THE EFFECTS OF WEALTH AND MARKETS ON RUBBER TAPPER USE AND KNOWLEDGE OF FOREST RESOURCES IN ACRE, BRAZIL

By

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A DISSERTATION PRESENTED TO THE GRADUATE SCHOOL OF THE UNIVERSITY OF FLORIDA IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE DEGREE OF DOCTOR OF PHILOSOPHY

UNIVERSITY OF FLORIDA

2004
For my family
ACKNOWLEDGMENTS

I have completed this journey with the guidance, support, and encouragement of many people. At the University of Florida, my dissertation committee members have been by my side every step along the way. I do not think it would be possible to find five faculty members more giving of their time and guidance. Dr. Karen Kainer in the School of Forest Resources and Conservation, a mentor and a friend, has always been a source for new ways of thinking about the role of forest products in rural livelihoods in Acre. Dr. Ronald Ward of the School of Food and Resource Economics worked with me patiently as I developed the economic models for the statistical analysis. The amount of learning that took place during those meetings was tremendous. Dr. Clyde Kiker, also of the School of Food and Resource Economics, helped me to step back and think about what I really wanted to say. Over the past two years, I knew a trip to Dr. Kiker’s office would leave me with a better understanding of what I was trying to achieve. Dr. Russ Bernard of the Department of Anthropology has had a great effect on my development in graduate school and my dissertation research. He has challenged me to think critically about my research questions and methods, and has shown me how exciting the field of anthropology can be. Finally, my chair, Dr. Marianne Schmink, has been a wonderful mentor and guide. She has taught me how much one can achieve by pursuing small ideas and accepting challenges. As she told me once, “It doesn’t hurt to dream.” Indeed, it does not. I thank her for her encouragement, patience, and support.
I also would like to thank the many people and organizations in Acre, Brazil, that helped me in the implementation of my fieldwork. I would like to thank the Research and Extension in Agroforestry Systems Group (PESACRE) for providing institutional and logistical support during the study period. I also want to thank the State Secretary for Forests and Extraction (SEFE), and in particular Arthur Leite, Andrea Alexandre, Mário Jorge da Silva Fadell and Alexandre Souza and Nuria Merched, who provided valuable insight into the changing extractive sector in Acre. At the Federal University of Acre, Francisco Kennedy de Souza was very helpful in developing my research instrument. The National Center for the Sustainable Development of Traditional Populations (CNPT)/Acre provided authorization to work in the Chico Mendes Reserve and I thank them for their continued support over the years. In Xapuri, I would like to thank the Association of Inhabitants of the Chico Mendes Reserve in Xapuri (AMOREX), which supported my research in the three communities in the Chico Mendes Extractive Reserve, and the Rural Worker’s Union (STR), which assisted in arranging transport animals for my fieldwork.

A number of individuals also assisted my research in diverse ways. Maria Lúcia Rodrigues, a geography student at UFAC, worked as my research assistant during the first round of fieldwork 2001. I would also like to thank Dione and Durival who assisted in fieldwork in 2002. Warm and special thanks go to the families in the communities of Rio Branco, Terra Alta, and São João de Guarani in the Chico Mendes Extractive Reserve. I thank them for opening their homes and sharing their lives with me. Very special thanks to João Pereira da Silva, who befriended me on my first visit to Xapuri in 1995. Since then, he has contributed to my research in so many ways, from assisting
with logistics of forest travel, serving as a guide, and helping with data collection. His friendship, and that of his family, I am privileged to have.

Many colleagues also contributed ideas and support along the way. They include: Samantha Stone, with whom I passed many hours discussing our research projects while sharing a house in Acre; Douglas Daly at the New York Botanical Garden and Evandro Ferreira of the National Institute for Amazon Research (INPA) who provided assistance in the botanical identification of free-list items, and Ricardo Godoy, Beth Byron and Mike Gavin, all of whom helped me better understand data collection and valuation methods. I would also like to give special thanks to Ana Cristina Puentes for her friendship and encouragement as I neared my destination. Finally, a warm and heartfelt thank you to my family for encouraging me to pursue my dreams, and giving me the confidence to realize them. This degree is as much theirs as it is mine.

Funding for this dissertation came from various sources and they deserve recognition. Pre-dissertation research was funded by a Tropical Conservation and Development Program field grant and the Charles Wagley Fellowship, both of the Center for Latin American Studies at the University of Florida, and the Dickinson Award of the School of Forest Resources and Conservation, also at the University of Florida. Fieldwork was funded by a National Science Foundation Doctoral Dissertation Improvement Award and a grant from the Conservation and Research Foundation.
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Abstract of Dissertation Presented to the Graduate School of the University of Florida in Partial Fulfillment of the Requirements for the Degree of Doctor of Philosophy

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By

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December 2004

Chair: Marianne Schmink
Major Department: Anthropology

This dissertation examines the changing livelihoods of rubber tappers in the Chico Mendes Extractive Reserve in the Western Brazilian Amazon. Employing both theory and methods from the fields of microeconomics and cognitive anthropology, this study explores how growing household wealth and integration into markets are transforming extractive activities in the reserve, and how these factors may be reshaping cultural knowledge of forest resources. It then considers the implications of these findings for conservation and development in the reserve, and for the extractive reserve concept.

Multivariate regression analysis found that wealth had a strong positive effect on household income and a weak negative effect on percent of income from extraction. Households of varying wealth earn similar incomes from forest extraction, arguing that families still extract forest resources even as they accumulate and diversify wealth holdings. Yet, wealth was positively correlated to cattle wealth and pasture area, indicating that wealthier households invest greater wealth in production activities that
involve cutting the forest. Integration into off-farm labor markets and product markets had moderately negative effects on both income from extraction and percent of income from extraction. Households earning the greatest share of income off-farm, those carrying out skilled wage and salaried labor, showed the most dramatic decline in the percent of income from extraction. There was no evidence that earnings were being invested in environmentally destructive land use, suggesting that the highest levels of integration into labor markets may have environmental benefits.

Cognitive tests revealed that rubber tappers maintain a high degree of shared knowledge on the domain of non-timber forest resources. This was true of study participants sub-divided by sex and age, and dividing sub-groups of individuals by level of wealth and market integration. However, moderately strong positive associations were found between integration into product markets and level of cultural knowledge for youth, and integration into off-farm labor markets and knowledge of young adults. Subtle trends in knowledge variation for rubber tapper youth suggest that youth from households at lower levels of market integration may be more likely to enter development projects promoting extraction.
CHAPTER 1
INTRODUCTION

This dissertation is about the changing lives of people living in the Amazon rainforest in Acre, Brazil. At its heart, it is about the changing economy of the seringueiros, rubber tapper families, living in the Chico Mendes Extractive Reserve. It explores the changing economy in the reserve, and examines economic factors that may be reshaping how rubber tappers use, and how they think about, the forest. It focuses in particular on the changing role of extractivism in the rubber tapper household economy.

This study really began during my previous research with rubber tapper families in the Chico Mendes Extractive Reserve in 1996 and 1997. Extractive reserves, originally conceived by rubber tappers, were designed to meet both the social and economic needs of rubber tapper households, providing families long-term use rights to the forest resources on which their livelihoods depended (Allegretti 1990). The Chico Mendes Reserve had only recently been established in 1990, the result of a violent struggle for land rights and social justice pitting rubber tappers against ranchers that culminated in the death of Francisco “Chico” Mendes, a rubber tapper and union leader for which the reserve is named (Schmink 1992). At that time I was conducting a study on the market system for traditional extractive products, rubber and Brazil nuts, examining how this system functioned, and the implications of trade patterns for diversifying production, particularly for extractive products. My study was a response to the growing concern over deforestation in the Amazon, and a search for sustainable development strategies. One alternative attracting increased attention was the potential for non-timber forest products,
such as fruits and nuts, and artisan crafts, to raise forest household incomes in ways fitting with traditional livelihoods without cutting the forest.

One of the things I learned during that period was how important extractivism was, both economically, and culturally, to forest households. At one of the first community meetings I attended to present my research project and ask households in the community if I might implement my study there, before it began, a women stood up in the stifling heat of the day and rallied everyone to sing the *Hino de Seringueiro*, the Rubber Tappers’ Anthem. In a short time, everyone was clapping and singing, and smiles were breaking out as they sang . . . *vamos dar valor ao seringueiro*, let’s give value to the rubber tapper. At that point, I began to learn that extractivism seemed to be as much about who you are, as what is being extracted.

Yet, as I hiked through the *seringal*, or rubber forests, visiting different *colocações*, or rubber tapper landholdings, I also saw how different households were financially and economically, even as they held common cultural ties that 100 years of history had woven. Yes, households came together for community workdays, Sunday church services, *fútbol*, or soccer matches, and during community meetings they debated the benefits of ongoing projects and priorities for the future, but when they went back to their landholdings, they resumed, to varying degrees, different economic lives. Some families no longer tapped rubber, some households had family members with salaried positions or who worked as carpenters, and a few households had a number of head of cattle. Some households maintained traditional home structures of palm slats and thatch, while other homes were made of sawn timber planks and wooden shingles. A few had small motors for making *farinha*, or manioc flour, while others used woven sifting baskets. One
household had a solar panel and battery to generate electricity to illuminate the house at night. Households were diversifying on-farm production, working off-farm, and investing in their landholdings in different ways.

Looking back, I had a very simplistic understanding of life in the Chico Mendes Reserve when I first ventured there. But then, at the time, the focus of academics, researchers, and policy makers writing about the reserve was on the success that rubber tappers had achieved through the establishment of the Chico Mendes Extractive Reserve, and subsequently debating its merits as a conservation and development strategy, rather than understanding the changes that were emerging in the forest and the implications of these changes for conservation and development.

This dissertation adds a small piece to our understanding of the changing lives and livelihoods of rubber tappers in the Chico Mendes Extractive Reserve. Drawing from the fields of microeconomics and cognitive anthropology, I respond to two related sets of questions to examine how a changing economy is transforming rubber tapper households. First, what are the effects of increasing household wealth and integration into markets on rubber tapper household income, and, more specifically, income from extractive resources? And second, what are the effects of increasing wealth and integration into markets on rubber tapper cultural knowledge of extractive resources?

In the following chapters, I argue that economic forces, in the form of growing wealth, and integration into markets, are bringing changes to rubber tapper production activities as well as cultural knowledge of forest resources. Not surprisingly, increasing household wealth positively affects rubber tapper household productive income, but wealthier households also hold more cattle and have converted more land to pasture. The
effects of wealth on extractive activities are less clear. Across wealth categories, households still rely heavily on extraction; however, rising wealth leads to a lower percent of household productive income earned from extraction. Concomitantly, increasing integration into both labor and product markets negatively affects household productive income from extraction, and increasing integration into labor markets leads to a fall in the percent of productive income earned from extraction.

The effects of increasing wealth and integration into markets on rubber tapper cultural knowledge of extractive resources are less clear but they suggest that youth hold different ideas compared to older generations. Employing cognitive anthropological methods, rubber tappers across generations and sex showed a very high degree of similarity in their cultural understanding of extractive resources. This similarity carried through when categorizing individuals by different levels of household wealth and market integration. However, a closer examination of the data reveals that as households integrate into markets, and have better market access, they are thinking differently about the two extractive items traditionally associated with rubber tapper income—rubber and Brazil nuts. It is a subtle change, but one with implications. For rubber tapper youth, in particular, this suggests that future household heads hold different ideas about the role of these items in household production. Together, these findings argue that market forces are bringing change to rubber tapper livelihoods in the Chico Mendes Reserve, with implications for both conservation and development in the reserve.

In this chapter, I introduce the reader to the theoretical views that inform the research questions and the historical-cultural context in which this research was undertaken. This demands an understanding of the emergence of the extraction of non-
timber forest products as a conservation and development strategy for tropical forest lands, and the theoretical debate and empirical research which guide the study research questions. Into this discussion, I insert the rubber tappers, providing the historical-cultural context in which the research took place to give the reader an understanding of who rubber tappers are and why extractivism has played such a critical role in their livelihoods. In the following chapter, which presents the research site, design and methods, I discuss the current policy environment of the Acre State “forest government” which has committed itself to a guiding vision of sustainable development for the state, a vision that actively promotes the sustainable exploitation of non-timber forest resources.

**The Emergence of Extractivism as a Sustainable Development Strategy**

The sheer scale as well as accelerating pace of deforestation in the Brazilian Amazon during the 1970s and 1980s brought international attention to the loss of tropical forestlands taking place in developing countries. In 1975, only 0.6% of the Brazilian Amazon had been deforested. By 1988 approximately 12.0% of the rainforest was gone, a twenty-fold increase in just 13 years (Mahar 1989). Although an alarming claim that the burning of the Amazon rainforest was destroying the “lungs of the world” (Moran 1996: 157) was “scientifically invalid” (Wood 2002: 2), the quickening rate of deforestation led policy makers, scientists and development practitioners to rethink large-scale development projects in the tropics, in particular colonization schemes and livestock development, and search for so-called sustainable development strategies for the Amazon region. These strategies would be ecologically benign, economically sound (i.e., profitable to inhabitants) and meet the social reproductive needs of traditional peoples.
The extraction of non-timber forest resources was one development alternative that appeared to meet the strict criteria of sustainable development (Allegretti 1990, Schwartzman 1989). The harvest and sale of forest fruits, fibers, nuts and oils, among other forest resources seemed well suited to the objectives of the sustainable development paradigm. Traditional peoples would collect forest resources, with which they were familiar and probably already used, and sell them, in their natural form or as processed derivative products. The forest would remain standing, diversity intact, and forest populations would earn higher incomes through a livelihood conforming to their social needs. Buoying early enthusiasm for this strategy was a study conducted in rainforest near Iquitos, Peru, which estimated the annual net market value of non-timber tree resources (fruits and latex only) of one hectare of land at $422, and the net present value of these resources at $6,330, over twice the present value of cattle production (Peters, Gentry and Mendelsohn 1989). The authors argued that, “Without question, the sustainable exploitation of non-wood forest resources represents the most immediate and profitable method for integrating the use and conservation of Amazonian forests” (Peters, Gentry and Mendelsohn 1989: 656).

Although this study has been widely criticized for unrealistic assumptions, it stimulated considerable debate regarding how forests might be both used and conserved.¹ The numerous, diverse and increasingly specialized studies that have emerged on this topic over the past 15 years indicate that Peters and his colleagues had raised an important

¹ A number of scholars have criticized the Peters, Gentry and Mendelsohn (1989) article for various reasons. Nugent (1991) argues that they make a number of unrealistic and simplifying assumptions about the stability of various economic factors, such as claiming rates of inflation are evenly distributed over markets and all products will be fully exploited. Godoy, Lubowski and Markandya (1993) argue that if value was based on product flow, (i.e., actual quantities taken from the forest) rather than the entire inventory, the value would be 4.0% of their calculated value and equal the timber estimate for the same area. See also Crook and Clapp (1998).

In addition, a growing number of case studies and overviews on non-timber forest resource extraction (Freese 1998, Neumann and Hirsch 2000, Shanley et al. 2003, Wollenberg and Ingles 1998) have helped synthesize this debate and led to more critical thinking about the role of research methods, resource valuation techniques, the role of markets, and “green” certification, among other issues, that are at the core of linking non-timber forest product extraction to conservation and development. Concurrently, warnings have been sounded regarding the damaging effects that entering markets may have on indigenous cultures (Gray 1990), and the potential for this development alternative to undermine indigenous peoples’ quest for self-determination and land rights (Corry 1993).

As studies have emerged, and this debate has matured, more recently, scholars have called for studies with a “situation-specific focus” that recognize the different local values, uses and conservation of resources by diverse local populations (Arnold and Perez 2001: 445), and an examination of the multivariate factors that may influence extractive resource use (Barham, Coomes and Takasaki 1999, Barham and Coomes 1996,
Shackleton 2001). It is within this site-specific context that I engage this debate, examining how economic forces are shaping use and knowledge of extractive resources among rubber tapper households in the Chico Mendes Extractive Reserve. Thus, this dissertation begins with a journey back over 150 years into the Amazon region, as it is in the forest, on the *estradas de seringa*, or rubber trails, that the history of the rubber tappers is told, where *mãe seringa*, the mother of the rubber tree, watches over her children, the *seringeira*, or rubber trees, and where the rubber tapper has plied his trade for over a century.

**Rubber Extraction in Acre: The History and Culture of the Seringeiro**

With the perfection of the vulcanization process for rubber by Charles Goodyear in 1839, worldwide demand for products fashioned of this new weather resistant rubber grew immensely. Demand for natural rubber, driven first by the bicycle craze of the late 1800s, then the invention of the automobile in the early 1900s, focused attention on the vast natural rubber stands of the Amazon region (Weinstein 1983).

During the rubber boom, which lasted from the late 1870s to approximately 1912, the Brazilian Amazon region became the world’s supplier of rubber with production growing from approximately 7.9 metric tons in 1871 to 34.3 metric tons in 1910 (Barham and Coomes 1996). What is now the state of Acre was not the initial source for rubber, although it soon came to be. In the early years of rubber extraction, rubber tree forests in the Eastern Amazon supplied the world market, but by the 1870s, capital and labor turned westward to the abundant, largely unexploited, and river-accessible natural rubber stands of the upper Amazon (Rancy 1992). This region, including the state of Acre and the southern region of the state of Amazonas, was home to the rubber tree *Hevea Brasiliensis*, which produced the latex of choice of the international market (Barham and
Coomes 1996). In addition, the *Hevea* tree, unlike *caucho*, another type of rubber extracted from the costilloa tree (*C. elastica* and *C. ulei*) that required felling to extract latex, could be tapped on alternate days (allowing the tree to rest one day) through the tapping season, for years, with each carefully placed incision producing a small amount of latex. (Bakx 1996: 59-60, Barham and Coomes 1996: 37).

Labor to work the rubber fields of Acre came largely from the northeast of Brazil, although *caboclos*, or mixed race forest dwellers and indigenous peoples living along the Amazon’s tributaries participated in rubber extraction, both voluntary and coerced, to varying degrees (Barham and Coomers 1996, Weinstein 1983). Severe droughts in the Northeast of Brazil in 1877 and 1879 and fabled riches of “ouro preto,” or black gold, provided a supply of poor farmers to the region and helped resolve the severe labor shortage in the Upper Amazon at the onset of the rubber boom period. Estimates vary regarding the number of migrants to the Western Amazon, ranging from approximately 160,000 to 260,000 over the period 1872 to1900 (Santos 1980).

Upon arrival in the *seringal*, the *seringalista*, or rubber baron, that virtually owned the forests, generally assigned the rubber tapper to two or three rubber trails on which he would carry out his trade. Each rubber trail covered considerable land area, approximately 100 hectares per trail, as rubber trees, although widely distributed in the upper Amazon region, have a very low density (Bakx 1986, Barham and Coomes 1996).

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2 See Collier (1968), Furneaux (1969) and more recently Stanfield (1998) for detailed accounts of the brutal enslavement of Amerindians by rubber barons in the Putumayo region of Northern Peru. Their detailed portrayals of the atrocities leveled on indigenous peoples, including enslavement, brutal beatings and murder represent the darkest side of the rubber boom.

3 Weinstein (1980) states that in the pre-boom period, some rubber tappers were able to establish claims to land and a few hundred trees and thus avoid having to pay the rubber baron rent. In these cases, trade was often carried out with itinerant traders rather than a rubber baron.
New arrivals were provided tools—a small hand-axe to cut the rubber trees, small tin cups to collect latex from each tree, and a larger bucket in which to pour latex from the cups—on credit.

A number of scholars (Bakx 1986, Barham and Coomes 1996, Dean 1987 and Weinstein 1983) have similarly described the rubber tapper workday during the rubber boom period. Tapping rubber consisted of rising early, often in the dark, and setting out on a rubber trail that wound past rubber trees in the area, making a small cut on each tree, and placing a small tin cup at the base of the slanted cut to catch the white milky latex as it dripped from the slash. Upon completing the looped trail, the rubber tapper would return to his hut for lunch. Later that day, the rubber tapper would follow the same trail tapped in the morning to collect the still liquid latex from the tin cups. Trees were tapped only during the dry season, lasting eight months of the year from approximately March to October, as water would collect in the cup during the rainy season, contaminating the extracted latex (Bakx 1986, Barham and Coomes 1996).

The late afternoon was spent smoking the collected latex over a smoky fire, fueled by oily palm nuts, in a nearby hut called a “defumador.” Latex was dripped onto a slowly turning long wooden pole where it would coagulate into a ball of black hard rubber. Rubber tappers would labor approximately 15 hours per day, six days per week in tapping, collecting and smoking activities (Bakx 1986: 60-64. See also Bakx 1988a: 146). At week’s end, the tapper would take his ball of rubber to the rubber baron’s central trading post to trade for food and provisions, where he might also socialize with other tappers (Burkhalter and Murphy 1989, Weinstein 1983: 16).

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See especially Bakx (1986: 56-64) for a detailed description of the process of rubber extraction and processing, including different methods employed for cutting the tree.
Exchange relations between rubber tapper and rubber baron were governed by the *aviamento* or debt-merchandise system (Barham and Coomes 1996, Weinstein 1983). As rubber tappers had already run up significant debt with the rubber baron upon arrival in the forest, including the cost of passage, and tools and supplies, rubber tappers were obligated to sell their rubber to the rubber barons (Bakx 1986). Prices were low and rubber tappers were easily cheated regarding the weight of their product and the credit they received (Weinstein 1983, Wolf and Wolf 1936). Payment was almost never made in cash with rubber tappers obliged to purchase high priced supplies with rubber earnings (Bakx 1986). Thus, Bakx (1986: 75-76) argued that rubber baron control of rubber tappers went beyond the exchange relationship, as armed guards were employed to ensure that rubber tappers did not plant food crops and tapped trees regularly. Maybe the most fitting account of this system comes from Euclides da Cunha (Cunha and Tocantins 1905: 59, my translation) who described the rubber tapper’s situation as one where “the man works to enslave himself.”

The rubber “boom” turned to “bust” with the domestication of rubber in Malaysia and elsewhere in the early 1900s. Yet, despite low world prices, many rubber tappers remained in the forest, now diversifying their production to include food crops, hunting and fishing. Many turned to raising families in the forest, marrying locally or sending for their families in the east (Campbell 1996). The region underwent a second “boom” when the Japanese took control of Asian rubber plantations and the Allied powers turned to the natural rubber stands of the Amazon to secure a supply of rubber during World War II

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5 Barham and Coomes (1996) provide a compelling interpretation of the debt-merchandise system, arguing that the high risk and transactions costs inherent in rubber baron-rubber tapper exchange help explain this relationship.
A second wave of immigrants, again from the Northeast, who became known as the “soldados da borracha,” or rubber soldiers, arrived in Acre during the war. However, with the end of the war, this brief boom surrendered to a global market that once again demanded cheap latex. Despite the collapse in world rubber prices during the 1960s and 1970s, many rubber tappers and their families remained in the forest and continued extracting rubber, with the price of rubber often supported by government subsidies (Dean 1987). As the rubber barons abandoned their estates, the “autonomous” rubber tapper emerged, now with greater freedom to diversify household production, including the collection and sale of Brazil nuts (Allegretti 1990). However, the aviamento system, in many respects, remained largely in place, with itinerant traders and urban merchants assuming the role of the patrão.

With the establishment of the Xapuri Agro-Extractive Cooperative (CAEX) in 1989 in the city of Xapuri, a small town in southeastern Acre that sits approximately 15-20 miles from the border of the Chico Mendes Reserve, rubber tappers essentially ended the unequal exchange that had dominated rubber trade in the region for more than a century. And even as financial problems have plagued the cooperative’s existence, at times even unable to purchase rubber production due to working capital problems, it has forced itinerant traders and merchants that still buy rubber and Brazil nuts to raise the prices they pay for these goods, and lower the price of basic supplies they provide in exchange (Campbell 1996).

But even as trade partners have changed and production has diversified, my own experience, as well as others’, suggests that rubber tappers still retain the accumulated knowledge of more than 100 years in the forest. These are found in the folk beliefs and
myths, hunting techniques, and preparation of medicinal remedies, many adapted from *caboclo* and indigenous populations (Esteves 1999, Galvão 1952, Smith 1996, Weigand 1996). Esteves (1999) argued that as new rubber tappers, or “brabos,” arrived in the forest, the “mansos,” rubber tappers who had lived in the forest for long periods, would “socialize them in the rituals of hunting and fishing, in taking care in the wild, in the ‘remedies’ that cure sickness” (my translation, Esteves 1999: 49). The *brabo* was “amansado,” his social identity reconstructed through new forms of social reproduction, the accumulation of cultural knowledge, and a new dependence on *mae de seringueira*, the rubber tree, “the woman who gives life,” as well as other rubber tappers for survival (Esteves 1999: 41). The “physical space of the forest, domesticated and incorporated as part of the identity of being a rubber tapper” (my translation, Esteves n.d.: 5). In this sense, one might argue that the experience of the rubber tappers has led to the creation of “identity symbols” that have produced “intense collective consciousness and a high degree of internal solidarity,” contributing to “self-definition and an image of themselves as they have performed in the course of their history” and thus suggesting a “persistent cultural system” (Spicer 1971: 798-799).

Even today, rubber tappers in the reserve use forest plants to make the medicinal remedies passed from generation to generation, and recount the myths that have humanized the forest and guide their use of natural resources. Weigand (1996) detailed how rubber tappers have claimed to have seen or heard *caboclinho*, described as a young boy with his feet turned backward riding a deer (although also appearing in other forms), who will punish hunters if they take more from the forest than they need. Indeed, I have overheard rubber tappers discussing *panemas*, a hex that prevents them from catching
game or fish (Wagley 1953). One rubber tapper was said to have not killed a deer after he referred to a deer as a “burro,” or mule. Another rubber tapper asked my research assistant, as we were parting for another landholding, not to place the leg of deer meat that he was sending with us to a neighbor’s house on top of the mule, or it would give him a panema.

Thus the rubber tappers have shared a history and culture intimately tied to the forest. The extraction of forest resources, both for consumption and the market, which has dominated their lives for decades, was governed by the accumulation of knowledge, and myths and beliefs, which have been passed down over generations. But what are the driving forces that now guide socioeconomic practices in the reserve? And how might these forces be reshaping rubber tapper knowledge of extractive resources?

Recent studies suggest that profound changes are taking place in the reserve, and that the intimate tie between rubber tappers and resources is being transformed. Campbell (1996: 115-116) found that many households in the reserve now view rubber tapping as “a necessary evil,” a “physically exhausting” activity that has “lost its social and economic importance.” She argues that there is a “changing cultural identity within the seringal” and “changing livelihood strategies [are] changing the reality and the image of who is a seringueiro.”

Esteves (n.d.: 16-17), researching three generations of five rubber tapper families in the Chico Mendes Reserve, also finds that social changes are recasting the social identity of the rubber tapper. She argued that the introduction of agroforestry systems, producing fruits and nuts destined for the market rather than domestic use, is creating new types of workers in the forest. As a result, spaces within the forest are now being recreated by the
younger generation. Despite new technologies for rubber tapping to increase quality and value, youth are not tapping rubber but searching for other economic alternatives. Esteves (n.d.) contends that these changes in land use are altering social relations of production as well as family social relations and bringing new generational conflicts to households. Fathers and grandfathers now feel threatened by their children and grandchildren, as they no longer dominate the reproductive activities on the landholdings. She argues that inheritance is no longer the transmission of “symbolic assets, social memory and identity, beliefs . . . knowledge” (Esteves n.d.: 6). Inheritance is now found in the landholding, reconstituted as an asset valued by new forms of market integration. This suggests that rubber tappers are “reconstituting their unique identities and territories” in diverse ways (Schmink 2003: 236).

Both Campbell (1996) and Esteves (1999, n.d.) argue that substantial changes are now taking place in the forest, both economically and culturally. Their studies call for a deeper examination of factors that may be remaking social life in the forest. This dissertation responds to this demand by examining how economic factors may be transforming rubber tapper household income earning activities, and the cultural knowledge of the resources on which they have depended for generations.

**Wealth, Markets and Extraction: Discussion and Hypotheses**

Anthropologists have played an important role in understanding the rural household economy and, in particular, the role of wealth and market activities in household livelihood activities. Earlier scholarly works (Foster 1967, Wolf 1966) noted how social obligations could maintain equality among peasant households, while other studies (Bartlett 1982, Netting 1993) have found that differences in wealth endowments, such as land, can lead to diverse livelihood strategies. Enriching this discussion were Marxist
studies that examined how access to productive wealth and power gives rise to inequalities (Plattner 1989).

Complementing the work of anthropologists, microeconomic studies have also played an important role in understanding peasant household economic behavior. Recently, studies have suggested that wealth is shaping peasant livelihood strategies and income generation. Demmer and Overman (2001: 106) argue that examining the effects of wealth on forest livelihoods is important, as wealth “makes it easier to achieve a better quality of life,” including meeting basic human needs, self-esteem, and freedom from servitude. Coomes (1996: 61) notes that wealth may be a better measure of peasant economic livelihood than income, as wealth reflects both prior income earned as well as future earnings potential.6

Recent studies have shown that wealth can serve as a source for income and consumption smoothing (Deaton 1994, Morduch 1995), while certain types of asset poverty (i.e., limited holdings in natural, human, or physical resources), can subvert diversification efforts by poor households (Reardon and Vosti 1995). In Tanzania, Dercon (1998) found that wealthier households were able to invest in high return activities, such as cattle rearing, increasing the income disparity between rich and poor households.

In their study in the Peruvian Amazon, Barham, Coomes and Takasaki. (1999; see also Takasaki, Barham and Coomes 2000) found that differences in household wealth holdings gave rise to considerable diversity and specialization in economic livelihood.

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6 Coomes (1996: 61) presents three main reasons why wealth may be a better measure of peasant economic livelihood than income: 1) peasants have few assets and their acquisition often is a memorable event; 2) assets are relatively apparent to the interviewer, and, as noted above; 3) wealth reflects both prior income earned as well as future earnings potential.
Demmer and Overman (2001), working with Amerindians in Honduras found that wealthier households consumed more agricultural products and industrial products, and spent less time on forest activities and more time on agricultural activities. However, higher wealth also led to greater cash earnings from diverse sources, including agriculture, the forest, and non-forest/non-agricultural activities. Pattanayak and Sills (2001) suggest that extractive products can be used to smooth consumption across both poor and wealthy households, providing “natural insurance,” and minimizing risks to forest families.

In this study, I argue that rubber tapper households with greater wealth will be able to invest labor in riskier, higher return activities, leading to higher incomes. And despite prior findings (Pattanayak and Sills 2001) that non-timber forest products may smooth consumption for both poor and wealthy households, I argue that households with greater wealth will rely less on the extraction of non-timber forest resources due to the opportunity cost of employing household labor in low return or subsistence activities. Therefore, I hypothesize that:

H1: As household wealth increases, household income will rise.

H2: As household wealth increases, the value of household income and consumption from non-timber forest resource extraction will fall.

H3: As household wealth increases, household consumption and income from non-timber forest resource extraction as a proportion of total income will fall.

Just as studies have demonstrated that household wealth is shaping production decisions in the forest, a growing body of research has argued that markets are also bringing changes to local communities. Indeed, an early anthropological study of extractive populations (Murphy and Steward 1956) argued that it was work patterns driven by market linkages that brought culture change to communities, including
transforming social relations and bringing increased dependency on traders for goods. Burkhalter and Murphy (1989: 114) found that cash transactions and paid labor activities among the Mundurucú in Brazil have begun to “supersede traditional arrangement” and “the transition from reciprocity to clientage and then to active reliance on cash bespeaks a change in the quality of social relations, in which one progressively eliminates . . . enduring relationships.”

A number of recent studies have examined the market’s effects on tropical lands and people, responding to Godoy, Wilkie and Franks’ (1997: 876) suggestion that the debate on the effects of markets on forests has focused on “documenting deforestation rather than on presenting models or testable hypotheses about the conditions under which markets may hurt or help conservation.” In a study carried out with four indigenous groups in Honduras and Bolivia, Godoy, Wilkie and Franks (1997) found a positive association between sale of cash crops and deforestation and an opposite association between wage labor and deforestation, though neither of the variables was significant. Pendleton and Howe (2002), employing agricultural prices as a measure of market integration, found that increasing prices led the Tsimane in Bolivia to greater old-growth forest clearance. Concomitantly, studies in the Peruvian Amazon have found that greater market-orientation for crops has led to a slightly higher deforestation rate (Bedoya Garland 1995) and more intensive market-oriented cultivation of crops (Henrich 1997).

The effects of integration into markets on the extraction of non-timber forest products are also now undergoing empirical study. Two recent studies conducted with forest populations in India (Hedge et al. 1996, Hedge and Enters 2000) have argued that integration into labor markets negatively affects income from the collection of non-
timber forest products. In an innovative model, Robinson, Williams and Albers (2002) find that effects of markets on extraction are related to the heterogeneity of the population and spatial patterns of resource collection. They argue, for example, that increasing market access may lead to less pressure on periphery areas as some villagers leave extraction, but may intensify pressure on core, pristine areas.

Maybe most notable among scholars examining the potential for extraction as a conservation and development strategy, is Alfred Homma’s model of extractive resource use by forest households. Homma (1992) argues that the extraction of non-timber forest resources is economically unsustainable over the long-term due to eventual domestication and development of synthetic substitutes, and eventual fall in prices for forest products. In Homma’s model, forest dwellers are rational actors. They operate under conditions of scarcity and will allocate scarce resources that maximize their financial return. Thus, so-called sustainable development projects that are based on extractive activities are ultimately unsustainable.

More specifically, in this model, production from the domestication of forest products increases supply and leads to a fall in the equilibrium price. This price reduction is particularly hard on the extracting population, as their cost per unit of production is much higher than that incurred by cultivated production systems, such as plantation or agroforestry systems. Extraction involves collecting forest goods over large areas often requiring large amounts of labor. As a result, both land and labor employed in extractive production come under rising opportunity costs. Homma argues that as extractivists see their product from labor, their extractivist wage, drop with a falling price, they will leave low return extractive activities and undertake other higher return
activities, such as wage labor, crop production or agroforestry activities. With the
domination of the agricultural frontier into extractive production areas, labor opportunities
become available and siphon off petty capitalist extractors into wage labor. Therefore,
rubber tapping and other extractive activities persist only when regional wages stay low.
Eventually, however, the opportunity costs of extraction rise too high, and extractors will
leave these activities.

