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Smallholders, Agrarian Reform, and Globalization in the Brazilian Amazon: Cattle versus the Environment

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Abstract: Smallholder farming in the Brazilian Amazon has changed markedly over the last few decades, following a pervasive swing to cattle production observed across the basin. These changes have brought opportunities for accumulating a modicum of wealth that were not available in the early stages of colonization. At the same time, they have reconfigured livelihood systems away from diversified agriculture to a strong engagement with the cattle economy. They are also exposing smallholders to new forms of exploitation by transnational corporations, seeking to pass risk upstream to less powerful economic agents who provide inputs to production, such as calves. The case of Southeastern Pará provides a natural laboratory for investigating such phenomena, which the article considers through the presentation of data from field research conducted in the region over the past decade. Here, agrarian reform efforts have been particularly intense, and social movements have often espoused a green rhetoric in favor of diversified agriculture, even though smallholders show little interest in anything but cattle. Household level incentives promote Amazonia's emergent cattle economy, demonstrating how global production networks have reached into the basin, where production relations between smallholders provisioning calves to large ranching operations often resemble what has been referred to in the literature as "contract farming" land grabs, given the exploitive terms of trade.

Keywords: global cattle economy; production chains and networks; settlement projects; Amazonia; land grabs

1. Introduction

Since the 1960s, the Brazilian government has advanced a series of comprehensive plans to integrate the Amazon region with the economic and political core of the country, including construction of a highway network to make accessible this vast frontier, subsidies and fiscal incentives to attract capital investment, and colonization programs to promote orderly in-migration and occupation necessary to secure Brazil's territorial claim while in the same efforts provide land to the landless. Amazonia's development history reveals that government motivations and subsequent policies have vacillated greatly between a national desire for economic growth via the support of private interests and the populist demand for land and opportunity, and the outcomes from these efforts likewise present mixed results. On the one hand, the highway network opened the frontier to waves of immigration with population increases from four million in 1960 to more than 24 million by 2010 [1], and reduced transportation costs making the region attractive to agroindustry [2]. Indeed, Brazil's economy has mostly thrived since the turn of the millennium, with agroindustry in Amazonia an important part of this success story, particularly the expansion of cattle ranching throughout the basin [3]. On the other

hand, the elaborate colonization programs intended to rectify Brazil's "rural problem" and ameliorate growing populist discontent were unable to completely satisfy the societal demand for land, and led to conflicts and rapid rates of deforestation [3].

Despite this checkered development history, there is little doubt that the livelihood systems of the smallholders who were originally targeted for colonization have evolved dramatically over the past few decades, from mostly subsistence farming based strictly on household resources, to small-scale ranching tied to the global economy via production networks. At the same time, a powerful agrarian reform movement has successfully pressured the government to provide land to the landless in thousands of new settlement projects (SPs) intended to support family farming. Amazonia's smallholders are no longer autarchic peasants living beyond the agricultural frontier. They are now fully engaged agents in Brazil's export economy, and, frequently, energetic participants in the region's agrarian politics. Although a potential development success in certain terms, this social transformation of Amazonia's rural population presents more dubious results for the environment, and for the participating households themselves. The livelihood systems are highly focused on animal husbandry, an agricultural activity held responsible for the lion's share of Amazonian deforestation. Further, the new economic status of the former peasant has also brought new potentials for exploitation on the part of large-scale ranchers and the emergent food-processing sector.

The goal of the present paper is to examine the productive activities of smallholders living in SPs, and how expanding engagement with the global cattle economy is affecting land-use decisions in agrarian reform settlements that were created as a mechanism to alleviate poverty and promote food security through diversified and sustainable crop production. It does so by first charting the path of cattle expansion in the Brazilian Amazon, and linking this to skewed patterns of land ownership that have arisen in its wake. The paper then explores how agrarian reform movements have arisen as a consequence, with a particular emphasis on the formation of SPs through political mobilization that has been referred to as *direct action land reform*, or DALR [4]. Next, research results are presented that document the circumstances that have encouraged smallholders in Southeastern Pará to adopt livelihood systems focused on cattle, which is in contradiction to the environmental requirements for SP formation. In addition, findings give evidence to the emergent cattle production chain, including the practice of contract "calving" arrangements that link smallholders in SPs to large ranching operations and the appearance in the region of heavily capitalized corporate interests engaged in export.

1.1. Cattle and Agrarian Reform

Amazonia's cattle economy has been key to Brazil's emergence as an economic power, but it came with a high cost to both the environment and society. In the Brazilian Amazon, it is mainly large-scale producers who are driving commercial agricultural development, while smallholders are finding it economically viable to replace forest and old croplands by planting pasture [5]. Walker et al. [6], Pocard-Chapuis et al. [7], and Vosti et al. [8] attributed this gradual transformation of crops and forestlands into planted pasture in small-scale farms to a widespread process of *pecuarização*, or expansion of the cattle ranching economy toward the Amazon's geographical limits. Participation of smallholders in the cattle economy has been analyzed in studies developed by Homma and Walker et al. [9,10]. Both studies compared cattle herds and pasture clearance in areas owned by small producers (land < 100 ha). Homma found that small producers living near the Transamazon highway in Altamira raised an average of 1.4 animals per 6.4 hectares of pasture in 1975 [9]. In the same region, in 2000, Walker et al. found that small producers had increased the average number of animals to 33, which required an average of 37 hectares of pastureland [10]. These findings show that, over time, more animals were being raised on each property. This in turn implies that more area was needed for pasture and consequently less was available for agriculture. In fact, Homma observed that the amount of land attributed to pasture was similar to the amount used for cropping in the properties visited in 1975 [9], while Walker et al. found that only one-tenth of the total land allocated to pasture was used for cropping [10].

