh, and Sumitter Bir Singh. 2008. "Decision Support System for Farm Management." *World Academy of Science, Engineering and Technology* 39:346–49.

Smeedin, Timothy M. et al. 1993. "Poverty, Inequaltty, and Famtly Living Standards Impacts across Seven Nations: The Effect of Noncash Subsidies for Health, Education and Housing." *Review of Income and Wealth* 39(3).

Smith, Nigel J. H. 1978. "Agricultural Productivity along Brazil's Transamazon Highway." 4:415–32.

Smith, Nigel J. H. 1976. "Utilization of Game along Brazil's Transmazon Highway." *Acta Amazonica* 6(4):455–66.

Solesbury, William. 2003. Sustainable livelihoods: A case study of the evolution of DFID policy. London: Overseas Development Institute.

Somarriba, E., M. Villalobos, and L. Orozco. 2009. *Cocoa in Central America*.

Somarriba, Eduardo et al. 2013. "Carbon Stocks and Cocoa Yields in Agroforestry Systems of Central America." *Agriculture, Ecosystems and Environment* 173:46–57.

Somarriba, Eduardo and Philippe Lachenaud. 2013. "Successional Cocoa Agroforests of the Amazon – Orinoco – Guiana Shield." *Forests, Trees and Livelihoods* 22(1):51–59.

Sombroek, W. G. 1984. "Soils of the Amazon Region." Pp. 1972–78 in *The Amazon. Limnology and landscape ecology of a mighty tropical river and its basin.* Vol. 1978, edited by H. Sioli. Dordrcht, Boston. Landcaster: Or W. Junk Publishers.

Steffan-Dewenter, I. et al. 2007. "Tradeoffs between Income, Biodiversity, and Ecosystem Functioning during Tropical Rainforest Conversion and Agroforestry Intensification." *Proceedings of the National Academy of Sciences* 104(12):4973–78.

Suich, Helen, Caroline Howe, and Georgina Mace. 2015. "Ecosystem Services and Poverty Alleviation: A Review of the Empirical Links." *Ecosystem Services* 12:137–47.

Tasciotti, Luca. 2006. *Food Expenditure as a Measure of the Italian Standard of Living*. Vol. 15.

Thaler, Gregory M. 2017. "The Land Sparing Complex: Environmental Governance, Agricultural Intensification, and State Building in the Brazilian Amazon." *Annals of the American Association of Geographers* 0(0).

Thaler, Gregory M., Cecilia Viana, and Fabiano Toni. 2019. "From Frontier Governance to Governance Frontier: The Political Geography of Brazil' s Amazon Transition." *World Development* 114:59–72.

Thewissen, Stefan; Kenworthy, Lane;, Brian; Nolan, Max; Roser, and Timothy Smeeding. 2015. *Rising Income Inequality and Living Standards in OECD Countries: How Does the Middle Fare?* Vol. 656. Luxembourg.

Le Tourneau, François-michel. 2015. *The Sustainability Challenges of Indigenous Territories in Brazil's Amazonia*.

Tremblay, Stéphane et al. 2014. "Agroforestry Systems as a Profitable Alternative to Slash and Burn Practices in Small-Scale Agriculture of the Brazilian Amazon." *Agroforest Syst*.

Tritsch, Isabelle and François Michel Le Tourneau. 2016. "Population Densities and Deforestation in the Brazilian Amazon: New Insights on the Current Human Settlement Patterns." *Applied Geography* 76:163–72.

Trzeciak, Lorena da Silva, Márcia Orie de Souza Hamada, Ademison Rodrigues Lisboa Filho, Thaís de Souza Macedo Matos, and Vinicius de Campos Paraense. 2018. "Contribuições Da Análise Swot Para a Produção de Cacau OrgâNico Em MedicilâNdia – Pará." *Revista de Administração e Negócios Da Amazônia* 10(2):55–66.

Uhl, Christopher and Robert Buschbacher. 1985. "A Disturbing Synergism Between Cattle Ranch Burning Practices and Selective Tree Harvesting in the Eastern Amazon." *Biotropica* 17(4):265–68.

Uhl, Christopher and J. .. Boone Kauffman. 1990. "Deforestation, Fire Susceptibility, and Potential Tree Responses to Fire in the Eastern Amazon." *Ecology* 71(2):437–49.

Uruará em Ação. 2012. "Pioneiros Da Transamazônica Lutam Por Aposentadoria." *Cirineu Santos*. Retrieved December 12, 2018 (uruaraemacao.blogspot.com).

Urzedo, D. I., E. Vidal, E. O. Sills, F. C. M. Pinã-Rodrigues, and R. G. P. Junqueira. 2016. "Tropical Forest Seeds in the Household Economy: Effects of Market Participation among Three Sociocultural Groups in the Upper Xingu Region of the Brazilian Amazon." *Environmental Conservation* 43(1):13–23.

VanWey, Leah K., Álvaro O. D'Antona, and Eduardo S. Brondízio. 2007. "Household Demographic Change and Land Use/Land Cover Change in the Brazilian Amazon." *Population and Environment* 28(3):163–85.

Vasconcelos, Ana Íris Tomás, Editinete André da Rocha Garcia, Cora Franklina Carmo Furtado, and José Ednilson de Oliveira Cabral. 2016. "As Dimensões Da Sustentabilidade Dos Sistemas Agroflorestais – SAFs: Um Estudo No Projeto de Reflorestamento Consorciado e Adensado – RECA, Ponta Do Abunã – RO." *Desenvolv. Meio Ambiente* 36:73–93.

Veiga, Jonas Bastos da, Jean-François Tourrand Tourrand, and Darcisio Quanz. 1996. "A Pecuária Na Fronteira Agrícola Da Amazônia: O Caso Do Município de Uruará, PA, Na Região Da Transamazônica." *Embrapa-CPATU* 87.

Verner, Dorte. 2004. "Poverty in the Brazilian Amazon : An Assessment of Poverty Focused on the State of Pará." *Policy Research Working Paper Series* 3357:66.

Vliet, Jiska A. Van et al. 2015. "De-Mystifying Family Farming: Features, Diversity and Trends across the Globe." *Global Food Security* 5:11–18.

Vronski, Magda and Silvia Maia Olimpio. 2016. "Production of the Organic Cocoa in the Amazon: A Case Study of the Amazon Organic Products Cooperative - COPOAM." *Revista Brasileira de Estratégia REBRARE* 9(3):351–61.

Wai, Ka, Maggie Lau, and Jonathan Bradshaw. 2016. "Material Well-Being, Social Relationships and Children's Overall Life Satisfaction in Hong Kong." *Child Indicators Research. Advance Online Publication* 11(2016):185–205.

Wainaina, Priscilla, Songporne Tongruksawattana, and Matin Qaim. 2014. "Tradeoffs and Complementarities in the Adoption of Improved Seeds, Fertilizer, and Natural Resource Management Technologies in Kenya." *Agricultural Economics* 47(August 2018):351–62.

Wale, Edilegnaw. 2012. "Explaining Farmers' Decisions to Abandon Traditional Varieties of Crops: Empirical Results from Ethiopia and Implications for on-Farm Conservation." *Journal of Sustainable Agriculture* 36(5):545–63.

Walker, Nathalie F., Sabrina A. Patel, and Kemel A. B. Kalif. 2013. "From Amazon Pasture to the High Street: Deforestation and the Brazilian Cattle Product Supply Chain." *Tropical Conservation Science* 6(3):446–67.

Walker, R., Emilio F. Moran, and L. Anselin. 2000. "Deforestation and Cattle Ranching in the Brazilian Amazon: External Capital and Household Processess." *World Development* 28(4):683–99.

Walker, Robert et al. 1994. "Farming Systems and Economic Performance in the Brazilian Amazon." in *Congresso Brasileiro sobre Sistemas Agroflorestais; Encontro sobre sistemas Agroflorestais nos países do Mercosul*, edited by Anais (ALICE). Porto Velho: Colombo: EMBRAPA-CNPF.