His model, however appealing and simply stated, is challenged by past studies of
economic behavior of peasant societies. Sahlins (1972) argued that the domestic mode of
production in “primitive” societies consistently under-produced while Chayanov (1967)
posited that peasant households balanced the drudgery of more work with its expected
benefits. 7 Netting (1989: 229) rejected the idea that smallholders would under-produce,
but also noted that they are not short-term maximizers, rather “serv[ing] the survival and
long-range interests of the domestic kin group.” “Agriculture as a household endeavor,”
he maintained, “reflects a decision that the extra work and the quite modest returns to
labor it brings are worth it—you eat better, [and] live more securely through the risks of
unemployment, sickness and old age.”

This dissertation empirically engages the above discussion by testing how
integration into off-farm labor markets and product markets, and market access,
measured by travel time to the nearest market, may affect forest household income and
income from extractive activities. I argue that as households earn a greater share of
income through off-farm labor, sell a greater percentage of production to the market, and
gain greater access to markets through shorter travel times to the city, household income

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7 Sahlins (1972: 87) defined the domestic mode of production as identified by a “small labor force
differentiated by sex, simple technology, and finite production objectives.”
will rise. Further, as households integrate into off-farm labor markets and product markets, and as they have better access to markets through shorter travel times, the opportunity cost of allocating labor to extractive activities will fall. Thus I hypothesize that:

H4: As the level of household market integration increases, household income will rise;
H5: As the level of household market integration increases, household income from non-timber forest resource extraction will fall, and;
H6: As the level of household market integration increases, household income from non-timber forest resource extraction as a proportion of total income will fall.

**Rubber Tapper Cultural Knowledge: Discussion and Hypotheses**

Cognitive anthropologists have argued that culture can be viewed as shared cognitive representations, and that there can be considerable intra-cultural variation among individuals within a culture (Boster 1986, Garro 1986, Romney et al. 1996, Weller 1987). An individual’s understanding of a particular domain may vary “depending on the characteristics of the individuals, . . . the nature of the domain learned, . . . and the social situations in which learning takes place” (Boster 1986: 429) and this can lead to differences in both the amount and types of information they know (Boster and Johnson 1989).

Past studies have demonstrated intra-cultural variation in knowledge of folk biology (Ellen 1979, Gardner 1976, Hays 1976). The field of folk biology, or ethnobotany, is a fertile area for exploration by anthropologists (D’Andrade 1995). By undertaking research on how people think about, categorize and use plant resources, we can learn much about the relationship people maintain with their environment—spiritual, economic and socio-cultural. The practical, applied use of this knowledge can be found in forest resource use and conservation planning that takes into account how families
think about and use the forest, the demarcation of forest peoples’ land rights that recognize and protect local knowledge of plant resources (Plotkin and Fomalare 1992), and the possibility of identifying tropical forest plant resources that can be tested for developing new drugs (Daly 1992, Plotkin 1993). The establishment of extractive reserves and the provision of land rights to rubber tappers based on the location of rubber and Brazil nut trees, is an example of how our understanding of local knowledge and use of plant resources can inform conservation and development policy (Allegretti 1990).

Ellen (1979: 346) suggested that intra-cultural variation in folk biology among the Nuaulu in Indonesia is due, in part, to a “relative absence of cognitive sharing between different subgroups.” However, he also argued that other factors must be considered to better understand knowledge variation, including: informant variability, such as gender and age; contextual variability, such as social, economic, or ecological contexts; variability in the properties of the natural entity; and, methodological indeterminacy, including analytical errors by the researcher (Ellen 1979: 346-357). Ross (2002: 136) found that variation in knowledge of animal-plant relationships among the Landacan Maya in Mexico was due to inter-generational differences in knowledge level, not due to “different stages in the development from novice to expert,” but because “members of the two generations subscribe to different underlying models of the world.” Yet, Reyes-Garcia et al. (2003) argued that the Tsimane’ Amerindians in Bolivia broadly share ethnobotanical knowledge. Might rubber tappers show intra-cultural variation, or consensus on their knowledge of forest resources?

Kainer and Duryea (1992: 423), in their study in the Chico Mendes Extractive Reserve in Acre noted that men and women share much knowledge about plant use, but
argued that “women possess particular proficiency in plant processing, especially of species used for food, spices, beverages and medicines” while “men are largely responsible for construction in the reserves, and are in charge of hewing fence posts” (Kainer and Duryea 1992: 420). Further, they noted that “children are known for being the only ones interested in those fruits produced in small quantity that yield little pulp” (Kainer and Duryea 1992: 422). Their findings hint at gender, as well as age-specific variation in cultural knowledge of extractive resources among rubber tappers.

As noted above, Esteves (n.d.), has argued that the rubber tappers’ struggle for land has brought new value to the forest, and land now serves a source of permanent tension among second generation Acreans seeking new forms of market integration. Her findings, combined with the work of Campbell (1996), as well as my own observations in the reserve, point toward a youth increasingly interested in off-farm employment opportunities and a concomitant fall in rubber tapping, and suggest that there are generational shifts in how rubber tappers think about the forest. Together, these studies suggest that there may be intra-cultural variation in knowledge of forest resources among sub-groups within the rubber tapper population.

In this study, I employed cultural consensus modeling to examine the intra-cultural variation in rubber tapper knowledge of the domain of non-timber forest resources. Consensus modeling analyzes the “pattern of agreement or consensus among informants to make inferences about their differential competence in knowledge of the shared information pool constituting culture” (Romney, Weller and Batchelder 1986: 316). The domain of non-timber forest resources is a particularly relevant one to explore as the use and sale of extractive resources have played a critical role in sustaining rubber tappers
over the past century. Indeed, who they are, i.e., “rubber tappers,” is defined by a native plant resource.

Building on my hypotheses presented above, I employ consensus analysis to test for the effects of wealth and market integration on cultural knowledge of all respondents, household heads and the knowledge of subgroups of household members (male-female, youth-young adults-adults). Using the statistic gamma, I argue that greater levels of household wealth and increased integration into off-farm labor markets and product markets, as well as increased market access through shorter travel time to the city, will be associated with lower levels of consensus analysis cultural knowledge scores. I hypothesize that:

H7: As the level of household wealth increases, the cultural knowledge of non-timber forest resources of all respondents, the household head, and knowledge sub-groups of individuals within the household (male-female, youth-young adults-adults) will fall, and;

H8: As the level of household market integration increases, the cultural knowledge of non-timber forest resources of all respondents, the household head, and knowledge of sub-groups of individuals within the household (male-female, youth-young adults-adults), will fall.

Further, I employ quadratic assignment procedure (Clark et al. 1998) to examine the similarity, or degree of fit, of cultural knowledge of different sub-groups of individuals (male-female, youth-young adults-adults), categorized by levels of wealth and market integration. My hypotheses are:

H9: The knowledge of sub-groups of individuals (male-female, youth-young adults-adults) in wealthier households will be significantly different from the knowledge of sub-groups of individuals in poorer households, and;

H10: The knowledge of sub-groups of individuals in households (male-female, youth-young adults-adults) with a higher level of market integration will be significantly different from the knowledge of sub-groups of individuals in households with a lower level of market integration.
Conclusion

In this chapter I have laid out the principal research questions that this dissertation will address. This study responds to the call for a greater understanding of factors that are shaping forest peoples’ use and cultural understanding of natural resources. In the state of Acre, the creation of the Chico Mendes Extractive Reserve has provided rubber tappers with long-term use rights to extractive resources. Development specialists and academics have hailed the creation of the reserve as sound policy for conservation and development in the tropics, yet little is known about factors that may be transforming the rubber tapper economy and cultural understanding of resources. Working with rubber tapper households in the reserve, this dissertation contributes to our understanding of how economic forces may be shaping livelihoods in the reserve by examining the effects of increasing household wealth and integration into markets on rubber tapper use and knowledge of extractive resources. I argue that these factors are transforming both resource use and knowledge, and these changes have implications for conservation and development in the reserve.

In the following chapter, I present the research site—introducing the reader to the state of Acre and the Chico Mendes Extractive Reserve—and the research design and methods employed to carry out the research. This will include a discussion of the Acre state policy environment that is guided by a vision of sustainable development and placing considerable resources toward developing the extractive sector. Chapters 3 and 4 will respond to hypotheses H1 through H6 above, describing and analyzing the diverse ways that rubber tappers hold wealth both on and off-farm, and the diverse income producing activities they undertake. Included is a particular focus on the role of extraction in consumption and trade activities. Chapters 5 and 6 respond to hypotheses
H7 through H10, examining the effects of wealth and markets on rubber tapper cultural knowledge of extractive resources. Chapter 5 also includes a detailed discussion of the results of the free-listing and pile-sorting activities, analyzing the different species of plants elicited by households as well as how they “think about” these items. Finally, Chapter 7 will synthesize the discussion, summarizing the key findings and considering the implications of the study results for conservation and development in the reserve.
CHAPTER 2
RESEARCH SITE AND METHODS

I remember the first time I hiked to the Chico Mendes Extractive Reserve. It was during the rainy season in 1996, five years before the research for this dissertation would take place. I was in Xapuri, a small, quiet town in Southeast Acre. I had made arrangements to hike with a few rubber tappers from the community of Rio Branco, one of three communities where I would conduct my research, and also included in this study. We met in the morning, crossing the Xapuri River by rowboat, hiking up the tall riverbank into Sibéria, a growing, poor neighborhood that sprawls to the river’s edge, and started our hike up the Estrada Petropolis, or Petropolis Road. We would be hiking on this long and rolling, unkempt feeder-road, filled with cracks and crevices—only a large tractor could pass in the dry season—for about two hours, then take a path through the forest for another three hours to reach the community center.

A light rain began to fall not long after we left Xapuri. Soon after the rain began my heavy hiking boots were covered with mud, the hard rubber notched soles locking in the wet soil. With each step I left behind slide marks showing where I tried to push myself forward. Trying to scrape the mud from my boots became pointless. It felt like I had an extra 5 lbs of weight on each foot. I carefully followed the path of my rubber tapper colleagues, hoping to avoid the deepest mud holes. I often fell behind, although my travel partners would wait patiently for me, stopping to allow me to catch my breath. I was exhausted when we arrived.
When I returned to Xapuri in 2000 to begin pre-dissertation research for this study, I tracked down my good friend Paulo,\(^8\) the son of a rubber tapper now living in Xapuri, who would accompany me to the forest. I suggested we get an early start the next morning. Even though it was the dry season, I was hoping to get an early start to reach the shade of the forest before the sun got too hot. To my surprise, he told me that if I wanted to pay, we could hire two *motoqueiros*, or motorcycle taxis, to take us to the community center in Rio Branco. The cost would be R$30.00 total, or about US$16.00 at the time. The *Estrada Petropolis* feeder road had been reformed, and another feeder road extended into the forest up to the community center in Rio Branco. Funds allocated by the Acre state government, known as the “forest government,” elected in 1998, had helped finance the road-building project, largely a dream when I had left in 1997. In 2001, the road was being extended further into the forest, approximately 40 kilometers, now reaching the community of São João de Guarani. Families still deeper in the forest talked about the road one day passing through their landholdings.

I looked at Paulo with doubt, recalling the condition of the road when I left, but he assured me that we could get to the community by motorcycle. That next day we hired two motorcycle taxis in *Sibéria*. It took us a little less than an hour to reach the community center. Things had changed in the three years since I had been there, and these changes were bringing new opportunities and creating new hopes for forest communities.

In this chapter, I introduce the state of Acre, and more specifically, the Chico Mendes Extractive Reserve and forest communities where this study was carried out. I

\(^8\) All of the names of individuals mentioned in this dissertation have been changed.
follow with a presentation of the research design and methods. I introduce the state of Acre by first situating the reader geographically, and also provide a brief background on the state, including the history, climate, ecology, economy, population, and natural resources of the region. I follow with a discussion of how national development policy for the Amazon region beginning in the 1960s through the 1980s led to land conflicts and deforestation in the state, and ultimately created a political space for the emergence of the current Acre state “forest government.” The Acre state government, with strong ties with local grass-roots organizations, including the rubber tappers, is pursuing a development agenda that aims to improve rural livelihoods through both use and conservation of the state’s natural resources (State of Acre 1999). The rebuilding of the feeder road into the Chico Mendes Reserve is an example of a policy directed toward improving the livelihoods of forest populations by creating conditions for better access to markets as well as public services, such as health and education. I follow this discussion by introducing the site of this study—three communities in the Chico Mendes Extractive Reserve—and the research design and methods.

**Acre: Geography, Climate and Ecology**

The state of Acre (see Figure 2-1 on the following page) sits in the Southwest Brazilian Amazon and is one of six states that make up the north region of Brazil. Other states include Amapá, Amazonas, Pará, Rondônia and Roraima. Acre forms part of the greater Amazon region, or Amazônia Legal, an area of over 5 million square kilometers including the entire north region of Brazil, and also extending to the northern region of the state of Mato Grosso and the eastern part of Maranhão. The state is cradled by Bolivia to the south and Peru to the southwest, while neighboring states of Amazonas and Rondônia sit to the north and east. The state covers an area of 153,150 square kilometers,
approximately 3.9% of the Brazilian Amazon region and 1.8% of all Brazil (State of Acre 2000a).

Source: Adapted from State of Acre (2000d).

Figure 2-1. Map of Acre, Brazil including definition of the Chico Mendes Extractive Reserve.

The climate of Acre is tropical, with an average annual temperature of 24.5° C and a maximum temperature of approximately 32° C. However, *friagens*, or cold fronts, are not uncommon during the dry season and temperatures can drop to as low as 10° C (State of Acre 2000a). The western region is much cooler due to its extratropical location near the Andean foothills. Seasonal rainfall patterns maintain considerable influence over transportation within the state. During the rainy season from October or November to April or May, heavy rainfall facilitates river travel although it can temporarily cut off forest population access to urban areas due to the flooding of small forest streams, while dirt feeder roads are often impassable by motor vehicles during this period. During the dry season from May through September, with water levels at their lowest, river transport is more difficult, while land travel in the forest permits the use of vehicles on most feeder roads. Annual rainfall in Acre varies between 1.6 meters and 2.75 meters per year (State
of Acre 2000a). The far western region of the state has a much shorter dry season than eastern Acre and thus receives greater rainfall.

The rainforest in Acre is divided into two ecological types, dense tropical rainforest and open tropical rainforest, with open rainforest dominating 90.0% of the state. Within these two ecological types, bamboo forests, palm forests and vine forests predominate (State of Acre 2000a). Climate differences between the western and eastern regions of the state have affected the distribution of tree species. For example, the Brazil nut tree (*Bertholletia excelsa* H.B.K. (*Lecythidaceae*)) does not occur in the far western region, although the region has a much more abundant and diverse palm population than eastern Acre. This distribution has in turn influenced the economies of these two regions. In eastern Acre, the collection of Brazil nuts often contributes substantially to household incomes, while in western Acre, the palm fruit of *buriti* (*Maritius flexuosa*), among other palm products, plays an important role in trade.

The biodiversity of Acre’s flora and fauna has seen limited study. Silveira et al. (1997) referred to Acre as a “*buraco negro*” or black hole, when it comes to the study of biological diversity. In 1999, approximately 316 species made up the Acre Flora Data Bank at the herbarium at the Zoobotanical Park at the Federal University of Acre. The State of Acre (2000a) notes that 1,319 species of vertebrate fauna have been identified, including: birds (752 species), fish (258 species), mammals (209 species), amphibians (119 species) and reptiles (94 species). Acre is home to approximately 45.0% of all birds, and 40.0% of all mammals, that occur in Brazil.

**Acre: Political History, Economy and Conservation**

Although Acre’s unique place in history extends back to the 1800s during the rubber boom, the region only became a Brazilian state in 1982. The land area now
encompassing the region officially became Brazilian territory at the turn of the 20th Century, with the signing of border treaties with Bolivia and Peru. The Treaty of Petropolis of 1903 with Bolivia led to Brazil’s purchase of the region that now largely encompasses Acre. A great celebration was held in Acre in 2003 to commemorate the 100-year anniversary of the Acre revolution that led to the transfer of the region to the Brazilian Republic. To the west, the Brazil-Peru Treaty of 1909 officially resolved disputed land claims between Brazil and Peru, drawing the Juruá region into the state. The capital of Acre is the city of Rio Branco, located in the highly populated eastern region of the state.

Politically, Acre is organized into five development regions: Lower Acre, Upper Acre, Purús, Taráuca/Envira, and Juruá. There are 22 municipalities, 10 of which were created in 1992, a sign of the increasing urbanization of the state, as demonstrated in Table 2-1 on the following page. After a slight fall in population from 1920 to 1940, likely the result of out-migration at the end of the rubber boom, the population has steadily increased, with the jump from 1940 to 1950 reflecting the influx of soldados da borracha during World War II. Table 2-1 also reveals the increasing urbanization and concomitant out-migration from rural areas that began in the 1970s, a response to falling rubber prices as well as the state government’s promotion of large-scale cattle ranching (discussed in greater detail below), resulting in the flight of rural workers into cities. Although urban population growth slowed in the 1990s, a rising urban population combined with limited urban industrial growth has resulted in the rise of urban periphery shantytowns and increasing unemployment (Bakx 1988b, Schwartzman 1992).
Table 2-1. The population of Acre, 1920 to 2000.

<table>
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<tr>
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<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Population</td>
<td>92,370</td>
<td>79,768</td>
<td>114,755</td>
<td>158,852</td>
<td>215,299</td>
<td>301,303</td>
<td>417,718</td>
<td>557,226</td>
</tr>
<tr>
<td>Urban</td>
<td>59,307</td>
<td>132,169</td>
<td>258,520</td>
<td>370,018</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rural</td>
<td>155,992</td>
<td>169,134</td>
<td>159,198</td>
<td>187,208</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>


The growing urban population in Acre reflects the changing economy of the state. Although extractive products, notably rubber and Brazil nuts, still maintain an important role in the regional economy, other sectors, such as public administration, are emerging. State rubber production fell in the 1990s due to the fall of world rubber prices and decline of federal support. Between 1975 and 1996, rubber fell as a percentage of the value of production from agriculture, extractivism and cattle ranching, from 31.0% to 6.0% (State of Acre 2000b). This fall mirrors the declining role of the agricultural sector in general. In 1985, agriculture (including extractive activities) accounted for approximately 23.2% of gross product in the state, second to public administration, social security and defense, which accounted for 29.6% of gross product (State of Acre 2000b). By 1997, agriculture fell to 3.9% of state gross product while public administration rose to 47.9%. The transformation of the Acre economy has been both dramatic and swift.

As the state economy has changed, there has also been a transformation of the forest. Acre has undergone a relatively steady increase in gross deforestation over the past 25 years. In 1976, the earliest data available on forest cover, only 1.6% of the forest had been cut. By 1988, 5.8% of the state was deforested, climbing to 8.7% in 1995. Gomes (2001) noted the inverse relationship between the fall of rubber production and increase in deforestation through the 1980s and 1990s. The regions that have undergone the greatest deforestation are Lower Acre and Upper Acre, found in the eastern half of the
state (Gomes 2001). The Upper Acre region straddles Highway BR-317 as it heads south and west toward Peru. This road opened the region to extensive cattle ranching, particularly around the municipalities of Xapuri, Epitaciolândia and Brasiléia, leading to substantial deforestation where the Chico Mendes Reserve was established. It was also the area that witnessed some of the worst conflicts between forest populations and ranchers.

In response to the steady increase in deforestation, the creation of conservation units and indigenous reserves, under both federal and state jurisdiction, has accelerated over the past decade. These areas now protect approximately 42.0% of the state. Conservation units include extractive reserves, state and national parks, and one ecological station. Together these areas claim approximately 4,282,842 hectares, or approximately 28.0% of the state. (See Table 2-2 on the following page). Federally administered indigenous lands, accounting for approximately 14.0% of the state, also contribute to the growing conservation mosaic in the state of Acre.

In addition to these protected areas, federally administered areas called Agro-Extractive Settlements (PAE) have also been established for the direct sustainable use and management of natural resources. PAEs are often referred to as extractive reserves, and are very similar in use, although they differ in fundamental ways. PAEs are established and administered by the National Institute for Colonization and Agrarian Reform (INCRA) while extractive reserves are established and administered by the Brazilian Institute for the Environment and Renewable Natural Resources (IBAMA), the federal environmental agency. PAEs, before established, were already under the jurisdiction of INCRA, thus land use was already under agrarian reform with titles held
by INCRA for distribution (Allegretti 1995). This facilitates the provision of official title of use concession to resident families.

Table 2-2. Federal and state conservation units, agro-extractive settlements and indigenous lands in the state of Acre.

<table>
<thead>
<tr>
<th>Conservation Units</th>
<th>Area (ha)</th>
<th>Creation Date</th>
<th>Families</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alto Juruá Extractive Reserve</td>
<td>506,186</td>
<td>1/23/1990</td>
<td>695</td>
</tr>
<tr>
<td>Chico Mendes Extractive Reserve</td>
<td>976,570</td>
<td>3/12/1990</td>
<td>1,500</td>
</tr>
<tr>
<td>Caçumbá-Iracema Extractive Reserve</td>
<td>750,794</td>
<td>9/19/2002</td>
<td>n.a.</td>
</tr>
<tr>
<td>Serra do Divisor National Park</td>
<td>843,012</td>
<td>6/16/1989</td>
<td>522</td>
</tr>
<tr>
<td>Macaúba National Forest</td>
<td>173,236</td>
<td>6/21/1988</td>
<td>18</td>
</tr>
<tr>
<td>São Francisco National Forest</td>
<td>21,600</td>
<td>8/7/2001</td>
<td>n.a.</td>
</tr>
<tr>
<td>Santa Rosa do Purus National Forest</td>
<td>230,258</td>
<td>8/7/2001</td>
<td>n.a.</td>
</tr>
<tr>
<td>Rio Acre Ecological Station</td>
<td>77,500</td>
<td>6/2/1981</td>
<td>-</td>
</tr>
<tr>
<td>Antimari State Forest</td>
<td>66,168</td>
<td>2/7/1997</td>
<td>250</td>
</tr>
<tr>
<td>Mogno State Forest</td>
<td>143,897</td>
<td>5/10/2004</td>
<td>n.a.</td>
</tr>
<tr>
<td>Rio Liberado State Forest</td>
<td>126,360</td>
<td>5/10/2004</td>
<td>n.a.</td>
</tr>
<tr>
<td>Total Conservation Units</td>
<td>4,282,842</td>
<td></td>
<td>2,986</td>
</tr>
<tr>
<td>Agro-Extractive Settlements</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>8 Agro-extractive Units</td>
<td>193,449</td>
<td>Various since 1988</td>
<td>869</td>
</tr>
<tr>
<td>Indigenous Lands</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>28 Distinct Groups</td>
<td>2,167,146</td>
<td>Various</td>
<td>n.a.</td>
</tr>
<tr>
<td>Total</td>
<td>6,643,437</td>
<td></td>
<td>3,855</td>
</tr>
</tbody>
</table>

Source: Adapted from Kainer et al. (2003), State of Acre (2000b and 2000c) and Amorim and Sousa (n.d.). N.A. indicates the information is not available.

Under the extractive reserve management regime, IBAMA faces a much more challenging task in providing titled use concessions to resident populations. In fact, inhabitants of extractive reserves do not have official titles for use concession. Unlike PAEs, areas appropriated for the creation of extractive reserves were not under the jurisdiction of either IBAMA or INCRA when appropriated, i.e., they were not under agrarian reform, and legislation for extractive reserves allows for regularization of land tenure after appropriation of areas (Allegretti 1995). As a result, land was appropriated for establishment of extractive reserves even as titles to these areas were often under dispute among private parties (to be discussed below), including extractivists, who claimed areas but had no titles. Thus, despite the appropriation of land and creation of
extractive reserves by IBAMA and the subsequent establishment of utilization plans by reserve communities, resident families still do not have title for use concession. Without title, rubber tappers have difficulty proving where they live and the years they have worked in the forest. This complicates administrative procedures for securing retirement and other social benefits, as well as obtaining credit.

The above discussion provides a general picture of Acre, a state increasingly urbanized, an economy with a growing administrative sector and declining agricultural sector, a natural resource base undergoing deforestation, and in response, the more recent creation of protected areas. However, this brief sketch of Acre’s changing socio-economic and natural resource landscape does not expose the development planning and conflicts that have shaped the region, and ultimately given rise to the current Acre state government, self-named the “forest government.” Thus, in the next section I want to go back a few decades and lay out the socio-political context that led to deforestation and the exodus of rural workers to the city. These policies fostered the growth of grassroots movements that led to the emergence of a very different vision of forest use that now guides economic development in the state.

**Large Scale Development Planning and Rural Conflicts**

Just as the promotion of rubber extraction defined development in the Amazon beginning in the late 19th century through World War II, a different set of national development objectives for the Amazon region greatly transformed the state of Acre, beginning in the 1960s and through the 1980s. Large-scale remaking of the Amazon region began under Operation Amazonia in 1964 when the military dictatorship assumed power in Brazil (Hecht and Cockburn 1989, Schmink and Wood 1992). Driven by geopolitical concerns and growing social problems in the south of Brazil, a product of the
industrialization of agricultural and land consolidation, Operation Amazônia was a basin-wide development program to colonize and integrate the Amazon region with the rest of Brazil. The program’s key components included extensive road building, agricultural colonization settlements, and generous fiscal incentives to attract agroindustry to the region (Mahar 1989).  

Up until the 1970s, Acre had remained relatively isolated from the rest of Brazil. Lack of a paved road connecting Acre to the neighboring state of Rondônia and onward to the south of Brazil made travel to the region difficult, and thus largely inaccessible. This began to change under Operation Amazônia. In 1968, the construction of highway BR-364 from Cuiaba to Porto Velho, although not yet paved, opened up the western Amazon frontier for the first time, and resulted in massive migration from the south of Brazil (Mahar 1989). By the 1970s, the highway finally reached Acre, with the extension (again unpaved) from Porto Velho to Rio Branco. In the 1980s, under the Polonoereste project, funded in part by the World Bank, highway BR-364 from Cuiaba-Porto Velho was paved. Further plans to pave the road into Acre, however, were only completed in the early 1990s.

While new roads were providing easier access to Acre, other national policies were shaping state development, resulting in a decline in the extractive sector and a concomitant leap in livestock development. The closing of the Amazon Credit Bank in the late 1960s ended credit to the rubber trade, leaving the rubber barons who remained without credit little choice but to abandon or sell their forest lands (Costa Sobrinho

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9 See Mahar (1989: 30-31) for a discussion of the mechanization of agriculture in the south of Brazil that led to land consolidation and the loss of small scale farmers and release of agricultural laborers, greatly affecting migration patterns in Brazil.
In the 1970s, the creation of the Bank of Amazonia (BASA) made available highly subsidized loans for livestock production (Schwartzman 1992; see also Hecht and Cockburn 1989: 166-168). Concomitantly, the Acre state government openly encouraged private investment from outside interests, namely ranchers from the south of Brazil (Costa Sobrinho 1992). Costa Sobrinho (1992) notes that while small and medium investors were interested in ranching, the largest investors purchased land for speculative purposes. Some estimates suggested that up to 80.0% of the territory of Acre may have been sold between 1970 and 1975. (Schwartzman 1992: 56). During this period, falsification of land titles was common, and titles issued by multiple entities, such as Brazil, Bolivia, and the state of Acre, further confused land ownership (Schwartzman 1992). As outside investors purchased land in Acre, land consolidation also ensued. By 1980, 22.0% of Acre’s land was in landholdings of 10,000 hectares or more. The state’s cattle herd grew from 72,166 head in 1970 to 356,446 head in 1987 (Schwartzman 1992).

The result of these policies was conflicts between new investors—ranchers from the south—and rubber tappers. Ranchers claimed title to the lands where rubber tappers had been living for generations, and employed threats, destroyed crops, and murdered residents to “clear” rubber tappers from their lands (Costa Sobrinho 1992: 148). Rubber tappers, assisted by rural union organizers and the Catholic Church, organized to resist them (Costa Sobrinho 1992, Keck 1995). To confront ranchers, the rubber tappers successfully employed empates, or non-violent stand-offs, during which men, women and children would surround trees to keep laborers hired by ranchers from cutting forests on their landholdings (Mendes 1989). The building of alliances with international environmental organizations sympathetic to their cause, placed pressure on the
international lending communities to withhold funding for paving of the highway BR-364 to Acre, and also forced the Brazilian government to resolve the growing crisis, becoming increasingly violent (Schmink 1992, Schwartzman 1992). This violence culminated in 1988, when Chico Mendes, a rubber tapper and rural union leader, who had traveled to the United States to take the rubber tapper cause to the World Bank and U.S. Congress, was murdered by hired gunmen outside of his home in Xapuri. The Chico Mendes Extractive Reserve, a symbol of the rubber tappers’ fight for their livelihoods, now bears his name. The victory of the rubber tappers not only secured their place in the forest, but also created a political space for new voices in state development. It is from this space that the current “forest government” emerged.

The Acre State “Forest Government”

The guiding vision of the Acre state “forest government,” elected in 1998, is one that embraces the idea of “sustainable development.” The government views “the forest as the basis for a new economic model” for the region, arguing that the largely intact forests can be both used and conserved (State of Acre 1999: 39). With strong ties to the rubber tapper movement and other grassroots organizations representing and working with forest populations, the government has implemented an ambitious social and economic development plan that includes the sustainable management of both timber and non-timber forest products. The government works directly with forest communities to involve them in community management of productive activities, diversifying production, improving production and processing techniques, and adding value to products locally (Kainer et al. 2003, State of Acre 1999). These policies aim not only to raise rural incomes, but also to fix rural extractors and workers in the forest, in order to reduce rural to urban migration induced by development policies of the past 30 years.
A central element of the Acre government’s sustainable development vision is “neoextractivism.” Neoextractivism, a concept developed by Fernando do Rêgo, an economist and former Secretary of Production for the “forest government,” contends that we cannot view the extraction carried out by forest families as purely an economic activity, strictly defined as the exploitation of naturally occurring resources (Rêgo 1999). He asks that we re-conceptualize extractivism as neoextractivism, a livelihood determined principally by the forest dweller’s “cultural universe,” structured by his relationship with nature, rather than rational economic behavior (Rego 1999: 65). Neoextractivism involves carrying out not only traditional extractive activities, such as rubber tapping and Brazil nut collection, but also small farming activities, agroforestry, enrichment plantings, and processing activities that bring greater product value to traditional populations. Rêgo’s concept came as a reply to Homma’s (1992) microeconomic model of extraction discussed in the previous chapter, which views extractivism as a purely economic activity governed by supply and demand and rational economic behavior.

The application of Rêgo’s vision of “neoextractivism” might be best seen in the state government’s creation of an Executive Secretary of Forestry and Extractivism (SEFE) charged to productively and sustainably develop the forest sector.10 SEFE had departments tasked to help develop both the extractivist and timber sectors, and also to work directly with communities and help build capacity in production and marketing activities of a diverse set of forest products. For the extractive sector, SEFE initially

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10 In 2003, SEFE was divided into two Executive Secretaries: Executive Secretary for Family Production (SEPROF), which directs public sector activities in the extractive sector, and the Executive Secretary for Forestry (SEF), which conducts the same in the timber sector.
focused on a set of specific extractive products, but subsequently turned to working on a regional basis to attend to the different needs of forest communities across the state. Courses and workshops have been implemented in the forest to improve extraction and processing technologies for both traditional and “new” products. To diversify production, twenty non-timber forest product species have been prioritized for development of sustainable management plans, including palm fruits, vines, medicinal plants, and seeds. Collaboration with the Federal University of Acre (UFAC) as well as private sector partners is aiding in the collection of ecological information for the development of management plans (Kainer et al. 2003). In addition, SEFE has provided technical assistance in marketing to COOPERACRE, a cooperative consisting of local producer groups and cooperative, and works with the private sector to improve plant infrastructure and management to facilitate the in-state processing of products.

While diversification of the forest economy is a fundamental part of state government development policy, rehabilitation of the rubber sector is also a core initiative. The Lei Chico Mendes, or Chico Mendes Law, also referred to locally as the “rubber subsidy,” implemented in January 1999, was one of the government’s first major policy initiatives. The subsidy, or environmental service payment, initially provided an additional payment to rubber tappers of R$0.40 per kilogram of rubber, subsequently increased to R$0.60 in January 2002. The law was enacted to increase the income of the extractive populations by supporting traditional extractive activities, but also aimed to achieve a number of other objectives. These included: securing extractive populations in the forest, thus helping to reduce rural to urban migration; promoting the organization of rubber tappers into associations—membership of an association or cooperative is
required to receive the payment (this also would block itinerant traders still operating in
the forest from receiving the payment destined for rubber tappers); improving the quality
of rubber; and, assisting in the legal documentation of the extracting population as a
means to provide proof of rural service, a requirement for receiving retirement benefits
(Kainer et al. 2003).

A first evaluation of the effects of the rubber subsidy indicates some positive
results. In 1998, rubber production registered by the state was 962,025 kilos, growing to
1,252,000 kilos in 1999, to 2,830,000 in 2000, and 2,980,000 in 2001. Concurrently, the
number of families that have benefited from the subsidy has also grown, from 1,480 in
1999 to 4,354 in 2000 and 6,154 in 2001 (Kainer et al. 2003, SEFE n.d.). In addition to
the state subsidy payment, producers have also been able to negotiate slightly higher
prices with outside buyers as production is centralized and sold through the cooperatives
(Kainer et al. 2003). Further, the government has been able to capture 70.0% of the cost
of the rubber subsidy through state taxes (Kainer et al. 2003). In addition, the policy has
resulted in the organization of numerous cooperatives and associations as well as the
legal documentation of rural workers (SEFE, n.d.). However, policy effects on stemming
rural-urban migration are less clear. Although the local press has reported that many
families are returning to the forest, studies to document these assertions have not been
undertaken (Kainer et al. 2003).