Farm level dynamics such as these underlie a pervasive shift to cattle ranching in the Amazon at large. Despite early prognostication that the region was not viable for agriculture and ranching in particular offered little promise of success without massive government subsidies [11], animal husbandry has proven more successful and resilient [12]. Ranching has a long Amazonian history, but when the military regime began its push in the mid-1960s to open the north, the region accounted for only about 8 percent of Brazilian stock [13]. By 1990, the Amazonian herd reached about 20 million animals, and by 2005 it added another 50 million head, growing to over 70 million animals dispersed widely across the basin. As of 2013, the cattle herd in Amazonia was over 80 million animals, accounting for more than 25 percent of Brazilian export of beef destined to satisfy demands around the world, with markets in Latin America, the European Union, the Middle East, and Asia, including China [2]. Along with cattle expansion, pasture increased from 0.7 percent of the total region in 1970 to 10 percent by 2004 [14]. Implicated in this process is deforestation, since more than 80 percent of cleared areas in the Brazilian Amazon are dedicated to pasture formation [10,15–17].

Unfortunately, land-extensive cattle ranching has also resulted in the replication of land inequality observed in other parts of Brazil, as early smallholders were forced from their land due to their inability to compete in markets or through violent appropriation by largeholders, which pushed them further into forest frontiers or growing frontier boom towns. By 2007, almost 60 million hectares of land in Amazonia were owned by one percent of establishments that formed an elite group of wealthy ranchers, while a limited 4.4 million hectares were occupied by small farmers, who represented 45 percent of the establishments [18]. Displaced farmers forced to urban areas exacerbate already high rates of unemployment and poverty [19]. In turn, growing cadres of the poor in cities are easily mobilized to participate in *direct action land reform*, or DALR, which is characterized by the militant occupations, carried out by hundreds of landless farmers on large ranches deemed illegal or unproductive by movement leaders [4]. This has enflamed land conflict in the region, as the landless and their advocates engage in DALR to confront large landowners and pressure the government to follow through on agrarian reform promises.

The government has responded with new policy initiatives, especially in the aftermath of the Eldorado do Carajás massacre in 1996 when 19 landless farmers were killed by the military police during a protest [3]. Rather than return to the large-scale, state-led colonization programs of the 1970s, the government shifted focus with the creation of a *Novo Mundo Rural*, or new rural world, based on the promotion and support of small farmers in SPs. To date, nearly 9250 SPs have been created in Brazil, housing more than 968,000 families; most are located in the north and northeast, the poorest regions in the country [20]. Unlike traditional state-led colonization efforts, policy mandates that SPs be initiated at the grassroots level, an action that usually initiates with the involvement of a social movement organization, or SMO, such as the Landless Rural Workers' Movement (MST). SMOs often play active roles in the management of SPs acting as representatives to the National Institute for Colonization and Agrarian Reform (INCRA), negotiating budgets for transfer payments and distribution, and facilitating extension services [2,4,21].

INCRA's administrative requirement is that participants first establish an official SP association, and next create a Development Plan (PDA) that outlines the social, economic, and environmental strategies to be pursued in achieving sustainable development. The expectation is that smallholders will have a greater investment in the SP, and chances for success will be higher given their engagement and commitment, as opposed to the colonization programs of the 1970s [22]. After the association and PDA are established, the government provides resources for housing and infrastructure, and additional support through a myriad of credits aimed at expanding formal and technical education, improving income of residents, and promoting sustainable economic activities beyond traditional methods of agriculture. Policy explicitly prohibits monoculture systems, such as cattle ranching, and suggests that credit and extension must focus on diversified and sustainable agriculture practices [23,24].

However, contrary to INCRA policies and the views of the SMOs, which are decidedly "green," a significant number of the smallholders living in SPs have focused production on cattle [4].

For example, in a study of SPs in Southeastern Pará, Simmons and colleagues in 2006 found that 75 percent of the occupants viewed cattle as their primary agricultural activity [4]. Such findings mirror recent ethnographic studies across the basin, suggesting that smallholders are shifting from subsistence agriculture to a pasture-based farming system [10,25,26]. Even traditional groups that originally engaged in extractive activities, such as the rubber tappers in the Chico Mendes reserve, have instead opted for cattle ranching [17].

The extent to which land use in the SPs reflects this more general interest in cattle on the part of smallholders points to an apparent disconnect between policy and practice. This situation is potentially problematic given Brazil's recent adherence to the principles of the UN program to reduce emissions from forest degradation and deforestation (i.e., UN-REDD). REDD+ policies recognize the negative role played by ranching as a driver of deforestation, and the importance of involving the region's residents in sustainable development activities to mitigate environmental degradation (<http://www.un-redd.org/> and www.imazon.org.br). If REDD is to be successful in Brazil, policymakers need to understand the agrarian sector, including the productive activities of the many smallholders presently residing in Amazonian SPs. Thus, it is essential to identify the factors motivating these farmers to participate in the expanding global cattle economy, as opposed to agroforestry or other green alternatives. This article directly addresses the gap in our knowledge on this front, and presents the results of field research examining the farming systems and decision-making of SP residents in the lower Amazon Basin. In doing so, it identifies the potential barriers to the implementation of more diversified and environmentally sustainable production systems that align with INCRA policy and new REDD+ programs. The research also provides evidence of the insertion of the SPs into the global cattle economy through contract farming, and subsequent implications for the social welfare of resident smallholders.

