

PATHS OF  
DIVERSIFICATION: LAND  
LIVELIHOOD STRATEGIES AND  
SOCIAL LEARNING ALONG  
THE AGING OF A LAND REFORM SETTLEMENT IN ACH

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DIVERSIFICATION: LAND USE,  
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AGING OF A LAND REFORM  
SETTLEMENT IN ACRE, BRAZIL

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### **Abstract**

This paper explores the story of settlers overcoming challenges common to the environment of expanding agricultural frontiers, and how this is reflected on the land-use and livelihood choices that unfold with the aging of settlements. The study site is a land reform project in the State of Acre, Brazil. We found that most families seek to diversify their livelihood strategies and take advantage of new opportunities as a way to cope with income uncertainties largely present on the frontier setting. As in other parts of the Amazon, cattle-ranching is the single most important activity to secure income, but complementary activities such as agroforestry and fish breeding are key for economic security and improvements.

Key words: land-use, Acre, Amazonia.

### **Resumo**

Este artigo explora a história de colonos que enfrentam os desafios de fronteiras agrícolas em expansão, e de como estes desafios se refletem nas escolhas de uso da terra e nas estratégias econômicas que se desdobram ao longo da vida dos assentamentos. A área de estudo é um projeto de reforma agrária no Estado do Acre, Brasil. Os resultados indicam que a maior parte das famílias busca a diversificação das estratégias de sustento, e se aproveitam de novas oportunidades como forma de se proteger contra incertezas relacionadas à renda familiar comuns às regiões de fronteiras agrícolas. Tal como em outras partes da Amazônia, a pecuária é a atividade mais importante para assegurar a renda familiar, mas atividades complementares como sistemas agroflorestais e criação de peixes são fundamentais para a melhoria e a segurança das condições econômicas.

Palavras-chave: uso da terra, Acre, Amazonia.

### **Resumen**

Este manuscrito explora la estoria de asentados que pasan por desafíos comunes al contexto de fronteras agrícolas en expansión, y de como estos desafíos se reflejan en las opciones de uso de la tierra y en las estrategias económicas que se desdoblán con el desarrollar de los asentamientos. El área de estudios es un proyecto de reforma agraria en el Estado de Acre, Brasil. Los resultados

indican que la mayor parte de las familias opta por la diversificación de las estrategias de se ganar la vida, y se benefician de las oportunidades como forma de protección contra las incertidumbres relacionadas a la renta familiar. Así como en otras partes de la Amazonía, la ganadería es la actividad más importante para asegurar la renta familiar, pero actividades complementares como sistemas agroforestales y el cultivo de pescados són clave para mejorar las condiciones de seguridad y económicas.

Palabras-clave: uso de la tierra, Acre, Amazonía.

## INTRODUCTION

The arrival of settlers from several parts of Brazil to the Transamazon colonization scheme in the early 1970s has been marked by rich patterns of social interactions among newcomers and between them and long-term residents, *caboclos*, a process explored in detail by Moran's 'Developing the Amazon' (1981). As opportunities and challenges of the new agricultural frontier were being vividly experienced in almost every aspect of everyday life, migrant settlers have learned important adaptive strategies from local culture. From fishing and hunting to selection of optimal sites for agriculture; from knowledge of herbal medicine against malaria and other diseases to detailed knowledge about nutrition and processing of native foods and crops; and from the fabrication of tools to architectural technologies adapted to the humid heat, incorporation of *caboclo* knowledge might have entailed the difference between survival and death for many colonist families. A similar process regarding the exchange of ethnobotanical knowledge, in this case among rural communities (rubber-tappers and *ribeirinhos*) and indigenous groups was described in the Southwestern Amazon (Campos and Ehringhaus 2003). The study compared known palm uses by each group, and found that while indigenous groups know significantly more about palm uses than folk communities, both groups benefitted from the knowledge obtained from each other.

According to Moran (1981), detailed knowledge on local ecosystem conditions was responsible for more effec-

tive economic performance of *caboclo* households, when compared to colonist families, including higher crop yields, better nutrition standards, housing arrangements better adapted to the heat and humidity of the Amazonian climate, and less dependence on the personnel of INCRA, the Brazilian agency responsible for colonization and land reform. Perhaps more importantly, it was observed that families with more flexibility to engage in a diversified set of economic alternatives, were also the families with higher chances of hiring external labor and owning businesses, and more likely to succeed economically in the frontier. Subsistence and specialized farmers, however, were found to be the ones with higher chances of abandoning their lots and moving either to the local urban center (Altamira, in Moran's study), or further into the frontier<sup>1</sup>.

This paper is part of a larger study focusing on the story of settlers overcoming challenges common to the environment of an expanding agricultural frontier in the State of Acre (Ludewigs 2006). The central theme is the land reform puzzle in Brazil and particularly in Amazônia: unassisted settlements, variable economic viability, different degrees of environmental impact, and high rate of lot turnover and land reconcentration (e.g. Moran, 1990, Lena and Oliveira 1992, Schmink and Wood 1992, Teofilo and Garcia 2003, Browder et al 2008, Brondizio and Moran 2008, Ludewigs et al 2009). After the pioneer work of Frederick J. Turner (1920) in the late 19<sup>th</sup> century on the historic im-

portance of frontier expansion to the formation of American society, frontiers have become the subject of intense study in the social sciences (McClintock 1986). Turner's assumptions have been largely debated. However, as pointed out by Richard Hofstadter's (1968) "... This mountain of Turner criticism is his most certain monument," it set the tone for substantial work on discussing agricultural frontier expansion worldwide and its socio-economic and political importance.

Frontier is a controversial term which carries plural meanings. By definition, however, frontiers are considered places where formal, legal and governmental agencies are largely absent (Alston et al. 1998, 1999), or exerting force from a distance and where the process of occupation and transformation represents competing claims (Schmink and Wood 1992) and where land use and environmental change happens at a fast pace (Rindfuss et al 2007). In the absence of formal institutions, or the non-enforcement of the rule-of-law, informal institutions or non-written rules or norms are usually created to deal with rights of access, usufruct and transferability of resources needed for economic activity (E. Ostrom 1990). Enforcement of formal and informal institutions is, however, uncertain on most agricultural frontiers. Under such circumstances, opportunistic behavior, such as free-riding and rent seeking is expected to rise among stakeholders (Margolis 1973, 1977). Likewise, as asserted by the Turner hypothesis of frontier expansion, individualism and

entrepreneurship among stakeholders are strengthened by the wide range of economic opportunities that are present in the frontier environment. On the other hand, the lack of infrastructure, limited access to markets, and competition for resources limit the ability of families to take advantage of economic opportunities, although creating incentives for their engagement with different forms of collective action (Muchagata 2002).

Diversification of land-use activities might be constrained by the environment, as for example the availability of fertile soils, as observed in the same Altamira site referred above (Moran 2000, Moran et al 2002). Also, studies on household and land-use relationships showed that demographic characteristics of households, such as composition and size, but also wage labor, retirement, and access to technology were important on conditioning the range of land-use options and investments that were feasible at different stages of farm-lot development (McCracken et al 1999, Brondizio et al 2002, Fudemma and Brondizio 2003, Moran et al 2005, Caldas et al 2007). For instance, larger households with more individuals engaged on production activities allow for a wider scope on potential land-use options to be explored, when compared to smaller and younger households (Perz 2000, 2001). In an agricultural frontier in the Ecuadorian Amazon, longitudinal studies have shown the importance of household demography and background, technology adoption determinants, and



market forces to the understanding of land-use and land-cover change (Pichón et al 2002). As in the Brazilian Amazon, diversification of livelihood strategies appeared as an important strategy to cope with the challenges and uncertainties typical of frontier contexts (Pichón et al 2001). Household life cycles and land-use combinations have been also studied in other fronts of the Transamazon colonization scheme, such as in the Uruará region, by incorporating market forces and decision-making under risk in the discussion of possible Land Use and Cover Change scenarios (Walker et al 2002). Other comparative studies (TransAmazon-Altamira and BR-163-Santarém) examining the life course of families and the life course of their lots in colonization settlements found that the number of times a lot has been turned over is important to explain their resulting land use strategy and land cover characteristics (Vanwey et al 2007, Ludewigs et al 2009).

Land-use decision-making frequently involves multiple dimensions with multiple goals (Chibnik 1994, Ozório de Almeida and Campari 1995, Tonio-lo and Uhl 1995). For instance, it was observed in the Peruvian floodplains that the lack of knowledge about the biophysical environment frequently increases the risk associated to the use of agricultural credit (i.e, related to the capacity of repayment). Credit use is related also to several other factors such as social organization, family size and land tenure, and plays considerable influence on determining crop allocation and field size (Chibnik 1994). In

this context, diversification of land uses comprises a strategy that is important both to reduce risks and to attend household consumption needs (Brondizio 2004, Pinedo-Vasquez et al 2002, Smith et al 1996).