Walker, Robert et al. 2013. "Modeling Spatial Decisions with Graph Theory: Logging Roads and Forest Fragmentation in the Brazilian Amazon." *Ecological Applications* 23(1):239–54.

Walker, Robert et al. 2009. "Ranching and the New Global Range: Amazônia in the 21st Century." *Geoforum* 40(5):732–45.

Walker, Robert, Stephen Perz, Eugenio Arima, and Cynthia Simmons. 2011. "The Transamazon Highway: Past, Present, Future." Pp. 569–99 in *Engineering Earth*, edited by S. D. Brunn.

Walker, Robert, Stephen Perz, Marcellus Caldas, and Luiz Guilherme Teixeira Silva. 2002. "Land Use and Land Cover Change in Forest Frontiers: The Role of Household Life Cycles." *International Regional Science Review* 25(2):169–99.

Walker, Robert Toovey et al. 1997. *As Contradições Do Processo de Desenvolvimento Agrícola Na Transamazônica*. Documentos. Embrapa Amazonia Oriental.

Walker, Timothy. 2007. "Slave Labor and Chocolate in Brazil: The Culture of Cacao Plantations in Amazonia and Bahia (17th-19th Centuries)." *Food and Foodways* 15(1–2):75–106.

Watson, Robert T. et al. 2005. *Ecosystems and Human Well-Being*. Vol. 5. edited by R. T. Watson et al. World Resources Institute.

Weich, Scott and Glyn Lewis. 1998. "Material Standard of Living, Social Class, and the Prevalence of the Common Mental Disorders in Great Britain." *Epidemiol Community Health* 52:8–14.

Weil, Connie. 1981. "Health Problems Associated with Agricultural Colonization in Latin America." *Social Science & Medicine. Part D: Medical Geography* 15(4):449–61.

Werth, David and Roni Avissar. 2002. "The Local and Global Effects of Amazon Deforestation." *Journal of Geophysical Research* 107(D20):8.

Whelan, M. et al. 2007. "Incorporating Livelihoods Approach for Biodiversity Conservation: A Case Study in Cocoa Agroforestry Systems in Talamanca, Costa Rica." *Biodivers Conserv* 16(2311–2333).

Wood, Charles. 2002. "Land Use and Deforestation in the Amazon." Pp. 1–38 in *Deforestation and land use in the Amazon*, edited by C. Wood and R. Porro. Florida: University Press of Florida.

Wood, Charles and Roberto Porro. 2002. *Deforestation and Land Use in the Amazon*. Vol. 48. Florida: University Press of Florida.

World Bank. 2007. *World Development Report 2008: Agriculture Development*. Washington DC: World Bank.

Wunder, Sven. 2001. "Poverty Alleviation and Tropical Forests - What Scope for Synergies ?" *World Development* 29(11).

Wunder, Sven. 2015. *Value Determinants of Plant Extractivism in Brazil*. 90.

Yamada, M. and H. L. Gholz. 2002. "An Evaluation of Agroforestry Systems as a Rural Development Option for the Brazilian Amazon." *Agroforestry Systems* 55(2):81–87.

Zenteno, Mario, Pieter A. Zuidema, Wil de Jong, and René G. A. Boot. 2013. "Livelihood Strategies and Forest

Dependence: New Insights from Bolivian Forest Communities." *Forest Policy and Economics* 26:12–21.

zu Ermgassen, Erasmus K. H. J. et al. 2018. "Results from On-the-Ground Efforts to Promote Sustainable Cattle Ranching in the Brazilian Amazon." *Sustainability* 10(4).

APPENDIX 1

INTERVIEW QUESTIONNAIRE

SISTEMAS AGROFLORESTAIS COM CACAU E PECUÁRIA BOVINA EM AGRICULTURA FAMILIAR

A) IDENTIFICAÇÃO DO ENTREVISTADO

Código Entrevista: _____ Data: ___ / ___ / _____

Entrevistador: _____ Duração da entrevista: ____h___ min

Município e Localidade:

- Vamos começar a entrevista?
- Primeiro, quero dizer que esta pesquisa não vai divulgar o nome do(a) agricultor(a) e as informações dos entrevistados serão todas misturadas para que a gente possa entender a região em geral, como um todo. Então, tudo que você disser é de uso apenas deste estudo e você não será prejudicado de forma alguma. Tudo bem?

2. Nome: _____ 3. Idade: _____ anos

4. Estado civil: _____ 5. Sexo: ( ) F ( ) M ( ) Outro

1. Você se importa se gravarmos nossa conversa? □ Sim □ Não

6.

a) Você participa de algum grupo organizado: ( ) Cooperativa, ( ) Associação, ( ) Coletivo, ( ) Sindicato, ( ) Nenhum ou algum ( ) Outro: _____?

b) Se sim, qual(is)?

_____

7.

a) Você estudou na escola alguma vez (ensino formal)? ( ) Sim ( ) Não

b) Se sim, qual a última série você completou?

_____

B) CARACTERIZAÇÃO DA PROPRIEDADE E PRODUÇÃO

8. Você lembra qual mês e qual ano você e sua família chegaram nesta propriedade? _____ /____

9. Essa propriedade está em área de assentamento? ( ) Sim ( ) Não. Se sim, qual?

10. Qual documentação da propriedade você tem? Se tem o CAR, posso fotografar?

CAR	
Memorial descritivo	
Escritura compra e venda	
Título judicial ou expedido por Poder Público	
Declaração expedida pelo INCRA	
Declaração expedida (Prefeitura, Sindicato Rural, Embrapa ou Emater)	

Outro(s):

_____

11. Para saber como sua propriedade está ocupada hoje com os usos da terra:

a) Qual o tamanho da área total da propriedade?

b) Tem mata primária ou virgem?

c) Se sim, qual o tamanho total dessa área que está dentro da sua propriedade?

PARA AS PROXIMAS QUESTÕES → Se a resposta for "Sim", perguntar:

I. Qual a idade dela?

II. Qual o tamanho total dessa área que está dentro da sua propriedade?

III. Qual é a história dessa área, ou seja, para que foi usada logo que retirou a floresta e quais os usos que vieram depois, em sequência, até chegar ao estado de uso atual? Quantos anos duraram cada um desses usos nessa história?

d) Tem capoeira antiga, área que foi derrubada, mas já tem mais de 20 anos? Se sim: I, II e II.

e) Tem capoeira grossa, média, mata entre 4 e 20 anos? Se sim: I, II e II.

f) Tem área de cacau? Se sim: I, II e II. (Se sim: checar e diferenciar se existir mais de uma área de cacau, com idades diferentes)

g) Tem área de pasto? Se sim: I, II e II. (Se sim: checar e diferenciar se existir mais de uma área de pasto, com idades diferentes)

h) Tem outras áreas produtivas, com mais de 1 ha, ocupadas com roçado/lavoura branca, culturas bianuais ou perenes? Se sim: I, II e II. (Se sim: distinguir quais são. Ex.: mandioca, milho, banana, café, pimenta, etc.)

USO ATUAL			HISTÓRICO							
Área	Alq*	anos	1ª	anos	2ª	anos	3ª	anos	4ª	anos
Total										
Mata Virgem										
Capoeira antiga										
Capoeira nova										
Cacau 1										
Cacau 2										
Cacau 3										
Pasto 1										
Pasto 2										
Pasto 3										
Lavoura Branca										

LEGENDA HISTÓRICO: 1- culturas anuais; 2- culturas bianuais; 3- culturas perenes; 4- pasto *1 alq = 5 ha;

12. Quais foram os alimentos consumidos nas suas três últimas refeições, café da manhã, almoço e janta? Quais desses alimentos foram produzidos aqui na propriedade? (observar quando possível)

ALIMENTOS	Comprado	Produzido	Desjejum	Almoço	Jantar	ALIMENTOS	Comprado	Produzido	Desjejum	Almoço	Jantar
Feijão						Sal					
Arroz						Açúcar					
Carne de gado						Óleo					
Peixe						Cebola					
Galinha						Alho					
Carne de porco						Ovo					
Café											
Água											
Leite											
Macaxeira											
Queijo											

13. Você pretende abrir novas áreas para uso? ( ) Sim ( ) Não. Por quê?

_____

14. Se tem mata: por que motivo você deixou a área de floresta e não abriu sua propriedade inteira?
( ) Lei proíbe ( ) Gosta da mata ( ) Chuva/água ( ) Oxigênio/carbono ( ) Regulação térmica ( ) Reserva p/ futuro ( ) Extração de recursos ( ) Outro: _____

MORADIA

15. Vou fazer algumas perguntas sobre sua casa:
a) Quantas pessoas moram aqui? ___
b) Qual o tamanho, largura e comprimento, da sua casa? ___x___ m
c) É de ( ) Madeira, ( ) Alvenaria ou ( ) Meio a meio?
d) Quantos quartos têm? ___
e) Quantos banheiros? É Fossa negra ou séptica? Tem vaso sanitário?