1.2. Conceptual Framework

Land Change Science (LCS) studies of Amazonian smallholders often rely on peasant economics and theories of the household life cycle that address behaviors of decentralized land managers who clear the forest in order to provide familial subsistence [26–28]. In these accounts, decisions are economically rational, if highly constrained by resource endowments. While acknowledging the utility of these foundational theories, the present paper heeds the call by Munroe et al. [29] to engage with approaches from New Economic Geography that redirect our attention from decentralized land managers to corporate actors, governance systems, the cultural embeddedness of economic activities, and globalized production and distribution networks [30]. In particular, we incorporate aspects of the production network perspective, and maintain that smallholders and ranchers, who in previous decades were adversaries in the struggle for land, today engage one another in input-output relations in the mutual interest of providing beef to an expanding global market. These new production relations are further motivated and maintained by Brazil's contradictory agrarian reform programs, and the unintended outcomes of environmental regulations. In the presentation and discussion of our results we describe the emerging global cattle economy in the region with specific attention to smallholder production systems and exchange mechanisms with ranchers. We provide evidence of exploitive production relations in the region, which may portend a new wave of contention brought on by what has been referred to in the literature as a land grab through informal contract farming [31–33]. Our theoretical contribution resides in building from theories of traditional peasant households and economics, and wedding the land grab concept to the emergence of new productive relations in the Amazon, specifically Southeastern Pará.

2. Methods

The present article attempts to shed light on the factors influencing the dominance of cattle-based systems in agrarian reform settlements, which contradict the agro-ecology and diversified production systems promoted by social movements. To this end, it presents the findings of several research

activities undertaken in Southeastern Pará, a region that has long been targeted by development policies, and has therefore experienced significant growth associated, in part, with an expanding cattle sector. Today, this region is one of Brazil's largest beef exporting areas to international markets, as a result of concerted government investments to eradicate Foot and Mouth Disease (FMD), and its subsequent designation as a FMD-free zone in 2007, open to international export under requirements of the World Organization for Animal Health [12]. The region also has a long history of land conflict, pitting the landless against large ranchers, and triggering political mobilization for the purposes of agrarian reform that has resulted in the creation of many SPs [4].

The research presented here was conducted in 2010, 2011, and 2012, summing to a total of six months of fieldwork that entailed: (1) household surveys with 104 residents, selected from a subset of households visited in 2006, from SPs in Southeastern Pará (Figure 1); (2) interviews with 30 key informants that included community leaders, SMO representatives, and government officials, as well as key actors in the region's cattle production chain; and (3) the collection and assessment of regional, economic and environmental data from government sources, such as the Brazilian Institute of Geography and Statistics (IBGE), the National Institute for Space Research (INPE), National Institute of Colonization and Agrarian Reform (INCRA), Fundação Casa da Cultura de Marabá, and the Brazilian Agricultural Research Corporation (EMBRAPA).

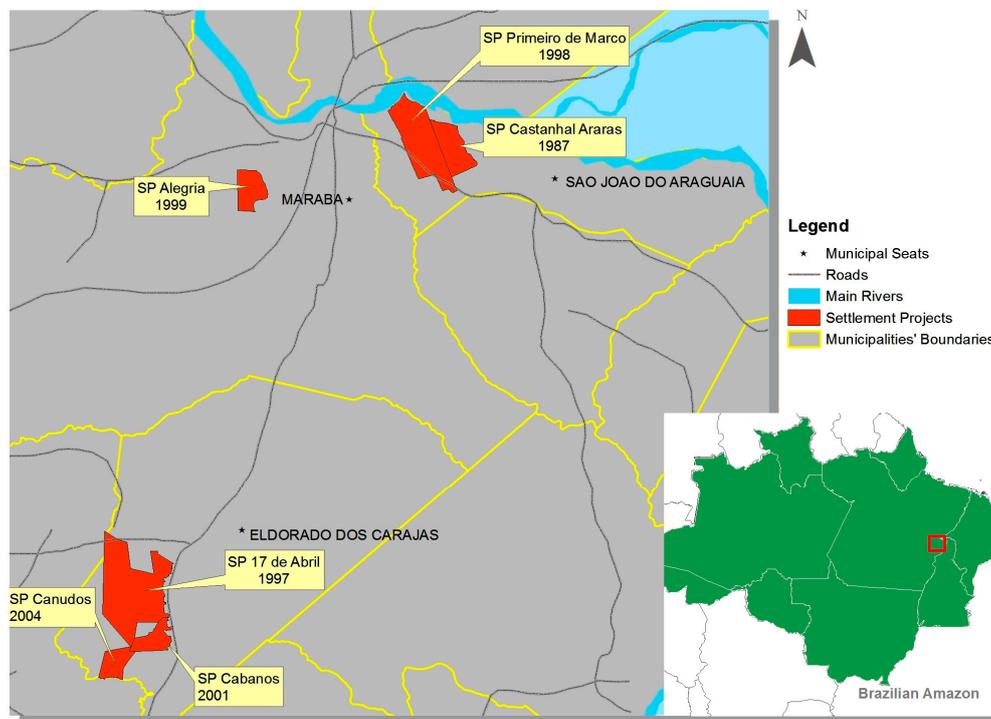


Figure 1. Study area: location and year of creation of settlements in Pará, Brazil. Source: INCRA, 2010 (personal contact).

The study sites include six SPs in three municipalities located in Southeastern Pará, which corresponded to a subset of sites visited during the Simmons-led, NSF-supported project in 2006 that resulted in the collection of extensive surveys on household characteristics and agronomic activities of residents [4]. The data identified those households engaged in cattle (i.e., head of cattle; area in pasture), but the survey instrument was limited in terms of explicating their production systems and the importance of institutional mechanisms for credit and agrarian support. Consequently, a subset of 121 households engaged in cattle from the 2006 fieldwork were selected for subsequent research and a new round of surveys was devised with the objective to elicit greater details on (1) cattle production (i.e., head of cattle for meat, for milk, quantity sold, to whom sold, prices and costs); (2) cropping

system (i.e., crop type, yield, area planted, quantity sold); and (3) the types of credit and technological extension provided for each activity.¹ Additionally, the household surveys enabled the collection of detailed data on income (e.g., government transfer) and expenses (e.g., food, revolving credit payments) that permitted an assessment of the importance of various economic activities on the livelihoods of the SP residents. The surveys also included open-ended queries to probe the respondents directly on their economic decisions, incentives/motivations, and potential barriers to production.