In this paper, we investigate livelihood options and land-use trajectories in an aging land reform settlement in the State of Acre of the Brazilian Amazon<sup>2</sup>. The settlement is P.C. Humaitá and is located in the municipality of Porto Acre, at some 38 km of Rio Branco, Acre's capital (Figure 1). Some of the guiding questions of this study include: *What kinds of economic systems (e.g. land-use, fisheries, off-farm employment) do farmers adopt during their life in a settlement? How do these systems change? What patterns emerge? How do farmers decide to specialize and/or diversify their economic portfolio?*

To approach these questions, we describe some of the experiences of P.C. Humaitá residents, which have been divided into three social groups for analytical purposes: (i) local rubber tappers – previous residents in the site, many of whom changed their main livelihood to agropastoral activities after settlement was officially instituted<sup>3</sup>; (ii) colonist farmers – farming families beneficiaries of the land reform program that migrated to Porto Acre from several parts of Brazil; (iii) land investors – not originally beneficiaries of land reform, they bought one or more lots from original settlers<sup>4</sup>. The survey (n=63 households) explored how Humaitá residents responded to challenges during their life in the region, such as the lack of access to markets

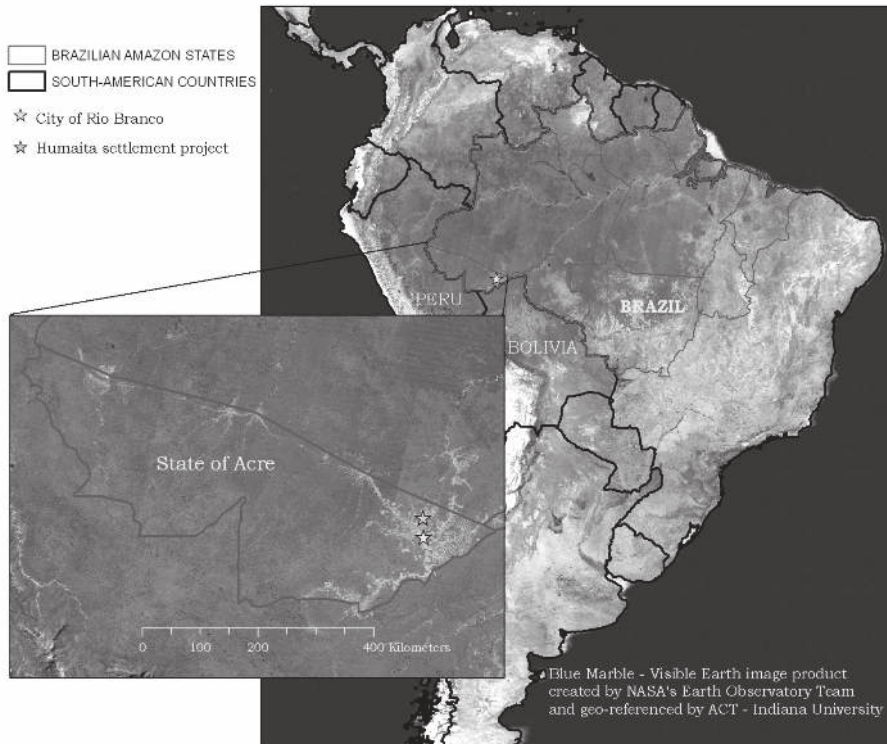


Figure 1 - Study site

and to basic public services (education and health) and are learning to live in an environment often harsh to newcomers. Ethnographic, participatory fieldwork provided a basis from which to contextualize household surveys and land use and cover change analysis of the whole settlement. We present and discuss changes in economic strategies and land use using data from the sampled population and a spatial estimation of fish farming ponds from 1986 to 2003. We present short “life-story” narratives for three Porto Acre residents/landowners, which are, we believe, illustrative of each social group. The life-stories are focused on the livelihood strategies that take place

as the settlement ages, and on the social learning processes that are both a driver and an outcome of such strategies. This discussion is important to understand farmers’ land-use options as an experiential process affecting future choices on livelihood strategies, and how these options are related to structural factors observed at the settlement level in land reform projects (Brondizio 2004).

Specifically, we look into the range of land-use activities and livelihood choices that had been evolving since farmers first arrived in the frontier, by exploring the following working hypothesis: *Households diversify their econom-*



*ic strategies overtime. As households mature in the frontier, they engage in an increasingly larger number of economic activities, aiming at diversifying income and minimizing risks.*

The survey instrument was based in an open-ended questionnaire that followed the methodology developed in McCracken et al (1999), Brondizio et al (2002) and Moran et al (2002) and described in detail in Ludewigs (2006). It included questions on land-use strategies, agropastoral production and commercialization, both by the time of arrival at Porto Acre and by the time of the interview. It included also questions on economic strategies for both time periods, including employment, retirement, subsistence strategies (hunting, fishing, gathering) and remittance of money by relatives. The quantitative analysis focuses on the importance and range of livelihood strategies between the time settlers first arrived in Porto Acre and during fieldwork (2003/2004). Our discussion focuses on issues relevant to the livelihood strategies in the region such as construction of ponds, rural producers' associations and agricultural credit, and the relationship between environmental legislation, demand for pastures and increase in land prices. The discussion is also based on the concept of social learning, given its importance to understand the development of social and economic networks in the frontier setting.

#### **SOCIAL LEARNING AND LAND-USE DECISIONS IN THE CONTEXT OF SETTLEMENT PROJECTS**

Social learning, as a learning process that takes place in arenas of social interaction (such as work meetings, markets,

religious encounters, or group hunts) plays a key role in enhancing adaptive strategies used by farmers (Chamley 2003), especially in frontier areas, where access to information related to land-use decisions might be very limited, more than in non-frontier areas. In the Amazon frontier, social learning may be important to cope with factors that contribute to uncertainty in the payoff structure of investments, such as harsh environmental conditions (e.g., excessive rains, poor soil fertility), lack of infrastructure and markets for agricultural products, and overall absence of formal institutions, as implied from in-depth studies carried out in the region (Moran 1981, Osório de Almeida and Campari 1995, Alston et al 1999, Pichón et al 2001, Brondizio et al 2002, Muchagata 2002, Campos 2006a, Ludewigs 2006).

By interacting with neighbors and observing their behavior and the outcomes of their behavior, farmers complement and reconsider the knowledge obtained from their own experiences in important ways. Here, we want to briefly discuss the meaning of 'social learning' used in this article within a wider theoretical perspective, since the literature offers different interpretations of this concept. Also, we will discuss some situations where social learning and other forms of social interactions takes place, and why these are important for increasing the welfare of households and communities.

The theoretical basis of social learning is rooted in experiential learning (Kolb 1984) and on participatory decision-making. Its conceptual body

is still scattered throughout the social sciences and needs to be better defined (Goodin 1996, Pahl-Wostl 2002). Nevertheless, it has been gaining strength in the study of human-environment systems, particularly in the fields of adaptive management and integrated assessment, and in discourses involving questions of sustainable development within the framework of human dimensions of environmental change (Gundersen et al. 1995, Pahl-Wostl 2005). Some of the main attributes of processes of social learning include the build-up of a shared perception of problems among actors, build-up of trust as a base for critical self-reflection, recognition of mutual dependencies and interactions, and engagement in collective decision and learning processes (Pahl-Wostl 2002). A broad definition of the role of social learning on the composition of human behavior and knowledge is:

*Learning would be exceedingly laborious, not to mention hazardous, if people had to rely solely on the effects of their own actions to inform them what to do. Fortunately, most human behavior is learned observationally through modeling: from observing others one forms an idea of how new behaviors are performed, and on later occasions this coded information serves as a guide for action.” (Bandura 1971: 22).*

Within the social and political sciences, there is a wide range of applications involving the concept of social learning. For instance, ‘herd behavior’ models were used to study situations where in-

dividuals would fail, according to neo-classic economic assumptions, to act as rational agents; however, under broader assumptions of bounded rationality, ‘herd behavior’ has been shown to be more efficient in achieving productivity goals than individualistic decision-making processes in several contexts (Chamley 2003). This is the case with the adoption of new technologies by farmers, as uncertainty about possible outcomes often frequently plays an important role in explaining the spatial and temporal patterns observed in rural areas (Brondizio and Moran 2008). By observing outcomes of adoption of new technology by neighbors, farmers make better informed decisions on whether to adopt a new technology. Social learning processes based on rules of thumb that favor adoption of more popular agricultural technologies tend to lead to fairly efficient decisions (effective incorporation of technologies into the production system in the long run), but adjustment can be slow when new technologies are first introduced (Ellison and Fudenberg 1993).

Social interactions with neighbors and social learning processes play an important role on increasing farmers’ chances of making productive use of the changing opportunities that are available in colonization areas, as suggested by Moran’s study (1981) mentioned above. More recently, it has been found that social networks in the Santarém region (fieldwork data, ACT-IU<sup>5</sup>) are important to minimize risks and uncertainties related to rainfall distribution (e.g., by following agriculture calendars used by locals and by

using popular/ecological indicators of weather variation such as behavior of animals) (Moran et al 2006, Brondizio and Moran 2008). As Amazonian settlements age, social learning helps farmers to maximize the use of opportunities related to public services<sup>6</sup> such as health services<sup>6</sup>, public transportation, education, identification of better lines of agricultural credit and organizing for the maintenance of better road conditions (Ludewigs 2006). Social learning is also critical on enhancing farmers' ability to negotiate better commercial deals when selling their agricultural produce, bargaining discounts in agricultural retail stores, or dealing with loggers and politicians on pond construction projects (as discussed further). Thus, social learning might be seen as a product of intercommunications and sharing of experiences within a forming community. It allows farmers to make more effective use of information, and guides farmers in taking advantage of their neighbors' experiences, reducing uncertainties that limit farmers' use of economic opportunities in frontier settings. Moreover, it helps farmers' on acquiring the knowledge that is necessary to diversify their economic portfolio.