Finally, just as the SEFE worked to improve the prices paid to extractivists, they
also helped facilitate payment of the federal subsidy for processed rubber to private
sector partners. In 2001, the federal subsidy for a particular quality of processed rubber,
known as Granulão Escuro Brasileiro (GEB), was R$.90 per kilogram. To receive this
subsidy, processors had to provide extensive documentation regarding buying, selling and transport, and once documentation was submitted, receipt of the federal subsidy could be delayed as long as nine months. To facilitate this payment, SEFE negotiated with the National Council for Agriculture and Supply (CONAB), the federal agency that administers the subsidy, to have the payment made directly to SEFE based on production estimates. This reduced the time period that private processors wait for the federal subsidy, to approximately one month.

Despite strong support from forest communities, and the building of partnerships with private enterprise to help stimulate the extractive sector, in some cases, implementation of the state policy has been guarded and slow (Kainer et al. 2003). In the case of timber management, the strong association that forest communities maintain with extractivism and the conflicting voices that have emerged among them regarding this alternative, have led to a cautious implementation process (Kainer et al. 2003). In the case of the extraction of non-timber products, different challenges have emerged. First, for many potential extractive products, there is little information available on the ecology of forest species; thus management plans, required for commercialization, have been slow to develop. Second, industrial buyers often require a very large supply of a particular product, which is of a special quality and purity, but production in the forest is still very low. And finally, although government reports have demonstrated the initial success of the Chico Mendes Law, the effects of the subsidy may be less clear than initial reports reveal. Results from my research, presented in Chapter 5, do find that rubber tappers have received a higher price for rubber due to the additional payment. However, comparing production data for 28 households from 1996 with 2001, my research shows
that five households left rubber production, and among those that still produce rubber, production has fallen dramatically. This suggests that simply increasing the price of an extractive product may not be enough to re-stimulate or maintain production among households that are already diversifying into alternative production activities.

Although substantial challenges remain, the forest government remains committed to engage both forest communities and the private sector in the sustainable use of the state’s forests. In addition to forest-based initiatives, major infrastructure projects, including the paving of the two major state highways (one destined to provide road access to the Pacific via Peru in the coming years) (Brown et al. 2002), as well as the improvement of feeder roads in rural areas, such as in the Chico Mendes Extractive Reserve, aim to help rural producers and businesses reach new markets for locally collected and processed products, in hopes of capitalizing on the state’s natural resource base (Kainer et al. 2003, State of Acre 1999).

The re-election of the government’s charismatic leader, Jorge Viana, a forest engineer, in 2002, has provided the government a mandate to pursue its vision of sustainable development. Further, the state should be able to count on substantial support from the federal government. The Minister of the Environment, Marina da Silva, a former Senator from Acre has strong ties to the state government, and her background, herself the daughter of rubber tapper, has provided rural extractors with an ally at the highest level of environmental policymaking in Brazil. In addition, with the 1992 election of the Worker’s Party (PT) candidate Lula Ignacio da Silva to President of the Republic, the Acre state government, also representing the PT, has gained national respect for its commitment to sustainable development of the region’s forests (Kainer et
al. 2003). Recent loans from the Inter-American Development, a substantial portion of which will be utilized to support sustainable forest management and extractive activities in the state, should also help improve the economic livelihoods of Acre’s forest population (Kainer et al. 2003).

The above discussion has described the social and political context in which this study was undertaken, with the current state “forest government” implementing a vision of development built on local alliances with forest populations and focused on the use and conservation of local resources, and emerging from a previous development agenda shaped largely by outside interests. I now present the site of this study, the Chico Mendes Extractive Reserve, and the communities that participated in the research. This is followed by a presentation of the research design and methods.

**Study Site: The Chico Mendes Extractive Reserve**

The Chico Mendes Extractive Reserve encompasses approximately 970,560 hectares of rainforest, stretching across six municipípios, or counties, including: Assis Brasil, Brasiléia, Sena Madeireira, Xapuri, Rio Branco and Capixaba. The reserve was officially established by Presidential Decree 98.987 on January 30, 1990 under President Jose Sarney. It is one of four extractive reserves in Acre. The Alto Juruá Extractive Reserve, located in the southwest corner of Acre, was the first extractive reserve established. The Chico Mendes Reserve, located in the southeastern corner of the state, followed shortly thereafter.

Rubber tappers initially proposed the concept of extractive reserves in 1985, during the first meeting of the National Rubber Tappers’ Council held in Brasilia, the capital of Brazil. Extractive reserves are defined by Allegretti (1990: 252, 258) as “public lands designated for the specific purpose of sustainable use of forest products” with “property
rights . . . designated according to traditional patterns of land use rather than imported models of occupation.” Upon their creation, extractive reserves were immediately hailed as a model for sustainable development in the region, with forests managed and conserved by rural inhabitants, raising local incomes and protecting rural livelihoods (Daly 1990, Fearnside 1989).11 As noted in the previous chapter, extractive reserves are unique areas of conservation, as landholdings, or colocações, are determined by resources rather than by conventional geographic shapes. Landholdings in the reserve are quite large, in general, 300 hectares or larger. Thus they provide extractive populations sufficient area to undertake market-oriented extraction for items such as Brazil nuts and rubber, which are found in low densities, and subsistence activities, affording large hunting grounds and area for fallow.

The Chico Mendes Reserve is administered by IBAMA, with the Centro Nacional de Desenvolvimento Sustentado dos Populacões Tradicionais (CNPT), an agency within IBAMA, maintaining direct contact with the associations that represent rubber tappers living in the reserve. This study was conducted in the municipality of Xapuri, where residents are represented by the Association of Inhabitants of the Chico Mendes Extractive Reserve in Xapuri (AMOREX).12 With the official establishment of the Chico Mendes Reserve, resident households were given 30-year use rights to forest resources, excluding minerals, on their landholdings. The utilization plan for the reserves was developed through three rubber tapper associations located in Assis Brasil (AMOREAB),

11 For views that question the economic and ecological sustainability of the extractive reserve concept, see Homma (1992) and Browder (1992a).

12 AMOREX is now known as AMORPREX, the Association of Inhabitants and Producers of the Chico Mendes Extractive Reserve in Xapuri.
Brasiléia (AMOREB) and Xapuri (AMOREX) and approved by IBAMA on April 18, 1994 (CNPT 1995). It stipulated that the resident population would enforce land use activities in the reserve. Some of the specific land-use regulations include:

- Brazil nut trees and rubber trees cannot be cut down; timber extraction is permitted only for construction of infrastructure on the landholding;
- Mineral extraction is prohibited; hunting and fishing is permitted only for household consumption;
- Up to 10% of the landholding may be used for agricultural activities; up to 50% of agricultural area (or 5% of the landholding) can be used for pasture, and;
- Sale or trade of use rights to the landholding can only be carried out with community approval (CNPT 1995).

In 1992, there were an estimated 1,834 families living in the reserve, spread over 46 seringais, or rubber tree forest areas, which fall in whole or part in the reserve (CNS 1992). This figure has declined in recent years, and currently there are an estimated 1,500 families (State of Acre 2000c). Concurrently, the reserve population has fallen from an estimated 9,000 in 1994 to approximately 6,000 in 1998, indicating heavy out-migration over this period. The forest areas serve as the basis for the organization of a range of socio-economic activities in the reserve, including community organization, elementary education, religious worship and soccer tournaments. CAEX, the rubber tapper cooperative in Xapuri, maintains trading posts in a few forest areas, to facilitate the selling of rubber and Brazil nuts as well as provide basic supplies.

This study was carried out in three forest areas in the reserve, all located in the municipality of Xapuri. They were selected as I had previously carried out research in each of these areas in 1996 and 1997. Thus, I was familiar with households living in these areas and would also be able to compare rubber production in two periods to evaluate the effects of the state rubber subsidy. The three study sites were: Seringal
Floresta, the community of Rio Branco; Seringal Boa Vista, the community of São João de Guarani; and, Seringal Filipinas, the community of Terra Alta.

These study sites were initially identified for study in 1996 using a purposive sampling framework. They were identified and selected in coordination with AMOREX. These three areas differ in terms of distance to the nearest town, Xapuri, and principal means of transport between the forest area and Xapuri—land or river. Thus, they represent a gradient of lesser to greater market involvement which will allow me to test the impact of wealth and markets on household income and extractive activities, key questions of this study. Figure 2-2 found on the following page, is adapted from drawings by community members and displays the location of community households, including those that participated in the study, within each community,

The community of Rio Branco in Seringal Floresta is approximately 20 miles by feeder road from the city of Xapuri. As noted in the introduction to this chapter, the rebuilding of the Petropolis Road and the construction of a feeder to the community center has recently improved community access to the city. However, many residents still use animal transportation or walk, to travel from their landholdings to the city. Few are able to pay the R$15.00 to hire a motorcycle from the community center of Rio Branco to Xapuri. From the community center in Rio Branco, travel time is approximately 5 hours.

The community of São João de Guarani in Seringal Boa Vista sits to the north of the Community of Rio Branco, deeper into the reserve. The feeder road that now

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13All research activities were conducted in coordination with AMOREX, including: the initial study proposal presentation to AMOREX officers, a follow-up presentation at a general meeting, the coordination of site visits, and the scheduling of presentation of the study objectives at community meetings in the forest.
Figure 2-2. Maps of study households in three research communities. Maps were adapted from drawings by community members. Triangles represent households in the community. Black triangles represent households that participated in the study.
connects the city of Xapuri with Rio Branco has been extended to the community center of São João de Guarani and trucks and even cars are able to use the road during the dry season. However, as the feeder road has not been sufficiently compacted, an afternoon rain can make travel difficult even in the dry season. Travel time by foot from the city of Xapuri to the community center of São João de Guarani is approximately 8-10 hours, depending on the route taken. It is much longer during the rainy season. During the rainy season, using pack animals to carry products to Xapuri, one-way travel time can last up to 16 hours, thus taking nearly two days of travel to arrive in the city. By vehicle, travel time is approximately two hours. Motorcycles charge approximately R$30.00 from Xapuri to São João de Guarani. The cost of renting a small pick-up (including the driver) from Xapuri to São João de Guarani was R$100.00 in 2002. Again, few residents can afford to pay to hire motorcycles or vehicles to make this trip.

Travel time and method of transport to arrive at Terra Alta are governed by the seasons. During the rainy season, all size canoes can navigate the entire trip, with small canoes with motors completing the voyage in 4 hours. However, during the dry season Riozinho becomes nearly impossible to navigate due to very shallow waters and exposed fallen trees. The main effect of the seasons is in determining the type and size of canoe that can reach the community. Larger canoes that can carry production to the city can only pass in the rainy season while smaller canoes can pass nearly all year. The cost of hiring a canoe for a one-way trip from Xapuri to near Terra Alta is approximately R$80.00. If the hired canoe and pilot must stay for more than an evening, an additional fee is charged.
Although residents of the Community of Terra Alta prefer to travel by river, land travel is often used, as river travel is not often available and is more expensive, even if one owns a canoe, due to the need to purchase gas and oil. Land travel from Xapuri to Terra Alta is approximately 7-8 hours walking, 4-6 hours by animal. Residents of the community are pressing the state and Xapuri municipal governments for the construction of a feeder road linking the city of Xapuri with Terra Alta, but currently there are no plans for its construction.

**Research Design and Methods**

A convenience sample was used to identify the 46 households that participated in the study. To identify families, a map of each community was drawn with the assistance from individuals from the communities. Household were then identified employing the following criteria: 1) the landholding would fall in part or whole in the Chico Mendes Extractive Reserve; 2) the household would not operate as a *marreiro*, or itinerant trader, trading products with other reserve families; 3) the household participated in some way in the community (i.e., they attend community meetings, provide labor at community work days, their children study in the community school); and, 4) the household had to be present on their landholding for a minimum of one year.  

The term community is more a social designation than geographical one. A household that lived outside of a specific forest area (but still in part within the reserve) could be included in the study if household members participated in community activities.

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14 One household whose landholding sits on the border of the reserve in the “area of protection,” what I would term a buffer zone for the reserve, was also included in the study. Households in the area of protection are required to follow the guidelines of the reserve utilization plan.
Households that met the above criteria were then ranked according to their comparative financial situation, based on the knowledge of the individuals from the communities and my own experience working there. Their location within the community was also considered. Thus families were identified based both on their financial situation and their location, to achieve a variation in wealth and market access. In some cases, landholdings had multiple households with the rubber trails divided among the separate family households and in a few cases multiple households from the landholding were included. If a household identified for inclusion in the study was not home when we arrived at the landholding (or we knew from other community members that the household members were not there), when possible, an attempt was made to return to the household later during the same field trip, or during another visit to the area at a later time. However, this was not always possible. In these cases, we made adjustments in the field, identifying other households for participation.

In the community of Rio Branco, 45 households participated in the community. Of these, five fell out of the reserve (although one in the area of protection was included—see above footnote), two act as itinerant traders, and two live on a small ranch. Of the remaining 36 households, 17 were selected and interviewed, for a total of 18 households. In the community of São João de Guarani, 26 households participated in the community. Of these, six had lived in the area for less than a year. Of the 20 remaining households, 13 were interviewed. In the community of Terra Alta, 24 households participated in the community. Of these 24 households, 15 were interviewed. Thus, of a possible 81 households (including one household in the area of protection), 46 were interviewed, or approximately 57.0% of potential participating households. During previous research in
the reserve, conducted in 1996 and 1997, I interviewed 39 households in these same three forest areas. Of these households, 29 were included in this sample.

This study employed both microeconomic and anthropological methods to test the hypotheses stated in Chapter 1. It consisted of three principal stages. The first stage, carried out in May and June 2000 involved presentation of the study objectives to administrators of the CNPT, IBAMA, leaders of AMOREX and rubber tappers in the Chico Mendes Reserve, and pre-testing of research methods and tools. All methods and tools utilized were pre-tested with a few selected reserve households in the participating communities. Methods tested included a structured questionnaire, cognitive research methods tools including pile-sorting and triad tests, and a semi-structured questionnaire, or open-ended interview.

The second stage of the research, conducted September through December 2001, involved the first round of data collection with participating households. Prior to implementation an open presentation of research objectives and tools for data collection was made in each community during a regularly scheduled community meeting. A research schedule was made to organize visits to participating households. The first round of interviews employed a structured questionnaire and cued recall to collect demographic data on individual household members, including age, sex, education and health, and household wealth and income. In addition, free-lists (Fleischer and Harrington 1998) were elicited from each family on the domain of non-timber forest resources. Forty-six households were interviewed during the four-month field visit.

The third stage of the research was carried out in June through October 2002. During this final visit, all but one of the households were visited again. One family in the
community of Terra Alta had moved from the forest area to a small farm area closer to the city of Xapuri. During this household visit, three activities were carried out: first, we clarified responses to the structured interview conducted the previous field visit; second, we conducted pile sorts (Roos 1998) with household members, and; third, we conducted semi-structured interviews that permitted all household members to respond to the same set of open-ended questions.

**Use of Participatory Data Collection Tools**

A participatory approach was employed to collect information on individual household members, such as age, sex, education and health, household wealth and income. As the interview would require the participation (and focused attention) of all household members (where possible) and would last anywhere from approximately 1-3 hours, rather than ask questions about household members and household structures, assets and income directly from the questionnaire, I developed an extensive set of tools in the form of diagrams to engage participants.

To collect information on household members, I diagrammed a set of 2” by 5” cards portraying men, women, boys and girls. A card representing each household member was placed on the floor in front of the group. Each card was then selected (in some cases, children were offered to hold the card), and then I asked for information about that person. For the youngest individuals, the female head of household often responded.

To obtain data regarding household assets and income, I developed an extensive set of 6” by 9” cards with diagrams of wealth items, including equipment, structures and consumer items, and agricultural and extractive resources which families collect, harvest or breed. This list of items was developed based on my prior experience in the reserve
and in collaboration with researchers at UFAC and rubber tappers in the reserve (cf. Gunatilleke, Senaratne and Abeygunawardena 1993). For wealth items, household members were asked questions regarding quantity, when and how acquired, and for high-ticket equipment items, such as chainsaws, their costs. For trade and consumption activities, household members were asked to recall the quantity of production, extraction, trade or barter of products and with whom any transactions took place. The cards encouraged the participation of all household members, not just the household heads, with one member (including children) frequently correcting the response of another. This method also encouraged the participation of female household members. In conducting the interviews, I displayed the cards and spoke directly with household members while my research assistant recorded responses and insured that all questions listed on the questionnaire were asked.

However, not all data collected during the structured interview was obtained in this manner. For example, questions regarding income from salary, wage labor, contracted work, and social benefits, such as retirement income, maternity salary, health-related benefits, among others, were asked directly rather than through the use of cards. Diagrams were not used in these cases for two general reasons: first, so as not to restrict the potential response of the household, such as the case of wage labor, where a diagram of one activity representing the category in general might restrict the potential response of the household, or potentially leaving out a wage labor activity not previously encountered; and second, some items, such as social security benefits due to health problems or membership in an organization, seemed better posed through a direct question rather than a diagram.
Operationalizing the Variables

To test the hypotheses, variables were constructed to measure net wealth per capita and market integration, as well as household income and income from extraction. Subsequently, the measures for net wealth per capita and market integration were categorized to rank individuals by level of net wealth per capita and market integration to test for differences in cultural knowledge of extractive resources across these measures. Explanatory and dependent variables used in the multivariate regression analysis to test hypotheses H1-H6, along with the ordinal variables used to calculate gamma to test hypotheses H7 and H8 and for employing quadratic assignment procedure (QAP) to test hypotheses H9 and H10, are operationalized below.

The effects of wealth and markets on income

Hypotheses H1 to H6 test for the effects of wealth and markets on household productive income and income from extraction. I hypothesized that as wealth and market integration increase, household income would rise, but that income from extraction, and the percent of productive income from extraction would fall. Variables for the multivariate regression analyses to test the hypotheses were operationalized as follows.

Explanatory variable: net wealth per capita. At the outset of the study, wealth was to be measured by land and non-land assets (Barham, Coomes and Takasaki 1999). Non-land assets would include wealth objects, such as household items, equipment, animals, and structures on the household landholding, such as the house, storage buildings, animal pens, fenced gardens, and fences. In addition, as some families own land and homes as well as other items in the city of Xapuri; these assets were to be included in the wealth measurement. For equipment and inputs, through explicit questions regarding specific objects owned by the household (Demmer and Overman
I would learn the type, quantity owned and used, how acquired, and the year acquired for all items still in use.\textsuperscript{15} I would conduct focus groups with rubber tappers from the research communities (Bernard 1995), to elicit the useful life of household assets and use straight-line depreciation to calculate their present net value (Demmer and Overman 2001). For animals, households were asked the number of animals they owned, both for transportation and production. For structures, households were asked what structures they maintained on their landholding, when they were constructed, materials used, and costs of labor and materials.

Despite pre-testing, collection of data to operationalize wealth in this manner ran into various problems. As an example, for equipment, although families were able to respond with the quantity of each object they owned, recall of when items were acquired, if more than five years in the past, was difficult. In addition, many items were acquired second hand, either purchased or donated. Other items were donated new through local development projects but rubber tappers were unsure of the year they were acquired. Thus use of straight-line depreciation encountered problems.

In addition, straight-line depreciation (i.e., liquidation value) did not capture the productive value of these items to their owners. Therefore, rather than depreciate equipment, I used replacement value for valuing them (Byron 2003, R. Godoy, personal communication). This method over-estimates the liquidation value of rubber tapper wealth holdings, though I believe it is more fitting to rubber tapper productive activities in the forest.

\textsuperscript{15} Households were asked if the equipment they owned was still in use. For example, a household might have 10 machetes, but only three might be used. Therefore, the number of machetes for which information was recorded was for three machetes, not for 10.
Another difficulty emerged in obtaining a value for land. To obtain this information, I asked households how much they thought their landholding was worth should they decide to sell it. One household had purchased the landholding approximately one year prior, and gave the actual price they paid. However, many immediately noted (not surprisingly) that they had no intention of selling their landholdings or moving. Thus, many speculated on what they thought their landholding might be worth, or provided an estimate based on what price it would take them to move. This resulted in inflated values that in many cases were clearly beyond the market value of the landholding. Valuation of land became more complicated with the building of the feeder road into the forest, which has improved access to urban areas. Due to these problems, I did not include a value for landholding. Wealth was divided into three categories: on-farm productive wealth, other on-farm wealth, and off-farm wealth. The total net wealth measurement was divided by the number of household members to calculate the household net wealth per capita. Wealth was measured as follows.

On-farm productive wealth includes:

- **Equipment.** Equipment included the value of 43 items. Equipment was valued at replacement cost based on the average of prices collected at four sellers in the city of Xapuri. For a small number of high-ticket items not found in Xapuri, such as chainsaws and rifles, equipment was valued at average purchase price by study households who purchased these goods in 2001. If stated purchase value was higher than this average purchase price, then the higher stated price was used;

- **Animals.** Animals (except for pigs) were valued at the average farm gate price of each community. If this price was not available, then the animal was valued at

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16 Reserve residents have use rights to resources, not land ownership, so when they purchase landholdings, they purchase the right to resources rather than the land itself. However, rubber tappers in the reserve consider themselves the owners of their landholdings.

17 Non-structural investments on land, such as the planting of perennials, also were not included in the wealth measure. This value would have been reflected in the household’s estimate of land value, which ultimately was not included.
overall average forest gate price. Pigs are sold by weight, not per unit. Thus, pigs were valued by first calculating the average weight of pigs consumed on all landholdings, multiplying this by the forest gate itinerant trader price to get an average pig weight, and multiplying this by number of pigs;\(^{18}\)

- **Productive structures.** Productive structures (not including residence) were valued at actual labor and material costs, or estimated based on like structure and materials. All fencing, regardless of material, was valued at the cost of building the stated meters of fencing in place with sawn wood posts and wire;

- **Stocks of inputs.** Seventeen input items were used to calculate input value. Stock items were valued at replacement costs based on average of prices collected at four sellers in the city of Xapuri, and;

- **Stock of goods.** Stocks of goods for eventual sale were valued at average farm-gate price for the community.

Other on-farm wealth includes:

- **Household structure.** The family residence was valued the same as productive structures, and;

- **Household consumer goods.** Nine consumer goods were valued at replacement cost using the average of prices collected in the city of Xapuri.

Off-farm wealth:

- **Urban wealth.** Urban wealth included land and structures, the value of seven consumer items, and animals held in the city of Xapuri. Land and structures (residences) were valued at stated value. If the owner did not know the value of land, or could not estimate the value, then the land or property was not included. The seven consumer items were valued at purchase price unless the price was not provided. If not provided, the item was valued at the average of prices collected at merchants in the city of Xapuri. Animals were valued at urban market price.

- **Other rural land.** Other rural land was valued at the stated value. Three households share other rural land with relatives but did not know and could not estimate the value of their share. They were not included.

- **Bank Account.** Five categorical replies were possible. The bank account was valued at the lowest value of the category indicated.

\(^{18}\) As pigs are generally slaughtered when they are full grown and fattened to produce a large amount of lard for cooking, this value is greater than the average selling price per pig across all landholdings.
**Explanatory variable: market integration.** Godoy, Brokaw and Wilkie (1998) operationalized market integration using three different measures: the share of rice harvest sold, share of cash income earned through wage labor, and share of income earned from the sale of forest goods. Godoy, Franks and Claudio (1998) measured market integration by rice sales, while Godoy, Wilkie and Franks (1997) used cash income from the sale of both crops and labor as proxy for market integration. Godoy (personal communication) also suggests other measures of market integration, including town-to-village distance, credit received, share of goods sold, and number of days worked for a wage.

I used three different indicators of market integration: 1) proportion of household income from wage labor, measured by cash income received for wage labor over the past 12 months divided by productive income over the past 12 months; 2) proportion of productive income from cash and barter trade, measured by the total value of cash sales and barter transactions over the past 12 months divided by total household income over the past 12 months; and, 3) travel time from household to the city of Xapuri by principal means of transport during the season when travel time is shortest.

**Dependent variable: net household income.** Net household income includes on-farm productive income, off-farm income, social income, and gift income minus hired labor costs earned over the previous 12 months. Focus groups with rubber tappers were employed to elicit rubber tapper valuation of non-traded resources. Categories include the following items and measures.

On-farm productive income includes:
• Basic crops. Basic crops include rice, beans, corn, and manioc flour. Consumption income is community average farm-gate price and trade income is actual value received or cash equivalent of barter good received;

• Animals. Animal income for production and work animals is valued as above;

• Extraction. Extraction items include rubber, Brazil nuts, fruits (7 items used for making fruit drinks), artisan items, medicinal items (23 items), honey, *copaiba oil*, and game.\(^{19}\) Fruit, medicinal items, and game were valued by two focus groups with rubber tappers. Other items were valued as above;

• Plants. Plant items include six perennial crops and other planted items valued by the value received or cash equivalent of barter good received;

• Processed goods. Processed goods include cheese, *rapadura*, a candy made from sugar cane juice, and *goma*, a thick liquid by-product from manioc processing. Cheese was valued by focus group. Consumption and trade income for *rapadura* and *goma* was valued as above.

Off-farm productive income includes:

Skilled and unskilled labor. Salary and wage income were valued as reported.

Other income includes:

• Social income. Income from monthly retirement, physical and mental disability benefits, and maternity benefits were valued as reported.

• Gift income. Gift income was valued as reported.

**Dependent variable: net productive income.** Net productive income was valued as above minus social income.

**Dependent variable: income from extraction.** Income and consumption from non-timber forest resource extraction was measured by the value of barter and cash transactions and consumption of extraction, as defined above.

**Dependent variable: proportion of productive income from extraction.**

Proportion of income and consumption from extraction was measured by the value of barter and cash transactions and consumption of extraction, as defined above.

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\(^{19}\) Fish were not included; pre-testing found that recall for this item was ill suited to the one-shot recall method. Medicinal items includes only forest-extracted medicinal items, not planted medicinal items. Fuelwood is also not included in this measure.
barter and cash transactions and consumption of extractive activities, as defined above, as a proportion of net productive income.

**The effects of wealth and markets on cultural knowledge**

Hypotheses H7-H10 test the effects of wealth and market integration on cultural knowledge of extractive resources. For H7 and H8, I hypothesized that as household wealth or market integration increases, cultural knowledge of individuals and sub-groups of individuals would fall, while for H9 and H10, I hypothesized that the cultural knowledge of individuals and sub-groups of individuals from households more integrated into markets would be different from the cultural knowledge scores of individuals and sub-groups of individuals from households with lower wealth and less integrated into markets. Data on the cultural knowledge of non-timber forest resources were collected through free-lists (Fleisher and Harrington 1998) and pile-sorts (Roos 1998). Free-lists on the domain of non-timber forest products were obtained from the household as a group during the second stage of the study—the first data collection visit. The household was asked, “Can you give a list of things from the forest that you use, except for wood and animals?” The free-lists were elicited at the outset of the structured interview before any questions regarding production or extraction were asked, to avoid response bias by the previous mention of forest resources. From the initial free-lists, 24 items were selected for conducting pile-sorts. Pile-sorts were obtained from household members 13 years and older.\(^\text{20}\) The results of two pile sort respondents were dropped before running the data: one was assisted by another family member, and a second continually observed the

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\(^{20}\) In three cases, younger household members were present and carried out the pile sort activity. In one case, the 12-year old son was assisted by his mother. In another case, a 12-year old daughter repeatedly watched her mother sort the cards and sorted her cards in nearly the exact same manner. In another case, a 10-year old grandson, who had completed the fourth grade, asked if he could carry out the activity. As other children his age were not given the opportunity to participate, his pile sorts were not included.
pile-sorting of another family member. More details regarding the implementation of cognitive methods will be discussed when the results are presented in Chapters 5 and 6.

Pile-sort cards included both a colored pencil drawing of the resource and the written name of the resource. For each participant, cards were placed in front of the individual, one card at a time, with the name of each item read to the sorter as it was placed in on the floor or table. Cards were shuffled after each use. Individuals were asked to place the cards in piles however they wished. They were instructed that they could form as many groups as they preferred—they could have a lot of groups or very few groups. The only two limiting criteria stated were that all cards could not be placed in a single pile, and that all cards could not remain separate. They were also advised that if an item did not have a group, then it could be alone. Respondents were reassured that however they did the assignment was correct—they could not do it wrong. On one occasion, an elderly adult male was unable to carry out the exercise.

Four sets of pile-sort cards were used to work with household members simultaneously to avoid one member viewing the sorting of another member. For households with more than four individuals old enough to undertake the pile-sort activity, it was emphasized that the inclusion of their pile-sorting was important to the study, but that their work could only be included if they did not view the work of other household members. This meant that those waiting usually left the room or area where pile sorting was taking place.

After each household member completed the pile-sort exercise, the individual was asked why he or she had placed cards together in the group, or the “name” of the group.
This information was noted as well as the items sorted together. Results of pile sorts were used to conduct consensus analysis on the domain of non-timber forest resources among the study individuals to identify the degree of agreement of each individual in the sample. Thus, for each individual, a score of estimated knowledge, or degree of cultural competence, was produced.

Hypotheses H7-H10 test the effects of level of net wealth per capita and level of market integration on cultural knowledge. Thus, to test for the effects of wealth on cultural knowledge (H7 and H9) individuals were categorized into four wealth rank groups based on their household net wealth per capita. To test the effects of level of market integration on cultural knowledge (H8 and H10) individuals were categorized into four (or three, in the case of travel time) market integration rank groups.

For hypotheses H7 and H8, level of cultural knowledge is measured by the individual’s consensus analysis score. Individuals were divided into sub-groups, including household heads, males, females, and three age categories (youth, young adults, and adults) to examine like individuals across levels of wealth and market integration. Individuals in each sub-group were then ranked by their consensus analysis score and categorized into two groups, one with the highest knowledge scores (top 50 percentile), the other with the lowest knowledge scores (lowest 50 percentile).

For hypotheses H9 and H10, individuals were categorized into sub-groups as noted above, and the results of the pile sort test were used to conduct QAP analysis to test for

21 In recording the results of pile sorts, if the respondent could not indicate the purpose for grouping items together into piles, i.e., unable to explain the rationale for creating most or all of the sorted groups, this was noted in the field book. The results of these individuals were eventually included in the study after running consensus analysis and finding that all received a positive consensus score.
differences in cultural knowledge across rank levels of net wealth per capita and market integration.

**Data Analysis**

Hypotheses H1 through H6 were tested employing multivariate regression analysis using the SAS® software package. Four models were tested, using the four dependent variables noted above. Each model included the independent variables for net wealth per capita and market integration. For the market integration, proportion of income from off-farm labor, the variable was categorized into four rank categorical variables. Dummy variables were then used for market rank categories 2, 3 and 4, while category 1 served as the intercept base, representing no income from off-farm labor. This was done, as the dependent variable in model 3, percent of productive income from extraction, must by definition go to 0 as percent of productive income earned from off-farm labor goes to 1.0. Ranking and categorizing the variable eliminates this problem. This same variable in its dummy form was used in all four models for consistency. In addition to the explanatory variables, control variables were also included. These are presented and operationalized in Chapter 6.

Hypotheses H7 and H8 were tested by calculating the non-parametric statistic gamma using SPSS® software package. Gamma is used to measure directional differences in the relationship of two ranked variables. As noted above, variables for net wealth per capita and market integration, as well as the measure of cultural knowledge, individual consensus analysis scores, were ranked and categorized. Hypotheses H9 and H10 employed QAP analysis using the Anthropac® software package (Borgatti 1996a). This software was used for all the cognitive methods analysis, including analyzing the
free-list and pile sort data and the subsequent use of hierarchical cluster analysis and multi-dimensional scaling.

Finally, all values in this dissertation are reported in Brazilian Reais, rather than converted to U. S. Dollars. The conversion rate when the economic data was collected in the fall of 2001 was approximately R$2.55 per U.S.$1.00.

**Conclusion**

Many of the rubber tapper households in this study participated in the *empates* to prevent ranchers from cutting the trees on their landholdings. Their fight to protect their livelihoods in the forest led to the establishment of the Chico Mendes Extractive Reserve. With the recent election of the “forest government” the rubber tappers now have an ally at the state level. The rebuilding of the feeder road into the reserve and the Chico Mendes Law are examples of a government policy attempting to assist rural families, providing better access to markets and build the economy on the region’s natural resources. Now, in collaboration with the “forest government” they are trying to identify new production activities to diversify and raise incomes.

This study will analyze the economic activities of 46 rubber tapper households in the Chico Mendes Reserve. Through the use of microeconomic and cognitive anthropological methods, I examine how economic forces may be shaping rubber tapper livelihoods in the reserve. In the following two chapters, Chapters 3 and 4, I analyze the rubber tapper economy, examining how wealth and integration into markets may be shaping household income, and more specifically income from extractive activities. In Chapters 5 and 6, I then turn to examine how wealth and market integration may affect rubber tapper cultural knowledge of extractive resources. In Chapter 7, I conclude the
discussion by examining the implications of these findings for conservation and development in the reserve.
CHAPTER 3
THE RUBBER TAPPER HOUSEHOLD ECONOMY

It must have been about 4:00 a.m. when Francisco awoke. He lit the wood-burning mud stove and filled a pan with water, and placed it on the stovetop to heat it for coffee. My research assistant and I twisted in our hammocks and attempted to fall back asleep. The radio went on. Music blared through the heavy crackle of static as Francisco tuned the radio: the signal faded in and out as it tried desperately to reach the twisted piece of wire that served as an antenna that ran from roof of the house to the radio on the dining room table. It seemed loud enough to be heard for miles across the forest, maybe even at the neighbor’s landholding, about two or three miles away. We were sleeping in the kitchen as the thatch roof of the large front porch where we would normally sleep was filled with holes and slowly falling apart. It had looked like rain the night before and Francisco and his wife Renata had insisted that we sleep in the kitchen. They had put off the much needed re-thatching of the roof because a new house was to be built. The wood to make the house had already been cut, the sawn timber planks stacked orderly in the clearing. Wooden shingles, or carvaco, for roofing, had also been cut and were ready.