The data collection involved both random and systematic sampling methods. For the initial 2006 data collection, the SP was divided into quadrants to ensure geospatial representation, and then every 3rd house along the road was selected; if the landowner was not present, the next house was visited, and so on until a 20 percent sample of households was reached. In 2010, a pilot study was conducted to test the survey instrument and ensure that the 2006 sampling strategy could be repeated, confirming our ability to reach the same small farmers for the follow-up surveys. Final data collection occurred in 2011, during which time 104 of the 121 households (85 percent) were located and surveys completed. The data presented here are from the 2011 fieldwork, which queried respondents about agricultural involvement and productivity measures from the previous year (2010). The analyses undertaken deploy multiple modes of assessment based on free-form interviews of key informants conducted in 2010, 2011, and 2012, and systematic surveys of settlement households in 2011. We use the interview data to provide our framing context, and also to identify biophysical, political, and historical circumstances of which individual households may be unaware. As for the survey data, we use descriptive statistics to portray household income and expenditures, as well as farming system attributes in the region. We also employ applications of inference to gauge the statistical significance of the key issues and arguments addressed in the present article. Thus, our analytical approach is a multi-method one that yields both context and detail.

Finally key informant interviews were conducted in 2011 and 2012 with public officials, SMO representatives, community leaders, and actors engaged in the cattle production chain. These interviews served multiple research objectives. First, they provided insight and context regarding the factors that impacted SP residents' decisions to invest in cattle, and the potential barriers to adoption of a more diversified agriculture system. Second, they provided necessary details that informed our understanding of the role of smallholders in the regional global cattle economy.

3. Results and Discussion

3.1. Household and Farming System Characteristics

Descriptive statistics for socio economic characteristics of households in the 2011 sample show that 71 percent of household heads were male, with a mean age of 53 years (see Table 1). On average, four people lived on each property, with a residence of 11 years on site. In terms of education, the average for the household head was three years of formal education, with 23 percent of those interviewed illiterate, and only one person in the entire sample who reached the maximum level of formal education (15 years with a college degree). The property size ranged from 8 to 50 hectares with a mean of 33 hectares, indicating that all properties fell within the regional limits (5 to 70 hectares) of the *Módulo Rural*, which is a classification for properties eligible for government agricultural assistance programs and deemed a size sufficient for family farming that ensures food security, as well as social and economic progress, which is the goal of the SPs (See Table 1).

Of the estimated 53 percent of households that reported involvement with cropping in 2010, most stated that the land dedicated to crops was small, and only 20 percent were able to report the area planted, which averaged 4 hectares. An estimated 7 percent indicated that they sold limited production

¹ The 2006 fieldwork resulted in 161 household surveys in the six SPs, and 121 respondents (75 percent) reported engagement in cattle activities.

to local markets. Corn, rice, and manioc were the three most important crops planted, primarily for family consumption or feed for animals, with the exception of two households that sold small quantities of manioc flour to neighbors (see Table 2). Beyond annuals production, a variety of fruit trees were planted in small numbers, with a handful of farmers selling banana and cacao. Despite the plans for diversified food production elaborated in the PDAs, smallholders indicated minimal involvement with cropping, and an estimated 47 percent of households stated that they planted no crops at all.

Table 1. General characteristics of households ($N = 104$).

Variable	Mean (Std. Dev.)	Min	Max
Age	52.73 (12.18)	19	78
Number of people	4.47 (2.57)	0	14
Length on property (years)	11.71 (4.70)	3	25
Lot size (hectares)	33.68 (10.17)	8	50
Education (years)	3.13 (3.19)	0	15

Table 2. Cropping system characteristics for primary crops in 2010 ($N = 104$).

Crop Type	No. Smallholders ¹	Area Planted (Hectares)				No. Who Sold Crops?
		Mean	Median	Min	Max	
Corn	16	0.37	0	0	5	0
Rice	13	0.08	0	0	1	0
Manioc	13	1	0	0	10	2
Banana	4	0	0	0	0	1
Cupuaçu	3	1.67	0	0	5	0
Sugarcane	1	5	5	5	5	0
Orange	2	0	0	0	0	0
Açaí	1	0	0	0	0	0
Passion fruit	1	1	1	1	1	0
Cacao	1	5	5	5	5	1

¹ A limited 55 out of the 104 households reported that they planted crops, and only 11 could define the area planted.

In contrast to lack of involvement in cropping, 71 percent of respondents reported having cattle in 2010. This is not surprising given that the focus of this research was smallholder cattle production activities in SPs, thus, the main criterion for sample selection was household engagement with cattle in the 2006 fieldwork by Simmons and colleagues. Of the 29 percent reporting no cattle in 2010, all indicated that they had cattle previously, but needed to sell animals in order to pay accumulating debts, and their plans were to re-build their herds in the future. Other smallholders stated that they rented pasture, at about 9 percent of the sample. A comparison of cattle data from the 2006 and 2011 surveys reveals some notable changes. The mean number of animals (cows) per property increased from 19 to 21, which corresponds with pasture expansion by almost 19 percent, from an average 18 hectares to 22 hectares per property (see Table 3). Despite these increases, there was a decrease in animal density per lot across the five-year period. The decline in cattle density would appear to contradict the expected *pecuarização* of Amazonia, and the overall importance of cattle in the region [12]. Indeed, the stocking density is below smallholder averages in other parts of Amazonia (i.e., 1 animal/hectare), which is reflective of a highly unproductive land use that raises concerns about smallholder welfare and environmental sustainability. However, further analysis of the data shows that while mean changes in animals between 2006 and 2011 were not statistically significant, changes in area under pasture and animal density (cows/hectare) were. These findings suggest that decreases in density were due to increases in pasture, rather than reduction in animals.