Social networks among settlers in the Amazon may offer also key elements for effective rainforest conservation strategies in the region (Muchagata 2002, Campos, 2006a and 2006b, Campos and Nepstad 2006). By articulating political representation among several farmers' unions along the Transamazon, the Movement for the Development of the Transamazon and Xingu

(MDTX) developed a pioneer proposal that included the creation of two conservation units in the so-called 'Terra do Meio' region in the State of Pará. The MDTX main points leading to the proposal are: a) widespread deforestation might put agricultural production at risk since it affects regional rainfall distribution; and b) conservation units might provide a buffer zone that blocks the advance of large-scale agricultural businesses, thus slowing down social tension related to land conflicts with smallholders. The proposal was adopted by the Brazilian federal government, who later started the process of establishing the proposed conservation units (Campos and Nepstad 2006). Transamazon settlers' activism has been successful also on contributing to establishing some other important benchmarks, such as the creation of FNO especial agricultural credit line (Tura and Costa 2000), on promoting participatory research agendas that include a wide range of environmental, socio-economic and political considerations in the treatment of development problems (Castellanet and Jordan 2002); and the Proambiente<sup>7</sup> program (Mattos 2004, Campos 2006a). Hence, smallholder settlers who had been historically connected to Amazonian deforestation either as villains or victims (Hecht and Cockburn 1989, Schmink and Wood 1992), are now being increasingly recognized for taking an active stake in proposing and accomplishing 'conservation strategies that strive to go beyond the establishment of parks and biological reserves' (Campos 2006b).

## DIVERSIFYING LIVELIHOOD OPTIONS AS A SETTLEMENT AGES

Before presenting richer and more detailed life-stories of local farmers, this section compares the range of livelihood options explored by Porto Acre farmers when they first arrived in the settlement with the range of livelihood options explored in 2003/2004. When the land-use and socio-economic sur-

vey was conducted, farmers were asked to rank their livelihood options according to its economic importance at each of these two moments. The economic importance of each livelihood option includes both market value and non-market value (as for example options used for household consumption, such as game or fishing). The results are presented on Table 1.

Table 1 - Relative importance of livelihood options in Porto Acre (%):

Livelihood options	Arrival at the Settlement <sup>8</sup>			2003-2004		
	1 <sup>st</sup>	2 <sup>nd</sup>	3 <sup>rd</sup>	1 <sup>st</sup>	2 <sup>nd</sup>	3 <sup>rd</sup>
Annual crops	34.9	17.5	3.2	11.1	17.5	11.1
Perennial crops	6.3	12.7	3.2	1.6	4.8	7.9
Agroforestry <sup>9</sup>	-	-	-	1.6	6.3	1.6
Wage labor	1.6	4.8	-	1.6	-	1.6
Salaries	7.9	1.6	-	9.5	9.5	-
Dairy	3.2	7.9	6.3	15.9	12.7	4.8
Beef	12.7	12.7	6.3	33.3	23.8	6.3
Fish breeding	1.6	-	-	4.8	1.6	1.6
Hunting	1.6	3.2	11.1	-	-	4.8
Fishing	-	1.6	7.9	1.6	1.6	3.2
Non-Forest Timber Products (NFTP)	9.5	3.2	-	-	3.2	-
Timber/coal	-	7.9	4.8	1.6	1.6	-
Commerce	3.2	-	1.6	4.8	3.2	6.3
Agro-industry	-	1.6	-	1.6	-	-
Pension	-	-	-	11.1	7.9	9.5
Others	6.3	1.6	1.6	-	1.6	7.9
Missing or no opinion	11.2	23.8	54.0	-	4.8	33.3
Total	100	100	100	100	100	100

Cattle-ranching for beef is the leading economic activity among farmers in 2003/2004, or the one that 33.3% of the interviewed farmers considered the most important as a livelihood option for maintaining their households; 15.9% of the farmers considered dairy

as the most important activity; 11.1% considered annual crops and other 11.1% considered pension as the most important economic source. For the second most important economic option, beef is again the most frequently listed, with 23.8% of the preferences,

followed by annual crops and by dairy. As for the third most important economic option, annual crops are mentioned first, followed by perennial crops and by beef. Note, however, that 33.3% of the farmers did not mention a third most important option (referred as missing, which seems to limit their activities to ranching and agriculture).

When asked about the first most important economic option when they arrived, 34.9% of the farmers answered that it was annual crops, while other 12.7% responded it was cattle-ranching<sup>10</sup> and 9.5% responded non-timber forest products (NTFP), which includes rubber-tapping and Brazil-nuts<sup>11</sup>. For the second most important option, annual crops comes again as the most frequently cited (17.5%), followed by perennial crops and beef in the second place and dairy and timber in the fourth place. For the third most important option, hunting is the most important, followed by fishing and by beef and dairy.

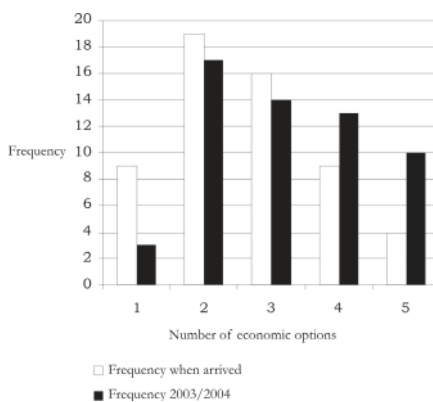


Figure 2 – Number of economic options by the time of arrival and in 2003/2004.

Figure 2 shows a comparison on the number of economic options explored by farmers when they first arrived in Porto Acre and in 2003/2004. The frequency of citations of four economic options<sup>12</sup> by farmers in 2003/2004 is 44% higher than the frequency of citations of four economic options when farmers arrived, and the frequency for 5 economic options is one and a half times higher than when farmers arrived, which points to a pattern of diversification in livelihood strategies occurring through the studied period.

#### LIVELIHOOD STRATEGIES AS PERCEIVED BY COLONIST FARMERS, RUBBER-TAPPERS AND LAND INVESTORS

The information is organized in a way to allow the visualization of the socio-economic, cultural and bio-physical diversity within the study area and through time. Three distinct life-stories were picked from household-heads interviewed during fieldwork, highlighting their adaptation strategies as a function of changing individual preferences as well as environmental, infra-structure and labor/capital constraints as households mature. These life-stories were selected based on the richness of details about factors shaping livelihood choices, and on how they illustrate the opportunities available to similar groups of farmers along settlement aging. Some of the factors affecting these strategies include the availability of labor and capital, subsistence resources, road conditions and commercialization of agropastoral products, household size and compo-

sition, and governmental policies such as agricultural credit, technical assistance and research initiatives.

**Seu Claudenor<sup>13</sup>: a local rubber-tapper engaged in cooperative networks**

*“Camarada acostumado na floresta sente muito a cidade grande. Seringueiro, quando vira colono, tenta se acostumar com roçado e gado; mas depois vê que o ramo dele é andar mata mesmo...”*

*“The fellow who is used to the forest feels it hard in the city. When a rubber-tapper turns into a settler, he tries to get used to agriculture and cattle; but sees later that his business is in fact to walk the forest...”*

*‘Seu’ Claudenor, 6/9/2004*

Seu Claudenor used to be a rubber-tapper until 1981, when INCRA arrived and implemented the land reform. He was born in Plácido de Castro, Acre, in 1948, and migrated to *Seringal* Panorama (rubber-farm Panorama) in 1976, to an area that corresponds to the actual *Mutum* road of Porto Acre settlement, where he acquired informally a *colocação* (household unit of rubber extraction<sup>14</sup>) with seven *estradas de seringa* (roads of rubber-trees), which was equivalent to approximately six INCRA lots or around 360 hectares. But he soon found out this *colocação* was not as productive as he expected it to be, and exchanged it later for another one located near what is now known as *Ramal Bujari* (Bujari road, not existent though when he arrived), and where he and his family still live today. The main reason he chose this *colocação* was that it

had plenty of productive rubber-trees, Brazil nuts and game. After INCRA’s implementation of the land reform, he was assigned an area of 66 hectares around his house and lost user rights to the rest of his *colocação*. While this gave him secure property rights to this piece of land<sup>15</sup>, it represented also a turning point in his life, since he no longer could live from rubber-tapping and had to change instead to agriculture and cattle<sup>16</sup>. The same drastic change in livelihood means occurred for 265 other rubber-tapper families living in Porto Acre area since 1981 (INCRA 1990).

Seu Claudenor met his wife *Dona Doralice* in his first *colocação* in *Seringal* Panorama. As they moved to Bujari, her brothers came along and a kin-based cooperative network was soon established. Since commercialization of agricultural produce was almost impossible due to the lack of passable roads (Bujari road is still one of the most problematic in the settlement), an exchange economy including extractive products from the forest (including game) and annual agriculture was established through the family network. Today, Claudenor and Doralice have 12 sons/daughters, three of them living in the lot, seven in Vila do V (located about nine kilometers from the lot, along Bujari road) and two in the recently established Porto Acre settlement<sup>17</sup>. The three sons and daughters living on the lot are responsible for the agricultural production, which is shared among the whole family. The ones living in Vila do V are either

studying or employed; the ones employed and Seu Claudenor, who is also employed as a security guard with the local school, help the ones living in the lot financially. One son is employed in the local sawmill, another as a *peão de boiadeiro* (cowboy), one daughter as a social assistant and another son as a teacher in the local school. While the three sons/daughters living in the lot did not finish elementary school, three of the other siblings did finish the 8<sup>th</sup> grade, three finished high-school and the other three are still studying. The family owns a small cottage in Vila do V, where they stay during most of the week. Dona Doralice, who is also employed in the local school as a cook, and Seu Claudenor are constantly moving back and forth from Vila do V to their lot, where they supervise agricultural activity. They own a motorcycle and a bicycle, which comprise their means of main transportation. They also use collective cabs (*peruas*) that often drive the Bujari road route up to Dois Irmãos road, in Projeto Porto Acre, during the dry season. Transportation during the rainy season is very problematic, when most Bujari residents often have to walk their way to schools and/or jobs in Vila do V. Some have horses and others have motorcycles adapted to muddy roads. Only land investors owning ranches in Porto Acre can afford four wheel-drive vehicles.