Nonetheless, it would be a few months before it would be built. Francisco was counting on help from his three sons to build the house, one a carpenter with house-building experience. However, it was not so easy to get them together. His oldest son still lived in the forest, in fact he lived on the same landholding which was now divided, but he now worked as a technical assistant for SEFE, assisting in the recently implemented copaiba oil extraction, part of the government’s efforts to diversify the
extractive economy. As a result, he was often traveling for days at a time. A second son was living in the city of Xapuri with his wife and child, studying for his high school degree and working for a small cooperative of *para-florestais*, rubber tappers trained as extension agents, in which he was a founding member. A third son, while still living in the forest, often worked for day wages at an uncle’s small farm on the Petropolis Road. He also worked on the labor crew that was building the feeder road that stretched from Xapuri to the Community of Rio Branco and was now being extended to the community center of São João de Guarani in the Boa Vista forest area. Eventually the house was built, months after the boards were cut and stacked.

Francisco was up early each day, either to head out to work in the *roçado*, or manioc field, to pull manioc for making *farinha*, or manioc flour, to hunt, or some combination of the two; manioc fields are a prime hunting spot for *paca*, a large forest rodent that in most rubber tapper homes is a staple part of the diet. The sale of manioc flour was now one of numerous activities in the household’s diverse income basket, which also included the occasional sale of a young steer or cow, or transport animal, the collection of Brazil nuts, and wage labor. Francisco had tapped rubber for years, even while neighboring households had given up this activity. However, he had recently stopped tapping rubber due to health problems. None of his sons tapped rubber (although all had when they were younger) and none had any plans to return to this activity, though his middle son now living in Xapuri sometimes talked about it when work was hard to find. However, now wages, both in the forest and in the city, were attracting their labor.

The household economy in the forest is changing: a wage labor opportunity appears with new development projects, the price of an agricultural product improves, savings
allow for the purchase of a cow, a son stops tapping rubber to work at a nearby farm or ranch. Together these changes are reshaping the rubber tapper household economy.

This chapter and the following explore the economic changes taking place in the Chico Mendes Extractive Reserve by examining the rubber tapper household economy. More specifically, I analyze the diverse wealth holdings and market-oriented activities—including product trade and off-farm labor—of rubber tapper households and how they are shaping household income, and more specifically income from extractive activities. I begin by briefly examining a few previous studies on the rubber tapper household economy conducted in the reserve. This is followed by general discussion of household demography, to introduce the study families. I provide this information as recent research in the reserve (Campbell 1996, Gomes 2001, Weigand 1997, Souza 2001) has focused less on the demographic makeup of rubber tapper families, which also reveals changes in the forest household.

I then turn to examining in detail the diverse wealth holdings of rubber tapper households, analyzing not only the varied ways that households invest capital in their landholdings in the forest, but also in the city. This includes exploring investments oriented toward both production as well as consumer goods. The variation in household wealth holdings is much greater than meets the eye as one initially enters reserve landholdings. Among the 46 households in this study, wealth holdings varied from approximately R$740.00 to R$41,000.00, the wealthiest household holding over 50 times the wealth of the poorest household. Although this highest figure is not typical in the reserve, it demonstrates the ability of forest households to generate substantial wealth in the forest. Further, and more importantly, I consider how household investments change
as household wealth grows. I argue that while households with greater wealth holdings invest a greater proportion of wealth in consumer items, they also undertake investments that are more associated with deforestation, including cattle production and construction of landholding structures that support this activity, such as fences and corrals. Thus, household accumulation of wealth in the reserve will likely pose challenges to the current reserve management plan that places limits on land clearing for agricultural activities, and more specifically pasture for cattle grazing.

The second half of this chapter examines rubber tapper income earning activities. I examine the diverse sources of income both from on-landholding production as well as from off-landholding labor activities. On-landholding, I consider the various production activities undertaken for both consumption and trade. Here I concentrate in particular on the role of extraction in both household consumption and trade, considering not only the value that traditional extractive products, such as rubber and Brazil nuts, add to household income, but also how medicinal products, vines, wild fruits and game contribute to household consumption. I argue that extraction remains an important activity for all reserve households, even among the most wealthy. Yet, the importance of specific income-earning activities, including extraction, changes as wealth grows. Indeed the diversity in annual productive income among study households, ranging from approximately R$1,650.00 to R$11,200.00 suggests that households are undertaking very different livelihood strategies. Within this discussion I analyze the role that off-farm labor activities play in household income, laying out the diverse off-farm income earning activities that rubber tappers undertake. These include both salaried positions with the
state, as teachers and health agents, as well as both skilled and unskilled wage and piece-meal positions.

I also explore very briefly the trading patterns of rubber tapper households, with a particular focus on the trade of rubber and how trade patterns have changed with the implementation of the state rubber subsidy. In comparing the findings of this study with data collected with many of the same households in 1996, I find that the subsidy has had a tremendous effect on trading patterns in the forest. Yet, the subsidy has not translated into increased rubber production, or the retaking of this activity by households that had abandoned it by 1996. Indeed, rubber production among 28 households fell dramatically over this five-year period.

In the following chapter I bring together the discussion of rubber tapper wealth and income by responding to the key questions that drive this study: how do wealth and integration into markets, both through the undertaking of trade and off-farm labor activities, affect household income, and more specifically income from extractive activities?

**Recent Household Economy Studies in the Chico Mendes Extractive Reserve**

Despite the importance the concept of extractive reserves holds for conservation and development in the Amazon region, we still know little about the livelihoods of the rubber tappers who live there and how they are changing. This lack of research leads us to cling to the images of the rubber tapper household economy found in historical accounts of the rubber boom period (Dean 1987, Weinstein 1983) and the post-World War II period (Allegretti 1979), with the rubber tapper plying his trade in the forest, tapping rubber trees and selling his production to his patrão, or patron, itinerant traders or commercial establishments in the city (always being exploited), growing rice, beans, and
manioc, and hunting wild animals. These images themselves are often found in the local media in Acre, with local newspapers publishing photos of a rubber tapper using a *porongas*, a headlamp, made of metal with a kerosene flame serving as a light. The *porongas* used to be standard equipment for rubber tappers, who would head out before sunrise to begin tapping rubber, a flickering flame lighting the way. The *porongas* is now long retired from use by most rubber tapper households. Among the 46 households in my study, only three households reported that they own one, and only two said they actually used it. Some residents smiled and chuckled softly when I asked them if they owned one.22

Although this traditional image of the rubber tapper remains strong, a few recent studies have begun to shed light on the changes taking place in extractive reserves in Acre, and more specifically the role that the extraction of forest products has played in the household economy over the last decade. Campbell (1996) conducted research in two communities (approximately 25 households total) located in the Chico Mendes Extractive Reserve and the Chico Mendes Agroextractive Settlement (commonly referred to as Cachoeira) in 1991 and 1994. She found that in both 1991 and 1994, Brazil nuts contributed, on average, more to household income than rubber and the sale of agricultural crops. Mean income from the sale of rubber fell considerably over this 3-year period, from approximately $292.00 to $93.00. For households where the male or female head of household was employed by the CAEX Brazil nut project, either by the in-forest mini-Brazil nut processing factory, or in a household level processing unit,

22 *Porongas* ultimately were not included in the wealth measure for equipment. Despite searching at numerous businesses, including CAEX, in Xapuri, a *porongas* could not be found to a value it. Assuming we could find one in Xapuri, we did not ask any of the three households that owned one the purchase price.
employment contributed on average $361.00 to income in 1994 (Campbell 1996: 124). For these same households, she found a significant difference in average household income from 1991 to 1994, growing from $656.00 to $1,363.00.

But while Campbell’s research showed the generous contribution that Brazil nuts can make to household income (for those who have them), through collection and selling, as well as the creation of employment opportunities, it also suggested a declining interest in rubber production. From 1991 to 1994, rubber’s contribution to household cash income fell from 45.0 % to 17.0 %. The number of households that did not tap rubber increased from 2 of 23 to 6 of 21 households (Campbell 1996: 111).

Hence, while Campbell’s research documented the substantial impact of the Brazil nut project on the income of some rubber tapper households, principally in the form of creating wage labor opportunities for forest households, but also from collection and sale of the nuts themselves, it also highlighted the effects of the falling price of rubber. Rubber tappers were beginning to seek other income sources, including the production and sale of other extractive or agricultural products, and off-farm wage and salaried labor.

In a more recent study carried out under the UFAC project, Análise Econômica dos Sistemas Básicos de Produção Familiar (ASPF) (Economic Analysis of Basic Systems of Family Production) in the Chico Mendes Extractive Reserve in 1996, Castelo (2000) examined reserve households through an economic lens, including wealth, and in particular, production income and costs, and compared these figures with urban-based

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23 Campbell conducted her research in two communities where Brazil nut trees are found. In particular, one community in the Chico Mendes Agroextractive Settlement is known for its large Brazil nut production. There are a number of areas within the Chico Mendes Reserve where Brazil nut trees are not found.
wages. Among the 67 households in the study, average household wealth totaled approximately R$4,203.00, the largest portion of wealth, R$1,990.00 or 47.3 %, coming from production animals (i.e., cattle, pigs, chickens, etc). Also important to household wealth status were landholding structures, valued on average, R$784.00, 18.6 % of total wealth, and products in stock, R$752.00, at 17.9 %. (Castelo 2000: 61).

In terms of income, market-based income before subtracting production costs averaged approximately R$1,912.00 per year, 8.2% greater than the minimum salary (including the 13th salary) of urban workers (Castelo 2000: 62). Subtracting production costs (including labor), income falls to R$138.00 per year, a figure equal to approximately 8.0% of the minimum wage figure. Only 51.0 % of households had a positive net income (Castelo 2000: 61). The value of goods produced for household consumption was, on average, R$2,449 per year with a total income in monetary terms of R$4,163. Using these figures, which totaled the equivalent of 1.4 and 2.5 times, respectively, of the minimum wage, he argued that the income of rubber tappers in the forest (including consumption values) compares favorably to that of urban workers living in the periphery of the city.

In another study drawn from the ASPF project, Souza (2001) calculated the median gross annual income of extractivists in the Chico Mendes Reserve at R$1,600.00. (Souza’s model does not include consumption as part of income). However, total production costs amounted to R$1,980.00, making reserve households, on average, income-losing ventures (Souza 2001: 6). Souza found that 63.0 % of extractivist households were operating at a loss. These households, unlike those that maintained a profit, gained a higher percentage of their income from extractive activities, 48.0 %, than
agriculture and animal husbandry. Households that had a positive income maintained a more even distribution of income across various production activities, which include extractive activities, totaling 35.0%, agriculture, at 37.0%, and animal husbandry at 28.0%. He argued that for extractivists to increase their income, they will have to pursue more environmentally destructive agricultural and cattle raising activities. This trend was reported in the Projeto Resex Report (2000, cited in Souza 2001: 8), with the portion of household income from animal husbandry in the reserve growing from 7.5% in 1992 to 27.0% in 1998.

Each of these studies has contributed to our understanding of the socio-economic changes now taking place the Chico Mendes Extractive Reserve. They all point to a decreasing dependence on rubber as a source of cash income. Souza’s study argued that agriculture and cattle are becoming more important to household income, and households that gain their greatest share of income from extraction are operating at a loss, and thus are the least efficient. Yet, Campbell’s study revealed the important role that Brazil nuts can play in raising incomes through both extraction and employment. Missing, however, is an understanding of the consumptive role that extractivism plays in the household, principally in the form of hunting and medicinal plant use. Further, by testing specific hypotheses regarding wealth, markets, and income, we can better understand the forces that may be driving changes in rubber tapper households, and in particular, forest resource use, among poor and wealthy families, and households more and less integrated into product and labor markets. This and the following chapter help fill this information gap, examining in detail the role of wealth and markets in shaping rubber tapper
productive activities, and in particular, extractive activities. I now turn to presenting a model of the rubber tapper household economy

**A Model of the Rubber Tapper Household Economy**

Although much has been written about the rubber tapper economy, and in particular the aviamento system that reigned over this economy at the turn of the 20th Century, lacking is a more recent and detailed picture of the rubber tapper household economy. Figure 3-1 below is a diagram of the rubber tapper household production system. Household demographic characteristics, including number of household members, age, sex, health and education level (formal and informal)\(^{24}\) of both children and adult members determine the level of household labor available. These factors influence both the quantity and type of household labor available, i.e., skilled or unskilled. The resource base, access to credit, household debt, technical and extension service available, and wages for off-farm income will influence how households allocate labor. For example, if a landholding does not have Brazil nut trees, then labor would not be allocated to the collection of Brazil nuts, at least as an on-farm activity. However, household labor could be sold off-farm to work in the collection and cracking open of Brazil nuts on another landholding. This model focuses primarily on the economic activities that households may undertake in the forest; it does not lay out the various social relations, such as religious affiliation, family networks or social organization membership (CAEX, AMOREX, STR (Rural Workers’ Union)) that might potentially influence household economic activities. However, data on membership in social organizations were collected and will be introduced into the statistical analysis as a control factor in the

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\(^{24}\) Informal education includes short training courses periodically offered both in the reserve and in the city of Xapuri.
regression models at the end of the chapter. In addition to productive income activities, twelve rubber tapper households received monthly government social payments through retirement programs such as: FUNRURAL, a special program for rural workers; soldado do borracha, a special retirement program for rubber tappers who arrived in the Amazon region to tap rubber during or shortly after WWII; and, benefits for physically and mentally handicapped persons in the household. Each of these programs provides the beneficiary one minimum salary each month of the year, except for the soldado do borracha program, which provides two minimum salaries per year. To collect this benefit, the recipient must travel to Xapuri on a designated day each month. All the beneficiaries, except for those who receive the soldado do borracha retirement salary, also receive what is termed a “13th” salary, which is paid at the end of the year. In addition, five households in the study noted that they received the salário maternidade, or maternity salary, benefit. This benefit, often provided through three or four monthly installments, but in some cases as a lump sum, is paid to women who give birth. Total maternity payments in this study ranged from R$514.00 to R$724.00. Many households indicated that this benefit was particularly difficult to obtain due to administrative processes and documentation required.

As portrayed in the diagram, households may allocate available labor to on-farm or off-farm activities. Salaries and wages paid for both skilled and unskilled labor will influence whether households supply labor to the off-farm salaried and wage labor market. On-farm labor has been broken down into five main production activities: Basic food crops (rice, beans, manioc, corn), farm animals (i.e., chickens, pigs, ducks, goats, sheep, cows), extractive resources (rubber, Brazil nuts, artisan-craft production,
Figure 3-1. Model of Rubber Tapper Household Economy.
hunting and other gathering activities), agricultural processing activities (such as making *goma*, a think gummy liquid that is a by-product of making manioc flour), and other planted crops, (i.e. coffee, banana, tobacco). Households can consume production, donate production to neighbors, or sell or barter output with a number of market outlets. In the forest, these trade outlets include other rubber tapper households, itinerant traders, and cooperative trading posts. In the city of Xapuri, they may sell to CAEX, commercial trading houses, itinerant trader commercial houses, restaurants, private homes, and government or non-government organizations. Together, both on-farm productive activities and off-farm labor activities contribute to total household productive income. I will discuss the trading system in greater detail below.

I now turn to laying out basic demographic data of the 46 reserve households included in this study. I begin by providing basic demographic data on household members, also considering from where residents arrived and the length of time household heads have been on landholdings. I also provide a brief discussion of education in the reserve and household membership in social organizations that provide social as well as economic support to rubber tappers. I caution that these figures are averages, and averages tend to obscure the diversity and uniqueness of each household. As noted above, this is not a random sample of households. Where appropriate, I include data on range and standard deviation to show the variation among households often hidden among averages. This said, based on my own experience working in the reserve and knowledge of rubber tapper households both in the study region as well as other areas I

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25 Itinerant traders buy and sell both in the forest and at trading houses in the city of Xapuri. For transactions in the city, they pay a higher price for products and sell supplies at lower prices in comparison to transactions at the landholdings of rubber tappers in the forest.
have visited, there is no reason to believe that the demographic data are not, in general, similar to what might be found through a random identification of households.

**The Rubber Tapper Household: A Demographic Portrait**

Rubber tapper households are diverse. Demographically, they differ in terms of family size, age of household heads, and education level. And although a great majority of study household heads has lived in the region since birth, they differ in terms of where they arrived from and how long they have lived on their landholding. They also vary in terms of how large a landholding they maintain, and even how they use their land. Differences extend to the social organizations to which they belong.

In the following pages I present a basic demographic portrait of the 46 households in the study. The purpose of this discussion is to provide a general idea of whom exactly I am talking about—literally—when I refer to a rubber tapper household. And while I provide averages in summarizing the data, ranges have also been included, and should be considered as important as the averages. Indeed, with more children (and adults) studying, some young adults leaving for the city to study or work, landholdings being divided to accommodate the many who stay, what is a rubber tapper household seems far from a statistical average, but rather a diverse mix of men and women, boys and girls, most sharing a similar history, although engaging with the forest and urban world according to individual means, as well as hopes and dreams.

**Age and Sex of Household Members**

Table 3-1 presents data on the age of household heads, sex and number of household members among the 46 households in the study. I consider both the oldest male and female as household heads (except in one case where the oldest female was 91 and nearly bedridden) as both carry out critical duties for the functioning of the
household and landholding. Two households had no females living permanently in the family home. *Meieros*, or hired hands that worked at the landholding tapping rubber, receiving 50.0% of the value of the rubber they collect, were not included as household members, even though they ate and slept at the house for at least part of the year. They were not included, as they do not share any of the return that they receive from collecting rubber with the rest of the household.

Table 3-1. Age of household heads, number of household members, sex, and years of residence on landholding for 46 rubber tapper households.

<table>
<thead>
<tr>
<th>Description</th>
<th>Mean</th>
<th>Range</th>
<th>Standard deviation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age of male household head</td>
<td>42.9 years</td>
<td>18 to 74 years</td>
<td>14.6</td>
</tr>
<tr>
<td>Age of female household heada</td>
<td>35.6 years</td>
<td>16 to 61 years</td>
<td>12.1</td>
</tr>
<tr>
<td>Total household members</td>
<td>5.7 members</td>
<td>1 to 15 members</td>
<td>2.6</td>
</tr>
<tr>
<td>Male household members</td>
<td>3.2 members</td>
<td>1 to 8 males</td>
<td>1.7</td>
</tr>
<tr>
<td>Female household members</td>
<td>2.5 members</td>
<td>0 to 8 females</td>
<td>1.6</td>
</tr>
<tr>
<td>Years male household head on landholding</td>
<td>14.1 years</td>
<td>0 to 37 years</td>
<td>10.5</td>
</tr>
<tr>
<td>Years female household head on landholdingb</td>
<td>11.3 Years</td>
<td>1 to 37 years</td>
<td>7.9</td>
</tr>
</tbody>
</table>

Notes: aOnly 43 households had a female head of household; bData missing for total of 6 households, not including 3 households with no female head.

The average age of the male head of household was 42.9 years, while the average age of the female household head was 35.6 years. Age of the male household head ranged from 18 to 74 years of age, while that for the female head was 16 to 61 years, demonstrating the diversity of lifecycle stages among forest households. The average number of household members was 5.7 members, although variation was considerable, with a range of 1 to 15 persons. The household with the greatest number of members was an extended family, with grandchildren making up part of the household. However, two nuclear family households had 11 members, each made up of two adult parents and nine children. The average number of male household members (including the male head of household) was 3.2 members and the average number of females was 2.5 members. The
number of male members ranged from 1 to 8 members, while number of females ranged from 0 to 8 members.

The average number of years of residence of the male household head on the landholding was 14.1 years, with a range of 1 to 37 years. For females, residency averaged 11.3 years with a range from 1 to 37 years. Table 3-2 below shows the previous residence of the male and female heads of household. The most frequent prior location was another landholding within the same seringal, or forest area. Two-thirds of all male and female household heads had a prior location of residence in a rural area within the municipality of Xapuri (the first three categories in Table 3-2), indicating that movement within the forest was local and also rural to rural. Six male heads of household have resided at the same landholding since birth. Only two females were born on the landholding where they currently reside. Seven male and eight female heads came to the landholding from an urban area.

Table 3-2. Previous residence of male and female heads of household.

<table>
<thead>
<tr>
<th></th>
<th>Same landholding</th>
<th>Other landholding in Forest Area</th>
<th>Other landholding in Xapuri</th>
<th>Other landholding outside Xapuri</th>
<th>Urban area</th>
<th>Farm in colonist settlement area</th>
</tr>
</thead>
<tbody>
<tr>
<td>Male household head</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>6 (13.0%)</td>
<td>18 (39.1%)</td>
<td>7 (15.2%)</td>
<td>3 (6.5%)</td>
<td>7</td>
<td>3 (6.5%)</td>
</tr>
<tr>
<td>Female household head</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>2 (13%)</td>
<td>20 (43.5%)</td>
<td>5 (10.9%)</td>
<td>3 (6.5%)</td>
<td>8</td>
<td>3 (6.5%)</td>
</tr>
</tbody>
</table>

Notes: aTwo cases missing. bThree households did not have a female head of households and two cases are missing.

Just as many families have lived on the same landholding for years, households also maintain strong family ties in forest areas. Of the 46 study households, 19, or 41.0% have a second family living in a separate structure on the same landholding. This figure does not include landholdings that are essentially one landholding that has been
subdivided, with children now residing on these subdivided holding, and where household members are only a few minutes apart. I consider these as separate landholdings, having been subdivided many years ago and each with its own rubber trails. Thirty-nine, or 85.0% of households have another family member living in the same forest area. Fifteen landholdings had patrilineal relationships, where a son lives on the divided landholding of his parents. A matrilineal relationship, where the daughter resides on the divided landholding of her parents, was found on two landholdings.

**Education in the Forest**

Education in the forest centers on the primary schools found in each of the three study communities. Formal education was largely unavailable for many rubber tappers of previous generations, although many forest communities now have elementary education. Students begin schooling in what is referred to as *alfabetização*, or beginning literacy, similar to kindergarten. Upon completion of basic literacy, students begin *primeiro grau*, or primary education. In each of the three research communities, students can study up until the *quarta serie*, or fourth grade. Education beyond the fourth grade must be completed in the city of Xapuri, requiring students to move to the city. In the forest, literacy and grade school are taught separately. However, first through fourth grade

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26 Subdivision of landholdings is becoming more common in the three communities in the reserve where the research took place. As children of households begin their own families and either cannot afford to purchase a landholding or there are no landholdings empty, or for sale, near their parent’s landholding, parents allow a child to build a home and allocate a set number of rubber trails for the new household to tap. In some cases, the new household grows its own basic crops while in other cases the households share labor duties for one crop area. Some landholding were divided years ago and are now essentially separate landholdings even though households from the same family may occupy these adjoined landholdings. However, others have only been divided only in recent years. In these cases, I consider the households to live on the same landholding.

27 In a third case, the daughter arrived first and her parents arrived a couple of months later.

28 It is important to note that not all communities or forest areas in the reserve have schools.
grade are taught together in one classroom. Students are required to pass an exam to complete each level of schooling. Each of the study communities also has begun an adult literacy program where enrolled adults study two days per week. This is held on the weekends to facilitate adult participation. Additional teachers were recruited from within the communities to teach adult literacy classes.

Professors in the schools are generally from the community where the school is located. However, recently the community of Rio Branco has the assistance of a young woman professor who travels from Xapuri on Sunday and remains in the community until Thursday afternoon. The number of students in this community grew to over 60 students, too large for a single professor to conduct class, thus a second professor was needed. The construction of the new feeder road to the Rio Branco community center provides excellent access during the dry season when school is in session. Residents of Rio Branco noted during the study that they hope to gain approval for primary education through the eighth grade, or completion of *primeiro grau*. Some suggested that with the improved feeder road, the municipality or state could provide daily transportation service—picking up students in the morning and dropping them off in the evening—which would allow students to study in the city of Xapuri, eliminating the need for youth to live in the city. The cost of sending a child to the city to study can be substantial, not only in terms of lost labor, but also due to the costs of maintaining them in the city. Parents also indicated that many who do study in the city do not want to return to the forest as they become accustomed to an urban lifestyle.

Education level among household members varies considerably across households. Labor needs at home and distance to school prohibit some students from studying. In the
community of Rio Branco, school is held four days per week, while in São João de Guarani and Terra Alta school is held three days per week. Table 3-3 details literacy and formal education levels among study households. Over half of both male and female heads of household indicated that they were able to read and write or had completed formal literacy training. Approximately one-third of male and female household heads have received formal schooling beyond literacy. Sixteen households have no adults (16 or older) with literacy or formal schooling. All households that have children 8 years or older indicated that they have at least one child who is studying or has completed one year of formal schooling.

Table 3-3. Literacy and formal schooling of male and female household heads.

<table>
<thead>
<tr>
<th>Proportion of All Households</th>
</tr>
</thead>
<tbody>
<tr>
<td>Male household head is literate (self-stated)</td>
</tr>
<tr>
<td>Female household head is literate (self-stated)</td>
</tr>
<tr>
<td>Male household head has formal education beyond one</td>
</tr>
<tr>
<td>year of literacy training</td>
</tr>
<tr>
<td>Female household head has formal education beyond one</td>
</tr>
<tr>
<td>one year of literacy training</td>
</tr>
<tr>
<td>At least one child 8 or older studies or has studied</td>
</tr>
<tr>
<td>Households with no adults with education</td>
</tr>
</tbody>
</table>

Notes: a Three households have no female head of household. b Only 33 households have children 8 years of age or older, a general age when children begin to study.

Table 3-4 on the following page provides a breakdown of the maximum level of education completed by at least one household member. Two households do not have a literate household member, while basic literacy is the maximum level of education for 11 households. Nineteen households have a member who has completed the 4th grade, the maximum one can complete in the forest, while only seven households have a current member that has completed at least one year beyond 4th grade. This suggests that

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29 Each household member was asked the highest level of education that they had completed. Although some members have not received formal training, they are able to read and write. Conversely, some household members who have attended schooling for literacy may be unable to read and write. No further questioning or testing was done to confirm the validity of each household member’s response.
households would likely benefit from the provision of additional years of schooling in the forest. The average number of years of education beyond literacy per household member 8 years or older for all 46 households was 1.59 years.

Table 3-4. Maximum level of education completed by study households.

<table>
<thead>
<tr>
<th>Maximum Level of Education Completed by Current Household Member</th>
<th>Proportion of All Households</th>
</tr>
</thead>
<tbody>
<tr>
<td>Non-literate</td>
<td>2/46</td>
</tr>
<tr>
<td>Basic literacy</td>
<td>11/46</td>
</tr>
<tr>
<td>1st Grade</td>
<td>2/46</td>
</tr>
<tr>
<td>2nd Grade</td>
<td>2/46</td>
</tr>
<tr>
<td>3rd Grade</td>
<td>3/46</td>
</tr>
<tr>
<td>4th Grade</td>
<td>19/46</td>
</tr>
<tr>
<td>5th Grade</td>
<td>1/46</td>
</tr>
<tr>
<td>7th Grade</td>
<td>2/46</td>
</tr>
<tr>
<td>Jr. High</td>
<td>3/46</td>
</tr>
<tr>
<td>High School</td>
<td>1/46</td>
</tr>
<tr>
<td>Total</td>
<td>46/46</td>
</tr>
</tbody>
</table>

Landholding Size and Land Use in the Forest

Table 3-5 on the following page details landholding size and use, in hectares, among study households. The size of household landholdings is based on the number of rubber trails it contains. Rubber tappers noted that each rubber trail is loosely equivalent to 100 hectares of land area, and I have used this measurement in calculating landholding size. Among study households, landholding size ranged from 200 to 1,400 hectares. The mode landholding size was 300 hectares, with 18 households indicating that they have three rubber trails.

Four principal categories of land use include basic crops, pasture, plantation/agroforestry perennial production, and fallow. The basic crops category includes area planted for rice and beans, as well as other crops such as corn and manioc root. Only one household did not plant basic food crops in the 12 months prior to data collection, which took place in September 2001. This household was a single male who had spent

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30 One hectare is equivalent to approximately 2.5 acres.
considerable time during the year in the city of Xapuri. Two households noted that they did not have pasture on their landholdings. Fifteen households noted that they did not have an area designated for perennials.

Table 3-5. Landholding size and land use type in hectares in 2001.

<table>
<thead>
<tr>
<th>Land Use</th>
<th>Mean</th>
<th>Mode</th>
<th>Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>All Households</td>
<td>545.65 ha</td>
<td>300 ha</td>
<td>200-1400 ha</td>
</tr>
<tr>
<td>Landholding size</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Basic crops&lt;sup&gt;a&lt;/sup&gt;</td>
<td>1.75 ha</td>
<td>1.0 ha and 2.0 ha&lt;sup&gt;b&lt;/sup&gt;</td>
<td>0.00 – 9.00 ha</td>
</tr>
<tr>
<td>Pasture</td>
<td>4.30 ha</td>
<td>2.0 ha</td>
<td>0.00 – 19.20 ha</td>
</tr>
<tr>
<td>Fallow</td>
<td>8.37 ha</td>
<td>2.0 ha and 10.0 ha&lt;sup&gt;c&lt;/sup&gt;</td>
<td>0.00 – 30.00 ha</td>
</tr>
<tr>
<td>Plantation/ Agroforestry</td>
<td>.40 ha</td>
<td>.35 ha</td>
<td>0.00 – 3.00 ha</td>
</tr>
</tbody>
</table>

Notes: <sup>a</sup>Data for two households have been dropped from this calculation. One household indicated it had 72 hectares of crops planted, while another indicated 17 hectares of crops planted. <sup>b</sup>Nine households stated 1 hectares and 2 hectares. <sup>c</sup>Five households stated 2 hectares and 10 hectares.

It is important to note that the planting of perennials in the reserve has been encouraged by two important projects, the Islands of High Productivity Project (IAP) and the Vai Quem Querzinho Project. Some households in the communities of Rio Branco and São João de Guarani have participated in both of these projects, receiving technical assistance as well as equipment from project sponsors. The IAP project was implemented in a number of forest areas in the Chico Mendes Reserve, including the Floresta forest area where nearly all households from the community of Rio Branco reside. This project, initially implemented by agronomists at the UFAC Zoobotanical Park and subsequently adopted by the state government, involves the planting of rubber tree saplings produced from seeds selected from high yielding adults in a consortium with other tree species in high-density plots (Kageyama 1991). The objective of the project is to increase rubber production through high-density plantings, thus increasing production (and income) of forest households, while at the same time dramatically reducing labor costs. Consortium plantings are designed to reduce attacks from disease and insects.
A second project, the Vai Quem Querzinho Project, funded by the Norwegian Rainforest Foundation, is based in the reserve at a landholding called Vai Quem Querzinho, centered among households in the communities of Rio Branco and São João de Guarani. Households from both communities have participated in the project, a sustainable development initiative focused on encouraging households to adopt agricultural technologies, such as the use of agroforestry, to reduce slash and burn agriculture in the reserve (Evaluation Report, n.d.). As with the IAP project, participating households have received technical assistance and equipment through participation. Thus households in the communities of Rio Branco and São João de Guarani have received outside encouragement and incentives for the planting of perennial crops, as well as equipment, such as machetes, hammers, post-hole diggers and saws.

Social Organizations in the Forest

In Chapter 2, I noted the role that social organizations have played, and continue to play, in supporting rubber tapper livelihoods both socially and economically. In Xapuri, the three principal organizations that support rubber tappers are AMOREX, CAEX and STR. Although these organizations, in general, work toward improving the livelihoods of all rubber tappers in the region, they also provide membership services. For example, membership in CAEX provides members a slightly higher selling price for rubber and Brazil nuts. Members in all three organizations have voting rights for choosing leaders and, in the cases of AMOREX, for establishing management practices for reserve residents.

The oldest of these organizations is the STR, begun in the 1970s to ally rubber tappers against ranchers encroaching on their lands (Costa Sobrinho 1992). CAEX was founded in 1988 to help rubber tappers earn a better price for rubber and Brazil nuts, as
well as provide basic supplies at lower prices than those offered by itinerant traders and trading houses. AMOREX was founded with the establishment of the Chico Mendes Extractive Reserve in the early 1990s, providing a voice for reserve residents living in the municipality of Xapuri and serving as a liaison between the federal government and rubber tappers. Membership in an association or cooperative is required in order to receive the state rubber subsidy. Membership in AMOREX and STR require annual payment of dues, R$12.00 and R$24.00 (R$2.00 per month) respectively, while membership in CAEX requires a one-time payment of R$100.00 or equivalent in kilos of rubber, to be returned to the member should they decide to leave the organization.\textsuperscript{31} Forty-two of the 46 study households are members of at least one of these organizations: 35 are members of AMOREX, 26 are members of CAEX, and 34 are members of STR.

The above discussion has provided a general demographic picture of the rubber tapper households in the study. I now turn to discuss the central questions of this study, how wealth and markets influence income-earning activities of rubber tapper households. I begin with a description and analysis of household wealth holdings, followed by a discussion of income. I conclude the chapter by bringing the two topics together to respond to the hypotheses posed earlier in the chapter.

\textbf{The Diversity of Rubber Tapper Wealth}

Rubber tapper households in the Chico Mendes Reserve hold wealth in a diverse set of assets. These are found on their landholdings in the forest, in urban areas, and in a few cases, other rural areas. To examine more closely how households of different wealth levels hold their wealth, I have broken household wealth into three asset groups—

\textsuperscript{31} The annual cost of membership in the STR rose to R$36.00, or R$3.00 per month in 2004.
on-farm productive wealth, on-farm non-productive wealth, and off-farm wealth. On-farm productive wealth includes equipment, stocks of inputs and goods, structures, and animals, both livestock and transport animals, wealth that produces or aids in the production of income. On-farm non-productive wealth includes the family house and consumer items. Arguably, the family residence does produce income through processing activities, such as cooking, that take place there. In addition, for some households, the house structure is used for stocking or drying (in the case of tobacco) production, and carrying out production activities such as weaving artisan items or rolling tobacco. However, I contend that the house structure is very different from other productive structures, as many households are now investing substantial capital for comfort, durability, and esthetic purposes, rather than to enhance production. Lastly, off-farm wealth includes land, houses and consumer items held in the city, rural land other than the landholding (one case), and bank accounts (two cases).