Table 3. Cattle, pasture, and stocking density: Changes between 2005 and 2010 ($N = 104$).

Farm System Characteristics	2006 Mean (Std. Dev.)	2011 Mean (Std. Dev.)	Diff Mean (Std. Dev.)
Cattle (heads)	19 (19.47)	21 (27.08)	1.21 (26.75)
Pasture Area (hectares) ¹	18.22 (12.41)	21.66 (11.98)	3.44 (14.24)
Density (animals/hectare) ¹	1.30 (1.15)	0.95 (1.03)	−0.35 (1.39)

¹ Statistically significant at 5 percent.

In general, the livestock system of smallholders is distinct from that of large ranchers, who specialize in commercial production with animals genetically manipulated to produce high quality beef in a short period. For their part, smallholders have a mixed herd (dairy and beef) rather than pure-bred cattle, because such animals are less expensive and they better meet the dual needs of milk production and calving. Of the 74 households reporting cattle in 2010, 30 percent reported engagement in dairy, 9 percent in meat production, and 61 percent of smallholders reported mixed dairy-meat activities (see Table 4). When it comes to animals sold in 2010, regardless of reported activity, calves were by far the most important, with 85 percent of the sample reporting calf sales compared to only 31 percent who sold cows for meat (see Table 4). Furthermore, almost three times as many calves were sold than cows, and those reporting meat or mixed meat-dairy production actually sold more calves. From the interviews with smallholders it became apparent that calving operations were the primary focus of their activities, and the vast majority of sales were to middlemen working with large ranchers in the region. In general, farmers stated that they sold primarily male calves to middlemen and ranchers, and cows over five years of age and sickly to the local butcher. Finally, nearly all households with cattle received credit originally provided for dairy cattle, but most of them are engaged in mixed production (dairy and beef), and only 13 percent said they produced a limited quantity of milk for sale in local markets, the remaining produced milk for self consumption.

Table 4. Cattle production system characteristics in 2010 ($N = 104$).

	No. (% Total Smallholders with Cattle)	No. (%) Who Sold Animals?	Type	Quantity		Mean	Buyer	No. (%) with Credit
				Min	Max			
Dairy	22 (30%)	18 (82%)	Calves	1	15	5.4	66% middlemen/local ranchers local butcher	18 (82%)
		6 (27%)	Cows	1	8	2.3		
Meat	7 (9%)	7 (100%)	Calves	1	15	5	71% to middlemen local butcher	7 (100%)
		2 (29%)	Cows	1	1	1		
Mixed	45 (61%)	41 (91%)	Calves	1	30	8.1	96% middlemen/local ranchers local butcher	38 (84%)
		15 (33%)	Cows	1	5	2.4		
TOTAL WITH CATTLE: 74 (100%)								

3.2. Income and Expenditures

Overall, non-cattle agricultural production ranked only fourth as a source of income, providing less than 10 percent of the annual average (See Table 5). Off-farm employment provided the highest income (28 percent), although only 30 percent of the sample reported involvement in such activities, and the average income was skewed as a result of a select few residents with formal sector jobs (e.g., teacher, ambulance driver). By and far the most important income source was (1) government transfers, at 28 percent average annual income, that were received by 68 percent of the sample, followed by (2) the sale of calves to large ranchers at 17 percent, involving 60 percent of those interviewed (Table 3). Government support included: (1) *bolsa-familia* (the Family Allowance); (2) *rural retirement*; and (3) *disability retirement*. *Bolsa-familia* is a governmental direct cash transfer program designed to reduce poverty, with payment tied to child vaccinations and school attendance. This monthly household stipend changes according to per person income, number of children and adolescents up to 17 years old, and number of pregnant and lactating women in the family. For the sample, the amount

varied from US \$16 to \$151 per month. *Rural retirement* benefits can be claimed by all rural workers who prove they have worked and contributed to social security for at least 180 months, and have met the retirement age (60 years for males and 55 years for females). The retirement income is always equivalent to one minimum wage, which at the time data were collected was US \$270² per month [30]. *Disability retirement*, also equivalent to one minimum wage, is a benefit granted to employees incapable of working due to illness or accident, in accordance with a certification by a medical group approved by the office of Social Security.

Table 5. Summary of annual income sources in 2010, in Brazilian reais (BRZ R\$), at household level (N = 104).

Income Source	Mean (Std. Dev.)	Min	Max	No. (%) Smallholders ³
Off-farm Jobs ¹	4004 (7773)	0	37,200	37 (30%)
Government payments	3929 (4837)	0	21,924	71 (68%)
Calves	2377 (3477)	0	27,000	65 (60%)
Crop Sales	1291 (3279)	0	18,000	30 (29%)
Milk	776 (2544)	0	17,217	13 (13%)
Off-farm Day Labor ²	772 (2112)	0	12,000	21 (20%)
Other Livestock	514 (1697)	0	11,800	35 (34%)
Cows	453 (1048)	0	5000	27 (26%)
Pasture Rental	231 (872)	0	6000	10 (10%)
Total Annual Income	14,405 (10,443)	1200	56,108	104

¹ Off-farm jobs refer to formal employment off the property, meaning that a family member has a steady job elsewhere; ² Off-farm day labor refers to wages earned by family members for working other properties;

³ Respondents reported more than one income source.