Everybody in Vila do V and in Bujari road knows Seu Claudenor. He is a very kind person with friends everywhere he goes. Talkative, making jokes and ready to help neighbors in need,

he has been the president of the local producers' association for the past 8 years. Associação São Bento currently has 69 associates along Bujari road, and is considered one of the few 'successful' producers' associations in Porto Acre in the long term, given the rate of approval of agricultural loans, projects, and overall attendance of associates to meetings. Despite commercialization difficulties, Seu Claudenor believes in the potential of agricultural crops to develop the region, and is fighting for the approval of a big loan with BASA. More on this loan is discussed below (rural producer's associations). Seu Claudenor was going to run for the city council of Porto Acre (*vereador*) in the 2004 elections and assured locals he would be willing to continue working with São Bento if he wins.

Seu Claudenor took two agricultural credit loans through FNO from 1998 to 2004, and could be considered a risk-taker for his willingness to invest on agricultural crops<sup>18</sup>. However, he and his family have adopted a livelihood strategy which is clearly based on the diversification of income sources and of other subsistence means. For instance, the agricultural credit loans were invested in cattle, infrastructure (fences, corral, pond construction), equipment (a manual weed cutter and a domestic manioc flour mill engine), and in a small coffee plantation. Besides owning 34 cattle heads for both dairy and beef, maintaining a diverse home-garden with several species and working with annual and perennial crops for both domestic use and commercial

sale, Claudenor and Doralice's household maintains a diversified set of animal husbandry activities (fowl, pork, horses and fish). Fish production in 2003 was of around 1,000 *curimatãs* (popular specie of Amazonian fish) in two ponds, from which 600 kg were sold, and another substantial quantity was either consumed among household members or given to neighbors. The household maintains some 12 hectares of forest cover in the lot (or 18%), from which *açai* fruit, Brazil-nut and timber are explored for domestic consumption. Game is no longer available, but was an important source of protein in the past.

The household cooperative system seems to work reasonably well, though only Seu Claudenor was interviewed. We don't know how his sons and daughters, particularly those living in the lot, feel about it, or his wife. This kind of household cooperation network is not uncommon in Porto Acre, and plays a significant role on eliminating risks otherwise significant in non-cooperative livelihood settings. Household and kin cooperation networks are probably much more important at the settlement level than the ones observed in producers' associations. Moreover, household size plays a key role in this setting, and so does the leadership role of Seu Claudenor on maintaining the system operating.

### **Seu Sebastião, a colonist farmer specialized on making cheese**

*"No ano em que cheguei no Acre (1976), recebi um convite de um fazendeiro para ir fazer derrubada no Amazonas. Fui com meus cun-*

*hados, mas não valeu a pena; terra ruim, madeira dura, cheio de mosquito, malária, nos lascamos...a terra foi abandonada para quem quisesse. Naquele tempo, não tinha Incra, pegava 'o tanto de terra que os olhos dava'..."*

*"When I arrived in Acre (1976), I received an invitation from a cattle-rancher to go to the State of Amazonas to put down trees. I went with my brothers-in-law, but it did not pay off; poor soils, hard timber, lots of mosquitoes, malaria, we went broke...the land was then abandoned to whoever was willing to take it. During that time, there was no Incra, and anyone could 'take' land 'as far as your eyes could see'..."*

*Seu Sebastião, 5/9/2004*

Seu Sebastião was born in the state of Minas Gerais, Southeast region of Brazil, in 1946. He used to work on clearing forests for third parties, and he married Dona Neusa when both were still teenagers. They then migrated together to the State of Mato Grosso (south of the Amazon Basin), and later to Mato Grosso do Sul. Neither Seu Sebastião nor Dona Neusa received much formal education. He attended only to two years of school, while she is illiterate. In 1976, they made their third migration to the municipality of Xapuri, Acre, where Seu Sebastião was hired by a logging company. In Xapuri, they joined the 7<sup>th</sup> Day Adventist church, and formed a united religious group that moved to nearby Capixaba municipality where they were settled in the agricultural production unit (*Pólo*



*Hortigranjeiro*) of the Alcobrás<sup>19</sup> project area. By that time, Alcobrás was already doomed to failure due to a big corruption scandal from the misuse of public funds. Seu Sebastião and colleagues enlisted as settlement beneficiaries in P.C. Humaitá, where they were granted lots by INCRA in 1982. In 1983 Seu Sebastião, Dona Neusa, their four children and their group of approximately 60 members of an Adventist church moved together to the Concórdia road.

When they arrived, the Concórdia road was still a trail in the forest, and their belongings had to be carried in several trips 'on their backs'. With their son and three daughters<sup>20</sup>, they cleared and cultivated an average of five hectares per year with rice, beans and corn. This area was usually planted with grass in the second year. Pasture establishment has often been problematic due to poor burns of agricultural fallows, and re-planting of grass has been common throughout following years. As fluctuation in annual crop prices and poor road conditions cut down profits of agricultural activity, they gradually began to replace part of the recently cleared areas with pastures, instead of planting annual crops, up to the point they stopped completely with annual crops, which happened in 1998.

The Concórdia road once had an association of rural producers that included the Adventist families and other residents; this association owned a tractor donated by a governor in the past. During that time, according to Seu Sebastião, he had an agricultural

'bonanza' and made some significant profits from commercialization of papaya, manioc and manioc flour. The key factor for the 'bonanza' was that the produce could be transported to Vila do V by the association's tractor. Seu Sebastião and his family had also significant economic outputs from selling chickens, and there was always "something to sell" during difficult times. The tractor however did not survive much longer, and the association disappeared due to out-migration of residents. From the initial 60 member group, only four families remained in the area by 2003; all others moved either to Rio Branco, to new settlement fronts, or to neighbor villages Vila do V or Vila do Incra. These were replaced by land investors who consolidated lots into larger properties.

Seu Sebastião and Dona Neusa's main land-use option in their 63 hectare lot today is pasture for dairy (1<sup>st</sup> income source) and beef (2<sup>nd</sup> income source) production. They don't sell milk because of problematic road access and make cheese instead, which is sold once a week in Rio Branco's central market for US\$ 0.90 for a 650-gram piece. Given that milk production varies seasonally, cheese production is of 170 kg/month during the dry season and 80 kg/month during the rainy season, totaling an average of 1,500 kg/year or US\$2,150/year. In 2003, however, they were forced to sell most of their cattle because a big fire burned most of their pasture, and made some US\$ 5,300 which was used to remodel their house. Another important source of income is Dona Neusa's retirement

pension of one minimum wage salary (about US\$ 80/month in 2003), and another equal amount received for the disability of their daughter.

According to Seu Sebastião, the fire that decimated their pasture resulted from a neighbor burning a slashed fallow under inappropriate conditions. It spread throughout 600 hectares of forest, secondary vegetation and pastures affecting around 10 lots. Fortunately, it could not cross the strip of forest that separates Concórdia lots from Bujari lots. According to Seu Sebastião, the frequency of fire incidents like this one has been increasing along with the increase in deforested areas. Another environmental problem affecting most of the lots along Concórdia and Mutum roads is the 'death of the pastures', which affects some 10% of the pasture area along these road. The alternative recommended by Embrapa-Acre and being used in the area has been to replace *Brachiaria brizantha* grass by *B. humidicola*, which is less vulnerable to death of the roots by asphyxiation. This is however an expensive measure and farmers have been experimenting this in small patches only. Seu Sebastião, for instance, has been unable to do anything about this problem by the time of interviews, since his focus has been on helping pastures to recover from the fire.

Their other three daughters and son have all formed families and are presently living in Rio Branco, with one daughter living in a settlement in the Senador Guiomard municipality. Only one daughter finished elementary

school. She works in commerce in Rio Branco. The oldest son attended only to the second school year and knows how to write, but not much, as it is the case of his two other sisters. He used to work in a timber sawmill in Rio Branco but is now unemployed. None of Seu Sebastião and Dona Neusa's son or daughters has ever helped them financially, after leaving the household.

Seu Sebastião life-story in Porto Acre illustrates a pattern of livelihood strategies that is common in areas with poor access to markets and in households that cannot count anymore on the labor force they once had. Seu Sebastião and Dona Neusa once had a more diversified set of economic activities, including commercial agriculture and mixed husbandry. Roads conditions have been always poor, but with the association's tractor (which was provided by a local politician) no produce was lost in the field. But as many neighbors started selling their lots to land investors, the association became weak and died. By the same token, after four of their sons and daughters left the lot<sup>21</sup>, their range of options on land-use activities became constrained, and Seu Sebastião specialized into the cheese business.

### **Seu Henrique, a land investor with a diversified portfolio**

*"Com a venda do gado, faço mais açudes; o relevo ajuda, e só no lote 31 há 8 vertentes. Minha previsão para 2004 é de 2000 kg de peixe em cada um dos 12 açudes, a R\$ 3 mil / tonelada, dá R\$ 72 mil..."*

*“By selling the cattle, I make more ponds; the topography helps, and just in lot 31 there are 8 water springs. My forecast for 2004 is of 2000 kg of fish for each of the 12 ponds, at R\$ 3,000 (US\$ 940) per ton, results in R\$ 72,000 (US\$ 22,500)”*

*Seu Henrique, 3/16/2004*

Seu Henrique was born in Cruzeiro do Sul, State of Acre, in 1961, in a family that used to make a living from agriculture. As a teenager, he migrated to Rio Branco where he took the military service, went to college, and later got a graduate degree. Currently working as a public agent for the government, he comes every weekend to his farm in Linha 3 road. The first two lots were bought in 1984, from a rubber-tapper and his daughter, who were both willing to move to Rio Branco. According to Seu Henrique, he had to choose, by that time, between buying a new car and buying these two neighboring lots, of 64 hectares each. He does not regret his choice, since as he puts it, land was initially bought with the intention to use it as a hedge against inflation, but he figured out soon that substantial money could be made out of cattle-ranching. Recently, he found out fish breeding is even more lucrative.