Banheiros	Qntde.	Com vaso sanitário	Sem vaso sanitário
Privada (Fossa Negra)			
Banheiro (Fossa Séptica)			

f) Chega luz? ( ) Sim ( ) Não
g) De onde vem a água de beber? ( ) Fora ou ( ) Dentro da propriedade?
( ) Poço ( ) Poço artesiano ( ) Igarapé ( ) Nascente

16. Quais são seus meios de transporte p/ ir na cidade? Quantos? De qual modelo?

Meios de transporte	Sim	Não	Qntde.	Modelo(s)/Ano
Cavalo ou Burro				
Moto				
Carro				
Caminhonete				
Motor p/ embarcação				
Barco				
Coletivo Público				
Coletivo Privado				

17. Quantos Km até a escola mais perto? ____km. Como as crianças fazem para ir às aulas?
( ) Coletivo público ( ) Coletivo Privado ( ) Transporte particular ( ) À pé ( ) Não se aplica
18. Quantos Km até o posto de saúde mais perto? ____ km. Recebe vista de agente de saúde?
( ) Sim ( ) Não ( ) Raramente
19. Quantos Km daqui até o centro comercial, vila ou cidade, mais perto? ____ km.
Quantos de estrada de chão? ____ km.

QUINTAL

20. Agora preciso fazer um desenho do seu quintal, com o tamanho dele e das construções, casa, paiol e outras que tiver.
a) O que é o quintal pra você? Pra quê serve?

_____
__
_____
___
( ) Lazer ( ) Descanso ( ) Criação de animais ( ) Atividades domésticas ( ) Regulação térmica
( ) Plantas p/ consumo ( ) Outro: _____

b) Quanto tempo faz que você usa essa área como quintal? ____ anos
c) Qual a largura da frente? ____m
d) Qual a largura de fundo? ____m
e) Qual o comprimento da frente até o fundo? ____m
f) Além da casa, o que mais você tem construído no quintal?
g) Qual a largura e comprimento dessas construções?

( ) casa 2: ____x____ m
( ) galinheiro: ___x___m
( ) curral: ____x____m
( ) paiol: ____x____m
( ) _____: ____x____m
( ) _____: ____x____m
( ) _____: ____x____m

21. Quantos animais vocês têm e criam no seu quintal (espaço ao redor da casa)?

GATO	CÃO	PATO	GADO	BURRO	GALINHA	CAVALO	PORCO	PERU	

22. Sobre a quantidade de árvores plantadas no seu quintal, por que decidiram fazer desse jeito?

_____

23. Quem se dedica mais para cuidar dessa área do quintal?
( ) Entrevistado ( ) Toda Família ( ) Esposa/Marido ( ) Filhos ( ) Ninguém ( )
_____

24. Quais plantas têm no quintal, incluindo madeiras, frutas, medicinais e hortaliças? Quantos pés de cada? Qual o uso? (anotar a partir de observações, quando possível)

*Código de utilidade: *1- Alimento p/ família; 2- Alimento p/ animais; 3- Madeira; 4- Medicinal; 5- Sombra; 6- Ornamental; 7- Lenha; 8- Oleífera; 9- Ciclagem de nutrientes; 10- Outros.*

ESPÉCIE (N. POPULAR)	**Qntd.**	**Vende ?**	**Pra quê vocês já usaram?**	**ESPÉCIE (N. POPULAR)**	**Qntd.**	**Vende ?**	**Pra quê vocês já usaram?**

CACAU

25.
a) Na sua área de cacau:

		CACAU 1	CACAU 2	CACAU 3			CACAU 1	CACAU 2	CACAU 3
COLHEITA	Quant. por ano?				PODA	Quant. por ano?			
	Quando foi a última?					Quando foi a última?			
ROÇO	Quant. por ano?				VENENO	Quant. por ano?			
	Quando foi a última?					Quando foi a última?			
ADUBO	Quant. por ano?				VENENO	Para quê?			
	Quando foi a última?					Para quê?			

b) Qual o espaçamento do cacau? ( ) 2x2m ( ) 3x3m ( ) 4x4m ( ) outro: _____ x _____ m

26.
a) Você deixa árvores no seu cacau? ( ) Sim ( ) Não. Por quê?
( ) Conservar natureza: fauna/flora ( ) Sombra p/ cacau ( ) Madeira ( ) Beleza ( ) Ajuda o cacau
( ) Outro: _____

b) Se sim, quais as três espécies de árvores que estão em maior quantidade no seu cacau? E quais tem menos? Você percebeu se elas prejudicam, ajudam ou não fazem diferença para sua área de cacau? Muito ou Pouco? Por quê? Elas possuem alguma utilidade?

	CACAU	PREJUDICA; AJUDA; INDIFERE					POR QUÊ?	USO* Códigos
>		-2	-1	0	1	2		
>		-2	-1	0	1	2		
>		-2	-1	0	1	2		
<		-2	-1	0	1	2		
<		-2	-1	0	1	2		
<		-2	-1	0	1	2		

*Código de utilidade: *1- Alimento p/ família; 2- Alimento p/ animais; 3- Madeira; 4- Medicinal; 5- Sombra; 6- Ornamental; 7- Lenha; 8- Oleífera; 9- Ciclagem de nutrientes; 10- Outros.*
□ Não soube responder ao certo

c) Se sim, como você escolhe as árvores pra ficar no cacau?

_____
___
( ) Qualquer uma que esteja em espaço com pouca sombra
( ) Beleza
( ) Identificação/reconhece o nome
( ) Ciclagem de nutrientes/adubo
( ) Tipo da sombra: ( ) grande ( ) pequena ( ) forte ( ) fraca ( ) outro: _____
( ) Tipo da folha: ( ) grande ( ) pequena ( ) grossa ( ) fina ( ) outro: _____
( ) Tipo da madeira: ( ) dura/resistente/não quebradeira ( ) leve/branca/quebradeira ( ) outro:
_____
( ) Tipo da copa: ( ) alta ( ) baixa ( ) grande/larga ( ) pequena/estreita ( ) outro: _____
( ) Produto de valor: ( ) não madeireiro ( ) madeireiro ( ) outro: _____

d) Se sim, como é a distância entre árvores de sombra?
( ) Sem planejamento ( ) Misto ( ) Planejado: _____

e) Se sim, você costuma fazer poda nas árvores ou dar algum outro cuidado? (Anelamento, Retirada)
( ) Faz poda ( ) Anelamento ( ) Desbaste ( ) Não faz nenhum manejo ( ) Outro: _____

27. Sobre os produtos do cacau:
a) Quais produtos vocês fazem que vêm da sua produção de cacau?
( ) Amêndoa ( ) Chocolate ( ) Licor ( ) Manteiga ( ) Polpa ( ) Outro: _____

b) Quais deles vocês consomem?
( ) Amêndoa ( ) Chocolate ( ) Licor ( ) Manteiga ( ) Polpa ( ) Nenhum ( ) Outro: _____

c) Além dos produtos do cacau, na área da sua lavoura formada, você tira alguma outra coisa pra consumir, comer, beber ou vender? ( ) Sim ( ) Não. Se sim, o quê?