In this section I examine how study households hold wealth, first by examining the wealth holdings of all study households together, and then examining how different households categorized by net wealth per capita invest their wealth. I demonstrate how rubber tappers hold wealth in a diverse group of items, and how household investment in wealth varies as per capital wealth holdings grow. My analysis also reveals the great disparity in wealth holdings across study households. That there is disparity among study households is not surprising, as households were selected based on differences in wealth holdings. However, the sheer differences in household ability to accumulate capital are somewhat startling. The valuation techniques for each wealth category have been explained in Chapter 2.
Table 3-6 on the following page presents the mean total and net wealth values for all 46 study households. It also includes a breakdown of the different asset groups that households maintain. I first consider the total and net wealth values, and then examine more closely the different categories of wealth holdings.

The mean total wealth holdings of all households was R$7,484.00, with a mean net wealth slightly lower at R$6,981.00. As noted in the introduction of this chapter, there is a gaping divide between the poorest and wealthiest households, with total wealth ranging from R$740.00 to R$40,949.00 and net wealth ranging from R$(305.00) to R$35,380.00—one household had more debt than wealth. A few of the wealthiest households maintain over 50 times the wealth of the poorest households, a substantial difference for a forest population historically considered to be a very homogeneous group. The median figures (not stated on the table) of R$5,337.00 and R$4,914.00, for total wealth and net wealth, respectively, remove the distorting effects of a few households with the greatest total and net wealth holdings and provide a better gauge of wealth holdings among study households. These figures are more closely in line with the mean reserve household wealth figure of R$4,203.00 noted by Castelo (2000).

Mean and range figures for total and net wealth per capita help level the wealth playing field by adjusting wealth to the number of household members. For all households, the mean total wealth per capita was R$1,585.00, with a range of R$93.00 to a high of R$6,371.00. Again the wide gap in wealth holdings is clear. Mean net wealth per capita was slightly lower at R$1,465.00, with a range of R$ (305.00) to R$6,233.00. The household with negative net wealth has only one member; therefore net wealth and
Table 3-6. Total and net wealth per capita for 46 rubber tapper households in the Chico Mendes Extractive Reserve in 2001.

<table>
<thead>
<tr>
<th>Wealth Category</th>
<th>Value (R$)</th>
<th>Mean Net Wealth</th>
<th>Range (R$)</th>
<th>Standard Deviation (R$)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Pct. of Total Wealth</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>On-Farm Productive Wealth</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Equipment</td>
<td>1,349.00</td>
<td>18.0</td>
<td>192.00 – 4,459.00</td>
<td>889.00</td>
</tr>
<tr>
<td>Animals</td>
<td>2,691.00</td>
<td>36.0</td>
<td>10.00 – 15,829.00</td>
<td>2,955.00</td>
</tr>
<tr>
<td>Fowl</td>
<td>204.00</td>
<td>(2.7)</td>
<td>10.00 – 580.00</td>
<td>140.00</td>
</tr>
<tr>
<td>Small animals</td>
<td>149.00</td>
<td>(2.0)</td>
<td>0.00 – 768.00</td>
<td>192.00</td>
</tr>
<tr>
<td>Cattle</td>
<td>1,567.00</td>
<td>(20.9)</td>
<td>0.00 – 12,806.00</td>
<td>2,289.00</td>
</tr>
<tr>
<td>Transport Animals</td>
<td>771.00</td>
<td>(10.3)</td>
<td>0.00 – 4,369.00</td>
<td>883.00</td>
</tr>
<tr>
<td>Structures</td>
<td>1,009.00</td>
<td>13.5</td>
<td>28.00 – 5,681.00</td>
<td>1,205.00</td>
</tr>
<tr>
<td>Stock of Inputs</td>
<td>98.00</td>
<td>1.3</td>
<td>8.00 – 628.00</td>
<td>145.00</td>
</tr>
<tr>
<td>Stock of Goods</td>
<td>174.00</td>
<td>2.3</td>
<td>0.00 – 816.00</td>
<td>204.00</td>
</tr>
<tr>
<td>Total On-Farm Productive Wealth</td>
<td>5,321.00</td>
<td>71.1</td>
<td>443.00 – 22,739.00</td>
<td>4,457.00</td>
</tr>
<tr>
<td>Other On-Farm Wealth</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Household Structure</td>
<td>796.00</td>
<td>10.6</td>
<td>58.00 – 3,200.00</td>
<td>647.00</td>
</tr>
<tr>
<td>Household Consumer Goods</td>
<td>271.00</td>
<td>3.6</td>
<td>0.00 – 4,889.00</td>
<td>787.00</td>
</tr>
<tr>
<td>Total Other On-Farm Wealth</td>
<td>1,067.00</td>
<td>14.3</td>
<td>113.00 – 6,639.00</td>
<td>1,173.00</td>
</tr>
<tr>
<td>Non-Farm Wealth</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Urban Wealth</td>
<td>1,004.00</td>
<td>13.4</td>
<td>0.00 – 10,072.00</td>
<td>2,115.00</td>
</tr>
<tr>
<td>Other Rural Land</td>
<td>54.00</td>
<td>0.7</td>
<td>0.00 – 2,500.00</td>
<td>369.00</td>
</tr>
<tr>
<td>Bank Account</td>
<td>38.00</td>
<td>0.5</td>
<td>0.00 – 1,500.00</td>
<td>223.00</td>
</tr>
<tr>
<td>Total Non-Farm Wealth</td>
<td>1,096.00</td>
<td>14.6</td>
<td>0.00 – 11,572.00</td>
<td>2,268.00</td>
</tr>
<tr>
<td>Total Wealth</td>
<td>7,484.00</td>
<td>100.0</td>
<td>740.00 – 40,949.00</td>
<td>7,330.00</td>
</tr>
<tr>
<td>Debt</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bank Debt</td>
<td>417.00</td>
<td>5.6</td>
<td>0.00 – 5,500.00</td>
<td>969.00</td>
</tr>
<tr>
<td>Other Debt</td>
<td>87.00</td>
<td>1.2</td>
<td>0.00 – 1,100.00</td>
<td>190.00</td>
</tr>
<tr>
<td>Total Debt</td>
<td>503.00</td>
<td>6.7</td>
<td>0.00 – 5,570.00</td>
<td>969.00</td>
</tr>
<tr>
<td>Net Wealth</td>
<td>6,981.00</td>
<td></td>
<td>(305.00) – 35,380.00</td>
<td>6,840.00</td>
</tr>
<tr>
<td>Total Wealth Per Capita</td>
<td>1,585.00</td>
<td></td>
<td>93.00 – 6,371.00</td>
<td>1,602.00</td>
</tr>
<tr>
<td>New Wealth Per Capita</td>
<td>1,465.00</td>
<td></td>
<td>(305.00) – 6,233.00</td>
<td>1,558.00</td>
</tr>
</tbody>
</table>
net wealth per capita are identical. Thus, even with wealth calculated on a per capita basis, the data demonstrate the great difference in wealth found in the forest.

**Household Wealth Holdings by Asset Category**

A breakdown of wealth holdings by asset group finds that on-farm productive wealth accounts for the great majority of rubber tapper household wealth, with 71.1% of total wealth held in this form. Other on-farm wealth accounted for 14.3% and non-farm wealth held 14.6% of total wealth.

Looking more specifically at on-farm productive wealth, animal wealth accounted for the largest share of productive assets, 36.0% of the total, followed by equipment at 18.0%, landholding structures at 13.5%, stocks of goods at 2.3%, and inputs at 1.3%. Again these findings differ moderately from the findings of Castelo (2000), who found that production animals accounted for 47.3% of total wealth, and structures 18.6% of total wealth. However a much larger difference was found in terms of stock of goods, with Castelo noting that households held 17.9% of wealth in goods, compared to the much lower 2.3% noted in this study.32

Cattle and transport animals, at 20.9%, and 10.3% of total wealth, respectively, made up the largest share of animal wealth, with cattle being the single largest asset category. One household held nearly R$13,000.00 in cattle. Of the 46 households, 31 held at least one cow and/or steer, and 28 held a cow. A cow is often one of the first large animals acquired by households (in addition to transport animals), as it provides the household with a steady supply of milk for consumption. Thirty-three households maintained an animal for transport—ox, horse, or mule. The value of animal wealth held

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32 Castelo (2000) does not state how assets were valued. It is possible that households were holding much larger quantities of rubber and Brazil nuts.
in fowl and small animals—mainly pigs—was much lower. Every household held chickens, while fewer held ducks (30) or *capotes* (6), also known as Portuguese hens. Thirty households raised pigs, sheep or goats.

Equipment is obtained through diverse means, including purchase, barter, as gifts, either from relatives or neighbors, acquired by development or community assistance organizations (such as AMOREX), and for participation in various projects, principally the IAP and Vai Quem Querzinho projects noted above, but others as well. Some equipment was simply found. Equipment items (43) for which data was collected were held in diverse quantities, some held by nearly every household, others by few. For example, all 46 households held machetes and a hatchet, while 44 households held a hammer, and 42 had shotguns. Twenty-eight households owned steel ovens used for making manioc flour, while 33 owned post-hole diggers. These figures contrast with the holding of equipment of much greater value. For example, only 11 households owned a chainsaw, while nine held a rifle, and eight owned a gas-powered motor used primarily for processing manioc roots into flour. Only three households owned a canoe and motor. Canoes and motors require a high capital investment, and this is one reason that many households do not hold them. In addition, as only households in the Terra Alta community travel by river, only residents of this community would need them.

Like equipment, the presence of productive structures on landholdings varies, with a few basic structures found on nearly all landholdings, while other structures were found on only a few. Forty-one households had a *paiol*, or storage building, while 28 had a *casa da farinha*, an open-air hut for processing manioc root into flour. Thirty-four households had some type of fencing on their landholding, while 28 had small fenced
gardens, 27 had chicken-coops, and 25 had pigpens. Of the 27 households that owned chicken coops, 13 benefited from a project sponsored by AMOREX that provided all the materials for their construction, including payment for the extraction and sawing of timber planks. Rubber tapper households provided the labor for construction. Only ten households owned corrals and nine had small structures to store saplings and produce seedlings. Only four households had *defumadores*, the small huts used by all rubber tappers in years past to smoke latex over fire to produce rubber. The value of investments in structures ranged from a low of R$28.00 to a high of R$5,681.00.

Households held a very small portion of total wealth in stocks of inputs and goods. The most commonly held inputs were hunting materials, including shotgun shell casings (35 households), gunpowder (30), lead shot (30), and firing caps (26). Rope and worm medicine for animals were also widely held, carried by 32 and 20 households, respectively. Less common were stocks of rock salt (16), barbed wire (14), and nails (14). Few households held vaccines (3) and vitamins (4) for animals, and no household held a stock of insecticides. Stocks of goods were held by numerous households in the form of agricultural goods, such as basic food crops (34), coffee (3), and tobacco (2). Six households were holding rubber in stock.

Although wealth held in income producing assets accounted for the largest share of wealth on the landholding, other on-farm assets accounted for 14.3 % of total wealth. The home structure was the principal holder of other on-farm wealth, valued at 10.6 % of total wealth. All households maintained a house on their landholding, although these houses differed in material and construction costs—the value of the homes ranged from R$58.00 to R$3,200.00. The highest value houses were made of sawn wood—in nearly
all cases requiring the hiring of carpenter to cut boards and build the structure—with roofs made of aluminum or Brasilit, a pressed-fiber board material, which must be purchased. Homes made of palms are almost always built with household labor—both for extraction of materials and construction—and only basic construction materials, such as nails. Of the 46 study houses, 22 were constructed of sawn wood, while 24 were constructed from palms, principally the *paxiúba* (*Iriartea deltodea* Ruiz & Pav.) and *açaí* (*Euterpe precatoria* Mart.) palms. The principal roofing material of households was palm thatch, most commonly *jarina* (*Phytelephas macroparca* Ruiz & Pav.) and *ouricuri* (*Attalea phalerata* Mart. ex Spreng.). Twenty-four households used palm thatching for roofing, while nine households used wood shingles, which require considerable household labor for preparation and placement. More expensive roof materials, in the form of aluminum sheets and Brasilit, were used by nine and three households, respectively.

Other on-farm wealth also included household consumer goods, which accounted for, on average, only 3.6% of total household wealth. However, the variation in the holding of consumer goods was great, ranging from zero to approximately R$4,900.00. Clothes and pots and pans would likely be the most commonly held consumer items, but the difficulty in obtaining an accurate and reliable measure of these items without conducting an extensive inventory led me to leave them out of the study. I focused on a short list of items that could be more readily recalled and counted by household members. Radios were the most commonly held consumer item, held by 31 households. Water filters were held by 16 households, while gas ovens and natural gas tanks were owned by eight and 11 households, respectively. Two households had solar panels,
rechargeable batteries and televisions. Four households owned revolvers, carried primarily for safety from predatory animals, mainly jaguars, when traveling in the forest.

Non-farm wealth, at 14.6% of total wealth value, was principally held in urban assets, including land, houses and consumer items, which accounted for 13.4% of total wealth. Thirteen households owned both land and a house in the city. One household owned only land, while another had partial ownership of a house. Among major consumer items held by households in the city, 14 owned gas ovens or counter top ranges, and 15 owned natural gas containers. Televisions (7), radios (6), stereos (6) and refrigerators (4) were less commonly owned. One household held chickens in the city. Again, the range in value of assets held in the city among study households was great. Thirty-three households held no assets outside the forest, while one household held urban assets valued at nearly R$12,000.00.

Non-farm wealth was also held in the form of other rural landholdings and financial holdings. Other rural landholdings accounted for 0.7% of total wealth. Four households noted that they owned land, or shared inheritance in rural area land other than their landholding. As noted in Chapter 2, the value of only one of these land areas is included in this figure. Financial holdings in banks totaled 0.5% of total wealth. Only two households held bank accounts.

Finally, debt, both to banks and trading houses, the cooperative, and individuals in region, amounted to 6.7% of total wealth. Debt to banks, in the form of both loans for production and custeios, or lines of credit for landholding improvement, accounted for most of this total. Eight households held outstanding bank debt for loans used for the planting of perennials, principally coffee, but also peach palm fruit (*Bactris gasipaes*)
Kunth). Nine households had outstanding debt for *custeiros*. Twenty-four households had debt with trading partners or individuals in the forest or urban area.\(^{33}\)

This snapshot of wealth holdings across the 46 study households finds that rubber tapper households hold a diverse set of assets, both on and off-farm. The great majority of wealth is held in the forest on landholdings, invested principally in productive activities. Animals were the largest single asset category, with cattle in particular, holding the greatest wealth value, although equipment and investments in landholding infrastructure were also important asset holdings. Conversely, other on-farm wealth and non-farm wealth together amounted to less than half of total household wealth, with the household structure maintaining the greatest share of non-productive wealth. While all study households held some form of productive wealth, the number of households holding assets in other categories differed greatly. For example, in measuring household consumer items, eight households did not maintain any of the nine items included in this measure, and an additional 21 held only one item—principally radios.

While the above description is useful in providing a basic understanding of rubber tapper wealth holdings, a more important question emerges regarding how asset holdings change as households become wealthier. More importantly, where are wealthier households investing their wealth, and what are the implications of these investments for future production activities in the reserve? And further, what are the implications for conservation? The following section will respond to these questions.

\(^{33}\) Data on outstanding debt other than bank debt are missing for one household.
A Portrait of Changing Wealth Investments in the Reserve

If you entered just about any rubber tapper landholding as recently as 20 to 25 years ago you probably would have encountered more or less the same picture. Houses were likely made of palm slats and palm thatch, and the front of most houses would have a large open-sided porch with a wooden railing. The cleared area surrounding the house would be small, and you would likely see a storage shed and a defumador, to the side of the house, and a casa de farinha, where manioc flour is made, nearby. You might find a pigpen as well, but probably not a chicken coop or a corral. Most fencing would be limited to closing the entrance of the forest path to the landholding, principally to keep the few large animals, a “reserva de recursos,” to be sold in case of emergency, rather than as part of a larger production strategy, from wandering away (CNS 1992: 14). Most landholdings probably did not even have these blockades, as many would not have to worry about animals escaping, as they did not have any.34

There are still a few houses in the forest that are just like this. Yet, the situation for other landholdings is very different now. Houses are made of different materials – some even painted and many without porches—and animals are frequently seen roaming across landholdings, with clearings for pasture stretching, in some cases, hundreds of meters. Fencing cuts across open fields, separating different pasture areas. These changes are not yet the norm, but they are appearing in diverse forms and they are clear signs that wealth holdings across rubber tapper households vary considerably.

In this section, I examine how rubber tapper households of different wealth have invested their holdings both on their landholdings and in the city. To do this, I have

34 See Allegretti (1979) for a detailed picture of life in the seringal in Acre in the 1970s.
divided the households into four different wealth rank groups. The division of households into ranked categories was determined by first producing a histogram that graphed the net wealth per capita of each household ranked from lowest to highest value. I then examined the histogram for natural breaks in the net wealth per capita values, resulting in the creation of four wealth rank groups. Table 3-7 below provides a summary of households ranked by net wealth per capita. Although the analysis will not focus on wealth differences across communities, I have also provided a breakdown of households in each wealth category by community.

Table 3-7. Rubber tapper households ranked by net wealth per capita in 2001.

<table>
<thead>
<tr>
<th>Wealth 1</th>
<th>Wealth 2</th>
<th>Wealth 3</th>
<th>Wealth 4</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Households by Community</td>
<td>Less than R$500</td>
<td>R$500 – R$999</td>
<td>R$1,000 to R$1,999</td>
<td>R$2,000 or greater</td>
</tr>
<tr>
<td>Rio Branco</td>
<td>4</td>
<td>3</td>
<td>4</td>
<td>7</td>
</tr>
<tr>
<td>Guarani</td>
<td>2</td>
<td>5</td>
<td>2</td>
<td>4</td>
</tr>
<tr>
<td>Terra Alta</td>
<td>5</td>
<td>8</td>
<td>2</td>
<td>0</td>
</tr>
<tr>
<td>Total</td>
<td>11</td>
<td>16</td>
<td>8</td>
<td>11</td>
</tr>
</tbody>
</table>

Table 3-8 on the following page displays the mean wealth holding figures for each of the four wealth rank groups. The mean figures are included primarily to provide a general idea of the volume of wealth held by each of the wealth groups. The discussion will focus on how investments in wealth holdings change as wealth holdings increase.

Table 3-8 demonstrates the shift in wealth investments that takes place as wealth holdings increase. The accompanying Figure 3-2 provides a graphic display of this shift across the four wealth rank groups. For wealth rank 1 households, all wealth is held on-farm: 75.8% of wealth is held in on-farm productive wealth and 24.3% of wealth is held in other on-farm wealth. Wealth rank 1 households maintain no off-farm wealth. This contrasts with wealth rank 4 households, who hold 65.1% of wealth in on-farm
### Table 3-8. Percentage of mean wealth from diverse wealth holdings for households ranked by net wealth per capita.

<table>
<thead>
<tr>
<th>Wealth Rank 1</th>
<th>Wealth Rank 2</th>
<th>Wealth Rank 3</th>
<th>Wealth Rank 4</th>
</tr>
</thead>
<tbody>
<tr>
<td>NWP Less than R$500</td>
<td>NWP R$500 to R$999</td>
<td>NWP R$1,000 to R$1,999</td>
<td>NWP Greater than R$2,000</td>
</tr>
<tr>
<td><strong>On-Farm Productive Wealth</strong></td>
<td><strong>On-Farm Productive Wealth</strong></td>
<td><strong>On-Farm Productive Wealth</strong></td>
<td><strong>On-Farm Productive Wealth</strong></td>
</tr>
<tr>
<td>Equipment</td>
<td>751.00</td>
<td>1,122.00</td>
<td>1,688.00</td>
</tr>
<tr>
<td>Animals</td>
<td>411.00</td>
<td>2,154.00</td>
<td>2,134.00</td>
</tr>
<tr>
<td>Cattle</td>
<td>(124.00)</td>
<td>(239.00)</td>
<td>(237.00)</td>
</tr>
<tr>
<td>Small animals</td>
<td>(72.00)</td>
<td>(172.00)</td>
<td>(146.00)</td>
</tr>
<tr>
<td>Transport Animals</td>
<td>(0.00)</td>
<td>(1,146.00)</td>
<td>(1,097.00)</td>
</tr>
<tr>
<td>Production structures</td>
<td>(177.00)</td>
<td>(800.00)</td>
<td>(729.00)</td>
</tr>
<tr>
<td>Stock of Inputs</td>
<td>36.00</td>
<td>86.00</td>
<td>69.00</td>
</tr>
<tr>
<td>Stock of Goods</td>
<td>111.00</td>
<td>94.00</td>
<td>176.00</td>
</tr>
<tr>
<td>Total On-Farm Productive Wealth</td>
<td>1,487.00</td>
<td>4,255.00</td>
<td>4,796.00</td>
</tr>
<tr>
<td><strong>Other On-Farm Wealth</strong></td>
<td><strong>Other On-Farm Wealth</strong></td>
<td><strong>Other On-Farm Wealth</strong></td>
<td><strong>Other On-Farm Wealth</strong></td>
</tr>
<tr>
<td>Household Structure</td>
<td>415.00</td>
<td>595.00</td>
<td>802.00</td>
</tr>
<tr>
<td>Household Consumer Goods</td>
<td>60.00</td>
<td>70.00</td>
<td>118.00</td>
</tr>
<tr>
<td>Total Other On-Farm Wealth</td>
<td>475.00</td>
<td>665.00</td>
<td>920.00</td>
</tr>
<tr>
<td><strong>Non-Farm Wealth</strong></td>
<td><strong>Non-Farm Wealth</strong></td>
<td><strong>Non-Farm Wealth</strong></td>
<td><strong>Non-Farm Wealth</strong></td>
</tr>
<tr>
<td>Urban Wealth</td>
<td>0.00</td>
<td>267.00</td>
<td>815.00</td>
</tr>
<tr>
<td>Other Rural Land</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
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<tr>
<td>Bank Account</td>
<td>0.00</td>
<td>0.00</td>
<td>31.00</td>
</tr>
<tr>
<td>Total Non-Farm Wealth</td>
<td>0.00</td>
<td>267.00</td>
<td>846.00</td>
</tr>
<tr>
<td><strong>Total Wealth</strong></td>
<td><strong>Total Wealth</strong></td>
<td><strong>Total Wealth</strong></td>
<td><strong>Total Wealth</strong></td>
</tr>
<tr>
<td>1,962.00</td>
<td>5,187.00</td>
<td>6,563.00</td>
<td>17,018.00</td>
</tr>
<tr>
<td><strong>Debt</strong></td>
<td><strong>Debt</strong></td>
<td><strong>Debt</strong></td>
<td><strong>Debt</strong></td>
</tr>
<tr>
<td>Bank Debt</td>
<td>375.00</td>
<td>277.00</td>
<td>237.00</td>
</tr>
<tr>
<td>Other Debt</td>
<td>179.00</td>
<td>72.00</td>
<td>44.00</td>
</tr>
<tr>
<td>Total Debt</td>
<td>555.00</td>
<td>350.00</td>
<td>282.00</td>
</tr>
<tr>
<td><strong>Net Wealth</strong></td>
<td><strong>Net Wealth</strong></td>
<td><strong>Net Wealth</strong></td>
<td><strong>Net Wealth</strong></td>
</tr>
<tr>
<td>1,407.00</td>
<td>4,837.00</td>
<td>6,312.00</td>
<td>16,182.00</td>
</tr>
<tr>
<td><strong>Total Household Wealth Per Capita</strong></td>
<td><strong>Total Household Wealth Per Capita</strong></td>
<td><strong>Total Household Wealth Per Capita</strong></td>
<td><strong>Total Household Wealth Per Capita</strong></td>
</tr>
<tr>
<td>370.00</td>
<td>777.00</td>
<td>1,479.00</td>
<td>4,051.00</td>
</tr>
<tr>
<td><strong>Net Household Wealth Per Capita</strong></td>
<td><strong>Net Household Wealth Per Capita</strong></td>
<td><strong>Net Household Wealth Per Capita</strong></td>
<td><strong>Net Household Wealth Per Capita</strong></td>
</tr>
<tr>
<td>187.00</td>
<td>717.00</td>
<td>1,402.00</td>
<td>3,879.00</td>
</tr>
</tbody>
</table>
productive wealth, 13.8% in other on-farm wealth, and 21.0% of wealth in non-farm wealth. Examining all four wealth rank groups, general trends across the categories emerge. First, there is a decrease of on-farm wealth as a percentage of all wealth holdings, as wealth holdings increase, and a corresponding percentage increase in non-farm wealth holdings. Looking more specifically at on-farm productive wealth, there is a general fall (except for wealth rank 2) in on-farm productive wealth holdings as a percentage of total wealth. Other on-farm wealth holdings, as a percentage of total wealth are greater for wealth rank 1, due to the high value of the physical house structure in comparison to other wealth holdings. However, as household wealth increases, the value of the house falls as a percentage of total wealth (from 21.2% to 8.5%), even as its value as a structure increases.

Figure 3-2. Wealth holdings for households by wealth rank group. Chico Mendes Extractive Reserve, 2001.

Thus, after an initial increase (see wealth rank 2) in the value of on-farm productive wealth, a lower percentage of total wealth is held in productive activities as households
allocate more wealth to off-farm investments, principally in the form of investments in land, houses and consumer goods in the city of Xapuri. Other on-farm wealth, held in the form of household structures and consumer items, falls as a percentage of total wealth, leveling off across wealth ranks 2, 3 and 4, with households investing a similar percentage – around 13.0 % – of household wealth in this category. However, while the percentage of wealth invested in other on-farm wealth is maintained relatively steady across wealth rank groups 2 through 4, for wealth rank 4 households, the value of the physical structure as a percentage of wealth falls, and correspondingly, the percentage value of wealth held in consumer goods increases.

The data suggest that at some point, the house structure is no longer improved upon, and investment shifts to the increased acquisition of consumer items. The growing interest in motorcycles among the wealthiest rubber tapper households in the community of Rio Branco, brought on by the improved feeder road, reflects this change. Between the first and second field visits, two households in the study—in wealth ranks 3 and 4—acquired motorcycles.

Table 3-8 also reveals important shifts in investments within the on-farm productive asset category. These shifts are shown graphically in Figures 3-3 and 3-4. In wealth rank group 1, the greatest percentage of wealth is invested in equipment, accounting for 38.3 % of total wealth, and over half (as seen in Figure 3-3 on the following page) of all productive wealth. Production structures on the landholding accounted for 9.0 % of total wealth, principally in the form of storage buildings and casas da farinha.35 Animals account for 20.9 % of total wealth, with transport animals

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35 Only households in the communities of Rio Branco and Terra Alta indicated that they benefited from the AMOREX chicken coop project. I am unaware of how households were selected for inclusion in this
Figure 3-3. Productive wealth holdings of rubber tapper households by wealth rank category. Chico Mendes Extractive Reserve, 2001.

Figure 3-4. Animal wealth holdings of rubber tapper households by wealth rank category. Chico Mendes Extractive Reserve, 2001.

If it is assumed that all households in these communities were eligible for this project, then nine of the 11 households in wealth group 1 would potentially be eligible. Of these nine households, only one household in this lowest wealth category indicated that they benefited from this project.
accounting for 10.9%, or over half of animal wealth, and fowl holding 6.3% of total wealth. Most notably, wealth rank 1 households did not own any cattle.

In contrast, the three greater wealth rank groups show considerable differences. First, the value of equipment holdings as a percent of total wealth falls substantially from wealth rank 1 to wealth rank 4 households. Although the monetary value of investments in equipment increases as total wealth rises, equipment accounts for a reduced percentage of total wealth, falling from 38.3% for wealth rank 1 to a low of 11.9% for wealth rank 4 households. Conversely, investment in animal wealth is much greater as a percentage among wealth ranks 2, 3 and 4 compared to wealth rank 1. For wealth rank 2 households, animals accounted for 41.5% of total wealth, with cattle making up the largest proportion of animal wealth and 22.1% of total wealth. Wealth rank groups 3 and 4 had similar percentages, 32.5 and 36.2, respectively, of animal wealth holdings. Wealth rank 4 had the greatest percent of wealth holdings in cattle among all wealth groups, with 24.0%, or nearly one-quarter of total wealth, held in cattle. Interestingly, the monetary value of wealth holdings in fowl and small animals did not change dramatically across wealth rank groups. Therefore, as a percentage of total wealth, the investment in these animals fell. However, investment in transport animals increases in value as wealth rises, and thus remains relatively constant as a percentage of total wealth across the four wealth rank groups.

An examination of investments in on-farm productive structures shows a general trend towards increased investments in structures as wealth rises, although as a percentage of total wealth this figure does not change dramatically. These investments result from the need for fencing and a corral with growth of the cattle herd. Although the
percentage of total wealth invested in production structures remains relatively stable across wealth groups, the monetary value of investment, particularly for wealth group 4, indicates that more fencing, and sturdier and larger corrals are being built. On-farm productive wealth holdings in stocks of inputs and stocks of goods as a percentage of total wealth were low for all four wealth rank groups and varied little among them.

Finally, Table 3-8 reveals differences in rubber tapper debt holdings across the wealth rank groups. The value of debt is greatest for the wealthiest households, although debt, as a percentage of total wealth, is much greater among wealth rank 1 households, reaching 28.3% of total wealth. Wealth rank 1 households also hold a greater percentage of non-bank debt, owed principally to trading partners and individuals both in the forest and urban area. This suggests that low wealth households rely more on short-term credit to fund purchases, while the wealthiest households rely on longer-term bank debt to invest in production activities.

The above discussion argues that as household wealth grows, households invest this wealth in different ways. Although on-farm productive wealth is where all wealth groups hold the majority of their wealth, the rubber tapper wealth portfolio changes as wealth grows. On-farm, productive investments shift from equipment to animals, with cattle an important asset for all but the lowest wealth households. Investment in productive landholding structures also grows, although not as dramatically as animal wealth. As wealth grows, households continue to invest in their homes, although as a proportion of wealth this investment falls. Consumer goods become particularly important for the wealthiest households. Wealthier households also diversify their holdings to include urban assets, through investments in land, houses and consumer
goods. This is most evident among the wealthiest households, which hold assets in the city of Xapuri that account for over 20.0% of total wealth. Thus, as households become wealthier, they continue to invest in productive activities, but also invest a growing proportion of wealth off the farm in the city of Xapuri.

The implications of changing wealth investments with a rise in household wealth have fairly clear consequences for resource conservation in the reserve. Most notably, the findings show that as households become wealthier, they invest a greater proportion of their wealth in cattle. A growing cattle herd requires increased pasture, which in turn requires the increased cutting of trees. Not surprisingly, positive and statistically significant correlation was found between pasture area and household cattle wealth (Pearson’s $r = 0.469$, p-value $= 0.001$) and household net wealth per capita (Pearson’s $r = 0.465$, p-value $= 0.001$). As the wealthiest households confront the reserve management plan limits for agricultural production and pasture, they will have to find new ways to invest their wealth. Initially, this will include the opening of bank accounts—only two households hold bank accounts, including the wealthiest household that is pushing the limits of pasture area—and increased investment in consumer items, such as motorcycles. In a very short time it is likely that the wealthiest households will own small pick-up trucks, potentially earning income by transporting other reserve residents to the city and back. Households will likely increase investments in both urban property and urban consumer items. They will probably seek out investments in other rural areas to expand productive activities that the reserve management plan limits. It seems possible that they may look to purchase other landholdings in the reserve to increase cattle production. As roads move deeper into the reserve, even distant locations become market accessible.
There may be a call for amending the reserve management plan that limits agricultural activities, a proposal that would likely provoke an emotional debate among reserve residents.

Having examined how rubber tappers hold wealth in the reserve, including the changing investment strategies of households of different wealth rank, I now move the discussion to a second critical component of the rubber tapper economy—income. Following this in-depth analysis of both on and off-farm income activities as well as an examination of how income changes, both in value, and in source, as wealth grows, I conclude with a statistical analysis of the role of wealth and market integration on household income, responding to the hypotheses stated at the outset of this chapter.

**Rubber Tapper Income in a Changing Forest Economy**

“Eu vou pra rua pra vender o meu borracha” (I am going to Xapuri to sell my rubber). Those were the words of six-year old Tomás as his family was preparing to head to Xapuri. I had just completed my second visit to the household in the Boa Vista forest area, nearly 2 days travel by animal to the city. Just about everyone in the household was planning on heading to the city the next day. The family was making its monthly trek to deliver 120 kilos of *farinha* under a contract established with a local merchant. The trade value of the *farinha*—approximately R$60.00—would be used to pay off the households’ debt for purchases made the previous month. Tomás wanted to go along to sell the few kilos of rubber that he had tapped over the past months. Although Paulo and Juliana sold *farinha* every month, they still relied principally on the sale of extractive items, Brazil nuts and rubber, for cash, which accounted for approximately 38.0 % of all trade income. But a quick glance across the large clearing on the landholding hinted that this would be changing in the coming years. The household had only recently built a new corral, and
the sale of two steers trained to carry cargo had fetched a good price over the past year—R$500.00 each—and contributed handsomely to income. This was more income than an entire year of rubber tapping had produced. Yes, Tomás was heading to the city to sell his rubber now. But would he be doing the same in 5 or 10 years?

In this section, I discuss the income earning activities of households, examining on-farm income producing activities—both for consumption and trade—as well as off-farm income earning activities, including an analysis of the trading patterns of reserve households. I begin by examining the findings for all 46 study households, discussing in some detail the various categories of activities which produce household income in the forest. I focus in particular on the role that extractive activities play in income generation. Building on this discussion, I then bring in the above discussion of household wealth, and examine how household income varies, both in terms of value and source, as wealth increases.

The rubber tapper household economy model presented above (Figure 3-1) illustrates the diverse productive activities, both on and off-farm, which contribute to household income. On-farm activities produce agricultural and extractive goods for both consumption and trade. Off-farm activities provide cash income to households. Although nearly every household plants basic food crops for consumption, as well as for sale in many cases, not all do. Among the 46 households in this study, three did not produce rice or beans in the 12 months prior to the first field visit. These households used income earned through off-farm labor to purchase basic goods for consumption.