Both lots were entirely covered in forest when Seu Henrique bought them in 1984. In 1987, he took a CrN\$ 100,000 (in Cruzados Novos, the Brazilian currency at the time<sup>22</sup>) loan from a Acre State bank which was used to convert 50 hectares of forest to pasture, and to build a corral and a house in the lot. He

was very concerned at the time with escalating interest rates on that loan, especially because of the rising inflation rates. By the end of 1987, however, and according to Seu Henrique, the government announced that due to the inflationary storm in Brazilian currency, all bank debts up to CrN\$ 100,000 were cleared, so he did not have to pay anything back to the bank (!).

The formation of these 50 hectares of pasture was very difficult, according to Seu Henrique, because of the poor burns and the high incidence of snakes, and secondary re-growth occurred in part of the area. In 2002, 20 hectares of secondary forest were manually converted to pasture, by contracting daily workers. Today, each lot is 77% formed with pasture, the remaining 23% covered with forest. Each lot also has 6 ponds, which are used both to supply cattle with water and to breed fish. Seu Henrique bought two additional lots in 1999 also connected to each other, but connected only through Linha 3 road to the other two lots that are around 1 kilometer away. The size of the lots acquired in 1999 is of 71 hectares and 69 hectares, both of them about 50% deforested at the time, with another 15% and 20% in secondary succession and the remaining in pasture. Each of these lots is about 85% formed with pasture today, with the remaining 15% still covered with forest. In 2004, the acquisition of a fifth lot of 65 hectares across Linha 3 road was being negotiated.

Connection among lots is an important issue to land investors, as it facilitates cattle and pasture management and re-

duces transaction costs. The same importance of connectivity among lots has been observed in consolidated soybean plantations in Santarém, (Ludewigs et al 2009), which contributes to the increase in land prices observed in the region<sup>23</sup>. Yet, in Porto Acre, demand for pasture instead of demand for potential soybean fields is what drives land prices up. Indeed, Seu Henrique mentioned land valorization rates of 100% a year along Linha 3 road<sup>24</sup>. Valorization on land prices has been also observed along paved roads or where infra-structure investments, such as ponds, corrals, fences, and electricity have already been high. Linha 3 is not paved, and was considered in very bad shape until 2003, when Seu Henrique asked Acre's government to reform the road. His request was approved and Linha 3 was one of the best unpaved roads of Porto Acre in 2004.

Another important factor determining sharp increase in lot prices relates to the recent decrease in rates of approval of clearing licenses emitted by IBAMA in Porto Acre and elsewhere in Acre. As cattle herd sizes tend to increase, leading to a corresponding increase in the demand for new pasture areas, prices of lots formed with pasture tend to rise in a higher rate than prices of forested lots, since restrictions to convert forests to pasture are stronger today than ever before in Porto Acre. Thus, we observed in 2003/04 that one hectare of land covered with well-formed pasture costs as much as six to eight hectares of land covered with mature forest. As a consequence, the temptation faced by colonist farmers to sell

land has been reaching a peak. One settler from Minas Gerais recently sold his 70 hectare lot in Porto Acre to buy a 250 hectare farm in Sena Madureira for a lower price. Others are buying land in Boca do Acre, State of Amazonas, (connected through some 150 km of dirt-road BR-317 to Rio Branco), where the local government has been receiving cattle-ranchers 'with open arms', and where enforcement of forest legislation has been ignored.

While many land investors in Porto Acre conduct cattle-ranching extensively, meaning that investments on increasing cattle-ranching productivity are kept moderate to low, Seu Henrique has been investing heavily on technology. With technical support from Embrapa-Acre, he has been rotating pastures, using electric fences, providing plenty of mineral salt to cattle, and even experimenting with artificial insemination of cows. Soil fertilization is not necessary since all his lots are located in rich Alfisols. Good harvests of corn have been obtained during the first year of forest conversion to pasture, by intercropping grass in corn rows. Corn production in 2003 was of 5,600 kg and was used to feed commercial husbandry (cattle and fish) and animals for local use/consumption (horses, pigs, chickens) of Seu Henrique's family and families of the two cowboys working for him. After feeding 44 cows and 55 oxen with grass and corn, these were sold in 2003 for US\$ 19,800. Other 688 cattle heads maintained on his 210 hectares of pasture represent a grazing pres-

sure of 3.27 cattle heads/hectare<sup>25</sup>, which is considered high for both Acre and Brazil standards, and probably the highest rate in Porto Acre. As may be noticed from the introductory note about Seu Henrique, he is a strong believer and supporter of fish breeding. In 2003, he sold 5 tons of *curimatã*, *matrinxã* and *piau* species all-together for a total of US\$ 4,800, 30% of which was considered by him as profit. A larger quantity, however, was stolen by neighbors. According to him, fish stealing is the single most important factor that kept him from investing more resources into fish breeding. Another farmer shared his strategy to keep fish robbers/stealers out of his ponds; being also a cattle-rancher and a butcher, he disposes of cattle carcasses around the ponds, which keeps his several watchdogs busy in these places and robbers away from it.

#### ARE FARMERS DIVERSIFYING THEIR ECONOMIC PORTFOLIO?

Both quantitative and qualitative data show Porto Acre households investing in a more diversified portfolio of economic options today than when farmers first arrived in the settlement. However, one finds significant variation in the ability of families to diversify. The working hypothesis described above “*Households diversify their economic and income strategies overtime. As households mature in the frontier, they engage in increasingly larger number of economic activities, aiming at diversifying income and minimizing risks*” is, therefore, accepted at the level of the settlement, but does not necessarily explain internal variations associ-

ated with individual families. It is also important to point out that while seeking diversification, most households have one or two economic activities which anchor a significant portion of their income. A number of additional reasons motivating this general trend towards diversification are clear in this as in other settlements in the Amazon:

- When 1<sup>st</sup> lot owners were settled by INCRA between 1981 and 1986, they had to start agro-pastoral investment in lots when most lots were still completely covered with forest. However, most families faced substantial restrictions on capital and labor force during that time. Given that forest clearing requires considerable inputs of labor, and that cattle-ranching requires larger areas of land to be cleared (per financial unit of output) when compared to annual and perennial crops, only few farmers were able and/or willing to invest resources in pasture formation from their very start in Porto Acre. Another reason not to invest promptly in pastures is that most small farmers in the frontier context operate with high discount rates (Schneider 1995), which leads them to prefer land-use options that are capable of offering financial return in the short term. Farmers arriving at later periods in the settlement (2<sup>nd</sup> and n<sup>th</sup> lot owners), however, were eventually able to buy land already partially cleared and with pastures, which allowed them to include cattle-ranching in their livelihood

portfolio in Porto Acre from the beginning, as observed elsewhere in Amazonia (Vanwey et al 2007).

- Labor markets are rarely available at early stages of frontier development (Sawyer 1984). Wage labor opportunities in Porto Acre's early stages were indeed limited, as shown in Table 1. Also, many rubber-tappers and/or eventually colonist farmers receiving retirement pensions by 1981 would be unlikely to be included in our sample, since many of them were deceased by 2003/2004.
- Given that practically all ponds in Porto Acre were built after INCRA started settlement implementation, fish breeding and other forms of animal husbandry were harder to be conducted in 1981-1986 (see discussion on Figure 3 below).
- Most households arriving in the region were formed by young couples. Given the household size and composition relationship with land-use diversification, it is more likely for young couples to manage more targeted land-use portfolios when compared to older and larger households.
- On the other hand, there were some economic options during initial stages of settlement, such as rubber-tapping, Brazil-nut collection, high valued timber exploration, hunting and other forest extractive economic options that were un-available or less available to most farmers in 2003/2004.

## PROCESSES AND POLICIES INFLUENCING THE RANGE OF LIVELIHOOD OPTIONS

This section discusses some processes and policies that became salient during fieldwork and data analysis, and are believed to influence the range of livelihood opportunities during the life of this settlement.

### *a) Construction of ponds*

Ponds have multiple uses in Porto Acre, and their number across the settlement has been increasing considerably in recent years. Figure 3 shows the evolution in the number of lots with pixels classified as water and in the total area classified as water across the temporal frame of the remotely sensed imagery dataset<sup>26</sup>. It shows that the number of lots with ponds has been increasing faster than the total area of ponds. Field observations confirm the importance that farmers attribute to ponds: ponds represent a cheap alternative to supply cattle with water, remain full-charge (of water) throughout the dry season, and, most importantly, allow for diversification in land-use and economic options, since they serve a diverse set of husbandry projects, especially fish breeding.

Interviews with farmers revealed that by the second half of the 1990s, facilities to finance the construction of ponds were provided by local government agencies (including INCRA, Porto Acre municipality and the State of Acre government). The main mechanism of pond financing is connected to road repair and maintenance operations, and works in the following way:

farmers organize and demand collectively for road improvements from local governments; depending on the resulting agreement (e.g., whether farmers will share part of the costs or not), and on the political agenda of mayors and the governor (e.g., investments on roads are substantially higher in electoral years), heavy machinery is sent out for road repairs and ends up being used for a second objective which is the construction of ponds. One particular governor of Acre was often mentioned by farmers as being “sensitive to farmers’ problems,” by allowing heavy machinery originally budgeted for road repairs to be used for pond construction, as long as farmers helped co-financing part of the costs (diesel and wages of machine operators).