Produto	Consome	Vende	Produto	Consome	Vende

28.

a) Contando desde 12 meses atrás, quantos reais você ganhou em cada mês com as vendas de cacau e também de produtos derivados, como doces, chocolate ou licor?

MÊS	JAN	FEV	MAR	ABR	MAI	JUN	JUL	AGO	SET	OUT	NOV	DEZ
Amêndoa (R$)												

□ Não soube responder ao certo.
Anotações:_____

b) Nesse período, qual foi o pior e o melhor preço pago por este(s) produto(s)?:
Cacau: Maior R$ _____ Menor R$ _____

29. Sobre a produção de cacau:
a) Quantos pés de cacau produtivo você tem? b) No geral, qual a produção média por ano de toda sua lavoura? c) Qual a renda média por ano?

PÉS	PRODUÇÃO MÉDIA	RENDA MÉDIA
	Kg/ano	R$/ano

( ) Não soube responder.
30. Você tem cacau de meia? ( ) Sim ( ) Não. Se sim:
a. Dentro ou fora da sua propriedade? Dentro ( ) Fora ( )
b. Quantos pés? Dentro _____ Fora _____
c. Tem meeiro que mora na sua propriedade? ( ) Sim ( ) Não. Se sim, quantos tem família? _____
Se tem família, quantas pessoas cada família? _____

PECUÁRIA - PASTO

31. Na sua área de pasto:

		PASTO 1	PASTO 2	PASTO 3			PASTO 1	PASTO 2	PASTO 3
SOLTA GADO	Quant. por ano?				QUEIMA	Quant. por ano?			
	Quando foi a última?					Quando foi a última?			
ROÇA	Quant. por ano?				VENENO	Quant. por ano?			
	Quando foi a última?					Quando foi a última?			
ADUBO	Quant. por ano?				VENENO	Para quê?			
	Quando foi a última?					Para quê?			

32. Seu pasto é dividido/rotacionado, ou é tudo uma coisa só (extensivo)? ( ) Dividido ( ) Sem divisão

33. Sobre a presença de árvores no pasto:
a) Você deixa árvores no seu pasto? ( ) Sim ( ) Não. Por quê? ( ) Conservar natureza: fauna/flora ( ) Sombra p/ gado ( ) Madeira ( ) Beleza ( ) Ajuda o capim
( ) Outro: _____

b) Se sim, quais os três tipos de árvores e palmeiras que tem mais no seu pasto? E quais tem menos? Você percebeu se elas prejudicam, ajudam ou não fazem diferença para sua área de pasto? Muito ou Pouco? Por quê? Elas possuem alguma utilidade?

	PASTO	PREJUDICA; AJUDA; INDIFERE					POR QUÊ?	USO* Códigos
<		-2	-1	0	1	2		
<		-2	-1	0	1	2		
<		-2	-1	0	1	2		
<		-2	-1	0	1	2		
<		-2	-1	0	1	2		
<		-2	-1	0	1	2		

*Código de utilidade: *1- Alimento p/ família; 2- Alimento p/ animais; 3- Madeira; 4- Medicinal; 5- Sombra; 6- Ornamental; 7- Lenha; 8- Oleífera; 9- Ciclagem de nutrientes; 10- Outros*

□ Não soube responder ao certo

c) Se sim, como você escolhe as árvores pra ficar no pasto?
_____
___

( ) Qualquer uma que esteja em espaço com pouca sombra
( ) Beleza
( ) Identificação/reconhece o nome
( ) Ciclagem de nutrientes/adubo
( ) Tipo da sombra: ( ) grande ( ) pequena ( ) forte ( ) fraca ( ) outro: _____
( ) Tipo da folha: ( ) grande ( ) pequena ( ) grossa ( ) fina ( ) outro: _____
( ) Tipo da madeira: ( ) dura/resistente/não quebradeira ( ) leve/branca/quebradeira ( ) outro: _____
( ) Tipo da copa: ( ) alta ( ) baixa ( ) grande/larga ( ) pequena/estreita ( ) outro: _____
( ) Produto de valor: ( ) não madeireiro ( ) madeireiro ( ) outro: _____

d) Se sim, como é a distância entre árvores de sombra?
( ) Sem planejamento ( ) Misto ( ) Planejado: _____

e) Se sim, você costuma fazer poda nas árvores ou dar algum outro cuidado? (Anelamento, Retirada)
( ) Faz poda ( ) Não faz nenhum manejo ( ) Anelamento ( ) Desbaste ( ) Outro: _____

34. Sobre os produtos que vêm da sua produção de pecuária:
a) Quais produtos vocês fazem?
( ) Gado ( ) Leite ( ) Massa ( ) Manteiga ( ) Queijo ( ) Requeijão ( ) Iogurte ( ) Outro: _____

b) Quais deles vocês consomem?
( ) Gado ( ) Leite ( ) Massa ( ) Manteiga ( ) Queijo ( ) Requeijão ( ) Iogurte ( ) Outro: _____

c) Além dos produtos da pecuária, na sua área de pasto, você tira alguma outra coisa para consumir, comer, beber ou vender? ( ) Sim ( ) Não. Se sim, o quê?

Produto	Consome	Vende	Produto	Consome	Vende

d) Contando desde 12 meses atrás, quantos reais você recebeu em cada mês com as vendas de gado, leite e produtos derivados?

MÊS	JAN	FEV	MAR	ABR	MAI	JUN	JUL	AGO	SET	OUT	NOV	DEZ
GADO (R$)												
LEITE (R$)												

□ Não soube responder ao certo.
Anotações:
_____

e) Nesse período, qual foi o pior e o melhor preço pago por este(s) produto(s)?:
Bezerro: Maior R$ _____ Menor R$ _____
Leite: Maior R$ _____ Menor R$ _____
Queijo: Maior R$ _____ Menor R$ _____

f) Qual a renda média por ano obtida com:

PRODUTO	RENDA MÉDIA
GADO	(R$)/ano
LEITE	(R$)/ano

35. Quais raças de gado você cria e quantas cabeças de cada?

ESPÉCIE	VACAS	TOROS	BOIS	BEZERROS	NOVILHAS
Misto					
Nelore					
Holandês					

36. Você tem gado de meia? Se sim, quais raças você cria e quantas cabeças de cada?

ESPÉCIE	VACAS	TOROS	BOIS	BEZERROS	NOVILHAS
Misto					
Nelore					
Holandês					

37. Quais os tipos de capim você tem no pasto?
( ) Brachiaria ( ) Brachiarão ( ) Mombaça ( ) Navalha ( ) Massai ( ) Tanzânia ( ) Elefante
( ) Rabo-de-burro ( ) Outro: _____

C) OUTROS MEIOS DE VIDA

38. Além dos produtos tirados da sua área de cacau/pecuária e do seu quintal, quais outras coisas você produz aqui na sua propriedade? Desses produtos, quais a sua família consome e quais vende?

ANIMAIS	C	V	HORTALIÇAS	C	V	ANUAIS	C	V	PERENES	C	V	MEDICINAIS	C	V	OUTROS	C	V
Galinha			Alface			Banana			Madeira			Boldo					
Pato			Rúcula			Milho			Pimenta			Cidreira					
Peixe			C. verde			Mandioca			Coco			Capim-santo					
Porco			Cebolinha			Arroz			Cupuaçu			Hortelã					
Peru			Couve			Feijão			Açaí			Cumaru					
			Maxixe			Abóbora			Caju								
									Acerola								

39. Nos últimos 2 anos, pensando em toda renda produzida na propriedade, de 1 até completar 10, qual um número representa a atividade de:

Cacau: __ Pecuária: __ Lav. Branca: __ Horta: __ Outros: _____

40. Sobre a renda que vem de fora da propriedade, vou citar algumas coisas e você, por favor, diga se alguém da família recebeu dinheiro dessa forma:

FONTE DE RENDA	Sim	Não	a) Nos últimos 3 meses, quanto cada pessoa recebeu (R$) de cada uma dessas formas?	b) Há quantos anos recebe mensalmente? (Caso receba mensalmente)	OBS
Diária na propriedade de outra pessoa					
Trabalho regular (empregado)					
Artesanato					
Bolsa família					
Bolsa escola					
Aposentadoria					
Seguro desemprego					
Remessa de parentes					
Pensão alimentícia					
PSA					
Aluguel					

D) CONFLITO COM ANIMAIS SILVESTRES

41. Sobre os animais nativos da região, você acredita que o cacau/pecuária ajuda a preservar, a reduzir, não faz diferença pros animais ou depende da espécie? Por quê?