In terms of monthly expenses, an estimated one-third of smallholder income is used to pay principal and interest on loans acquired during initial creation of the SPs (31 percent), and an additional 28 percent of monthly income is used to purchase food at local grocery stores. Indeed, despite claims extolling the virtue of and commitment to agro-ecology and food sovereignty advocated in SP policies, the vast majority of households (88 percent) reported that they bought most of their food at grocery stores. Corroborating this finding, one smallholder reported that, “It’s cheaper to buy vegetables and meat in the grocery stores than produce them myself” (personal communication, April 2011). Another substantial expense stems from monthly installments to pay off credit for the purchase of durable goods, such as motorcycles, refrigerators, and TVs, amounting to about 9 percent of monthly income. Interestingly, the increase in debt from the purchase of durable goods coincides with the arrival of electricity in the SPs as part of the *Luz Para Todos* program (Light for All), initiated in 2003 to eradicate electricity exclusion in Brazil’s rural areas [26]. By the time of the 2011 fieldwork, 71 percent of households stated they had access to electricity for the first time, with average monthly costs of US \$21, or 3.5 percent of total income. Other monthly expenses, in order of importance, include medication, water, and rent for housing nearer the city center, which is necessary for sending children to school.

3.3. Smallholder Decision Making: Crops versus Cattle

In terms of institutional support for agriculture, only 33 people said they received credit for non-cattle (or alternative) activities. Of those who did receive credit for alternative production such as cropping (e.g., cassava, banana, coconut) or small animals (e.g., poultry), a limited 3 people are still involved in those activities in 2011. When queried as to the reasons for no longer engaging in these activities, respondents identified, in order of importance: the absence of technical support, accidental fires, and their lack of experience with intended crops. As one smallholder put it, “Crops did not develop since there was no technical support or evaluation of soils and water in the region. There was no contract establishing banana sales, and I would not know where to sell the product even if it had

² The minimum wage in Brazil changes every 1 January. In 2012 this value reached US \$308.

worked out well” (personal communication, April 2011). In addition to criticism associated with lack of technical support and market strength, it was also mentioned with high frequency that soils were not sufficiently fertile, and that additional inputs would be needed, such as expensive fertilizers and tractors, which only large-scale farmers can afford.

All extension agents interviewed recognized the potential viability in the region for the production of cassava flour, banana, pineapple, passion fruit, *cupuaçu* and *açaí*. However, these options are limited by a number of problems that must be resolved before these crops can be productive. Foremost among them is the absence of a well-developed production chain for those products. Furthermore, roads are in poor condition during the extended rainy season, making it impossible to bring perishable products to the city in time to get a good return. For instance, *acerola* cherry and *açaí*, two viable and profitable crops for the region, need to reach the market within 24 h after harvest, and *cupuaçu* within a window of four days (personal communication, extension agent, Marabá, April 2011). When it came time to recommend productive activities for the region, these logistical barriers were of greater concern than the physical and chemical characteristics of the soils. Another problem relates to the lack of continuity in technical support for diversified crop production after the contract with INCRA has ended. A final obstacle to crop production stems from the lack of laboratories in the region qualified to perform scientific analysis of soils, which is essential for any agricultural plans.

Of those 33 smallholders who had invested in alternative production, only nine (27 percent) considered this more profitable than investments in cattle. The most frequent explanation related to inadequate lot size for cattle to be economically viable and the long-term unsustainability of pasture in an area where soil quality is questionable. Indeed, smallholders understand that productivity and profitability are related to seasonality, investment in technology and soil quality in the region. The importance of seasonality became an issue for consideration during our data collection. For example, when the questionnaire was tested in July 2010, smallholders from SP Castanhil Araras reported that the region was not good for anything, and that after 23 years of settlement creation, there was not a single profitable plantation operating in the region. However, during the final data collection in 2011, which happened during *cupuaçu* harvest season, we learned that many smallholders were engaged in production of that fruit.

One respondent reported that it was possible to sell up to 60 kilograms of *cupuaçu* pulp per day, at a price up to US \$2.50 per kg. However, price instability for crops in the region, such as *cupuaçu*, made the activity less appealing than investing in cattle, which have stable prices and demand. Furthermore, *cupuaçu* is harvested during the rainy season, which corresponds to a time when road conditions are the most problematic. Agricultural extension agents confirmed that all crop production during the rainy season, even that of farmers engaged in banana and cassava, has experienced serious problems due to the lack of options for sales. As a result of these failures, in the short-term many smallholders, even those who received credit for cropping, shifted their land use to pasture and began to invest in cattle.

Given an understanding of these economic gains coupled with the need to reduce deforestation in the region, i.e., by the inclusion of Marabá in the List of priority Municipalities³, a number of strategies to include smallholders in diversified initiatives have been developed by agronomists. However, inadequate lot size was cited by extension agents and smallholders as being the main barrier to their involvement in such green economic activities. For instance, an economically viable project for carbon sequestration requires an area of at least 1000 hectares, which excludes the smallholders who participated in this research, as the average property size is 33 hectares. To be feasible, smallholders would need to form a cooperative. Although not impossible, cooperative formation has proven to be a challenge in the SPs located in this region and elsewhere. An additional constraint is the long-term planning time horizon to see a profit, since it would be several years before the standing forest generates

³ Marabá was added to the list of priority municipalities in reduction of deforestation and degradation in 2009 through MMA DECREE No. 102 OF 24 MARCH 2009. This decree provides a list of municipalities located in the Amazon biome, where priority actions focus on prevention, monitoring and control of illegal deforestation.

income from carbon sequestration at the level required by the project. According to key informants, the opportunity costs for forest protection under programs, such as REDD, are too great, and smallholders see no motivation to keep their land in forest if they are unable to receive a profit.