Two other common ways of financing ponds include deals with the timber sector (*madeireiros*) and loans from agricultural credit programs. Log prices paid by *madeireiros* to farmers used to vary between R\$ 40 and R\$ 60 (around US\$ 16 and US\$ 24 for late 1990s currency rates), which is substantially below the market price for good quality hardwoods (including *cedro*, *cerejeira* (or *cumaru-de-beiro*) and *cumaru-ferro*). As a compensation, *madeireiros* build and fix roads, and construct small ponds for farmers as well. Another important mechanism of financing of ponds is agricultural credit from FNO for pond construction, as seen in Seu Claudenor’s story above. Application for agricultural credit is conditioned to affiliation to rural producers’ associations.

The sharp increase in the number of ponds observed in Porto Acre illus-

trates the importance given by farmers to diversify their livelihood portfolio, since most ponds allow fish breeding for consumption and commercialization, and provides a stable water source for cattle. A well-established market for fish in Rio Branco helps to maintain fish prices relatively stable. The high increase in the number of ponds illustrates also how farmers make use of opportunities provided by local governments, credit programs and loggers to invest in their lots. Pond construction is expensive and most settlers would not be able to/willing to pay this price, if it were not for the multiple opportunities of pond financing that have been created by them (by their negotiation power).

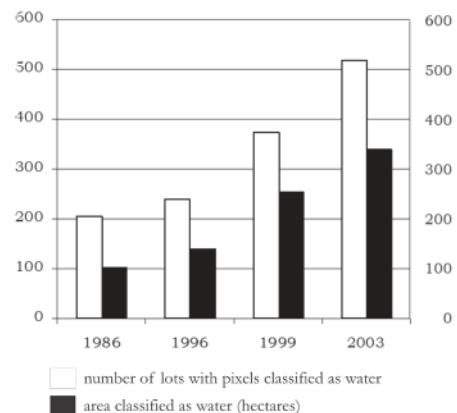


Figure 3 - Evolution in the construction of ponds along settlement aging.

Negotiation of ponds itself does not depend as much on collective action as the process of learning the strategies necessary for success. Farmers in settlement projects and elsewhere are always observing and learning from their neighbors’ experiences, and also use

details from shared experiences (e.g. negotiation stories are openly shared among farmers through social interactions taking place during festivities, religious celebrations, or in bars, markets, associations, etc...) to increase their chances of getting a good deal. For instance, if a logger contacts a farmer and tells him that for  $x$  amount of logs he would be willing to pay the farmer by constructing a pond of size  $y$ , farmers may use information gained from social networks to argue: "I need a pond of size  $2y$ ; I know this is feasible for you since this deal was obtained by other people around here". This type of negotiating power gained from sharing experiences applies also when farmers negotiate pond projects with local politicians and bank representatives. These examples illustrate the social learning process that develops in farming communities as farmers try to benefit from opportunities available in settlement projects.

*b) Rural producer's associations*

As mentioned in the life-story of Seu Claudenor, Associação São Bento is locally considered a 'successful' association. For instance, the financing of a completely subsidized manioc flour mill project has been approved, recently after Seu Claudenor and colleagues from the association's were able to prove to the state Agricultural Production agency of Acre that there were sufficient agriculture oriented farmers associated with São Bento to supply the mill with raw material (manioc). In 2004, São Bento was negotiating the approval of a US\$ 156,000 loan with

BASA, to finance the purchase of two tractors (one regular, one crawler), a plow, a planting machine and a harvest machine, for planting corn, manioc, rice and beans, and for the construction of ponds. If granted approval, each of São Bento's 69 associates would be liable to cover part of the loan, with additional collateral as the value of the association (US\$15,600). Interest rates will be of 4% a year under FNO – Pronaf financing system, with 4 years of grace period and another 8 years for repayment.

According to Seu Claudenor, if granted approval, individual members of the association will be responsible for operating the machinery and to manage its agenda. Associates will pay only diesel and operators' wages, non-associates will pay more. Some residents of Bujari road doubt that this project will produce positive outcomes. They argue that poor road conditions will not allow for commercialization of harvests, that associates do not have enough experience managing common property (e.g., agricultural machinery), and that the loan cannot be repaid by association members, who might be forced to sell their lots to pay the bank. Another issue is the ecological impact of heavy machinery on soils. Soil compaction might increase erosion problems, especially on Plinthic Ultisols (*tabatinga*), present in moderate proportions along Bujari, which should not be plowed at all. According to Seu Claudenor, however, most soils are good for mechanization, as proved already by some successful experiences



of settlers renting heavy machinery and planting larger areas of land with annual crops, and *tabatinga* soils would not be used for agricultural crops. In relation to road quality, Seu Claudenor points out that he and other associates will press the government for better road maintenance, since “where there’s agricultural production, there should be good roads”.

Seu Claudenor believes also the ‘organization’ of the São Bento association is already sufficiently strong to allow for successful management of the loans and equipment use. The apparent ‘success’ of the São Bento association on approving and preparing projects, and getting associates to attend meetings would be more difficult if it were not for the outstanding dedication of Seu Claudenor and his leadership skills. According to him, several farmer producers’ associations ceased to exist because when presidents and members of the directory have to work hard on their own lots to make a living, they can’t dedicate enough time to the associations, which end up ‘dying’. In Seu Claudenor’s case, he is fortunate to have a job and a family organization which allows him to dedicate considerable part of his time to the association. Otherwise, it could have already ‘died’ as well, which indicates that most responsibilities on the maintenance of São Bento’s activities are centered on himself.

c) *The “Reserva Legal” in Porto Acre*

The Forest Code of 1965 instituted several norms for protection of forested areas on private and public lands, located in rural and urban areas of

Brazil (Brasil, 2001a). Among these norms, the Forest Code included the implementation of the *Reserva Legal* (Legal Reserve), which states that a minimum percentage of land in rural properties above a minimum size shall be maintained with native vegetation. For the Amazon region, this minimum percentage of *Reserva Legal* was established at 50%. Enforcement of the *Reserva Legal* in Porto Acre, as stated in the Forest Code legislation of 1965, was weak up to the late 1990s, when state agencies increased monitoring and control of irregular forest clearing. This increased control was reinforced by the *Medida Provisória* N.º 2166/67 (Brasil, 2001b), issued by the federal government in August 2001, that changed the 50% rule to an 80% rule. The election of president Luiz Inácio Lula da Silva in 2002 is also believed to play a role on increasing control over deforestation in the State of Acre<sup>27</sup>. There is a strong political reason for that. Since Acre has been administered by the Workers’ Party (PT) since 1999, the same party of president Lula, and since it is also the home state of Lula’s now dismissed Minister of the Environment Marina Silva, it has been set as the state where the implementation of the idea of sustainable development should serve as an example to other states in the Amazon and to the country as a whole. To be consistent with deforestation rate reduction goals expressed in the *Amazônia Sustentável* plan (MMA 2006), both environmental agencies operating in Acre -IBAMA and SECTMA (State Secretary of the Environment), would have to increase

control over deforestation, which has been pursued through stricter monitoring and enforcement of fines, and through restricting the number of deforestation licenses granted<sup>28</sup>. Most Porto Acre residents have been expressing dissatisfaction to what they consider an unfair change in the rules of the game, because: a) by the time settlement opportunity was offered to them, and up to the late 1990's, the 50% rule of the Forest Code of 1965 was never really enforced; suddenly, in 2001, it is not only enforced but changed to an 80% rule, without any consultation with representatives of the farmers; b) according to Porto Acre farmers, several large forest clearings (over 100 hectares) were allowed between 2001 and 2004 in cattle-ranches surrounding Porto Acre settlement which passed unnoticed by the environmental agencies monitoring the region they add: "If large farmers can deforest large areas, how come we small farmers cannot clear smaller areas?" c) Many farmers that had followed the *Reserva Legal* rules have been recently denied license for clearing extra land; many of these farmers regret not having cleared the whole lot before, when Forest Code legislation was not being enforced, since their neighbors with lots more than 50% deforested are considered better off financially and are not facing any penalty for not following the rule; d) Some Porto Acre residents have been buying land in the Tocantins settlement project<sup>29</sup>, where most 60 hectare lots are still under 20% deforested, and where the new 80% rule is also being enforced;

they argue that it is not economically feasible to carry out agro-pastoral activities with only 12 hectares of land available, and defend the idea that the government should create protected areas for each settlement project, and allow settlers to undertake agricultural activities in the whole lot (instead of promoting settlement of families and later keeping these families from making economic use of their lots).