Cacau: ( ) Preservar ( ) Reduzir ( ) Não faz diferença ( ) Depende da espécie

_____
___
_____
____

Pecuária: ( ) Preservar ( ) Reduzir ( ) Não faz diferença ( ) Depende da espécie

_____
_____
_____

42. Sobre a presença dos animais na sua área de cacau/pecuária:
a) Quais os animais que mais passam dentro da sua área de cacau/pecuária (aves; mamíferos; répteis...)?
b) De todos esses animais, quais você gostaria que tivessem mais, menos, e quais tanto faz? Muito ou pouco?
c) Algum deles te incomoda ou pode ser um problema? Qual(is)? Muito ou pouco? Por quê (afeta/reduz ou não a produção)?

Nº	NOME POPULAR	Cacau	Pasto	TER MENOS		Tanto faz	TER MAIS		INCOMODA			AFETA PRODUÇÃO		
				Muito	Pouco		Pouco	Muito	Não	Pouco	Muito	Não	Pouco	Muito
1		x		-2	-1	0	1	2	0	-1	-2	0	-1	-2
2		x		-2	-1	0	1	2	0	-1	-2	0	-1	-2
3		x		-2	-1	0	1	2	0	-1	-2	0	-1	-2
4		x		-2	-1	0	1	2	0	-1	-2	0	-1	-2
5		x		-2	-1	0	1	2	0	-1	-2	0	-1	-2
6		x		-2	-1	0	1	2	0	-1	-2	0	-1	-2
7		x		-2	-1	0	1	2	0	-1	-2	0	-1	-2
8		x		-2	-1	0	1	2	0	-1	-2	0	-1	-2
1			x	-2	-1	0	1	2	0	-1	-2	0	-1	-2
2			x	-2	-1	0	1	2	0	-1	-2	0	-1	-2
3			x	-2	-1	0	1	2	0	-1	-2	0	-1	-2
4			x	-2	-1	0	1	2	0	-1	-2	0	-1	-2
5			x	-2	-1	0	1	2	0	-1	-2	0	-1	-2
6			x	-2	-1	0	1	2	0	-1	-2	0	-1	-2
7			x	-2	-1	0	1	2	0	-1	-2	0	-1	-2
8			x	-2	-1	0	1	2	0	-1	-2	0	-1	-2

Comentários: CACAU		PECUÁRIA	
1		1	
2		2	
3		3	
4		4	
5		5	
6		6	
7		7	
8		8	

d) Se algum deles incomodar: Você já fez alguma coisa para resolver esse problema? ( ) Sim ( ) Não. Se sim: o quê fez? Melhorou, piorou ou ficou igual? Muito ou pouco?

Nº	DESCRIÇÃO DA AÇÃO CONTROLE	CONTROLA			PIOROU			MELHOROU	
		Não	Pouco	Muito	Muito	Pouco	=	Pouco	Muito
		0	-1	-2	-2	-1	0	+1	+2
		0	-1	-2	-2	-1	0	+1	+2
		0	-1	-2	-2	-1	0	+1	+2
		0	-1	-2	-2	-1	0	+1	+2

43. Você ou alguém da sua família utiliza sua área de cacau/pasto para pegar caça pra comer? Por quê? E para vender?

	Caça		Venda		Por quê?
	Sim	Não	Sim	Não	
Cacau					
Pasto					

E) PERCEPÇÃO POR INDICADORES DOS MEIOS DE VIDA SUSTENTÁVEIS (MVS)

ORIENTAÇÕES AO ENTREVISTADOR

- A linguagem informal da pergunta pode ser adaptada de acordo a situação, a fim de manter a fluidez do diálogo e a eficácia da comunicação, mantendo o foco e sem alterar o propósito do questionamento.
- Sempre que a pergunta conter "ISSO", significa que o entrevistador pode repetir a resposta da questão anterior, para melhor explicar ao que se refere a pergunta em

- Antes de continuarmos, nesta pesquisa, queremos entender o quanto o cacau ou a pecuária fazem diferença na qualidade de vida dos agricultores, colocando a sua opinião em primeiro lugar. Por isso, as coisas que você acha são muito importantes! =)
- Você quer dar uma parada na entrevista e terminamos noutro horário, ou podemos continuar?
- Para responder às próximas perguntas, vamos pensar sempre no que aconteceu nos últimos 2 anos, tudo bem?

Capital Humano (H_)
H1. Foco: segurança alimentar. Diversidade de alimentos consumidos e origem da produção.
Hipótese: o cacau proporciona maior segurança alimentar do que a pecuária.

44. O seu trabalho com cacau/pecuária tem alguma coisa a ver com a alimentação da sua família? Por quê?

_____

45. Lembrando das comidas e bebidas que você e sua família mais comem no almoço, na janta e no café-da-manhã, a maioria desses alimentos são produzidos:
( ) Na propriedade, ( ) Fora da propriedade **ou** ( ) Meio a meio?

46. Você usa o dinheiro ganho com o cacau/pecuária pra comprar as comidas que vem de fora da propriedade?
Cacau: ( ) Sim ( ) Não ( ) Não sei dizer
Pecuária: ( ) Sim ( ) Não ( ) Não sei dizer

47. Se você não tivesse sua área de cacau/pecuária, você acha que produziria mais alimentos na sua propriedade ou não? Por quê?
Cacau: ( ) Sim ( ) Não ( ) Talvez ( ) Não sei dizer

_____

Pecuária: ( ) Sim ( ) Não ( ) Talvez ( ) Não sei dizer

_____

48. Pensando nas coisas que vocês comem e bebem - por exemplo, arroz, feijão, mandioca, carne e sucos e todas outras coisas:
a) A variedade de comidas é:
( ) Grande, ( ) Média ou ( ) Pequena?

b) Sobre ISSO, você está: ( ) Satisfeito, ( ) Insatisfeito ou ( ) Mais ou menos satisfeito? Por quê?

_____

c) Você acha que a variedade de alimentos da sua família é (Grande/Média/Pequena) por causa da sua área de:
Cacau?: ( ) Sim ( ) Não ( ) Não sei dizer
Pecuária?: ( ) Sim ( ) Não ( ) Não sei dizer

H2. Foco: acesso a novos conhecimentos, aprendizados gerais que contribuam para as atividades agropecuárias desenvolvidas na propriedade (ex. novas formas de produção, gestão, habilidades e técnicas para produção, beneficiamento e comercialização).
Acesso a: assistência técnica, cursos, oficinas, intercâmbios, aprendizados empíricos, dicas e etc.
Hipótese: agricultores que trabalham com cacau possuem maior acesso a novos conhecimentos.

49. Trabalhar com cacau/pecuária te faz aprender coisas novas pra melhorar a produção sua propriedade?

50. Pensando no tempo que você usa trabalhando:
a) Você diria que seu aprendizado de coisas novas:
Com Cacau tem sido: ( ) Muito, ( ) Médio ou ( ) Pouco?
Com Pecuária tem sido: ( ) Muito, ( ) Médio ou ( ) Pouco?

b) Sobre ISSO, você está: ( ) Satisfeito, ( ) Insatisfeito ou ( ) Mais ou menos satisfeito? Por quê?

_____

_____

c) Você tem feito na prática, aqui na propriedade, algum aprendizado novo?
( ) Sim ( ) Não ( ) Ainda não, mas tem planos.

51. Você recebeu alguma assistência técnica para cacau/pecuária?
Cacau: ( ) Sim ( ) Não. Se sim, de quem? _____
Pecuária: ( ) Sim ( ) Não. Se sim, de quem? _____

52. Você participou de algum curso, oficina ou intercâmbio sobre cacau/pecuária?
Cacau: ( ) Sim ( ) Não.
Pecuária: ( ) Sim ( ) Não.