Cattle, and in particular calving, is the only activity in the region that has a well-consolidated supply chain and does not depend on road conditions to reach the market in good condition. All told, credit availability for cattle production is the key motivation cited by smallholders in their decision to invest in cattle. Our 2011 interviews show that an estimated 79 smallholders reported that they received government credit exclusively for investment in cattle, and of those farmers, 63 (80 percent) still have animals on their property. According to our analysis, there was a statistically significant relationship between receiving credit for cattle and having cattle in 2010. Those no longer engaged in cattle activities, despite receiving credit, explained that they had no option but to sell their animals in order to pay debts, mostly related to medical expenses, and all expressed their intention to buy more cattle in the future.

Agricultural extension agents and smallholders alike have the perception that cattle provide better economic returns when compared to crops. This is especially so since herds move by themselves regardless of season, eliminating transportation costs, and they provide the added benefit of milk production for familial consumption. Therefore, once smallholders perceive that there is a well-established chain for calf sales, they open small plots of pasture without any credit and at the time of PDA development, they refuse to switch to more diversified production.

It is logical for smallholders to pursue an activity that requires less labor, receives easy credit, and has a stable market for their production. This fact perpetuates cattle production in the region. Even extension agents, who are tasked with explaining the benefits of agricultural diversification, argue that smallholders make more profit in cattle ranching. Given the small number of extension agents and high demand for their services, agents interviewed reported that they save time, and are, therefore, able to provide services to more SPs, if the recommended projects promote cattle as opposed to crop diversification, which requires feasibility studies and training for several crops, in accordance with the settler's history as PDA and policy require. According to a lawyer working with the landless movement (personal communication, April 2011), smallholders work by following the logic of immediate results, and the mechanics of bringing products to market in larger cities remain a challenge. Even new smallholders receiving a piece of land inside SPs know that crop diversification would be a better option for the environment; however, it is easier to get credit for cattle only, since rarely is credit made available for other production activities. In addition, a lawyer for the landless movement emphasized that some smallholders have previously worked on farms as *vaqueiros* (cowboys), which is an important factor when it is time to decide about investments in the lot: "They stay with the activity that they know when it comes to establishing their own land" (personal communication, April 2011).

3.4. Emergent Production Chains

In the SPs of Southeastern Pará, a multiplicity of factors potentially affect the switch from subsistence agriculture to cattle ranching, including the availability of credit and strong economic returns stemming from the global demand for beef [2,12,17]. Within the region, many smallholders started ranching in order to produce milk for home consumption and to sell to local micro-industries. It is important to recall that credit given for SP livestock was originally meant for milk production, although few households today are engaged in this activity. However, an important secondary product of dairy production are calves, which proved to be economically more profitable. Over time, many smallholders began selling off their male calves, which makes sense given calf prices rose from US \$137 in 2005 to US \$363 in 2011 [34,35]. The viability of such marketing has involved the development of commodity chain links between smallholders and large-scale ranchers, who buy calves to fatten on the way to the slaughterhouse. The precipitous rise in calf prices probably reflects the sudden insertion of Southeastern Pará into the global economy by way of a fast hook-up to transcontinental value chains

in the provision of chilled beef. The expansion of meat processing capacity in the region has come quickly, from not even one modern slaughterhouse in 2000, to 14 modern facilities by 2014, capable of processing from 500 to 1200 animals per day (Table 6). This new industrial capacity also reflects global interests with significant transnational participation. For example, the Brazilian Company JBS, which is today the world's largest meat-processing corporation, possesses five of the region's slaughterhouses. Its record of corporate buyouts includes the acquisition of the formerly US-held businesses Swift & Company in 2007, Smithfield Foods in 2008, and Pilgrim's Pride in 2009.

Table 6. Slaughterhouses with federal inspection (SIF) in the south of Pará in 2005 and 2015.

SIF ¹	Location	Company Name 2005	Classification ² 2005	Company Name 2015	Classification 2015
807 ³	Redenção	Redenção Frigorífico do Pará Ltda	MB2	JBS S/A	MB2
457	Maraba	Bertin Ltda.	MB3	JBS S/A	MB3
1110	Santana do Araguaia	Redenção Frigorífico do Pará Ltda	MB3	JBS S/A	MB3
4398	Xinguara	Frigoxim Comercial Ltda.	MB3	Xinguara Ind. E Com. S/A	MB3
593	Eldorado do Carajás	Frigorífico Industrial Eldorado Ltda.	MB4	JBS S/A	MB4
2350	Tucumã	Redenção Frigorífico do Pará Ltda.	MB4	JBS S/A	MB4
2583	Água Azul do Norte	Frigol Pará Ltda.	MB4	Frigol Pará Ltda.	MB3
4413	Xinguara	Mafripar Matadouro frigorífico Paraense Ltda.	MB4	Mercúrio Alimentos S/A	MB4
112	Rio Maria	Frigorífico Rio Maria Ltda.	MB4	Frigorífico Rio Maria Ltda.	MB4
2437	Sao Geraldo do Araguaia	-	-	Masterboi Ltda.	MB1
4150	São Félix do Xingu	-	-	Frigol Para Ltda.	MB3
1497	Tucumã	-	-	MFB Marfrig Frigoríficos Brasil	MB4
2258	Redenção	-	-	Abatedouro de Bovinos Sampaio Ltda. - ME	MB4
1745	Santa Maria das Barreiras	-	-	NPL Frigorífico e Indústria Ltda. ⁴	MB5

¹ SIF (Sistema de Inspeção Federal, or Federal Inspection Service) is a mandatory registry for slaughterhouses selling to other states and countries; ² The classification here includes 5 levels, from the biggest, MB1, to smallest, MB5, and is based on the capacity to slaughter animals per hour and quantity of veterinarians needed. In the biggest classification, for example, MB1, the industry can slaughter more than 80 animals per hour, industrialize 20 or more tons of meat per day and must have at least three veterinarians following all steps of the production. A slaughterhouse with classification MB2 has the same capacity of slaughtering, can or cannot have an industrialization area and two veterinarians are employed in the production. The remaining classes only employ 1 veterinarian and can slaughter between 40–80 animals/h (MB3), 20–40 animals/h (MB4) or less than 20 animals/h MB5 (Monteiro, 2012); ³ Note that the SIF does not change between years, and so this number shows that companies have been bought by larger companies along the years; ⁴ This company has been leased by JBS S/A since 2014. It is not operating.