*d) Cattle includes both beef and dairy ranching as a preferred economy but not a 'cure all' strategy*

As mentioned above, cattle-ranching is the preferred land-use option in Porto Acre, for several reasons: less dependence on good quality roads, on electricity, or on qualified labor; it may work as a retirement fund or as an insurance policy, since cattle herd size keeps growing and can be promptly sold whenever money is needed (Hecht 1993, Veiga et al 2001). Beef prices are more stable than many other products; cattle-ranching is also relatively easy and cheap to manage. Thus, it is no surprise that cattle is a key part of the livelihood strategy portfolio of 95% of Porto Acre households in our sample, and the most important in 49% of the cases. However, it cannot be implied from this that cattle is an effective strategy for all types of farmers to improve their economic condition in the long term. Among other reasons, without significant investment in technology, most small farmers cannot afford the amount of land which is required to yield consistently larger income from cattle-ranching alone. This is probably why mixed husband-



ry and diversification on land-use and livelihood options have been found to be so important in Porto Acre. There is also indication that livelihood options based on more intensive land-use systems (higher inputs/area of land) such as agroforestry, annual and perennial crops and fish breeding, provide more consistent opportunities for improvement of economic situation in the long term that does cattle alone. This is especially true if some kind of extra value can be aggregated to products, such as by processing fruits into dried bananas and pineapples (as in the fruit drier processing plant owned by the Group of Ecological Farmers of Porto Acre), processing milk into cheese or production of manioc flour or tapioca starch (*goma para tapioca*). Another important strategy to increase household earnings is to take the opportunity of marketing agricultural produce directly to consumers in the farmers' market in Rio Branco, as has been practiced by farmers oriented toward organic agriculture. By offering differentiated products (organic products<sup>30</sup>), this group of Porto Acre farmers was able to guarantee a stand (physical place in the market) and a stake (share of consumers preferences) in Rio Branco's market.

While production from annual and perennial crops might be able to improve Porto Acre farmers' livelihoods and income, this is true only for families that can rely on good roads to get to markets. Risks of losing harvests due to lack or excess of rain, infestations and diseases are also high, and so are risks of poor payoffs due to low crop prices

(e.g. many coffee-growers went broke in the early 2000s due to low prices). Again, these circumstances provide background explanation for the diversification of land-use and livelihood options observed in many areas.

Steady sources of income (such as monthly salaries or other guaranteed income flows) have been found to be very important for maintaining Porto Acre's lower income families, such as the ones living off subsistence agriculture and extractivism, when they run low on their budgets. It has been found that income from non-agricultural sources composed mainly by retirement pensions responds for 58% of local rubber tappers' total annual income (Ludewigs, 2006). Jobs available locally in ranches, timber companies and Vila do V and Vila do Inca villages (such as in local schools, health centers, furniture factories and commerce) are also important on providing secure sources of income to several households in Porto Acre. Not that there are plenty of jobs available. To the contrary, unemployment levels were believed to be very high in both villages at the time fieldwork was conducted there, as population in both villages has been steadily increasing. Timber companies take advantage of this situation and continue to buy high quality timber at prices significantly below market prices in Rio Branco or prices of pre-processed timber elsewhere. Since there is practically no more timber in P.C. Humaitá, selective timber exploration is done mostly in Tocantins settlement and neighbor-

ing farms. Humaitá residents are either contracted by service (*empreitada*) to realize forest clearings (*derrubadas*) or work as autonomous selective tree loggers, when they own an electric saw, which allows for higher payoffs; in this case, they purchase trees directly from Tocantins' settlers, cut them down, process them into boards which are then sold to furniture factories or construction firms.

Most land investors and cattle-ranchers in Porto Acre have not been investing as much resources as Seu Henrique into productive activities, or into techniques to increase agropastoral productivity. From an economic perspective, many farmers might argue that buying more land is good enough of a strategy to attend demands from increasing cattle herds. With increasing land prices and with promising new technologies, however, investments on pasture productivity have been calling the attention of a larger number of cattle-ranchers in Porto Acre and Acre. As increases in pasture productivity are matched by increases in agropastoral profits, the big question is whether improving technology is helping forest conservation in Acre<sup>31</sup>. Even with stricter enforcement of forest legislation accomplished in recent years, the lack of regulatory policies (such as taxes and incentives to less destructive land-use alternatives) on the expansion of agro-pastoral activities into forested areas might undermine efforts on controlling deforestation rates.

Seu Henrique's entrepreneurship on the adoption of new technologies is

matched by his strategy on diversifying his income portfolio. As a well paid public agent with a secure flow of income, he may afford experimenting alternative land-use options such as fish breeding. As a well-educated professional of the financial sector, however, he is also very well informed about profit possibilities of several of these options and would not invest in fish breeding without previous supporting information and experience. Other land investors interviewed in Porto Acre are also well employed and could therefore afford to invest more in technology adoption or in diversification of land-use activities. Many of them, on the other hand, own lots in less accessible roads, and others just don't have time or the will to do it, and prefer to adopt the 'risk-averse' strategy of focusing on extensive systems alone. This 'risk-averse' gradient might be relative to the temporal context; what is considered risk-averse at the short term might be considered risk-taking in the long term: a cattle-rancher that does not invest in new technologies today might be facing problems of lack of pastures for growing cattle herds in the future. Moreover, Seu Henrique's case and Seu Claudenor's as well show that while diversification of land-use and livelihood options might be regarded as effective strategies to spread risks of financial failure, by 'not keeping all eggs in one basket', this does not turn them into risk-averse farmers. On the contrary, both like to experiment with new alternatives and pursue new economic opportunities, which imply taking risks. Diversification of land-

use options, in Porto Acre, might thus be seen not only as a risk minimizing strategy, but also as a more efficient way of resource use and of taking advantage of a wider range of economic opportunities. And opportunities are, as pointed by Frederick J. Turner 100 years ago, the main engine leading migrants to frontiers and shaping their economic decisions.

### FINAL CONSIDERATIONS

In this article, we presented quantitative and qualitative analysis to assess our hypothesis that colonist households choose to diversify livelihood strategies and economic choices through time. At a settlement level we observed that households do engage in an increasingly larger portfolio of livelihood options (which include both market and non-market economic options) as the availability of economic opportunities increase with settlement aging, allowing them to diversify income and minimize risks. However, we also found intra-settlement variation in the ability of households to sustain a diverse portfolio of activities. Some points of interest include:

- A noticeable pattern of diversification in livelihood strategies occurred since the opening of the settlement during the early 1980s [within the sample of farm-lots studied here (n=63)].
- Cattle-ranching is the preferred land-use option in Humaitá, and part of the economic portfolio of 95% of the sample. It is also the most important land-use strategy

in 49% of the cases (includes beef and dairy). However, cattle-ranching is not seen as a 'cure-all' remedy for farmers, given land limitations of most agricultural family enterprises. In Humaitá, this gap is filled by mixed husbandry and diversification of land-use and other economic options. For many families, fieldwork data indicates that agroforestry and fish breeding, for instance, provide more consistent opportunities for improving the economic situation in the long term than does cattle alone.

- Annual crops were an important economic alternative for all three social groups when they first arrived in the settlement (or by 1981, in the case of rubber-tappers), but lost much of their commercial importance by 2004. However, annual and perennial agriculture continue to be important for household consumption (especially for local and colonist farmers).
- Retirement pensions seem to be more important than both salaries and hourly wages. Pensions are more important for rubber-tappers, as this group has a higher elderly population proportion than the other social groups. Also, most retired rubber-tappers have been granted *soldado-da-borracha* (rubber soldier) pensions, which are equivalent to approximately two minimum wages. Most colonist farmers, however, receive pensions approximately equivalent to one minimum wage
- Humaitá farmers have been using social learning processes to better

adjust to frontier conditions and to compensate for the deficiency in access to information. For example, it was observed that local economies based on exchange of agricultural/forest goods and reciprocity tend to be stronger in parts of the Humaitá settlement that are poorly connected by roads to urban centers, when compared to more accessible areas. Also, farmers build networks of communication and use them later to get information about eventual government investments in the region.

The life histories of different farmers indicated that diversification of livelihood strategies occurs as an adaptation to the uncertain and dynamic conditions of settlement areas. Farmers diversify their economic base to take advantage of the widening range of economic opportunities that are common in developing frontiers, but they also suffer from the downfall associated with the ups and downs of market, credit, and political opportunities. They cope with uncertainty by exploring a range of natural resources available at the farm-lot level, including plants and game from the forest, fish from rivers and raised in ponds, and a wide range of crops and animal husbandry that are used both for household consumption and commercialization. Diverse farming systems adopted by smallholders' communities worldwide also play a key role in protecting agro-biodiversity (Brookfield et al 2005, Pinedo-Vasquez et al 2002, Smith et al 1996). Farmers also are engaged in wage labor and a range of urban and rural commercial

activities. Additionally, surpluses are frequently exchanged among households, supporting a parallel economy based on reciprocity and strengthening of social networks and cooperation.

However, diversification of land-use activities requires inputs of labor, which might be less available to smaller households or farmers with restricted capital. In some cases, households with a diversified set of economic options contradict the diversification trend and reduce their range of exploration of livelihood options, occurring for instance in cases where part of the household labor force, typically second generation members (e.g., sons, daughters, and in-laws), out-migrates to urban centers or other fronts. This situation requires the first generation settlers (e.g., their parents) to re-adapt to new conditions, especially when capital availability is restricted, and limits hiring of wage labor. A reduced labor force limits the range of economic options and level of diversification. Hence, most elderly settlers in this situation choose to focus on cattle-ranching to secure their source of income. For elderly Humaitá residents, retirement pensions often play a key role in providing the basic source of income that sustains their living situation. Remittance money from sons, daughters and in-laws also plays an important role in sustaining elderly settlers.

Life-stories suggest that local rubber tappers have built stronger ties to land and to community life in Porto Acre when compared to colonist farmers (most land investors live in Rio Branco

and experience limited community life in the settlement). Rural producers' associations formed by rubber tappers, or by a considerable proportion of individuals belonging to this social group, seem to be focused on multiple projects and 'survive' for longer periods than ones formed mainly by colonist farmers (who are often focused on bank requirements for credit acquisition). Stronger ties to community life result normally from shared kinship and from shared experiences that have evolved since the time before agricultural settlement. This social environment and the build-up of trust among the oldest P.C. Humaitá residents provide the building blocks of collective action among the ex-rubber tapper community.