H3. Foco: satisfação do extrativista/agricultor com o seu trabalho (cacau/pecuária). Estar feliz com sua principal atividade de renda.
Hipótese: tanto o cacau quanto a pecuária deixam o agricultor satisfeito em seu trabalho.

53. O seu trabalho com cacau/pecuária tem alguma coisa a ver com sua felicidade?
_____
_____

54. Podemos dizer que sua felicidade com o trabalho de cacau/pecuária é:
Cacau: ( ) Grande, ( ) Média ou ( ) Pequena?
Pecuária: ( ) Grande, ( ) Média ou ( ) Pequena?

55. Pensando sobre tudo que você faz durante o seu trabalho com cacau/pecuária:

a) Você está:
( ) Satisfeito, ( ) Insatisfeito ou ( ) Mais ou menos satisfeito? Por quê?
_____

b) Quais são as coisas que mais te animam no seu trabalho com cacau/pecuária?
Cacau: _____
Pecuária: _____

c) E as que mais desanimam?
Cacau: _____
Pecuária: _____

H4. Foco: intenção de permanecer na propriedade/região.
Hipótese: tanto o cacau quanto a pecuária contribuem para a permanência dos agricultores.

56. Sobre viver aqui nesta região, você tem planos de se mudar ou ficar por aqui mesmo?
_____
_____

57. Sobre viver nesta propriedade, a gente pode dizer que você está:
( ) Satisfeito, ( ) Insatisfeito ou ( ) Mais ou menos satisfeito? Por quê?
_____

58. Em relação à sua família:

a) Você diria que a vontade de todos em continuar morando aqui na propriedade é:
( ) Grande, ( ) Média ou ( ) Pequena?

b) Você acha que ISSO acontece por causa do cacau/pecuária ou por outros motivos? Por quê?
( ) Cacau ( ) Pecuária ( ) Outros motivos ( ) Cacau/Pecuária junto com outros motivos

_____
_____
_____

Capital Social (S_)
S1. Foco: se a atividade gera oportunidade de trabalho para os jovens (importância da atividade para permanência do jovem no campo).
Hipótese: tanto o cacau quanto a pecuária geram pouca oportunidade para os jovens.

59. Pensando sobre os jovens, na faixa de 16 a 21 anos de idade:

a) Em quê você acha que eles gostam mais de trabalhar?
( ) Cacau ( ) Pecuária ( ) Outra coisa dentro da propriedade ( ) Outra coisa fora da propriedade

b) Pra você, ISSO é: ( ) Bom ( ) Ruim ou ( ) Tanto faz? Por quê?
_____
_____

c) Você acha que a produção de:
Cacau gera: ( ) Muita, ( ) Média ou ( ) Pouca oportunidade de trabalho para esses jovens?
Pecuária gera: ( ) Muita, ( ) Média ou ( ) Pouca oportunidade de trabalho para esses jovens?

d) Algum jovem dessa idade trabalha na sua área de cacau/pecuária? ( ) Sim ( ) Não

e) Se sim, eles ganham por esse trabalho? ( ) Sim ( ) Não

S2. Foco: participação da mulher nas atividades produtivas.
Hipótese: o cacau propicia maior participação das mulheres do que a pecuária.

60. Pensando nas coisas que as mulheres fazem aqui nesta propriedade:

a) Elas são responsáveis em fazer o quê?
( ) Ajuda em tudo ( ) Cuidar da casa ( ) Cuidar da horta e/ou quintal ( ) Atividades com cacau
( ) Atividades com pecuária ( ) Atividades com cultivos anuais ( ) Comida
( ) Outras: _____

b) Você diria que a participação delas no trabalho com:
Cacau é: ( ) Grande, ( ) Média ou ( ) Pequena? Por quê?
_____
Pecuária é: ( ) Grande, ( ) Média ou ( ) Pequena? Por quê?
_____

c) Sobre essa participação das mulheres, você está:
( ) Satisfeito ( ) Insatisfeito ou ( ) Mais ou menos satisfeito? Por quê?
_____

S3. Foco: contribuição/influência nas relações com parceiros e instituições (externos) envolvidos nas atividades produtivas.
Hipótese: o cacau proporciona maiores relações com parceiros.

61. Sobre relações com parceiros:

a) Trabalhar com cacau/pecuária tem feito você ter parcerias com instituições ou organizações, ex.: Prefeitura, secretarias, ONGs, empresas, Universidade...?
Cacau: ( ) Sim ( ) Não.
Pecuária: ( ) Sim ( ) Não.
Anotações: _____

b) Se sim, você tem ( ) Muitos, ( ) Poucos ou ( ) Mais ou menos parceiros? Quais?
_____

c) Com ISSO, você está: ( ) Satisfeito, ( ) Insatisfeito ou ( ) Mais ou menos satisfeito? Por quê?
_____

d) Nesses últimos 2 anos, você participou de algum trabalho coletivo, mutirão pra trabalhar com cacau/pecuária? Se sim, qual?
Cacau: ( ) Sim ( ) Não. _____
Pecuária: ( ) Sim ( ) Não.
_____

*grupo organizado com pessoas que se ajudam, trabalham junto, como em cooperativas, associações, entre amigos ou alguma coisa parecida.

S4. Foco: interferência nas relações sociais com as pessoas mais próximas.
Hipótese: tanto o cacau quanto a pecuária não interferem nas relações com os vizinhos.

62. Sobre sua relação com as pessoas mais próximas, família e vizinhos:

a) Está tudo bem ou tem tido problemas?
_____
_____
_____

b) Então, você diria que a convivência entre as pessoas aqui da sua família está:
( ) Boa, ( ) Média ou ( ) Ruim?

c) E a relação com os vizinhos, está:

( ) Boa, ( ) Média ou ( ) Ruim?

d) Sobre ESSA relação com família e vizinhos, você está:
( ) Satisfeito, ( ) Insatisfeito ou ( ) Mais ou menos? Por quê?
_____
_____

e) Tem alguma parte do seu trabalho com cacau/pecuária que você faz junto com sua família?
Cacau: ( ) Sim ( ) Não
Pecuária: ( ) Sim ( ) Não

f) Tem alguma parte do seu trabalho com cacau/pecuária que os seus vizinhos te ajudam?
Cacau: ( ) Sim ( ) Não
Pecuária: ( ) Sim ( ) Não

g) Sobre ESSAS relações com as pessoas próximas, você acha que o seu trabalho com:
Cacau: ( ) Faz melhorar, ( ) Faz piorar ou ( ) Não faz diferença?
Pecuária: ( ) Faz melhorar, ( ) Faz piorar ou ( ) Não faz diferença?

Capital Físico (P_)
P1. Foco: acesso à infraestrutura necessária para realização das atividades de comercialização do cacau/pecuária fora da propriedade.
Hipótese: tanto o cacau quanto a pecuária permitem acesso à infraestrutura necessária para realização dessas atividades.

63. Fora da propriedade, tem alguma coisa que falta ou que precisa melhorar para poder facilitar a venda dos produtos de cacau/pecuária?
Cacau:_____
____
Pecuária:_____
____

64. Sobre a estrutura que já existe para usar, quando precisa vender os produtos de cacau/pecuária, você diria que a necessidade de melhorias é:
Cacau: ( ) Grande, ( ) Média ou ( ) Pequena?
Pecuária: ( ) Grande, ( ) Média ou ( ) Pequena?

65. Sobre ESSA estrutura de venda/comercialização, você está:
( ) Satisfeito, ( ) Insatisfeito ou ( ) Mais ou menos? Por quê?
_____
_____

P2. Foco: acesso à infraestrutura necessária para realização das atividades produtivas e de comercialização do cacau/pecuária dentro da propriedade.
Hipótese: tanto o cacau quanto a pecuária permitem acesso à infraestrutura necessária para realização dessas atividades.