Table 3-9 on the following page summarizes the income earning activities for all 46 study households. Both mean and range values are provided to demonstrate the diversity
### Table 3-9. Mean income of 46 rubber tapper households in the Chico Mendes Extractive Reserve for 12-month period in 2001

<table>
<thead>
<tr>
<th></th>
<th>Consumption Mean</th>
<th>Trade Mean</th>
<th>Total Mean</th>
<th>Pct. of Prod. Inc</th>
<th>Pct. of Tot. Inc</th>
<th>Range (R$)</th>
<th>St. Deviation (R$)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Productive Income</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>On-farm</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Basic crops</td>
<td>620.00</td>
<td>122.00</td>
<td>742.00</td>
<td>17.4</td>
<td>14.2</td>
<td>0.00 - 2,327.00</td>
<td>466.00</td>
</tr>
<tr>
<td>Animals</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fowl</td>
<td>183.00</td>
<td>89.00</td>
<td>272.00</td>
<td>6.4</td>
<td>5.2</td>
<td>65.00 - 1,562.00</td>
<td>275.00</td>
</tr>
<tr>
<td>Small</td>
<td>65.00</td>
<td>65.00</td>
<td>130.00</td>
<td>3.1</td>
<td>2.5</td>
<td>0.00 - 1,030.00</td>
<td>218.00</td>
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<tr>
<td>Cattle</td>
<td>15.00</td>
<td>354.00</td>
<td>369.00</td>
<td>3.7</td>
<td>3.0</td>
<td>0.00 - 2,510.00</td>
<td>619.00</td>
</tr>
<tr>
<td>Transport</td>
<td>89.00</td>
<td>89.00</td>
<td>2.1</td>
<td>1.7</td>
<td>1.7</td>
<td>0.00 - 800.00</td>
<td>206.00</td>
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<td>Extraction</td>
<td>878.00</td>
<td>765.00</td>
<td>1,643.00</td>
<td>38.6</td>
<td>31.4</td>
<td>38.00 - 4,198.00</td>
<td>1,021.00</td>
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<td>Plants</td>
<td>145.00</td>
<td>9.00</td>
<td>155.00</td>
<td>3.6</td>
<td>3.0</td>
<td>0.00 - 1,825.00</td>
<td>290.00</td>
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<tr>
<td>Processing</td>
<td>35.00</td>
<td>3.00</td>
<td>38.00</td>
<td>0.9</td>
<td>0.7</td>
<td>0.00 - 210.00</td>
<td>59.00</td>
</tr>
<tr>
<td>Other</td>
<td>6.00</td>
<td>0.1</td>
<td>0.1</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00 - 200.00</td>
<td>32.00</td>
</tr>
<tr>
<td><strong>Total On-farm Inc.</strong></td>
<td>1,941.00</td>
<td>1,496.00</td>
<td>3,442.00</td>
<td>80.9</td>
<td>65.8</td>
<td>247.00 - 8,188.00</td>
<td>1,888.00</td>
</tr>
<tr>
<td>Off-farm</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Unskilled labor</td>
<td>51.00</td>
<td>1.2</td>
<td>1.0</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00 - 400.00</td>
<td>109.00</td>
</tr>
<tr>
<td>Skilled labor</td>
<td>760.00</td>
<td>17.9</td>
<td>14.5</td>
<td>0.00 - 7,260.00</td>
<td>1450.00</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Total Off-farm Inc.</strong></td>
<td>812.00</td>
<td>19.1</td>
<td>15.5</td>
<td>0.00 - 7,260.00</td>
<td>1,449.00</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Total Productive Inc.</strong></td>
<td>4,253.00</td>
<td>100.00</td>
<td>81.3</td>
<td>1,659.00 - 11,217.00</td>
<td>2,241.00</td>
<td></td>
<td></td>
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<tr>
<td>Social Income</td>
<td>950.00</td>
<td>18.2</td>
<td>18.2</td>
<td>0.00 - 6,498.00</td>
<td>1,729.00</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Gift Income</td>
<td>29.00</td>
<td>0.6</td>
<td>0.6</td>
<td>0.00 - 1,185.00</td>
<td>175.00</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Total Income</strong></td>
<td>5,232.00</td>
<td>100.00</td>
<td>100.00</td>
<td>1,728.00 - 13,383.00</td>
<td>2,711.00</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Production Costs</td>
<td>40.00</td>
<td></td>
<td></td>
<td>0.00 - 300.00</td>
<td>73.00</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Net Productive Inc.</strong></td>
<td>4,214.00</td>
<td></td>
<td></td>
<td>1,617.00 - 11,016.00</td>
<td>2,223.00</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Net Total Income</strong></td>
<td>5,192.00</td>
<td></td>
<td></td>
<td>1,728.00 - 13,182.00</td>
<td>2,233.00</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Net Prod. Income per day labor</strong></td>
<td>5.98</td>
<td>1.71</td>
<td>12.21</td>
<td>2.5316</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
(and disparity) of income earned overall, and also within each category. On-farm income activities are broken down into consumption and trade.

Mean household productive income, including both on and off-farm activities was R$4,253.00, with a range from R$1,659.00 to R$11,217.00. The mean net productive income of R$4,214.00 was nearly identical to that noted by the ASPF study of R$4,163.00, conducted in the reserve in 1996 (Castelo 2000). Mean total income, including income earned through various retirement programs, healthcare payments due to physical or mental handicapped household members, or maternity benefits was R$5,232.00, ranging from R$1,728.00 to R$13,383.00. Productive income as a percentage of total income was 81.3 %, with government benefits and gift income accounting for 18.7 % of total income. On-farm income provided the greatest share of productive income, accounting for 80.9 % of production. Consumption accounted for more than half of the value of on-farm productive income.

At the bottom of the Table 3-9 is the figure for the return on labor, calculated by dividing net productive income by total labor available. For all households, the mean return on labor was approximately R$6.00, approximately the value of a day of off-farm manual labor working in the forest, which ranged from R$5.00 to R$8.00, as reported by individuals in study households. Notable is the range of return on labor that households experienced, from R$1.71 to R$12.21 per day labor available: one household earned over seven times the return on labor than the lowest return households. In comparison to the minimum wage earned by urban workers during the same 12 month period, approximately R$2,166.00, including a 13th minimum monthly salary that employees are provided, an average rubber tapper net productive income, including consumption, of
R$4,214.00 compares favorably, nearly two times the minimum salary. However, it is important to note that the work of an entire rural household is being compared to the earnings of an individual in the city.

Thus, a quick examination of household income data suggests that the majority of rubber tapper income is earned on-farm. It also finds that there is a great disparity in income across households as well as return on labor. Below, an analysis of income variation across wealth group categories suggests that wealth holdings shape the income earning activities of households, and that it is the high wealth households that are able to earn the greatest return on labor. However, before analyzing how income varies across wealth rank groups, I want to examine more closely both on and off-farm production activities, including the sources of income for all households. As this study is particularly interested in the role of extraction in the household economy, I will present the findings on extractive activities in greater detail.

**On-Farm Productive Income: Consumption and Trade in the Forest**

On-farm production activities accounted for 80.9% of productive income, with off-farm activities accounting for 19.1% of productive income. Slightly more than half, or 56.4%, of on-farm income came through consumption, with 43.5% earned through market transactions, both barter and sale. A small fraction of productive income was related to one household renting pasture for grazing animals. Figure 3-5 on the following page shows the percentage of income earned from different on-farm production activities. Extraction provided the greatest percentage of on-farm productive income, followed by
animal production, and basic crops. Perennials and other planted food crops and
processed goods accounted for a very small percentage of on-farm production.\textsuperscript{36}

![Chart showing income sources]

Figure 3-5. Percent of rubber tapper on-farm income earned from different production

**Consumptive income in the forest: the important role of extraction**

All households carried out on-farm production for consumption. Among all
households, the mean value of consumption was R$1,941.00, ranging from R$197.00 to
R$5,040. Consumption accounted for, on average, 56.4 \% of income, ranging from a low
of 28.0 \% to a high of 100.0 \%—one household did not sell any production, earning all
its non-consumptive income from off-farm labor. Annual per capita household
consumption averaged R$367.00, with a range from R$67.00 to R$860.00. This low
value is related to a household that purchased most of its food, as both adult heads work
off-farm. The second lowest figure of R$142.00 is more appropriate in considering the

\textsuperscript{36} The value of income from plant production would have been higher if an accurate and reliable
measurement could have been made. The one-shot cued recall method was ill suited to accurately and
reliably capture the consumption of tree fruits, including citrus fruits, oranges and limes, as well as papaya
and mango, and food crops, such as gourds. Thus, they have not been included in the income figure.
low range of per capita household consumption for a household producing its own basic food crops. Thus household income varied greatly, not only in the value of production consumed, but also in per capita consumption. The low per capita consumption figure for a household producing its own basic crops is particularly startling.

Figure 3-6 shows that extraction and production of basic food crops were the principal sources of household consumption, although animals, plant products and processed goods also made contributions to consumptive income. Nearly all households reported consumption of extractive items, basic crops (produced on-farm), planted items, and at least one farm animal. Chickens were the most frequently consumed animals, consumed by 45 households: in contrast, only two households consumed cattle. Only 20 households indicated that they had produced and consumed one of three processed goods—goma, rapadura (including alfamin, a similar sweet), or cheese.\textsuperscript{37} Although not

\begin{figure}[h]
\centering
\includegraphics[width=0.5\textwidth]{figure3-6.png}
\caption{Percent of on-farm household consumption income contributed by different on-farm production activities. Chico Mendes Extractive Reserve, 2001.}
\end{figure}

\textsuperscript{37} One household also produced yogurt, although this item was not included in the valuation of processed goods.
valued due to problems with accuracy and reliability, 29 households noted that they had collected eggs on their landholding over the past year, while 26 households produced milk for consumption.

Extraction provided the largest single contribution to consumption, accounting for 45.2% of consumptive income. As the role of extraction in the forest economy is a principal focus of this study, I will go into some detail here to lay out more specifically the important role that different extractive items play in household consumption.

Table 3-10 on the following page displays the contribution that different extractive activities make to consumption and trade income. Wild game contributed, on average, R$807.00 to household consumptive income, equivalent to 90.0% of all consumption from extractive activities. Brazil nuts, wild fruits, artisan production from plant fibers, and medicinal plants made only very small contributions to household income. Here I briefly discuss the contribution of each of these categories.

**Wild game.** All households reported at least a portion of income from game. Table 3-11 provides a list of the animals that were hunted over the past year as well as the number of animals taken and value per unit. *Paca* was the most frequently killed animal among households, followed by *capelão* (also locally referred to as *guariba*), howler monkeys, and *jabuti*, turtles. However *veado*, deer, provided the greatest consumption value to households, totaling R$10,058.00, followed by *paca* at R$7,947.00, and *porco da mata*, collared peccaries, at R$4,741.00. All households hunted at least one animal, although the contribution of this activity to household consumption varied greatly, from
Table 3-10. Income from extractive activities of 46 rubber tapper households in the Chico Mendes Extractive Reserve for 12-month period in 2001.

<table>
<thead>
<tr>
<th></th>
<th>Consumption (R$)</th>
<th>Trade (R$)</th>
<th>Total Consumption and Trade Income (R$)</th>
<th>Range (R$)</th>
<th>St. Deviation (R$)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mean</td>
<td>Mean</td>
<td>Mean</td>
<td>Pct. of Ext. Inc</td>
<td>Pct. of Prod. Inc</td>
</tr>
<tr>
<td>Rubber</td>
<td>0.00</td>
<td>316.00</td>
<td>316.00</td>
<td>19.2</td>
<td>7.4</td>
</tr>
<tr>
<td>Brazil nuts</td>
<td>42.00</td>
<td>425.00</td>
<td>467.00</td>
<td>28.4</td>
<td>11.0</td>
</tr>
<tr>
<td>Fruits</td>
<td>12.00</td>
<td>1.00</td>
<td>13.00</td>
<td>0.8</td>
<td>0.3</td>
</tr>
<tr>
<td>Artisan</td>
<td>8.00</td>
<td>4.00</td>
<td>11.00</td>
<td>0.7</td>
<td>0.3</td>
</tr>
<tr>
<td>Medicinal Plants</td>
<td>1.00</td>
<td>1.00</td>
<td>1.00</td>
<td>0.1</td>
<td>0.00</td>
</tr>
<tr>
<td>Copaiba/Honey</td>
<td>7.50</td>
<td>19.00</td>
<td>27.00</td>
<td>1.6</td>
<td>0.6</td>
</tr>
<tr>
<td>Game1</td>
<td>807.00</td>
<td>0.00</td>
<td>807.00</td>
<td>49.2</td>
<td>19.0</td>
</tr>
<tr>
<td><strong>Total Extraction Income</strong></td>
<td>878.00</td>
<td>765.00</td>
<td>1,642.00</td>
<td>100.00</td>
<td>38.6</td>
</tr>
</tbody>
</table>

Note: aConsumption figure is based on focus groups with rubber tappers to value non-market extractive resources. For comparative purposes, if game consumption was valued at the black market price for game meat that is purchased, combined with rubber tapper values for game meat for which there is no black market price, the value of game consumption would be R$484.00, 60.0% of the rubber tapper value.
R$28.00 to R$3,187.00. Game animals are for household consumption rather than for trade—the reserve management plan stipulates that trade in game is prohibited.  

Table 3-11. Number and value of game animals and birds hunted by rubber tapper households over a 12-month period. Chico Mendes Extractive Reserve, 2001.

<table>
<thead>
<tr>
<th>Common Name in Portuguese</th>
<th>Common Name in English</th>
<th>Scientific Name or Family</th>
<th>Number killed</th>
<th>Unit Value(^{b}) (R$)</th>
<th>Total Value (R$)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Paca</td>
<td>Paca</td>
<td>Agouti paca</td>
<td>277</td>
<td>28.69</td>
<td>7,947.13</td>
</tr>
<tr>
<td>Capelão/guariba</td>
<td>Red howler monkey</td>
<td>Alouatta spp.</td>
<td>182</td>
<td>20.00</td>
<td>3,640.00</td>
</tr>
<tr>
<td>Jabutí</td>
<td>Tortoise</td>
<td>Geochelene spp.</td>
<td>162</td>
<td>12.50</td>
<td>2,025.00</td>
</tr>
<tr>
<td>Nambú</td>
<td>Tinamou</td>
<td>Tinamidae</td>
<td>149</td>
<td>4.13</td>
<td>1,862.50</td>
</tr>
<tr>
<td>Porco da mata</td>
<td>Collared Peccary</td>
<td>Tayassu tajacu</td>
<td>129</td>
<td>36.75</td>
<td>4,740.75</td>
</tr>
<tr>
<td>Quatipuru</td>
<td>Red-tailed squirrel</td>
<td>Sciurus spp.</td>
<td>108</td>
<td>2.00</td>
<td>216.00</td>
</tr>
<tr>
<td>Quexada</td>
<td>White-lipped peccary</td>
<td>Tayassu pecari</td>
<td>103</td>
<td>38.75</td>
<td>3,991.25</td>
</tr>
<tr>
<td>Veado</td>
<td>Deer</td>
<td>Mozana spp.</td>
<td>99</td>
<td>101.60</td>
<td>10,058.40</td>
</tr>
<tr>
<td>Jacú</td>
<td>Guan</td>
<td>Cracidae</td>
<td>99</td>
<td>4.50</td>
<td>445.50</td>
</tr>
<tr>
<td>Cutia</td>
<td>Agouti</td>
<td>Dasyprocta spp.</td>
<td>72</td>
<td>5.50</td>
<td>396.00</td>
</tr>
<tr>
<td>Aracua</td>
<td>Chachalaca</td>
<td>Cracidae</td>
<td>43</td>
<td>1.50</td>
<td>64.50</td>
</tr>
<tr>
<td>Jacamim</td>
<td>Trumpeter</td>
<td>Psophiidae</td>
<td>42</td>
<td>4.00</td>
<td>168.00</td>
</tr>
<tr>
<td>Tatu</td>
<td>Armadillo</td>
<td>Dasyphus spp.</td>
<td>27</td>
<td>42.00</td>
<td>1,134.00</td>
</tr>
<tr>
<td>Papagaio</td>
<td>Parrot</td>
<td>Psittacidae</td>
<td>22</td>
<td>1.75</td>
<td>38.50</td>
</tr>
<tr>
<td>Titi</td>
<td>Unknown</td>
<td>Unknown</td>
<td>11</td>
<td>1.25</td>
<td>13.75</td>
</tr>
<tr>
<td>Macaco prego</td>
<td>Capuchin</td>
<td>Cebus spp.</td>
<td>10</td>
<td>3.75</td>
<td>37.50</td>
</tr>
<tr>
<td>Tucano</td>
<td>Toucan</td>
<td>Ramphastidae</td>
<td>10</td>
<td>1.63</td>
<td>16.30</td>
</tr>
<tr>
<td>Juriti</td>
<td>Dove</td>
<td>Columbidae</td>
<td>9</td>
<td>0.75</td>
<td>6.75</td>
</tr>
<tr>
<td>Cutiari</td>
<td>Macaw</td>
<td>Columbidae</td>
<td>6</td>
<td>1.50</td>
<td>9.00</td>
</tr>
<tr>
<td>Anta</td>
<td>Tapir</td>
<td>Tapirus terrestris</td>
<td>3</td>
<td>511.88</td>
<td>1,535.64</td>
</tr>
<tr>
<td>Araçari</td>
<td>Araçari</td>
<td>Ramphastidae</td>
<td>3</td>
<td>1.50</td>
<td>4.50</td>
</tr>
<tr>
<td>Capivara</td>
<td>Capybara</td>
<td>Hydrochaeris</td>
<td>1</td>
<td>66.64</td>
<td>66.64</td>
</tr>
<tr>
<td>Maracana</td>
<td>Macaw</td>
<td>Psittacidae</td>
<td>1</td>
<td>0.75</td>
<td>.75</td>
</tr>
<tr>
<td>Nambu macucal</td>
<td>Tinamou</td>
<td>Tinamidae</td>
<td>1</td>
<td>2.50</td>
<td>2.50</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td></td>
<td>1,569</td>
<td>37,120.27</td>
<td></td>
</tr>
</tbody>
</table>

Notes: a For birds, only the family has been noted. bValue based on two focus groups—total of 12 rubber tappers. Sources: Sick (1993) and Andrade (1985) were used to identify the families for birds. Emmons and Feer (1997) was used to identify the mammal species.

Medicinal goods. Wild collected medicinal items—primarily plant barks and leaves—also contributed to household consumption income. Prior research in the reserve has documented the diverse group of forest plants used for home remedies. Kainer and

38 During the years I have conducted research in the reserve, I have witnessed only the clandestine sale of jabutí, a turtle with highly valued meat, both in the reserve and in the city. No households indicated that they had sold any game over the past 12 months. Even though I have known many of these households for years, I do not think they would tell me if they did sell game. In 1996, I observed one household that participated in this study sell two jabutí during a canoe trip to the city. Although it is possible that households in this study did sell game during the research period, I would argue that this is unlikely.
Duryea (1992) conducting research with 14 rubber tapper women in one forest area in the Chico Mendes Reserve and nearby Cachoeira Reserve, as well as approximately 30 additional informants, identified 145 species representing 60 plant families that were used for medicinal purposes. Of these 145, the authors note that approximately 35.0% were collected from the forest, thus women listed approximately 51 forest plants. Ming and Amaral Junior (n.d.), in a more recent study of medicinal plant use in the reserve found similar results. Conducting interviews with 53 individuals in 18 forest areas, they identified 158 species in 61 plant families used for medicinal purposes. Of these 158, approximately 65.0% were native to the Amazon region, with approximately 53.0%, or 84, plants collected from the forest, and 12.0% domesticated. Approximately 35.0% of the species recorded were not native to the Amazon.

Among the 46 study households, 28 households consumed a portion of income through the extraction of 23 medicinal items. These items included 21 native plants, the tooth of a collared peccary, and *cupim*, the encrusted dirt-like termite-produced termite housing material found in the forest as well as in clearings. Table 3-12 on the following page presents a list of the items, including the scientific name and the number of households that indicated they extracted the item over the past year.

The 21 plant species noted by households represented a minimum of 11 plant families. The most commonly used plant for medicinal purposes was *jatobá*, the bark of which was extracted by 17 study households. Fifteen households extracted the bark of *copaíba*. The bark of *cumaru* was noted eight times, although it is possible that this plant was harvested by households and sold to rubber tappers. The remaining 11 species were used by fewer than 10 households each.

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39 During the household interviews, 33 households noted that they had extracted and used forest plants for medicinal purposes over the past year. However, two focus groups conducted with rubber tappers found that some plants that households had noted as forest extracted were domesticated plants, grown in the “quintal” or in the clearing near the house. Only forest-collected plants are included in this figure.
item was referred to a total of 12 times, as at least one species referred to as *cumaru* is also referred to as *cerejeira*.  

Table 3-12. Extractive medicinal items used by households in the Chico Mendes Reserve.

<table>
<thead>
<tr>
<th>Extractive Medicinal Item</th>
<th>Genus and/or Species</th>
<th>Family</th>
<th>Part used</th>
<th>Number of Households</th>
</tr>
</thead>
<tbody>
<tr>
<td>Unha-de-gato</td>
<td>Uncaria spp.</td>
<td>Rubiaceae</td>
<td>Bark</td>
<td>4</td>
</tr>
<tr>
<td>Pau d’arco rocho</td>
<td>Tabebuia spp.</td>
<td>Bignoniaceae</td>
<td>Bark</td>
<td>1</td>
</tr>
<tr>
<td>Picão</td>
<td>Unknown</td>
<td>Unknown</td>
<td>Leaf</td>
<td>1</td>
</tr>
<tr>
<td>Cerejeira</td>
<td><em>Amburana cearensis</em> (Allemao) A.C. Sm</td>
<td>Fabaceae</td>
<td>Bark</td>
<td>4</td>
</tr>
<tr>
<td>Jatobá</td>
<td><em>Hymenaea courbaril</em> L.</td>
<td>Caesalpinaceae</td>
<td>Bark</td>
<td>17</td>
</tr>
<tr>
<td>Jutai</td>
<td><em>Hymenaea spp. or Dialium spp.</em></td>
<td>Caesalpinaceae</td>
<td>Bark</td>
<td>5</td>
</tr>
<tr>
<td>Cumaru</td>
<td>Unknown</td>
<td>Fabaceae</td>
<td>Bark</td>
<td>8</td>
</tr>
<tr>
<td>Copaiba</td>
<td>Copaifera spp.</td>
<td>Caesalpinaceae</td>
<td>Bark and oil&lt;sup&gt;a&lt;/sup&gt;</td>
<td>15</td>
</tr>
<tr>
<td>Cumaruzinho</td>
<td>Unknown</td>
<td>Unknown</td>
<td>Bark</td>
<td>3</td>
</tr>
<tr>
<td>Angico</td>
<td>Parkia spp.</td>
<td>Mimosaceae</td>
<td>Bark</td>
<td>2</td>
</tr>
<tr>
<td>Bacuri</td>
<td>Unknown</td>
<td>Clusiaceae</td>
<td>Bark</td>
<td>1</td>
</tr>
<tr>
<td>Pimenta longa</td>
<td>Piper spp.</td>
<td>Piperaceae</td>
<td>Leaf</td>
<td>3</td>
</tr>
<tr>
<td>Cipó escada</td>
<td>Dalbergia spp or Bauhinia spp.</td>
<td>Caesalpinaceae</td>
<td>Bark</td>
<td>1</td>
</tr>
<tr>
<td>Tatajuba</td>
<td><em>Macularia tinctoria</em> (L.) Steud.</td>
<td>Moraceae</td>
<td>Latex, sap</td>
<td>1</td>
</tr>
<tr>
<td>Fumaça (Tucumã)</td>
<td>Unkown</td>
<td>Aracaceae</td>
<td>Unknown</td>
<td>1</td>
</tr>
<tr>
<td>Cedro</td>
<td>Cedrela spp.</td>
<td>Meliaceae</td>
<td>Bark</td>
<td>3</td>
</tr>
<tr>
<td>Mangirioba</td>
<td>Cassia spp or Senna spp.</td>
<td>Caesalpinaceae</td>
<td>Leaf</td>
<td>1</td>
</tr>
<tr>
<td>Cajú</td>
<td>Anacardium spp.</td>
<td>Anacardiacae</td>
<td>Bark</td>
<td>1</td>
</tr>
<tr>
<td>Castanha</td>
<td><em>Bertholletia excelsa</em> H.B.K.</td>
<td>Lecythiseae</td>
<td>Nut covering</td>
<td>1</td>
</tr>
<tr>
<td>Cuaita</td>
<td>Unknown</td>
<td>Lecythiseae</td>
<td>Bark</td>
<td>1</td>
</tr>
<tr>
<td>Tipi</td>
<td>Petiveria spp.</td>
<td>Phytolaccaceae</td>
<td>Root and bark</td>
<td>1</td>
</tr>
<tr>
<td>Porquinho</td>
<td>Tayassu tajacu</td>
<td>n.a.</td>
<td>Tooth</td>
<td>1</td>
</tr>
<tr>
<td>Cupim Nest</td>
<td>n.a.</td>
<td>n.a.</td>
<td>Nest</td>
<td>3</td>
</tr>
</tbody>
</table>

Note: <sup>a</sup>Copaiba oil is valued under the copaiba oil and honey category. Unknown indicates that species, and in some cases the plant family, and in one case the part used, could not be identified. N.A. indicates not applicable.

The bark of plants was the most commonly used item among forest households, although leaves, *leite*, or tree sap, and roots were also noted. Plant collection was generally carried out as needed, i.e., when an illness arose, rather than on a predetermined schedule. Extraction of the required plant material can take from a few minutes, if the

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<sup>40</sup>I have noted them separately in the table, as only one household indicated the full common name—*cumaru de cheiro*—that refers to this same plant species. The common name *cumaru* might refer to one of three different genera for *cumaru* that have been collected and identified in Acre (NYBG, n.d.).
plant or plants are near the family dwelling, to a few hours, when plants are scattered across the landholding. This activity is often carried out during routine work activities in the forest, such as tapping rubber, collecting Brazil nuts, or hunting. When collecting the plant material, the extractor may collect more than required for the particular use. For example, when collecting bark, the collector might extract a chunk of tree bark that can serve for more than one use.

Although one household noted that it had collected *unha-de-gato* on 10 separate occasions, more frequently households collected individual medicinal items only a few times a year. For example, *jatobá* and *copaíba*, the plant items most commonly used among study households—17 and 15 households respectively—were extracted by these households from one to five times, with a single extraction the most common response for both items.

Notwithstanding the importance of forest medicinal items to rubber tapper households, the contribution of these items to extractive income was minimal due to the low use value that rubber tappers assigned to these items during focus group interviews. Consumption of medicinal plants contributed, on average, only R$1.00 to household income, approximately 0.1 % of extractive income.

**Honey and copaíba oil (*Copaifera spp.*)**. Honey and copaíba oil have been separated from other medicinals as they are both consumed and sold. Nineteen households collected honey for consumption, while two households indicated that they had collected copaíba oil for home medicinal use. That few households noted that they extracted copaíba oil for household use was somewhat surprising, as it is recognized to be a natural *cicatriz*, a natural healer that is quick to close open sores and cuts. The
frequency with which I have seen open cuts, wounds and sores over the years would argue that every household should be stocking it. It is quite possible that they do, having extracted the item in years past, and storing the oil in a jar or bottle, and using it when needed. Yet, as noted, only two households indicated that they had used copaíba oil, and households were provided two opportunities to note it – one at the beginning of the interview when asked to list illnesses and treatments, and a second time later in the interview when they were asked specifically about copaíba oil.

As with other medicinal items, Table 3-10 reveals that honey and copaíba oil contributed only marginally to extractive consumption income, less than 1.0 %. Further, although 19 households earned a portion of consumptive income from these two items, three households accounted for over half of the total consumption.

**Brazil nuts and tree fruits.** In addition to medicinal use, extracted plant items also contributed to consumption in other important ways. Brazil nuts, although principally destined for the market, were consumed by 37 households. Nuts are eaten in raw form, but the oil of the Brazil nut is also used for cooking, tenderizing and flavoring game meat. Wild tree fruits, including *açai* (*Euterpe precatoria* Mart.), *bacaba* (*Oenocarpus mapora* H. Karst), *patauá* (*Oenocarpus bataua* Mart.), *cajá* (*Spondias mombim* L.), *cajarana* (*Spondias spp.*), *apuruí* (*Alibertia spp.*) and *cagaça* (Family Sapotaceae) were collected and used to make *vinho*, or fruit drinks, often consumed with sugar and manioc flour, by 34 households. *Açaí* was the most commonly extracted fruit item, with 23 households collecting *açai* and making *vinho*. Among these households, *açai* was collected from one to five times during the fruiting season, and processed into 10 to 15
liters of vinho.\textsuperscript{41} Patauá was collected and processed into vinho by 14 households and bacaba by 11 households, with the other fruits extracted and processed much less frequently. The difficulty in extracting the palm fruits (as opposed to cajá, cajarana, and cagaça which are collected from the ground) inhibits some households from consuming them. In particular, the fruit bunches of açaí and patauá can be difficult to extract—açaí palms are very thin and tall, while patauá, has a very thick and rough trunk surface making them hard to climb. Households must either have an individual who can climb them, construct ladders from nearby trees to aid in climbing the shorter patauá trees, or cut them down, destroying the plant and eliminating future production.

Although extracted and used by many households, like medicinal items, these forest fruit items, while important to individual households, particularly those that enjoy the grainy, black raspberry taste of the açaí fruit, or the nutty (and even chocolate-like) flavor of bacaba and patauá, they contribute little in pure economic value to household income. However, the excitement that swirls around the households as children anticipate eating a bowl of açaí filled with manioc flour as their mother prepares the vinho suggests a greater cultural value that is poorly suited to measurement by economic valuation techniques.

**Plant fibers for artisan goods.** Lastly, plant resources are also used for producing what are locally referred to as artisan items. I would argue that these goods are more utilitarian than artisan, due to their importance for practical use rather than artisan

\textsuperscript{41} See Strudwick and Sobel (1988) for a comprehensive discussion of açaí extraction in Belém, including photographs. Although their research was conducted on a different species of açaí (Euterpe oleracea), the process for extraction and in-forest processing is very similar. Brondizio and Siqueira (1997) provide an informative analysis of the marketing system for açaí in Eastern Amazon, an in particular the city of Belém, Pará.
quality. Seventeen households earned a portion of income from the extraction and manufacture of brooms, baskets, sifting baskets, or rubber shoes. The most commonly produced item was a simple broom, produced by 14 households, most often made of *cipó timbó* (*Thoracacarpus* or *Evodianthus spp.*). Other items were much less commonly produced, as they require greater skill. Only five households made large strong carrying baskets constructed of *cipó ambé* (Family Araceae) used for hauling manioc, corn, Brazil nuts, from harvest or collection locations back to the house. Sifting baskets, woven from *cipó timbó, arumã* (*Ischnosiphon spp.*) or fibers extracted from the palm fronds of *bacaba* were made by four households. Interestingly, only two households manufactured rubber shoes, made from *Hevea* latex, once staple footwear for rubber tappers.

In summary, a diverse group of extractive items contribute to household income. But while extractive resources made, on average, the largest contribution to household consumptive income, the importance of this activity to households varied greatly, ranging from a low of just 4.0% to a high of 85.0% of consumptive income. Households participate in extractive activities to varying degrees, depending on skills (such as climbing), the presence of resources on their landholdings, preferences for goods, and knowledge of medicinal remedies, among other factors. In the following chapter, I will also argue that economic factors affect extractive resource use.

Thus, rubber tapper households plant and extract a diverse group of products on their landholdings for consumptive use. Extraction and basic food crops play the most important role in consumption, with game meat preferred over farm animal meat. Crops such as tobacco and coffee play a small but important role within individual households, particularly where cash income is low. Less important are processed goods, such as
goma, sweets and dairy products. Milk, although not valued in this study, also plays an important role, providing a nutritious addition to the household diet and eliminating the need for the purchase of expensive powdered substitutes. The value of consumption income among study households varied greatly, as did per capita household consumption. The findings reflect the diverse livelihood strategies that households follow, including reliance on on-farm production versus off-farm labor for consumption. But the findings also certainly suggest that there is great disparity in consumptive practices in the reserve.

**Income from product trade**

Table 3-9 above also identifies the major sources of household trade income while Figure 3-7 below highlights the different contributions that product categories make to productive income. As with consumption, extractive activities made the largest contribution to trade income, accounting for just over half of trade income. Farm animal trade also played an important role, with the sale or barter of cattle, from newborns to

![Figure 3-7. Percent of household on-farm production income from trade. Chico Mendes Extractive Reserve, 2001.](image-url)
mature cows and steers, making the largest contribution to animal trade. Cattle trade provided nearly four times the income value of the trade of fowl or transport animals. Although basic food crops played an important role in consumption, their contribution to trade income was much smaller, accounting for 8.1% of trade income. Income from the trade of plant and processed food items played only a very minor role in rubber tapper trade, together accounting for less than 1.0% of trade income.

Trade income resulted from transactions with a number of different trade partners. Table 3-13 identifies the various trading partners with whom households traded. Trading partners are found both in the forest, and in urban areas. In the forest, they are other rubber tapper households, the CAEX trading post, itinerant traders and cattle buyers, some based in colony areas near Xapuri, who will travel to the forest to purchase animals. One itinerant trader, a former rubber tapper, lives in the community of Rio Branco. He buys and sells only animals.

Table 3-13. Trading partners of rubber tapper households in the Chico Mendes Reserve.