Lot turnover is also playing a key role in the development of the agrarian structure of P.C. Humaitá, in this case acting as a barrier that limits the unfolding of community life and the development of the social learning (Ludewigs et al 2009). With the out-migration of settlement members from Humaitá and their replacement by incoming families, trust relationships are seriously affected, often disappearing with each out-migration and having to be slowly re-built, thereby affecting collective action and all entrepreneurial activities that depends on it, such as community development projects and infrastructure maintenance, agricultural product processing plants and transformation industries, and other agricultural projects proposed by rural producers' associations (RPAs). Other factors affect-

ing the build-up of trust within RPAs include the conflict between individual and common interests of members of RPAs (see also Castellanet and Jordan 2002, Muchagata 2002, Campos 2006). For instance, many cases of members using the RPA arena for personal political interests were reported during fieldwork. Other problems include 'free riding' where members are willing to use RPA resources without giving anything in return to the association.

In this article, we considered the role of social learning processes as part of our analytical approach for land-use decision-making and diversification of households' portfolio. This concept has proven useful to understand settlement developments observed during fieldwork. New approaches based on more holistic perspectives, focusing on social networks and on social learning processes rather than on analysis centered on individuals trying to cope alone with a wide range of uncertainties, might be more helpful to understand the changes that take place as societies and institutions evolve (Pahl-Wostl 2002). Although representing a concept still 'under construction', it might gain strength in the study of agricultural frontiers, as it has been the case in the fields of adaptive management and integrated assessments, to which frontier dynamics might also be related. Also, as pointed by Chibnik (1994), land-use choices in frontiers often involve multiple goals; integrated studies are thus important for addressing the farmers' rationale under such settings. The assessment and life-stories presented in this article point to di-

versification of livelihood options as a dominant strategy of adaptation to the dynamic conditions of settlement areas. Social interactions with neighbors and social learning processes play an important role on increasing farmers' chances of making a living and taking advantage of the changing opportunities available in colonization areas. Diversification represents a strategy to take advantage of some opportunities while overcoming the lack of others, such as the lack of infrastructure and support during different stages of development of a settlement. These stories also illustrate that families vary in their ability to diversity and to withstand difficulties. As such, Turner's thesis on frontier expansion (1920) - 'it's all about opportunities' tells only a part of the story experienced by families who settle in colonization areas such as the Amazon.

#### ACKNOWLEDGEMENTS

The authors want to thank the Anthropological Center for Training and Research on Global Environmental Change (ACT), the Center for the Study of Institutions, Population, and Environmental Change (CIPEC), the School of Public and Environmental Affairs, the Department of Anthropology at Indiana University, and the Universidade Federal do Acre (UFAC). Fieldwork was made possible thanks to grants from the World Wildlife Fund (WWF) Prince Bernhard scholarship for Nature Conservation, from the Tinker Field Research Grant granted by the Center for Latin American and Caribbean Studies – Indiana Univer-

sity (CLACS/IU) and from CIPEC – Indiana University. We want also to thank the support from U.S. National Aeronautics and Space Administration NASA LBA-ECO Program (grants NCC5-334, NCC-695, NNG06G-D86A). We also thank the Conselho Nacional de Desenvolvimento Científico e Tecnológico (CNPq) for supporting the first author during his doctoral training in the USA. We thank for the constructive comments and suggestion of one anonymous reviewer and the journal editors. Last, but not least, our warm thanks go to the ones who are writing the land reform story in Brazil, and to all those who answered our interview questionnaire.

#### NOTES

<sup>1</sup> For more on frontier expansion along different sections of the Transamazônica Highway see Moran (1981), Moran et al (2002), Araujo (1993), Muchagata (1997, 2002), Brondizio et al (2002), Castellanet and Jordan (2002), McCracken et al (2002), Walker et al (2002), Campos (2006), Campos and Nepstad (2006), and Aldrich et al (2006), Smith, N. (1982). Rainforest corridors: The transamazon colonization scheme. Berkeley: University of California Press. Fearnside, P.M., (1986). Human Carrying Capacity of the Brazilian Rainforest. New York: Columbia University Press.

<sup>2</sup> Other components of this study include examining changes in the agrarian structure that followed settlement aging, more specifically the relationship among land-use, land-cover change, lot turnover and transportation networks, as well as the strategies adopted by settling families to



cope with those changes (Ludewigs et al 2009; Ludewigs, 2006).

<sup>3</sup>For most families of this group, rubber-tapping is not considered an economic option anymore; nevertheless, we refer them as ‘rubber-tappers’ throughout this paper.

<sup>4</sup>Detailed description of each social group (local rubber tappers, colonist farmers and land investors) can be found in Ludewigs (2006).

<sup>5</sup>Anthropological Center for Training and Research on Global Environmental Change (ACT), Indiana University.

<sup>6</sup>Including job offers that are put available by public agencies.

<sup>7</sup>For more information about the Proambiente program, see <http://www.mma.gov.br/sitio/index.php?ido=conteudo.monta&idEstrutura=33>

<sup>8</sup>Most settlers arrived in P.C. Humaitá from 1981 to 1985, though this analysis considers also the ones arriving later. In the case of rubber-tappers, Table 1 relates to the livelihood choices in 1981, the time P.C. Humaitá begun.

<sup>9</sup>Defined as the deliberate association of trees with crops and/or husbandry for economic purposes.

<sup>10</sup>Very few 1<sup>st</sup> owner farmers (farmers originally settled by INCRA and rubber-tappers) had enough pasture at the time they arrived to consider beef as their first option by that time. Therefore, this figure represents mostly 2<sup>nd</sup> owner colonist farmers and land investors buying land already formed with pastures.

<sup>11</sup>The ‘missing’ values in this case (11.1%) represent second generation residents that moved to Porto Acre when they were still children.

<sup>12</sup>Includes only the economic options considered

important by farmers. Farmers were allowed to include as many economic activities in their ranking as they considered important. For example, economic options ranked as 4<sup>th</sup> and 5<sup>th</sup> by farmers when they arrived at the settlement and when the research was conducted are not included in Table 1, but are mentioned here given their importance on showing differences in the range of economic choices for both time periods.

<sup>13</sup>All names presented are pseudonyms. ‘Seu’ is usually a respectful form of addressing someone (men) in Portuguese, as ‘Dona’ is used for women.

<sup>14</sup>He paid 80 cruzeiros for this colocação to the previous *posseiro* (squatter).

<sup>15</sup>Many *posseiros* at the time feared losing their land through disputes with *seringalistas*, who often sold land to cattle-ranchers, who in turn often found themselves in the right to expel rubber-tappers from their *colocações*.

<sup>16</sup>The rubber-tapping activity, as it is normally practiced in Acre, requires at least 300 – 400 hectares of land per household to be economically efficient (Gomes 2001).

<sup>17</sup>This new settlement carries the same name as the municipality of Porto Acre. It is a small settlement with some 40 lots averaging around 30 hectares. It used to be a private property, which was found abandoned (the owner supposedly left Acre) by local residents, who organized then an invasão (squatting), by establishing small agricultural plots in it. Later, use rights were requested and granted by INCRA.

<sup>18</sup>For a discussion of agricultural credit in Porto Acre see Ludewigs, 2006.

<sup>19</sup>Alcobrás was an ethanol production project established by a private group in the early 1980s with substantial government subsidies. The project was composed by sugar

cane plantations, an ethanol production plant and an agriculture production unit, designed to supply the project with food.

<sup>20</sup> A fourth daughter has a disability and has been unable to help in agricultural activities.

<sup>21</sup> Only the disabled daughter remains with them.

<sup>22</sup> CrN\$ 100,000 are equivalent to US\$ 2,420 of 1987.

<sup>23</sup> Soybean farmers increase often the amount of money offered to small farmers whose lots are 'in between' potential soybean production areas, when their first bid is not accepted by small farmers.

<sup>24</sup> For example, one neighbor offered R\$ 35,000 for one of his lots in 2003 and another one R\$ 70,000 in 2004. These prices are consistent with land prices observed in other highly valued areas of Porto Acre settlement, such as along paved roads.

<sup>25</sup> 298 oxen (1 ox = 1 cattle head), 320 cows (1 cow = 0.75 cattle heads), and 300 calves (1 calf = 0.5 cattle head).

<sup>26</sup> By overlaying a property grid to each classified image, it was possible to estimate the areas of each land cover class for each property. More details on the remote sensing component of this study may be found in Ludewigs (2006). The years 1975 and 1992 were excluded from this analysis (evolution in the number of ponds) because of spectral separability problems between water and cloud shadow classes.

<sup>27</sup> This does not imply that the federal or the state government were effective on curbing down deforestation rates by that time in the Amazon and in Acre, respectively. By the contrary, increasing rates of deforestation until the 2003-2004 measurement are shown elsewhere (Ludewigs,

2006). After this measurement, rates begun to drop again.

<sup>28</sup> It has been argued, however, that political influence played by corporate ranchers might have allowed them to escape fines in several instances.

<sup>29</sup> Tocantins was established in 1996, neighboring the northern border of P.C. Humaitá. Many second generation residents of Porto Acre were either direct beneficiaries in Tocantins (originally settled by Incra), have been buying land there, or have been working on selective timber exploration in Tocantins.

<sup>30</sup> Certification of their "Produto Orgânico do Acre" ("Organic product of Acre") stamp is underway.

<sup>31</sup> For more on this, see Valentim (2006) and Vosti (2001).

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