66. Tem alguma coisa faltando pra você poder trabalhar melhor com o cacau/pecuária aqui na sua propriedade?
Cacau: _____
Pecuária: _____

67. Vou dizer algumas coisas e você responde se tem:
Geral: ( ) moto-roçadeira ( ) bomba p/ aplicar veneno () cerca suficiente
Cacau: ( ) barcaça/estufa ( ) cocho ( ) moto-poda
Pecuária: ( ) cerca suficiente ( ) curral

68. Pensando em tudo o que você ainda precisa para trabalhar com cacau/pecuária, você diria que sua necessidade de materiais e ferramentas é:
Cacau: ( ) Grande, ( ) Média ou ( ) Pequena?
Pecuária: ( ) Grande, ( ) Média ou ( ) Pequena?

69. Sobre as coisas que você já tem pra trabalhar, você está:
( ) Satisfeito, ( ) Insatisfeito ou ( ) Mais ou menos?
_____
_____

P3. Foco: interferência na infraestrutura individual/familiar, extra atividade produtiva.
Hipótese: o cacau e a pecuária não diferem sobre a moradia.

70. Me conte a história de como foi a construção desta casa que você mora. Quando foi feita? Ainda falta alguma coisa?
_____
____

Construída em: _____ ( ) Pronta ( ) Inacabada

71. Sobre o tamanho da casa, pra caber a família toda,:
( ) Tem espaço ( ) Não tem espaço ou ( ) Tem, mas precisa aumentar?

72. Sobre a casa, você diria que está: ( ) Satisfeito, ( ) Insatisfeito ou ( ) Mais ou menos? Por quê?
_____
_____
_____
_____

73. Pra construir a casa, o seu trabalho com:
Cacau: ( ) Ajuda ou ( ) Não ajuda?
Pecuária: ( ) Ajuda ou ( ) Não ajuda?

P4. Foco: interferência na aquisição/venda de bens pessoais, extra atividade produtiva.
Despesas: comida, medicamentos, combustível, luz, água, telefone, etc. Coisas/Bens pessoais: carro, móveis, roupas, canoa, fogão, TV, geladeira, lavadeira, telefone, som, computador, etc.
Hipótese: o cacau e a pecuária não diferem sobre a aquisição de bens pessoais.

74. Nos últimos 2 anos:

a) Você precisou vender coisas pessoais pra pagar as despesas da sua família?
( ) Sim ( ) Não. Se sim, quais?
_____

b) Se sim, você fez isso por causa das despesas com o cacau/pecuária, pra manter a produção?
( ) Por causa do cacau ( ) Por causa da pecuária ( ) Por outros motivos

c) Você conseguiu comprar coisas novas pra casa e família?
( ) Sim ( ) Não. Se sim, quais?
_____

d) Se sim, a renda do cacau/pecuária contribuiu para comprar essas coisas?
( ) Cacau contribuiu ( ) Pecuária contribuiu ( ) Outras fontes de renda contribuíram

75. Sobre as coisas que você tem - por exemplo: moto, geladeira, fogão e outras - você está:
( ) Satisfeito, ( ) Mais ou menos satisfeito ou ( ) Insatisfeito?

76. Se você conseguisse um dinheiro, qual seria a próxima coisa que você tem prioridade pra comprar/investir?
_____
____
_____
____
_____
____

Capital Financeiro (F_)
F1. Foco: satisfação com a relação custo-benefício da produção.
Hipótese: o cacau e a pecuária não diferem sobre a satisfação com a relação custo-benefício.

77. Sobre os seus gastos e ganhos com a produção:

a) Você diria que o gasto que você tem com a produção de:
Cacau é: ( ) Muito ( ) Médio ou ( ) Pouco? Por quê?
_____
_____
Pecuária é: ( ) Muito ( ) Médio ou ( ) Pouco? Por quê?
_____
_____

b) E o dinheiro que você ganha com as vendas de:
Cacau: ( ) Tem compensado ou ( ) Não tem compensado os gastos com a produção?
Pecuária: ( ) Tem compensado ou ( ) Não tem compensado os gastos com a produção?

c) Sobre ESSA renda com cacau/pecuária, você diria que está:
( ) Satisfeito, ( ) Insatisfeito ou ( ) Mais ou menos? Por quê?
_____
_____
_____
_____

d) Quanto você acha que seria um preço justo pro kg do cacau?
Convencional (não fermentado): _____
Fermentado:_____

F2. Foco: mudança de preço dos produtos. Influência do agricultor sobre o mercado e vice-versa.
Despesas: comida, medicamentos, combustível, luz, água, telefone, etc.

78. Os agricultores que fazem um produto de cacau/pecuária com melhor qualidade conseguem vender por um preço maior ou não?
Cacau: ( ) Maior ( ) Não.
_____
_____
Pecuária: ( ) Maior ( ) Não.
_____
_____

79. Quem diz o valor do preço do seu produto de cacau/pecuária, é você ou o comprador?
Cacau: ( ) Produtor ( ) Mercado
Pecuária:
Gado: ( ) Produtor ( ) Mercado
Leite: ( ) Produtor ( ) Mercado
Queijo: ( ) Produtor ( ) Mercado

80. Nos últimos 2 anos:

a) Os preços do cacau/pecuária:
Cacau: ( ) Mudaram muito, ( ) pouco, ( ) mais ou menos ou ( ) não mudaram?
Pecuária: ( ) Mudaram muito, ( ) pouco, ( ) mais ou menos ou ( ) não mudaram?

b) E pra você, ISSO é: ( ) Bom, ( ) Ruim ou ( ) Tanto faz? Por que?
_____
____

F3. Foco: garantia de comercialização.

81. Quando você precisa vender os produtos de cacau/pecuária, como você faz? Sempre consegue vender ou nem sempre?
Cacau: ( ) Sempre vende ( ) Nem sempre consegue vender
Pecuária:
Gado: ( ) Sempre vende ( ) Nem sempre consegue vender
Leite: ( ) Sempre vende ( ) Nem sempre consegue vender
Queijo: ( ) Sempre vende ( ) Nem sempre consegue vender

82. Então, você diria que vender os produtos de cacau/pecuária tem sido:
Cacau: ( ) Fácil, ( ) Mais ou menos ou ( ) Difícil Por quê?
_____
Pecuária: ( ) Fácil, ( ) Mais ou menos ou ( ) Difícil Por quê?
_____

83. Sobre a garantia pra conseguir vender os produtos de cacau/pecuária, você diria que está:
( ) Satisfeito, ( ) Insatisfeito ou ( ) Mais ou menos?
_____
_____

F4. Foco: interferência na possibilidade de escolher o comprador de seus produtos. Autonomia do agricultor diante do mercado.

84. Você tem liberdade para escolher quem vai comprar seu produto cacau/pecuária?
Cacau: ( ) Sim ( ) Não
_____
Pecuária: ( ) Sim ( ) Não
_____

85. Sobre os compradores do seu produto de cacau/pecuária:

a) Você tem:
Cacau: ( ) Muitos, ( ) Mais ou menos ou ( ) Poucos
Pecuária: ( ) Muitos, ( ) Mais ou menos ou ( ) Poucos

b) Sobre ESSA liberdade pra escolher o comprador dos seus produtos de cacau/pecuária, você está:
( ) Satisfeito, ( ) Mais ou menos ou ( ) Insatisfeito? Por quê?

_____
_____

Capital Natural (N_)
N1. Foco: estratégia de manutenção do recurso manejado.

86. Me conte, como está indo sua produção de cacau/pecuária? Por quê?

_____
_____

87. Desde que você trabalha na sua propriedade, você diria que sua produção de cacau/pecuária está ficando:
Cacau: ( ) Maior, ( ) Menor ou ( ) Tem ficado igual?
Pecuária: ( ) Maior, ( ) Menor ou ( ) Tem ficado igual?

88. Sobre a produtividade do seu cacau/pecuária, você diria que está:
( ) Satisfeito, ( ) Mais ou menos ( ) Insatisfeito? Por quê?