<table>
<thead>
<tr>
<th>In-Forest Trading Partners</th>
<th>Urban and Other Trading Partners</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rubber tapper</td>
<td>CAEX cooperative in Xapuri</td>
</tr>
<tr>
<td>CAEX trading post</td>
<td>Merchants in Xapuri</td>
</tr>
<tr>
<td>COOPERACRE (through SEFE)</td>
<td>Households, restaurants, and other in Xapuri</td>
</tr>
<tr>
<td>Itinerant traders</td>
<td>Colony areas near Xapuri</td>
</tr>
<tr>
<td>Visitors to forest</td>
<td></td>
</tr>
</tbody>
</table>

Rubber tappers also sell copaiba oil to a local cooperative, COOPERACRE, established with the assistance of SEFE. However, every household, when asked to whom they sold copaiba oil, responded simply “SEFE,” never mentioning the cooperative.42 One household in the community of São João de Guarani sold rapadura, a

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42 The role of COOPERACRE in the sale of copaiba oil was brought to my attention by SEFE. See Wallace (2002). See also Kainer et al. (2003) for a brief discussion of the role of COOPERACRE in the marketing of products in Acre.
hard sweet food item made from sugar cane juice, to romeiros, individuals from the city who flock to the bricks and mortar chapel in the community of São João de Guarani at the end of June to commemorate the festival of the patron Saint John and “pagar promessas,” paying their thanks by making the long hike to the community for having their prayers answered. In the city, buyers of goods include CAEX, merchants, households and restaurants, and colonists in the region who purchase cattle. CAEX and merchants purchase principally rubber and Brazil nuts, but also buy agricultural goods, such as manioc flour. Households and restaurants purchase small animals as well as processed goods.

Rubber tappers as a group traded a variety of goods, including items from each of the productive income categories. Table 3-14 on the following page provides a list of these categories and the items sold under each. The table suggests that the rubber tapper trade economy is limited to a relatively small number of agricultural and extractive products. Only 27 products were traded among all households.43 However, the trade of goods certainly goes beyond the trade of production items, and shotguns, radios, among other consumer goods are commonly bartered and sold in the forest. Indeed, I was informed that some individuals in the forest continually trade items, always seeking a higher valued item for a series of objects or animals. For this study, however, I have focused on those items produced on the landholding rather than the trade of consumer goods.

43 After one interview was conducted, I was informed that a household had sold a homemade hot sauce in the city of Xapuri on a recent visit trip. This has not been included in the results. It is possible that a few other items were sold in very small quantities that were not noted in the interview.
The number of products traded by individual households ranged from 0 to 11 items (mean = 5.1, mode = 7, median = 5). I have considered “cattle” an all-encompassing item representing the different sizes and production purposes (meat or dairy) of cattle. Only one household did not trade any products while two households traded 10 or more items. Forty-two households traded extractive items, and the same number traded at least one farm animal as well. Approximately half of the study households traded basic crops. Only a small number of households traded plant products or processed goods.


<table>
<thead>
<tr>
<th>Basic Crops (23)</th>
<th>Animals (42)</th>
<th>Extraction (42)</th>
<th>Plants (5)</th>
<th>Processed Items (2)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rice (11)</td>
<td>Cattle (17)</td>
<td>Rubber (33)</td>
<td>Tobacco (3)</td>
<td>Rapadura (1)</td>
</tr>
<tr>
<td>Beans (10)</td>
<td>Horse (7)</td>
<td>Brazil nuts (36)</td>
<td>Pineapples (1)</td>
<td>Goma (2)</td>
</tr>
<tr>
<td>Corn (8)</td>
<td>Mule (3)</td>
<td>Copaiba oil (6)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Manioc flour (13)</td>
<td>Chickens (33)</td>
<td>Açai juice (2)</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Capote (1)</td>
<td>Honey (2)</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Duck (19)</td>
<td>Brooms (4)</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Pig (11)</td>
<td>Sifting baskets (2)</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Goat (2)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Sheep (3)</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Brazil nuts were the most commonly traded item among households, sold by 36 households, followed closely by rubber and chickens, both traded by 33 households.

Seventeen households traded cattle. The table does not list coffee, as no households sold this item. However, three households were holding fairly sizeable stocks of coffee (from 400 to 720 kilograms), which they intended to sell in the near future. All were hoping that the selling price would increase in the coming months.

The low number of items traded by households reflects the importance that a few items hold as cash (or barter) income earners. Table 3-15 below lists nine products that played a key role in providing trade income. Clearly Brazil nuts and rubber continue to play an important role in trade income. Nine households gained 50.0 % or more of trade
income from Brazil nuts, and the same was true for rubber. Five households gained 50.0%
or more of trade income from cattle, while two households earned more than half of
their trade income from selling chickens. One household earned 100.0% of trade income
from the sale of a single mule, while another household earned 96.0% of household trade
income from the sale of a horse. Both of these households relied heavily on salaried
income with one member of each household holding a position as a professor; each sold
only one animal accounting for all, or nearly all, of trade income. Thus, 28 of 46
households earned 50.0% or more of household trade income from only one product,
demonstrating the high dependency households have on individual products. The
continuing importance of extraction in generating trade income is also clear: 18
households earned at least 50.0% of trade income from either rubber or Brazil nuts. In
contrast, five households earned at least half of trade income from cattle, three from the
sale of small farm animals, and two from the sale of transport animals. Further, although
not noted in Table 3-15, 28 households earned over 50.0% of trade income from the
trade of extractive products, and 39 households earned at least 25.0% of trade income
from extraction.

Table 3-15. Principal trade income sources as a percent of trade income for 46 rubber

<table>
<thead>
<tr>
<th>Product</th>
<th>25.0 – 49.0 %</th>
<th>50.0 – 74.0 %</th>
<th>75.0 – 100.0 %</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Brazil nuts</td>
<td>12</td>
<td>5</td>
<td>4</td>
<td>21</td>
</tr>
<tr>
<td>Rubber</td>
<td>11</td>
<td>5</td>
<td>4</td>
<td>20</td>
</tr>
<tr>
<td>Cattle</td>
<td>7</td>
<td>5</td>
<td>0</td>
<td>12</td>
</tr>
<tr>
<td>Horse</td>
<td>1</td>
<td>0</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>Mule</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Manioc flour</td>
<td>3</td>
<td>0</td>
<td>0</td>
<td>3</td>
</tr>
<tr>
<td>Tobacco</td>
<td>3</td>
<td>0</td>
<td>0</td>
<td>3</td>
</tr>
<tr>
<td>Chicken</td>
<td>1</td>
<td>2</td>
<td>0</td>
<td>3</td>
</tr>
<tr>
<td>Pig</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>Total</td>
<td>37/46</td>
<td>17/46</td>
<td>11/46</td>
<td></td>
</tr>
</tbody>
</table>
Yet, the above analysis presents a somewhat distorted view of household reliance on the sale of a few products, as many households do not rely principally on trade to obtain income to purchase goods. Of the 46 study households, only 26 households earned the largest share of non-consumptive income—income from trade, off-farm labor, or social benefits—from trade. Twelve households earned the greatest share of incoming cash through social benefits, while eight relied principally on off-farm labor.

Looking only at the 26 households who rely primarily on trade for generating cash, all earned 50.0% or more of their trade income from one or two products. Sixteen households earned 50.0% of more of their trade income from extractive activities, and 15 of these earned 50.0% or more of trade income from rubber and/or Brazil nuts. Thus, 15 households, one-third of all study households, still rely principally on rubber and Brazil nut trade to obtain cash. This argues that rubber and Brazil nuts remain extremely important to many households. However, it also suggests that many households have identified other income sources to obtain cash income for maintaining the household.

**The role of extraction in trade activities**

As extractive activities made the largest contribution to trade income I want to briefly consider the different sources of extractive income. In addition, a closer look at trade patterns for these two items reveals the continuing role of barter in the forest.

Returning to Table 3-10 above, Brazil nuts and rubber account for a great majority—nearly 97.0%—of trade income from extraction. The sale of copaiba oil and honey made modest contributions to trade income, as did the production of artisan items—brooms and sifting baskets made from forest fibers—and *açai* juice. Yet, very few households engaged in the sale of extractive items other than Brazil nuts and rubber;
six households sold copaíba oil, three households sold honey, four households sold artisan objects, and two sold açaí juice. So, although market-oriented extraction plays an important role in household income, few households have diversified extraction for the market beyond rubber and Brazil nuts.

Rubber and Brazil nuts are traded with five principal trading partners: CAEX trading posts in the forest, CAEX in Xapuri, merchants in Xapuri, itinerant traders, and other rubber tapper households in the forest. Each of these partners, including in one case, the rubber tapper household in the forest, provides the household not only with an outlet for their production, but also serves as an important supplier of basic household goods. Of the 37 households that sold Brazil nuts, 22 received a portion of the value in supplies, while 11 applied a portion of the value to debt held with the trading partner. Approximately 35.0 % of the value of Brazil nut transactions was received in supplies rather than cash. The findings were similar for rubber. Of the 33 households that sold rubber, 22 households received a portion of the transaction value in goods, and 14 applied a portion of the value to debt. Nearly 45.0 % of the value of the sale of rubber was received in supplies. Hence, the barter system, if not the aviação system described in Chapter 1, remains strong in the forest, even as trading partners have changed.

Table 3-16 and the accompanying Figure 3-8 display the trade patterns for rubber among the 33 households that sold this product. I have chosen to focus on rubber, rather than Brazil nuts (although a similar pattern was found) as the findings demonstrate the impact that the State rubber subsidy, discussed in Chapter 2, has played in shaping trading patterns in the forest. Table 3-16 and Figure 3-8 both show that in 2001, households traded the majority of rubber to the CAEX in-forest trading posts in the
communities of Rio Branco and São João de Guarani, with the CAEX office in Xapuri the second most used trade outlet. As noted above, to obtain the state rubber subsidy payment of R$0.40 (rising to R$0.60 in October 2002), households must be associated with AMOREX or CAEX, and sell their product through CAEX, either its in-forest trading post or at their Xapuri operations.

Table 3-16. Trading patterns for rubber by 33 households in the Chico Mendes Extractive Reserve, 2001.

<table>
<thead>
<tr>
<th>Trade Partner</th>
<th>Households</th>
<th>Value (R$)</th>
<th>Kilos</th>
<th>Pct. of Rubber Sold</th>
<th>Average Price per Kilo</th>
</tr>
</thead>
<tbody>
<tr>
<td>CAEX Trading Post in Forest</td>
<td>24</td>
<td>8,530.00</td>
<td>7,180</td>
<td>59.3</td>
<td>1.19</td>
</tr>
<tr>
<td>CAEX in Xapuri</td>
<td>13</td>
<td>5,063.00</td>
<td>4,009</td>
<td>33.1</td>
<td>1.26</td>
</tr>
<tr>
<td>Urban Merchant in Xapuri</td>
<td>5</td>
<td>533.00</td>
<td>533</td>
<td>4.4</td>
<td>1.00</td>
</tr>
<tr>
<td>Itinerant Trader in Forest</td>
<td>2</td>
<td>152.00</td>
<td>140</td>
<td>1.2</td>
<td>1.09</td>
</tr>
<tr>
<td>Rubber Tapper in Forest</td>
<td>2</td>
<td>260.00</td>
<td>260</td>
<td>2.1</td>
<td>1.00</td>
</tr>
<tr>
<td>Total</td>
<td>33</td>
<td>14,537.00</td>
<td>12,122</td>
<td>100.0</td>
<td></td>
</tr>
</tbody>
</table>

Note: "A few households traded with more than one partner.

Figure 3-8. Location and percent of rubber production traded by rubber tapper households. Chico Mendes Extractive Reserve, 2001.

Twenty-four households sold rubber to one of the two in-forest trading posts (there are CAEX trading posts in other forest areas as well) while 13 households sold directly to CAEX in Xapuri, where they obtained a slightly higher price per kilo sold. A few
households sold small amounts of rubber to itinerant traders, urban merchants or other rubber tappers in the forest. These trade channels are used as a means to obtain supplies or cash quickly. However, in the case of one transaction between two rubber tapper households, the seller did not have transportation to deliver his rubber to the side of the feeder road or to the CAEX trading post. He sold his rubber to another rubber tapper for a slightly lower value than the full subsidy price. Interestingly, he did not receive the full value of this transaction in cash, but was provided supplies for half the value of the transaction. The household that purchased the rubber (not among the 46 study households) viewed this as a favor to the other household rather than a money making business venture.

The effects of the subsidy on rubber trading patterns are more clearly identified in Figure 3-9. This figure compares the trade patterns for rubber sales of the same 28 households in the years 1996 and 2001. It shows that in 1996, these households sold principally to urban merchants and itinerant traders in the forest. With the implementation of the State rubber subsidy in 1999, a dramatic shift in trading partners took place; in 2001, these same households sold nearly all of their rubber production to the CAEX trading posts and to CAEX operations in Xapuri.

Yet, while trading patterns have changed, the impact of the subsidy on rubber production was quite different. Although households received a higher price for rubber in 2001, and thus a higher return for their labor, fewer of these 28 households collected rubber in 2001. In 1996, 24 households sold rubber, while in 2001, only 18 sold rubber. Of the four households among the 28 in 1996 that did not tap rubber, none returned to rubber tapping in 2001. Further, rubber production among these households fell
dramatically from 1996 to 2001 as demonstrated in Figure 3-9. In 1996, total production among these 28 households was 11,697 kilos. In 2001, rubber sales fell to 6,877 kilos, a 41.2% drop in production. Only four households produced more rubber for sale in 2001 than was recorded in 1996.

![Graph showing comparison of trade patterns for rubber (kilos) for 28 households in the Chico Mendes Extractive Reserve in 1996 and 2001.]

Figure 3-9. Comparison of trade patterns for rubber (kilos) for 28 households in the Chico Mendes Extractive Reserve in 1996 and 2001.

Thus, the rubber subsidy has helped households gain a higher price per kilo for rubber. And, concomitantly it has helped CAEX purchase a greater share of rubber production in the region, thus increasing its negotiating abilities with outside buyers. Yet, among households in this study, the rubber subsidy is not stimulating production, nor encouraging households to return to tap rubber. Indeed, the number of households who collected and sold rubber fell over this five-year period, as did the quantity of rubber they produced.

The above discussion on trade income argues that extraction maintains an important role in forest trade. Extractive activities, in particular the collecting of Brazil nuts and tapping of rubber, provide over half of the cash income to 15 of 26 households
that rely principally on trade for cash income. Over 70.0% of households tap rubber while over 75.0% collect Brazil nuts, attesting to the prevalence of these activities. The barter system remains very strong in the reserve, with many households trading rubber and Brazil nuts for supplies and paying debt, rather than receiving cash. The implementation of the State rubber subsidy has helped households earn a greater return for their labor, eliminating the middlemen that many households traded with only a few years past. Yet, the data also suggest that the extractive trade economy is highly specialized, limited to only a few products, and that rubber and Brazil nuts dominate trade. Further, the analysis of trade income indicates that cattle trade is also an important income earner for rubber tapper households. Seventeen households earned income from the sale of cattle, and five earned more that half of trade income from cattle production. The following chapter will examine how income varies across wealth categories, and consider the effects of wealth and integration into product markets on extractive activities. First, however, I want to examine the third and final contributor to rubber tapper household productive income—the role of off-farm labor in the rubber tapper economy.

**Off-farm Labor Income**

Although off-farm income from wage labor and salaried positions accounted for a lower percentage of household productive income than on-farm activities, it is an important source of income for many forest households. Among study households, productive income from off-farm activities ranged from R$0.00 to R$7,260.00, and accounted for 19.1% of total productive income. A total of 33 households earned at least part of total productive income from off-farm labor activities. Of these 33 households,
off-farm labor accounted for nearly 40.0% of all trade and off-farm income, or earned cash income, which comes into the household.

Table 3-17 lists the different salaried and wage labor activities undertaken by study households. Ten households received at least a portion of total income from a salaried position while 26 households participated in wage labor activities. Men were the primary earners of salaries, with only two women earning a fixed monthly salary for all or a portion of the year, one as a teacher and one as a health agent. Salaried employees of the government—teachers and health agents—also benefit from an extra, or “13th”, monthly salary that comes as a benefit of employment, further increasing household income.44

Table 3-17. List of off-farm skilled and unskilled labor activities. (The number of households participating in activity is in parentheses).

<table>
<thead>
<tr>
<th>Off-farm skilled labor activities</th>
<th>Off-farm unskilled labor activities</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chainsaw operator (3)</td>
<td>Laborer on other landholding (6)</td>
</tr>
<tr>
<td>Carpentry (3)</td>
<td>Laborer on nearby ranch (2)</td>
</tr>
<tr>
<td>Teacher (5)a</td>
<td>Laborer in the city (3)</td>
</tr>
<tr>
<td>Community health agent (2)a</td>
<td>Laborer to clear river (1)</td>
</tr>
<tr>
<td>Agroforestry extensionist (paraforestal) (1)</td>
<td>Transport animals (1)</td>
</tr>
<tr>
<td>Trading post manager (2)a</td>
<td>Brazil nut collector/cracker (3)</td>
</tr>
<tr>
<td>Cooperative factory manager (2)a</td>
<td>Operate rice thresher (1)</td>
</tr>
<tr>
<td>Association administration (2)b</td>
<td>Other labor (4)</td>
</tr>
<tr>
<td>Association – other (2)</td>
<td></td>
</tr>
<tr>
<td>Municipal government (1)</td>
<td></td>
</tr>
<tr>
<td>Brazil nut factory worker (nut sheller) (5)</td>
<td></td>
</tr>
<tr>
<td>Forest Guide (1)</td>
<td></td>
</tr>
<tr>
<td>River transport (1)</td>
<td></td>
</tr>
<tr>
<td>SEFE extensionist (1)</td>
<td></td>
</tr>
<tr>
<td>Nanny (1)</td>
<td></td>
</tr>
</tbody>
</table>

Notes: aPosition is salary based although the number of months of pay for the year varies. bOne position at AMOREX was based on a monthly salary for only 3 months.

Of the 26 households that earned at least a portion of income from wage labor (not salaried labor), 18 earned wages from skilled labor, while 13 carried out unskilled wage

44 Teachers who work in the program for adult literacy are not contracted for the year and thus do not receive the 13th salary that other teachers receive.
labor. Five households earned income from both skilled and unskilled wage labor. Men were the primary wage earners among study households, although females also earned wage labor income. Wage labor among females was limited to four women who earned income working at the in-forest Brazil nut processing factory located in the community of Rio Branco.

For 13 households, off-farm labor (either salaried or wage) accounted for 50.0% or more of total trade and off-farm income. In other words, 13 households earned at least half of their cash income (excluding social benefits) from off-farm labor. Of the 23 households that earned income from skilled labor (either salary or wage), skilled labor contributed on average 31.0% of productive income and accounted for nearly 50.0% of earned cash entering the household. One household earned 94.2% of productive income from off-farm labor, while another earned 86.5%. For two households, income from skilled labor accounted for all of the household’s trade and off-farm activities. In contrast, off-farm income from unskilled labor accounted for only 4.0% of productive income. These figures suggest that entering skilled labor markets, either salaried or wage, is likely to have a greater impact on on-farm production activities.

Thus, income earned off-farm, principally in the forest, but also in the city, whether from a salaried position or from wage labor, played an important income role in the reserve, and households undertook a varied list of activities to bring cash into the household. For salaried workers, off-farm labor provided a steady flow of cash. Indeed, for two households, participation in off-farm salaried labor, combined in one case with skilled wage labor, resulted in almost no income from on-farm production or extraction. This is less true for wage labor, but the skilled wage labor market did provide households
substantial earnings. Unskilled wage labor played only a supplemental role in productive income, serving as an opportunity to bring quick cash into the household rather than as a major source of income around which on-farm production is planned.

**Conclusion**

In this chapter I have explored in detail the rubber tapper household economy, providing an in-depth analysis of rubber tapper wealth holdings and income. In doing so, I have argued that rubber tappers are not a financially or economically homogenous group, but rather hold wealth in diverse assets, varying as wealth increases, and earn income from a variety of sources, both through on-farm production and off-farm labor.

I introduced this chapter with brief demographic portrait of the 46 study households. The data showed that households vary in size as well as stage in their life cycles and the time that household heads have lived on their landholdings. However, most household heads grew up in the forest areas near where they now live, with half of male and female household heads indicating that they lived in the same forest area prior to their current residence, while two-thirds noted that they came from rural Xapuri. Family ties in the forest are strong: almost all households, 85.0 %, have another family member living in the same forest area where they reside, while 41.0 % have another family member living in another house on the same landholding. A moderately strong patrilineal relationship was found among households, with 15 landholdings exhibiting this father-son relationship. Strong social ties complement family ties: a great majority (42 of 46) of households are also a member of at least one of three social organizations that support reserve households, or rural families in general. The data also showed that households are investing in education, with all but two households having at least one literate member. Nineteen households have at least one member that has completed the
fourth grade, the highest grade achievable in the forest, suggesting a demand for a higher level of educational services in the forest.

A brief discussion of land use among households indicated that households produce basic food crops mainly for subsistence, with the area for this activity normally one or two hectares, and also maintain small areas for the planting of fruit trees for consumption. Notable is the area for pasture. Although the average pasture area held was 4.3 hectares, the range of zero to 19.2 hectares suggests that rubber tapper households have different on-farm production strategies. This variation was documented in the analysis of wealth holdings and income.

An in-depth examination of rubber tapper wealth holdings demonstrated that study households hold their wealth in diverse ways, and as wealth increases, households invest their wealth in different ways. As household net wealth per capita increases, households shift investments into on-farm non-productive assets, such as consumer goods, but also into urban assets, including land, homes and consumer goods in the city of Xapuri. Thus on-farm productive wealth as a proportion of total wealth actually declines as net wealth per capita increases. However, investments in on-farm productive assets shift as wealth increases, with increased investments in cattle, and landholding structures that support this activity. This indicates that as rubber tapper household wealth increases, they undertake more destructive land-use practices, and indeed, a moderately strong positive correlation was found between net wealth per capita and pasture area.

The diverse ways that rubber tapper households invest capital on their landholdings suggests that their production activities vary, and in the second half of this chapter I examined in detail the various on and off-farm production activities that rubber tappers
carry out to earn income. On-farm, production is dominated by extraction, growing basic food crops and raising both small and large farm animals. For all households, production is destined for both consumption and trade: every household engaged in some type of market activity. The extraction of non-timber forest resources provided the greatest share of both consumptive and market-oriented income; basic food crops provided the second largest contribution to consumption while farm animal trade made the second largest contribution to trade income. The value of extraction for consumption consisted largely of eating wild game. Although most households consume a variety of forest goods, including medicinal plants, tree fruits, and forest fibers for making artisan items, in general, these items are not highly valued by the market-economy, nor, in the case of medicinal plants, by rubber tappers themselves, at least economically.

Market-oriented extraction is dominated by the trade of rubber and Brazil nuts. Thirty-three households extracted and sold rubber and 36 households collected and sold Brazil nuts. Eighteen households earned over half of their income either from Brazil nuts or rubber. The barter role these two items continue to play suggests that an evolving forest economy still values services that trading partners provide as well as better prices. In contrast to extraction, only seventeen households sold cattle, and only five households earned over half their income from this activity. Thus data argue that on-farm production is largely dominated by extraction. However, despite the importance of this activity to many rubber tapper households, the State rubber subsidy, while bringing higher returns to those tapping rubber, is not initiating a return to rubber extraction. On the contrary, a comparison of income from rubber tapping from 1996 finds that income from rubber tapping has fallen and production has dropped despite higher prices.
The analysis of off-farm income earning activities demonstrates that salaried labor and skilled wage labor contribute substantially to household income. This is less true for unskilled wage labor that contributes little to overall productive income although I would argue that even this small cash infusion is nonetheless important for those households that earn it. Maybe more important is the general finding that 33 households undertook some type of off-farm labor activity. Thus the question emerges regarding how integration into labor markets might influence productive activities. In the following chapter, I respond to this question in examining the role of both wealth and integration into market on rubber tapper income.
CHAPTER 4
WEALTH, MARKETS, INCOME AND EXTRACTION

In the previous chapter, I provided both a detailed description and analysis of the wealth holdings and income earning activities of rubber tapper households. The analysis of household wealth demonstrated that rubber tapper wealth holdings change as wealth increases, with increased investments in animals, particularly cattle, but also a shift in investments into consumer goods and urban assets, including land, houses and consumer items. An examination of income earning activities of rubber tapper households has demonstrated that extraction plays an important role in the household economy, through both consumption and trade: extraction, among all households, makes the largest single contribution to both consumption and trade. Yet, even as extraction retains an important role, many households are entering into labor markets, and off-farm income earnings are considerable, and are clearly shaping on-farm production decisions. This leads us back to the principal questions asked by this study: how do wealth and integration into product and labor markets, as well as access to urban markets, affect rubber tapper household income, and in particular, income from extractive activities?

In this chapter, I return to the hypotheses that have directed this study and bring together the discussion on rubber tapper wealth, trade and labor. To anticipate my main findings, I found that an increase in household wealth has statistically significant positive effects on net household income and net productive income. I also found that wealth had a positive effect on extractive income, although this relationship was not significant. However, I found that wealth has a negative and statistically significant effect on the
percent of income earned from extraction, indicating that although extraction income may increase as wealth grows, it contributes less as a percent to productive income. Yet, this relationship was very weak, indicating that even the wealthiest households rely heavily on the forest for income.

In examining the effects of integration into the market economy and market access on income, I found a statistically significant and positive relationship between travel time to the city and net income, opposite of that hypothesized, indicating that as market access improved, income fell. I also found a statistically significant and negative relationship between integration into off-farm labor and product markets as well as travel time to the city and extractive income. The finding for travel time is opposite of that hypothesized, indicating that households with poorer market access earn less income from extractive resources. Only integration into off-farm labor markets had a statistically significant and negative affect on the percent of productive income earned from extraction. A simulation of the effects of labor markets on extraction demonstrates that the most negative effects on extraction income are found among households that undertake skilled labor activities (salaried or wage) rather than occasional unskilled wage labor jobs. Yet, these households did not maintain more land in pasture or hold greater cattle or animal wealth, suggesting that while integration into labor markets may reduce on-farm extraction, it does not lead to more destructive land use practices.

To begin the analysis, I briefly review the six hypotheses stated in Chapter 1 that test the effects of wealth and markets on income. I then build on the discussion in the previous chapter to examine how household income varies across the four wealth rank
categories. This leads to the final section of the chapter, where I present the results of the multivariate regression analysis that tests the six hypotheses.

Statement of Hypotheses

This study examines factors that may be influencing household income earning activities, and in particular, income from extractive activities (destined for both consumption and the market). More specifically, as introduced in Chapter 1, I am interested in how two specific variables—wealth and integration into market activities—may be driving changes in household extraction of non-timber forest products.

My own observations through prior research in the Chico Mendes Reserve found that there are considerable wealth differences among resident rubber tapper households. Previous studies have noted that families that have greater household wealth are able to invest both capital and labor in riskier, higher return activities, leading to higher incomes (Dercon 1997, Reardon and Vosti 1995). Families poorly endowed in wealth might be expected to invest in low risk, low return activities to insure against unforeseen income shocks and smooth their income stream, leading to lower income. Therefore, my first hypothesis (H1) states, as household wealth increases, household income will rise.

Building on the H1, households that have greater household wealth are able to invest in riskier, higher return activities. For these households, the opportunity cost of employing household labor in low return or subsistence activities will increase, and therefore they will leave these activities to invest in higher return activities. Conversely, wealth-poor families will invest labor in activities that require lower capital investment, such as extractive activities. Therefore, my second hypothesis (H2) states, as household wealth increases, the value of household net productive income (including consumption) from non-timber forest resource extraction will fall.
Two previous studies in Asia (Gunatilleke, Senaratne, and Abeygunawardena 1993, Appasamy 1993) found that extraction of plants (including fuelwood) accounted for a greater share of household income among poor families. Families that have greater wealth, and therefore the ability to invest capital and labor in riskier income generating activities (that may require increased capital investment for entry), will not only receive less income from extractive activities, but the proportion of total income from extraction should decrease. Therefore, my third hypothesis (H3) states, as household wealth increases, household income (including consumption) from non-timber forest resource extraction as a proportion of household productive income will fall.

Recent studies have examined the market’s effects on tropical lands and people, such as deforestation (Bedoya Garland 1996, Godoy 2001, Godoy, Wilkie and Franks 1997), health (Byron 2003, Godoy and Cárdenas 2000) and indigenous knowledge of plants (Reyes-Garcia 2001, Godoy, Brokaw and Wilkie 1998). I measured market integration as: 1) proportion of net productive income earned through off-farm labor; 2) proportion of net productive income earned through cash sales or barter of extractive or agricultural products; and, 3) travel time from the household to the city of Xapuri, the closest major market center.

Participation in the market for wage labor also may influence on-farm productive activities (Godoy 2001). My previous research in the reserve revealed that many rubber tapper households supplement income from extractive activities through off-farm salaried and wage labor activities, contracted both in Xapuri and in-forest. As off-farm wage labor opportunities appear, the opportunity cost of low return on-farm labor activities increases. Income from cash sales and barter from agricultural and extractive products also provides a
meaningful measure of market integration (Godoy, Wilkie and Franks 1997, Godoy 2001). My previous research in the reserve found that households in the reserve sell and barter a variety of extractive and agricultural products with diverse trading partners, located both in the forest and in the city of Xapuri, and households vary in terms of their integration into product markets. Finally, households living closer to the city of Xapuri will have greater access to markets and therefore should have greater ease in selling products. They may also have lower costs to reach off-farm labor opportunities (Murphy, Bilsborrow and Pinchón 1997). Thus, my fourth hypothesis (H4) states, that for each indicator of market integration, as market integration increases, household income and productive income will rise.

Building on this hypothesis, the same argument is made for income from non-timber forest products. As income from wage labor increases, households will have fewer resources to allocate toward traditional extractive activities and thus income from this activity should fall. As income from cash sales and barter increases, they will leave less risky but low return extractive activities. And finally, as travel time to the city decreases, families will have greater access to markets, which may facilitate and encourage diversification of market-oriented activities, and therefore decrease income from non-timber forest resource activities. Therefore, my fifth hypothesis (H5) states, as market integration increases, household income (including consumption) from non-timber forest resource extraction will fall. Further, following this same line of argument, as market integration increases, not only will income from non-timber forest resources fall, but the proportion of household productive income (including consumption) from this activity will also fall. Thus my sixth hypothesis (H6) states, as market integration
increases, household income from non-timber forest resources, as a proportion of household productive income, will decrease.

Having presented the six hypotheses to be tested, I now turn to present the findings of my analysis of how household income varies across the four wealth rank categories. I conclude with the results and discussion of the statistical analysis of hypotheses H1 through H6.

**Rubber Tapper Income and Wealth**

Tables 4-1 and 4-2 on the following two pages summarize the income sources of rubber tapper households categorized by net wealth per capita rank as noted above. Figure 4-1, which follows Tables 4-1 and 4-2, displays the percent of income earned from different production categories by wealth rank. The percent of income from on-farm activities was higher for wealth rank 1 than the three wealthier categories. Over 90.0% of productive income of the poorest wealth group came from on-farm production, with the other three wealthier groups ranging from 75.6% to 80.4%. Thus wealthier households are gaining a greater share of productive income from off-farm activities. Looking more specifically at the contribution of different categories of productive income, animal income makes a smaller contribution, only 11.8%, to productive income among wealth rank 1 households, compared to the three higher wealth rank groups. Wealth rank groups 2, 3, and 4, at 18.4%, 17.4%, and 29.1%, respectively, earned a greater proportion of income from farm animal production. Regarding income from cattle trade, no households in the lowest wealth rank category earned income from the sale of cattle (as noted earlier in the chapter, they did not own any cattle either), while cattle production accounted for 14.7% of productive income of the wealthiest households.
Table 4-1. 12-month income summary for rubber tapper households ranked by net wealth per capita. Chico Mendes Extractive Reserve, 2001.

<table>
<thead>
<tr>
<th></th>
<th>Wealth Rank 1 NWPC Less than R$500</th>
<th></th>
<th>Wealth Rank 2 NWPC R$500 to R$999</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Consumption</td>
<td>Trade</td>
<td>Total (R$)</td>
<td>Pct. of Productive Income</td>
</tr>
<tr>
<td>Productive Income</td>
<td>On-farm</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Basic crops</td>
<td>509.00</td>
<td>86.00</td>
<td>595.00</td>
<td>19.2</td>
</tr>
<tr>
<td>Animals</td>
<td>164.00</td>
<td>202.00</td>
<td>366.00</td>
<td>11.8</td>
</tr>
<tr>
<td>Fowl</td>
<td>125.00</td>
<td>42.00</td>
<td>167.00</td>
<td>5.4</td>
</tr>
<tr>
<td>Small</td>
<td>39.00</td>
<td>91.00</td>
<td>131.00</td>
<td>4.2</td>
</tr>
<tr>
<td>Cattle</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.0</td>
</tr>
<tr>
<td>Transport</td>
<td>68.00</td>
<td>68.00</td>
<td>136.00</td>
<td>2.2</td>
</tr>
<tr>
<td>Extraction</td>
<td>853.00</td>
<td>725.00</td>
<td>1,578.00</td>
<td>50.8</td>
</tr>
<tr>
<td>Plants</td>
<td>276.00</td>
<td>10.00</td>
<td>286.00</td>
<td>9.2</td>
</tr>
<tr>
<td>Processing</td>
<td>15.00</td>
<td>0.00</td>
<td>15.00</td>
<td>0.5</td>
</tr>
<tr>
<td>Other</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.0</td>
</tr>
<tr>
<td>Total On-farm Inc.</td>
<td>1,817.00</td>
<td>1,023.00</td>
<td>2,840.00</td>
<td>91.4</td>
</tr>
<tr>
<td>Off-farm</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Unskilled labor</td>
<td></td>
<td>54.00</td>
<td>1.7</td>
<td></td>
</tr>
<tr>
<td>Skilled labor</td>
<td></td>
<td>213.00</td>
<td>6.9</td>
<td></td>
</tr>
<tr>
<td>Total Off-farm Inc.</td>
<td></td>
<td>267.00</td>
<td>8.6</td>
<td></td>
</tr>
<tr>
<td>Total Productive Inc.</td>
<td></td>
<td>3,107.00</td>
<td>100.00</td>
<td></td>
</tr>
<tr>
<td>Social Income</td>
<td>132.00</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Gift Income</td>
<td>112.00</td>
<td></td>
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</tr>
<tr>
<td>Total Income</td>
<td>3,351.00</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Production Costs</td>
<td>30.00</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Net Productive Inc.</td>
<td>3,077.00</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Net Income</td>
<td>3,321.00</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Net Prod. Income per day labor</td>
<td>5.30</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Net Income per day labor</td>
<td>5.90</td>
<td></td>
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</table>
Table 4-2. 12-month income summary for rubber tapper households ranked by net wealth per capita. Chico Mendes Extractive Reserve, 2001.