Because of smallholders' lack of access to technology, largeholders still provide a decisive commercial link between smallholders and final consumption, via slaughterhouses in the region. This is because modern slaughterhouses, highly capitalized and corporate, only buy in truck-lots of at least 18 animals. Since smallholders possess neither the land nor the resources to produce this many animals at one time, largeholders with fattening operations purchase aggregated production

from multiple smallholders within SPs in their vicinity. Indeed, our fieldwork establishes that more than two-thirds of smallholders resident in SPs sell calves to local largeholders. Consequently, such purchase arrangements, often informal in nature, put considerable market power in the hands of largeholders to set the terms of trade, leaving smallholders at a disadvantage.

This study uncovered several questionable instances where individual largeholders bought the entire production of a SP, coercing smallholders to accept payments in kind instead of monetary compensation, including pasture improvements, fence repairs, etc. In most cases there is no formal contract specifying the rights and duties of each actor. For instance, one settler stated that he owed money to the rancher for the expenses to build a fence, which was necessary to make his property ready to receive the ranchers' animals. It was agreed that the amount owed would be deducted from the final pasture rental payment, which was to be paid not in currency, but in calves born on the smallholder's property. However, at time of reconciling accounts, the smallholder owed more than the quantity of animals he was supposed to keep as payment for the land rental. In the end, the smallholder had no calves in payment, and he had a debt still owed to the rancher, which was in turn tacked onto the subsequent pasture-for-calves rental agreement.

The newly emergent production chain linking large and smallholders has the potential to undermine Amazonian family farming, with implications for food security [5]. Starting in 1989, crops, such as beans (*Phaseolus vulgaris*), cassava (*Manihot esculenta* Crantz), and coffee (*Coffea arabica* L.), which historically were important in that region, began to yield space to more commercial products such as soybeans (*Glycine max*) and cattle ranching [5]. During this evolution, soybeans utilized more hectares in Northern Mato Grosso, while cattle expanded toward the so-called arc of deforestation [36]. In this process, food security concerns stem from exposure to the vagaries of the market, as food insecurity can result from a market crash. However, investing in diversified production provides access to nutritious food, and does not expose the producer to economic crashes, for example, in case a disease affects commercial products, not only reducing production, but also in closing markets.

4. Conclusions

For a variety of reasons, the smallholders we spoke with were not using their land in a manner consistent with long-term sustainability, at least with respect to the environment. Instead, they have articulated with global production chains for beef, now governed in part by large transnational enterprises, including Brazil's JBS, the world's largest beef products corporation. The nature of credit provision appears to be a key factor undergirding this result. In particular, the financial capital available to smallholders in the form of low interest loans has incentivized cattle production at the expense of diversified systems. This outcome stands at odds with the original agricultural goal for both agrarian reform movements and the Brazilian state. Our informants point to the ease of obtaining credit for cattle, while quite the opposite situation prevails for those desiring to implement diversified farming systems. Credit for cattle is meant to stimulate the dairy sector, but smallholders have discovered that calving operations aimed at beef production provide a greater return. Although they do not express it this way, the smallholders in our sample find the opportunity costs of both diversified farming and dairy production to be too high, given the good prices and sure market for calves that have in all likelihood resulted from Brazil's emergence on the world stage as a premier beef supplier. Complementing the land-use choices of the smallholders in our sample is low soil fertility throughout the region, a circumstance that has been observed by extension agents in our research network. Newly available transfer payments (e.g., *bolsa-família*) have also helped build the smallholder cattle economy by reducing the supply of rural labor, critical for the implementation and maintenance of diversified farm systems with intensified production. The fact that smallholders invest in cattle as their main economic activity deserves attention for a number of reasons, three of which we now consider.

First, it is contrary to agrarian reform policy, meant to secure both livelihood and environmental sustainability by supporting diversified family farming. Second, the substitution of cattle herds for diversified agriculture exposes smallholders to price fluctuation affecting any monocultural

system. Third, smallholder interest in cattle facilitates absentee ownership given reduced labor requirements. In other words, credit availability meant to help smallholders might reduce the numbers of family farms, and potentially open the door to land concentration. The importance of cattle to smallholders in Southeastern Pará (and Amazonia more generally) has a basis in the failure of government to adequately vet regional market opportunities in the settlement formation process, which requires federal approval of the PDA. Barriers to sustainable development in the Brazilian Amazon are historically tied to public policies that have brought people to a region without providing adequate infrastructure. Mistakes of the past are amplified at the present time by the provision of credits favoring cattle acquisition, and stimulating more deforestation than might otherwise be the case, given the extensive nature of ranching. Opportunity costs associated with diversified agriculture in Southeastern Pará appear to stimulate Amazonia's emergent ranching economy. This economic consequence, although it has provided smallholders a modicum of accumulation, contradicts the principle of sustainability, as originally conceived by both the social movements and the Brazilian government. Furthermore, smallholders in the SPs appear to be subject to exploitive terms of trade by virtue of the informal calving contracts that often leave them in debt. Such arrangements make these SP residents "contract" ranchers, who bear a disproportionate share of risk in the supply chains to which they deliver calves. Thus, like contract farmers around the world, the smallholders in our study sample arguably maintain a tenuous link to the land they own, and, as such, are subject to a form of land grab now endemic to global production networks. Consequently, the cattle economy could add a new phase to this region's intransigent history of land conflict.

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