_____
_____
_____
_____

89. Como está a qualidade, fertilidade, da sua terra de cacau/pecuária?

_____
_____
_____
_____

90. Desde que você trabalha na sua propriedade, pensando na fertilidade da terra:

a) Você diria que a área de:
Cacau está ficando: ( ) Cada vez melhor, ( ) Cada vez mais cansada ou ( ) Tem ficado igual?
Pecuária está ficando: ( ) Cada vez melhor, ( ) Cada vez mais cansada ou ( ) Tem ficado igual?

b) Sobre ISSO, você diria que está: ( ) Satisfeito, ( ) Mais ou menos ( ) Insatisfeito? Por quê?

_____
_____
_____
_____

91. O trabalho pra roçar as plantas que crescem naturalmente na sua área de:
Cacau tem: ( ) Aumentado, ( ) Diminuído ou ( ) Ficado igual? Por quê?

_____
_____

Pecuária tem: ( ) Aumentado, ( ) Diminuído ou ( ) Ficado igual? Por quê?

_____
____

N3. Foco: interferência em recurso natural fundamental para os processos produtivos e qualidade de vida.

92. Você tem algum igarapé que passa dentro da sua área de cacau/pecuária?
Cacau: ( ) Sim ( ) Não
Pecuária: ( ) Sim ( ) Não

93. Pensando no volume de água: quando um igarapé passa dentro de uma área de cacau/pecuária, você acredita que o cacau/pecuária faz com que a quantidade da água:
Cacau: ( ) Aumente, ( ) Diminua, ( ) Fique igual ou ( ) Não faz diferença? Por quê?
_____
____
Pecuária: ( ) Aumente, ( ) Diminua, ( ) Fique igual ou ( ) Não faz diferença? Por quê?
_____
___

94. Agora, pensando na qualidade da água: quando um igarapé passa dentro de uma área de cacau/pecuária, você acredita que o cacau/pecuária faz com que a limpeza da água:
Cacau: ( ) Aumente, ( ) Diminua, ( ) Fique igual ou ( ) Não faz diferença? Por quê?
_____
____
Pecuária: ( ) Aumente, ( ) Diminua, ( ) Fique igual ou ( ) Não faz diferença? Por quê?
_____
___

95. Sobre a água que você consome, você está:
( ) Satisfeito ( ) Mais ou menos ( ) Insatisfeito? Por quê?
_____
_____
____

N4. Foco: manutenção do recurso florestal.
Observações: questão relacionada com o desmatamento, bem como perda da complexidade funcional, envolvendo os aspectos de composição e estrutura florestal.

96. Você acredita que, dentro da mesma propriedade, é possível ter cacau/pecuária e manter uma outra área de floresta em pé? Por quê?
_____
_____

97. Então, pra manter as matas em pé, você acha que produzir cacau/pecuária:
Cacau: ( ) Ajuda, ( ) Prejudica ou ( ) Não interfere?
Pecuária: ( ) Ajuda, ( ) Prejudica ou ( ) Não interfere?

98. Sobre a quantidade de mata aqui na região, você diria que está:

( ) Satisfeito, ( ) Mais ou menos ou ( ) Insatisfeito? Por quê?

_____

_____

99. Você acha que as árvores da sua área de:
Cacau podem: ( ) Ajudar, ( ) Prejudicar ou ( ) Não fazem diferença na conservação das matas?
Pecuária: podem: ( ) Ajudar, ( ) Prejudicar ou ( ) Não fazem diferença na conservação das matas?

100.
a) Você diria que a quantidade de árvores na sua área de:
Cacau é: ( ) Grande, ( ) Média ou ( ) Pequena?
Pecuária é: ( ) Grande, ( ) Média ou ( ) Pequena?

b) Sobre ESSA quantidade de árvores no seu cacau/pasto, você gostaria de:
Cacau: ( ) Ter mais, ( ) Ter menos ou ( ) Manter como está? Por quê?

_____

Pecuária: ( ) Ter mais, ( ) Ter menos ou ( ) Manter como está? Por quê?

_____

101.
a) Você diria que a variedade de árvores diferentes na sua área de:
Cacau é: ( ) Grande, ( ) Média ou ( ) Pequena?
Pasto é: ( ) Grande, ( ) Média ou ( ) Pequena?

b). Sobre ESSA variedade de árvores diferentes no seu cacau/pasto, você gostaria de:
Cacau: ( ) Ter mais, ( ) Ter menos ou ( ) Manter como está? Por quê?

_____

Pecuária: ( ) Ter mais, ( ) Ter menos ou ( ) Manter como está? Por quê?

_____

102. Pensando na produção de cacau/pecuária, as árvores que estão na sua área:
Cacau: ( ) Aumentam, ( ) Diminuem ou ( ) Não fazem diferença na produção? Por quê?

_____

Pecuária: ( ) Aumentam, ( ) Diminuem ou ( ) Não fazem diferença na produção? Por quê?

_____

APPENDIX 2

Composition of variables for each factor used in our research methods and respective variation range and units for calculations (made per household).

Factor (unit)	**Composition of variables**	**Variation range**	**Unit** (original)	**Unit** (adapted)	**Calculation**
Diversification (products)	1. Commercialized farm products	1 to 14	products	-	-
Education (0-1 scale)	1. Educational level	11 levels	categoric	0-1 (scale)	-
Farmer age (years old)	1. Age of farmer	19 to 88	years old	-	-
Food variety (ingredients)	1. Eaten food	11 to 28	ingredients/day	-	-
Housing (0-1 scale)	1. Bedroom comfort	0.33 to 3.50	bedroom/person	0-1 (scale)	Average
	2. Bathroom comfort	3 levels	category	0-1 (scale)	
	3. Building material quality	4 levels	category	0-1 (scale)	
	4. Size comfort	3 levels	category	0-1 (scale)	
Income (USD/year)	1. Cacao income	1,200 to 117,500	USD/year	-	Sum
	2. Cattle income	725 to 34,250	USD/year	-	
	3. Other farm income	50 to 21,700	USD/year	-	
	4. Off-farm income	175 to 29,000	USD/year	-	
Labor (family size)	1. Family members	1 to 9	people	-	-
Land size (ha)	1. Property area	3.5 to 350	ha	-	-
Land tenure (0-1 scale)	1. type of document	3 levels	categoric	0-1 (scale)	-
Market distance (km)	1. Distance from city	0 to 80	km	-	-
Market niches (0-1 scale)	1. Access to better price	3 levels	categoric	0-1 (scale)	-
Property age (years)	1. Years of residency	2 to 48	years	-	-
Public services (0-1 scale)	1. Electricity access	2 levels	categoric	0-1 (scale)	Average
	2. Health access	7 levels	categoric	0-1 (scale)	
	3. Education access	5 levels	categoric	0-1 (scale)	
Social interactions (0-1 scale)	1. Social enrollment level	5 levels	categoric	0-1 (scale)	Average
	2. Partnership intensity	5 levels	categoric	0-1 (scale)	
	3. External partnership	3 levels	categoric	0-1 (scale)	
	4. Community integration	3 levels	categoric	0-1 (scale)	
	5. Family/Neighbor relationship	3 levels	categoric	0-1 (scale)	
Soil fertility (0-1 scale)	1. Class of soil tipology	5 levels	categoric	0-1 (scale)	-

Continue...

Factor (unit)	**Composition of variables**	**Variation range**	**Unit** (original)	**Unit** (adapted)	**Calculation**
Technology (0-1 scale)	1. General equipment demand	5 levels	categoric	0-1 (scale)	Average
	2. Required equipment	10 levels	categoric	0-1 (scale)	
	3. Intensity of equipment demand	3 levels	categoric	0-1 (scale)	
	4. Satisfaction about equipments	3 levels	categoric	0-1 (scale)	
Water access (0-1 scale)	1. Access to water	12 levels	categoric	0-1 (scale)	Average
	2. Satisfaction about water	3 levels	categoric	0-1 (scale)	
Women integration (0-1 scale)	1. Women farm responsibility	5 levels	categoric	0-1 (scale)	Average
	2. Women work in cacao/cattle	3 levels	categoric	0-1 (scale)	
	3. Satisfaction about women work	3 levels	categoric	0-1 (scale)	