<table>
<thead>
<tr>
<th>Wealth Rank 3</th>
<th>Wealth Rank 4</th>
</tr>
</thead>
<tbody>
<tr>
<td>NWPC R$1,000 to R$1,999</td>
<td>NWPC R$2,000 or greater</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Productive Income</th>
<th>Consumption</th>
<th>Trade</th>
<th>Total (R$)</th>
<th>Pct. of Productive Income</th>
<th>Consumption</th>
<th>Trade</th>
<th>Total (R$)</th>
<th>Pct. of Productive Income</th>
</tr>
</thead>
<tbody>
<tr>
<td>On-farm</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Basic crops</td>
<td>573.00</td>
<td>218.00</td>
<td>791.00</td>
<td>19.0</td>
<td>739.00</td>
<td>174.00</td>
<td>914.00</td>
<td>17.6</td>
</tr>
<tr>
<td>Animals</td>
<td>220.00</td>
<td>504.00</td>
<td>724.00</td>
<td>17.4</td>
<td>295.00</td>
<td>1,213.00</td>
<td>1,508.00</td>
<td>29.1</td>
</tr>
<tr>
<td>Fowl</td>
<td>183.00</td>
<td>119.00</td>
<td>301.00</td>
<td>7.2</td>
<td>175.00</td>
<td>191.00</td>
<td>366.00</td>
<td>7.0</td>
</tr>
<tr>
<td>Small</td>
<td>37.00</td>
<td>100.00</td>
<td>137.00</td>
<td>3.3</td>
<td>119.00</td>
<td>99.00</td>
<td>219.00</td>
<td>4.2</td>
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<tr>
<td>Cattle</td>
<td>0.00</td>
<td>261.00</td>
<td>261.00</td>
<td>6.3</td>
<td>0.00</td>
<td>760.00</td>
<td>760.00</td>
<td>14.7</td>
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<tr>
<td>Transport</td>
<td>25.00</td>
<td>25.00</td>
<td>0.6</td>
<td>0.6</td>
<td>0.6</td>
<td>164.00</td>
<td>3.2</td>
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<tr>
<td>Extraction</td>
<td>697.00</td>
<td>732.00</td>
<td>1,429.00</td>
<td>34.3</td>
<td>926.00</td>
<td>667.00</td>
<td>1,592.00</td>
<td>30.7</td>
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<tr>
<td>Plants</td>
<td>126.00</td>
<td>2.00</td>
<td>128.00</td>
<td>3.1</td>
<td>89.00</td>
<td>23.00</td>
<td>112.00</td>
<td>2.2</td>
</tr>
<tr>
<td>Processing</td>
<td>47.00</td>
<td>0.00</td>
<td>47.00</td>
<td>1.1</td>
<td>32.00</td>
<td>3.00</td>
<td>35.00</td>
<td>0.7</td>
</tr>
<tr>
<td>Other</td>
<td>25.00</td>
<td>0.6</td>
<td>25.00</td>
<td>0.6</td>
<td>7.00</td>
<td>1.0</td>
<td>1.0</td>
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<tr>
<td>Total On-farm Inc.</td>
<td>1,663.00</td>
<td>1,456.00</td>
<td>3,144.00</td>
<td>75.6</td>
<td>2,080.00</td>
<td>2,081.00</td>
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<td>80.4</td>
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<tr>
<td>Off-farm</td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Unskilled labor</td>
<td>81.00</td>
<td>1.9</td>
<td>82.90</td>
<td>2.0</td>
<td>11.00</td>
<td>0.2</td>
<td>11.20</td>
<td></td>
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<tr>
<td>Skilled labor</td>
<td>936.00</td>
<td>22.5</td>
<td>958.50</td>
<td>23.0</td>
<td>1,003.00</td>
<td>19.4</td>
<td>1,197.00</td>
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<tr>
<td>Total Off-farm Inc.</td>
<td>1,017.00</td>
<td>24.4</td>
<td>1,261.40</td>
<td>25.0</td>
<td>1,014.00</td>
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<td>1,197.00</td>
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<tr>
<td>Total Productive Inc.</td>
<td>4,161.00</td>
<td>100.00</td>
<td>5,181.00</td>
<td>100.0</td>
<td>4,175.00</td>
<td>7,315.00</td>
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<tr>
<td>Social Income</td>
<td>0.00</td>
<td></td>
<td>0.00</td>
<td></td>
<td>2,133.00</td>
<td></td>
<td>2,133.00</td>
<td></td>
</tr>
<tr>
<td>Gift Income</td>
<td>14.00</td>
<td></td>
<td>14.00</td>
<td></td>
<td>0.00</td>
<td></td>
<td>0.00</td>
<td></td>
</tr>
<tr>
<td>Total Income</td>
<td>4,175.00</td>
<td></td>
<td>7,315.00</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Production Costs</td>
<td>42.00</td>
<td></td>
<td>88.00</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Net Productive Income</td>
<td>4,119.00</td>
<td></td>
<td>5,093.00</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Net Income</td>
<td>4,133.00</td>
<td></td>
<td>7,227.00</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Net Prod. Income per day labor</td>
<td>7.00</td>
<td></td>
<td>7.12</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Net Income per day labor</td>
<td>7.12</td>
<td></td>
<td>11.41</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Tables 4-1 and 4-2 also display the return the different wealth groups received on labor. Wealth rank groups 3 and 4 received more than R$1.70 more per day labor available, an approximate 33.0 % greater return per day labor, than wealth rank groups 1 and 2, arguing that households with greater wealth are able to employ their labor resources with greater efficiency.

![Graph showing percent of productive income for different wealth ranks.](image)

**Figure 4-1. Percent of rubber tapper household productive income from on and off-farm activities by wealth rank category, Chico Mendes Extractive Reserve, 2001.**

Income from extraction made the largest categorical contribution to productive income among all wealth rank groups, although the proportion of income from extraction fell from just over 50.0 % of productive income for wealth rank 1 households to approximately 30.0 % for wealth rank 4 households. Interestingly, and clearly shown in Tables 4-1 and 4-2, the *Real* value of extractive activities, both for consumption and trade, remained relatively stable across the four wealth rank groups. Figure 4-2 on the following page details the sources of extractive income across the four wealth rank groups. Game consumption contributes the greatest value to extractive income for all wealth rank categories, although game’s proportional contribution to productive income
falls across the wealth groups. Brazil nuts and rubber are clearly important to productive income for all wealth rank groups. However, the roles of these two products diverge as wealth holdings grow. Brazil nuts remain a strong contributor to income across wealth categories while the contribution of rubber to productive income falls in wealth rank groups 3 and 4. As discussed earlier in the chapter, extractive activities other than game, Brazil nuts and rubber contributed very limited value to extractive income, and this held true for all wealth rank groups.

![Graph showing income from extraction by wealth rank group](image)

Figure 4-2. Value of extraction from consumption and trade by wealth rank group for rubber tapper households. Chico Mendes Extractive Reserve, 2001.

Figure 4-3 displays the *percentage* contribution of different extractive activities to extractive income. This figure mirrors the findings displayed in Figure 4-2. Game accounts for the greatest percentage of income from extraction, followed by Brazil nuts and rubber. The importance of game and Brazil nuts to productive income and concomitantly, the decreasing importance of rubber, as wealth increases, are clearly displayed in this figure. Although not noted in Figure 4-3, also notable is the fall in importance of extractive activities to trade income across the wealth rank groups. As
noted in the previous chapter, income from trade in extractive products provides at least 50.0% or more of trade income to 28 study households. However, this includes only six of 19 households in the two highest wealth rank groups. Further, nine of the 11 households in the greatest wealth category are found among the 18 households that earn less than 50.0% of trade income from extraction. This suggests that while extraction is important across wealth categories, it does not maintain the same level of importance to trade income.

Figure 4-3. Percentage contribution of extractive activities to rubber tapper household extractive income by wealth group rank. Chico Mendes Reserve, 2001.

Thus, the above discussion suggests that as household wealth increases, productive activities on-farm, and more specifically, extractive activities are also undergoing changes. To analyze how wealth may be reshaping productive income, as well as how integration into product and labor markets may be redirecting production activities, I conclude the chapter by employing a statistical model to measure the strength and significance of the relationship between these economic variables.
The Effects of Wealth and Market Integration on Household Income

To measure the effects of wealth and market integration on different measures of household income, I included the key test variables, as defined in Chapter 2, as well as a number of control variables. Table 4-3 displays the dependent and independent variables included in the four multivariate regression models. For the regressions, the measure of integration into labor markets—percent of productive income earned from off-farm labor—has been broken into three dummy variables. This was necessary, as the dependent variable in model 4, percent of income from extraction (piext), must, by definition, fall to 0.0 % when the continuous variable, percent of labor from off-farm labor, increases to 100.0 %. The use of dummy variables eliminates this problem. The dummy variables also allow for a non-linear relationship between off-farm income and the four different measures of income and extractive income. The models can be found in Appendix A.

Table 4-3. Multivariate regression model variables.

<table>
<thead>
<tr>
<th>Variables</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dependent</td>
<td></td>
</tr>
<tr>
<td>Inctvrt</td>
<td>Total net household income (R$)</td>
</tr>
<tr>
<td>Princtvrt</td>
<td>Net productive household income (R$)</td>
</tr>
<tr>
<td>Extinct</td>
<td>Income from on-farm extractive activities (R$)</td>
</tr>
<tr>
<td>Piext</td>
<td>Percent of household productive income from on-farm extraction (Pct)</td>
</tr>
<tr>
<td>Independent</td>
<td></td>
</tr>
<tr>
<td>Nwper</td>
<td>Net wealth per capita (R$)</td>
</tr>
<tr>
<td>Pisv</td>
<td>Percent of productive income from barter or trade of products (Pct)</td>
</tr>
<tr>
<td>Mkt1mk2</td>
<td>Percent of productive income from off-farm labor (1-10%)a</td>
</tr>
<tr>
<td>Mkt1mk3</td>
<td>Percent of productive income from off-farm labor (11-45%)a</td>
</tr>
<tr>
<td>Mkt1mk4</td>
<td>Percent of productive income from off-farm labor (&gt; 45%)a</td>
</tr>
<tr>
<td>Travtime</td>
<td>Travel time to city (minutes)</td>
</tr>
<tr>
<td>Totlabor</td>
<td>Total labor available including family and hired labor (days)</td>
</tr>
<tr>
<td>Landsize</td>
<td>Landholding size (hectares)</td>
</tr>
<tr>
<td>Yredp8up</td>
<td>Education per capita 8 years of age and older (years)</td>
</tr>
<tr>
<td>Yrshead</td>
<td>Years male household head on landholding (years)b</td>
</tr>
<tr>
<td>Socsal</td>
<td>Household member received a monthly social paymenta</td>
</tr>
<tr>
<td>Nutsell</td>
<td>Household sold Brazil nuts over the past 12 monthsa</td>
</tr>
<tr>
<td>Caex</td>
<td>Household member holds a membership in CAEXa</td>
</tr>
</tbody>
</table>

Notes: a Dummy variable; b Where three is no male head of household, the data for the female head was used.
I employed the same method described above in dividing households by net wealth per capita to place households into different levels of market integration, creating a histogram of households, ranking households from lowest to highest levels of percent of income from off-farm labor, then dividing the households into groups by natural breaks in the histogram. Table 4-4 indicates the four labor market integration rank groups and the number of households in each. The intercept for the model serves as the base for interpreting the dummy variables and represents no income from off-farm labor.

Table 4-4. Rubber tapper households ranked by level of household integration into off-farm labor markets. Chico Mendes Extractive Reserve, 2001.

<table>
<thead>
<tr>
<th>Community</th>
<th>Group 1: No Off-Farm Labor</th>
<th>Group 2: 1-10% Income Off-Farm</th>
<th>Group 3: 11-45% Income Off-Farm</th>
<th>Group 4: Greater than 45% Income Off-Farm</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rio Branco</td>
<td>2</td>
<td>8</td>
<td>7</td>
<td>1</td>
<td>18</td>
</tr>
<tr>
<td>Guarani</td>
<td>6</td>
<td>3</td>
<td>2</td>
<td>2</td>
<td>13</td>
</tr>
<tr>
<td>Terra Alta</td>
<td>5</td>
<td>5</td>
<td>3</td>
<td>2</td>
<td>15</td>
</tr>
<tr>
<td>Total</td>
<td>13</td>
<td>16</td>
<td>12</td>
<td>5</td>
<td>46</td>
</tr>
</tbody>
</table>

In addition to the key test variables, the following control variables were also included in the regression model: household labor available, household education level, landholding size, years the household head has lived on the landholding, whether the household sold Brazil nuts (dummy to control for whether the landholding held a marketable quantity of Brazil nuts), whether the household was a member of CAEX (dummy to control for membership in CAEX), and whether the household received a monthly government social payment (dummy to control for receipt of monthly retirement or physical/mental disability income).

45 Years of education per household member eight years of age and older (yredp8up) was moderately positively correlated ($r=0.64$, $p<0.001$) with the variable, percent of productive income from off-farm labor (ppirtlab). I regressed yredp8up onto ppirtlab to further examine the strength of this relationship. The results of this regression were significant ($R^2=0.41$, $F=30.25$) with ppirtlab having a coefficient of 0.10, indicating that a one year increase in the number of years of education per household member eight years or older would lead to a 0.10 increase in percent of income from off-farm labor, i.e., for each additional year of study per member, off-farm income increases 10.0%. Thus, one could argue that education was
payment during the prior 12 months were not coded as a “1” for this last independent variable, as a maternity payment is not a regular and long-term benefit that would affect production planning.

Table 4-5 on the following page presents the results of the four regression models. The top row of the table contains the different dependent variables tested. The independent variables are found on the left column. For model 2, a natural log transformation of household net productive income was used to normalize residuals.

The first three models were run with only 45 households. One case was removed from the analysis on these three regression models as an examination of the influence (dfbetas) of observations indicated that this one household was exerting a particularly large influence on at least one of the key test variable coefficients. I have included the results of the regression models with all 46 observations in Appendix B.46

endogenous with off-farm labor. Ultimately I chose to use dummy variables to represent different levels of market integration in each of the four models. Eliminating yredp8up did not substantially alter the coefficients or t-values of the off-farm dummy variables (mkt1lnk2, mkt1lnk3 and mkt1lnk4). The variable yredp8up was retained in the models to avoid bias in the coefficients. An examination of the conditional index for each model did not indicate multicollinearity among independent variables.

46 Christenson (1997) suggests that for small samples, dfbetas above 1.0 should be examined closely. An examination of the influence statistics found that for one case the dfbetas were greater than 1.0 for at least one key test variable in models 1, 2 and 3. For model 3, in particular, dfbetas were greater than 1.0 for four of the six test variables and greater than 2.0 for one variable. Thus, this case was heavily influencing the regression coefficients, including the sign and statistical significance of variables in the model. As a result, I eliminated this case from the model. A number of factors may help explain this: the household had relatively low wealth (wealth group 2) likely due to the selling off of approximately 25.0 % of transport animal wealth and nearly all cattle wealth over the past year; the household earned substantial income from the sale of rubber and Brazil nuts and the sale of animal assets; the household gained a very high share of production income from trade; it earned a share of productive income from off-farm skilled labor, and; it received a monthly income throughout the year for the mental disability of a daughter. An examination of the results of the analysis with 45 households showed that one case had dfbetas ≥ 1 for one key test variable in model 2 and two key test variables in model 3. An examination of this case found nothing particularly odd regarding the test variables than having very high net wealth per capita holdings. Thus, as the influence of this case on the variables was only moderately higher than that recommended, and an examination of the case revealed nothing particularly odd, the case was kept in the model. Running these two models without this case altered the results slightly. In model 2, the $R^2$ dropped slightly and the coefficients for the variables mkt1lnk2, mkt1lnk3, pisv and yrshead became positive, but remained statistically nonsignificant. In model 3, $R^2$ increased slightly and the variable nwper became statistically significant ($p \leq 0.05$).
Table 4-5. Multivariate regression models relating wealth and market integration to measures of household income and income from extraction

<table>
<thead>
<tr>
<th>Variable</th>
<th>Model 1: Household Net Income</th>
<th>Model 2: Household Net Productive Income&lt;sup&gt;a&lt;/sup&gt;</th>
<th>Model 3: Household Extractive Income</th>
<th>Model 4: Percent of Productive Income from Extraction</th>
</tr>
</thead>
<tbody>
<tr>
<td>Net wealth per capita (R$)</td>
<td>0.72***</td>
<td>0.00017***</td>
<td>0.12</td>
<td>-0.00004**</td>
</tr>
<tr>
<td>Pct. of productive income from barter or trade</td>
<td>-1,665.88</td>
<td>-0.29296</td>
<td>-2,238.27**</td>
<td>-0.18352</td>
</tr>
<tr>
<td>Percent productive income from off-farm labor (1-10%)&lt;sup&gt;c&lt;/sup&gt;</td>
<td>303.27</td>
<td>-0.00718</td>
<td>-532.08*</td>
<td>-0.16628**</td>
</tr>
<tr>
<td>Percent productive income from off-farm labor (11-45%)&lt;sup&gt;c&lt;/sup&gt;</td>
<td>-34.95</td>
<td>-0.07847</td>
<td>-1,276.50***</td>
<td>-0.24914***</td>
</tr>
<tr>
<td>Percent productive income from off-farm labor (&gt; 45%)&lt;sup&gt;c&lt;/sup&gt;</td>
<td>528.26</td>
<td>0.13518</td>
<td>-1,483.32***</td>
<td>-0.41360***</td>
</tr>
<tr>
<td>Travel time to city (minutes)</td>
<td>3.91*</td>
<td>-0.00008</td>
<td>-1.59*</td>
<td>-0.00023</td>
</tr>
<tr>
<td>Total Labor available (days)</td>
<td>3.07***</td>
<td>0.00067***</td>
<td>0.41</td>
<td>0.00009</td>
</tr>
<tr>
<td>Landholding Size (hectares)</td>
<td>2.48*</td>
<td>0.00085***</td>
<td>3.02***</td>
<td>0.00023*</td>
</tr>
<tr>
<td>Education per capita 8 yrs and older (years)</td>
<td>193.44</td>
<td>0.01093</td>
<td>-32.74</td>
<td>-0.00670</td>
</tr>
<tr>
<td>Years Head on Landholding</td>
<td>13.52</td>
<td>-0.00411</td>
<td>2.51</td>
<td>-0.00068</td>
</tr>
<tr>
<td>Monthly social payment&lt;sup&gt;b&lt;/sup&gt;</td>
<td>1,055.90</td>
<td>-0.68948***</td>
<td>-1,488.33***</td>
<td>-0.03129</td>
</tr>
<tr>
<td>Sold Brazil nuts&lt;sup&gt;b&lt;/sup&gt;</td>
<td>130.43</td>
<td>-0.02635</td>
<td>212.03</td>
<td>0.06929</td>
</tr>
<tr>
<td>CAEX membership&lt;sup&gt;b&lt;/sup&gt;</td>
<td>1,346.68**</td>
<td>0.15520</td>
<td>529.23**</td>
<td>0.04151</td>
</tr>
<tr>
<td>Observations</td>
<td>45</td>
<td>45</td>
<td>45</td>
<td>46</td>
</tr>
<tr>
<td>Adjusted R-squared</td>
<td>0.68</td>
<td>0.54</td>
<td>0.65</td>
<td>0.50</td>
</tr>
<tr>
<td>Pr &gt; F</td>
<td>&lt;0.0001</td>
<td>0.0001</td>
<td>&lt;0.0001</td>
<td>0.0003</td>
</tr>
</tbody>
</table>

Notes:  
<sup>a</sup> Used natural log transformation. <sup>b</sup> Dummy variable. Membership in AMOREX and the STR were also tested for possible inclusion in the model, but were not significant. CAEX better captured the economic influence of social organizations working with rubber tapper households in the reserve. <sup>c</sup> Dummy variable. The coefficient represents the change compared to the intercept base. The base is no income from off-farm labor. *Significant at ≤0.10; ** significant at ≤0.05; *** significant at ≤0.01.

Models 1 and 2 respond to hypothesis H1 and H4, examining the effects of wealth and market integration on two measurements of household income. I argued that an increase in wealth or integration into markets, or greater market access, would lead to an increase in household income. In Model 1, with the dependent variable net household income, all variables showed a positive relationship with the dependent variable except for two of the key test variables representing trade income and the dummy variable for households most integrated into labor markets. The model showed a good fit in explaining the dependent variable (Adjusted $R^2 = 0.68$, $F = 8.16$, Pr $> F < 0.0001$). Of
the key independent variables, net wealth per capita \((p \leq 0.01)\) was highly statistically significant and travel time \((p \leq 0.10)\) weakly significant. The coefficient of 0.72 for the net wealth variable indicates that as net wealth increases by R$1.00 per capita, total net household income increases by R$0.72, controlling for all other variables. For the travel time variable, the positive coefficient of 3.91 is opposite the relationship hypothesized. Thus, total income rises by nearly R$3.91 for each minute increase in travel time. The negative coefficient for percent of income from trade and one of the dummy variables for integration into off-farm labor markets, also represent relationships opposite of those hypothesized, although these variables were not statistically significant. Three control variables, including total household labor available \((p \leq 0.01)\), the dummy variable for membership in CAEX \((p \leq 0.05)\), and landholding size \((p \leq 0.10)\), were also statistically significant and positively related to total household income.

Model 2 examines the relationship between the dependent variable—net productive income—and the same independent variables. I hypothesized that an increase in wealth and level of market integration or market access would lead to an increase in productive income. The model provided a moderately good fit in explaining the dependent variable \((\text{Adjusted } R^2 = 0.54, F = 5.01, Pr > F = 0.0001)\). However, among the key test variables, only net wealth per capita was statistically significant \((p \leq 0.01)\). Although not statistically significant, coefficients for the market integration variables percent of income from trade as well as the two lowest levels of integration into labor markets showed a negative association with net productive income, opposite of those hypothesized, indicating that linking into product and labor markets led to lower
productive income. The coefficient for travel time had a negative association as hypothesized.

Among the control variables, landholding size, household labor available, and the dummy variable for receiving a monthly social benefit were all highly significant \((p \leq 0.01)\). The negative and high value of the coefficient for the receipt of a social benefit reflects the non-inclusion of monthly social benefits in the dependent variable net productive income.

Figure 4-4 on the following page simulates the effects of an increase in net wealth per capita on net productive income, controlling for all other variables in model 2. For the simulation, I used the mean figure as the default value for the continuous independent variables. For the dummy variables, I applied the following codes: as the majority of households sold Brazil nuts, nutsell is coded “1”; as the majority of households do not receive a monthly social salary, socsal is coded “0”; as more than half of the households are members of CAEX, caex is coded “1.” For the off-farm labor dummy variables, all have been coded “0.” To simulate the effects of higher or lower net wealth per capita holdings on productive income, I have used the mean figure for net wealth per capita and different fractions and multiples of the mean.

Starting at the mean net wealth per capita, or R$1,466.00, the model simulates the effects of both a decrease and increase in net wealth per capita. At the mean, the model produces a net productive income of R$4,653.00. A doubling of net wealth per capita, while holding all other variables constant, results in an increase in productive income of approximately 30.0 % to R$6,011.00. Concomitantly, a net wealth per capita of 25.0 % of the mean, or R$367.00, produces productive income of approximately R$3,841.00.
Thus, holding all variables constant, household net wealth per capita maintains a moderately strong positive effect on productive income.

![Figure 4-4. Simulation of the effects of a change in net wealth per capita on net productive income. Chico Mendes Extractive Reserve, 2001.](image)

Model 3 examines the effects of household wealth and market integration on income from extractive activities, responding to hypotheses H2 and H5. I argued that an increase in wealth or market integration, or market access, would lead to a decline in income from extraction. Again, the model exhibited a strong fit for explaining the dependent variable (Adjusted $R^2 = 0.65$, $F = 7.27$, Pr $> F = < 0.0001$). All of the key test variables except for the wealth variable were statistically significant in model 3. Each of the three dummy variables measuring integration into off-farm labor markets were negative, as hypothesized, and statistically significant, with the variables for percent of productive income from off-farm labor from 11-45 % and greater than 45% highly significant ($p \leq 0.01$). The increasing value of the coefficients indicates a decline in household extractive income as the level of integration into labor markets increases. The two other key test variables, percent of income from trade ($p \leq 0.05$) and travel time ($p \leq$...
0.10) were also statistically significant. The variable for integration into product trade was negative as hypothesized, indicating a decline in extractive income as households enter into product markets. However, the travel time variable coefficient was negative, opposite from the hypothesized direction, indicating that as travel time increases, income from extraction falls. The coefficient for net wealth per capita was slightly positive, indicating a positive association between wealth and extractive income, opposite that hypothesized, although as noted above, it was not significant.

Control variables for landholding size (p ≤ 0.01), monthly social benefits (p ≤ 0.01), and CAEX membership (p ≤ 0.05) were also statistically significant. The values of the regression coefficients for both CAEX membership and landholding size were positive, indicating a positive association with extractive income. Moving from non-membership in CAEX to membership increased extractive income R$529.00, holding all other variables constant, while an increase in land area of 100 hectares results in an increase in extractive income of R$302.00. Conversely, the receipt of monthly social benefits carries a negative coefficient, indicating that moving from no monthly retirement or health benefit to receiving this benefit leads to a R$1,488.00 fall in extractive income. This likely reflects the aging of the household and concomitant decline in on-farm production.

Figures 4-5 and 4-6 on the following pages simulate the effects of integrating into labor and product markets.47 Both simulations use the mean value for continuous variables, with the dummy variables coded as noted in the above simulation. Figure 4-5 simulates the effects of integrating into off-farm labor markets on extractive income. The

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47 A simulation of the effects of travel time on extractive income has not been included as it was only significant at the p ≤ 0.10 level.
simulation demonstrates the negative effect that integration into labor markets maintains on household extractive activities. For an “average” household, holding all other variables constant, as the household gains a greater share of income from off-farm labor, extractive income falls from an initial level of R$2,914.00, representing no income from off-farm labor, to a low of R$1,431.00, when a household earns 45.0 % or more of income off-farm.

![Graph showing income from extractive activities vs. percent of income from off-farm labor](image)

Figure 4-5. Simulation of the effects of integration into off-farm labor markets on income from extractive activities. Chico Mendes Extractive Reserve, 2001.

Figure 4-5 shows that the largest decrease in extractive income comes as a household moves from greater than 1.0 - 10.0 % of income from off-farm labor, to 11.0 - 45.0 % of income from off-farm labor. This would suggest that shifts in productive activities leading to a reduction in extractive income are greater as labor moves from occasional unskilled wage labor activities to skilled off-farm labor activities. An examination of income earned from off-farm labor confirms this. Of the 16 households that earned between 1.0 - 10.0 % of productive income off-farm, only six provided
skilled labor service. In contrast, of the 12 households that earned between 11.0 - 45.0 % of productive income off-farm, all provided skilled labor services.

Figure 4-6 simulates the effects of integrating into product markets on extractive income. With all other variables held constant, an increase in the percent of productive income earned from trade leads to a fall in income from extraction. For a household that earns only 10.0 % of productive income off-farm (i.e., consumption accounts for 90.0 % of productive income), extractive income totals R$3,433.00. With 33.0 % of productive income earned through product trade, extractive income falls to R$2,930.00. Earning 66.0 % of income from product trade, extractive income decreases to R$2184.00. For each 10.0 % increase in income from product trade, extractive income falls approximately R$220.00.

![Figure 4-6](image-url)

**Figure 4-6.** Simulation of the effects of integration into product markets on income from extractive activities. Chico Mendes Extractive Reserve, 2001.

Model 4 examines the effects of wealth and markets on the percentage of productive income from on-farm extractive activities, responding to Hypotheses H3 and H6. I hypothesized that an increase in household wealth and market integration, and
market access, would lead to a decrease in the percent of productive income from extraction. The model displayed a moderately good fit in explaining the dependent variable (Adjusted $R^2 = 0.50$, $F = 4.50$, Pr > F = 0.0003). Among the key test variables, net wealth per capita and the three dummy variables for percent of income earned from off-farm labor were statistically significant. The coefficients for each variable are as hypothesized, indicating a decline in the percentage of income from extraction as net wealth per capita and integration into off-farm labor markets increase. Other key test variables, percent of income from trade and travel time to the city were not significant in this model. However, the coefficient for percent of income from trade was negative, as hypothesized. This was not true for the travel time variable, which indicated an association with percent of income from extraction opposite of that hypothesized.

Among the control variables, only landholding size was statistically significant. The coefficient for this variable was positive, indicating that a 100 hectares increase in landholding size brings a 2.3% increase in the percent of income from extraction, controlling for all other variables.

Figure 4-7 on the following page simulates the individual and combined effects of rising net wealth per capita and increased integration into off-farm labor markets on the percent of productive income from extraction. Again, the simulation employs the mean value for all continuous variables held constant, with the dummy variables coded as noted above. On the far left of the figure, a household with 25.0% of the mean net wealth per capita, or approximately R$367.00 per household member, would earn 67.0% of its productive income from extraction if it earned no income from off-farm labor. An increase in net wealth per capita to the mean value of R$1,466.00 would result in very
slight decrease in the percent of productive income from extraction to 63.0 \% of productive income, controlling for all other variables. A household holding twice the mean net capital wealth would earn 44.0 \% of productive income from extraction. Thus, the simulation demonstrates that even as net wealth per capita increases dramatically, households still retain a substantial proportion of productive income from extractive activities.

Concomitantly, Figure 4-7 also displays the effects of an increase in the percent of income earned from off-farm labor on the percent of income from extraction. For a household at the mean net wealth per capita, or R$1,466.00, and receiving no income from off-farm labor, extractive income would account for 63.0 \% of productive income. At the lowest level of integration into labor markets, or 1.0 - 10.0 \% of income earned off-farm, a household at the mean net wealth per capita level would earn 46.0 \% of income from extraction, holding all other variables constant. Greater reliance on off-farm
income leads to a further drop in the proportion of productive income from extraction: a household earning 11.0 - 45.0% of income off-farm would earn 38.0% of income from extraction, while a household earning more than 45.0% of income would earn just 21.0% from extraction.

Simulating the combined effects of a rise in net wealth per capita and increased integration into off-farm labor markets finds that a household with twice the mean net wealth per capita and earning greater than 45.0% of productive income off-farm would earn only 3.0% of productive income from extraction. This suggests that for wealthy households that are highly integrated into labor markets, hunting as well as market-oriented extractive activities, such as the collection of Brazil nuts and rubber, fall dramatically.

The results of the regression models suggest mixed findings regarding the six hypotheses tested and the key test variables. Net wealth per capita was positive and statistically significant in explaining the two measures of household income, net household income and net productive income (models 1 and 2), confirming hypothesis H1. This argues that as household wealth increases, household income and productive income increase. The simulation of the effect of wealth on net productive income (model 2) showed a moderately strong positive relationship between wealth and productive income. Net wealth was negative and statistically significant in explaining the percent of income from extraction (model 4), confirming hypothesis H3; with an increase in household wealth, the percent of productive income from extraction falls. However, the simulation showed that wealth has only a moderate negative effect on the dependent variable, suggesting that other factors can better explain a decline in the percent of
income households earn from extraction. Finally, wealth was not significant in explaining extractive income (model 3), thus rejecting hypothesis H2 that an increase in wealth leads to a fall in income from extraction. This finding confirms statistically the data displayed in Tables 4-6 and 4-7. Households across wealth categories earn sizeable income (if not proportional to productive income) from extractive activities.

Statistical tests measuring the effects of integration into markets on household income and income from extraction also provided mixed findings. In testing the three measures of market integration, or market access, on the two measures of household income (models 1 and 2), travel time showed a weak statistically significant relationship with household net income. However, the coefficient indicated a positive relationship between travel time and household income, opposite the hypothesized direction—as travel time to the city increases (indicating poorer market access), household income also increases. This argues, counter intuitively, that households with better access to markets earn lower incomes. The results of this measure of market integration might be attributed to the dynamic changes taking place in the reserve and the disparity in access to transport. Road building and access to motorized transport, such as access to the municipal truck that services the communities of Rio Branco and São João de Guarani during the dry season, has decreased travel time to the city of Xapuri for many households that are geographically distant from the city. However, not all households reported that motorized transport is their principal means of transport. Thus, travel time to the city varied widely, with some households geographically closer to the city reporting longer travel times to the city than more distant households that use motorized transport. This
might help explain the unexpected results of this measure of market integration for each of the regression models.

Neither the level of integration into product markets or labor markets of the other two measures was statistically significant in their relationship with the two measures of household income. Thus, the statistical analysis rejects hypothesis H2 and finds that higher levels of market integration or better market access do not lead to higher income.

The findings on the effects of market integration on extractive income and percent of income from extraction (models 3 and 4) also varied. Market integration measured by percent of productive income from product trade showed a negative relationship with both extractive income and percent of income from extraction. However, this relationship was statistically significant only with the dependent variable extractive income. The simulation showed a moderately strong effect of increasing integration into product markets on extractive income. The variable travel time was negative and statistically significant only for the dependent variable extractive income (model 3). However, this relationship was opposite the hypothesized direction, indicating that as travel time to the city increases, income from extraction falls. I expected households with longer travel times to the city to use the forest more intensively. This finding indicates that poor access to markets negatively affects the ability of households to commercialize extractive products. As noted above, the results of the regression for this measure of market integration might be partially explained by the variation in travel time across households with similar geographic distances to the city. Finally, market integration measured by the three dummy variables for percent of productive income from off-farm labor showed negative and statistically significant relationships with both extractive income and
percent of productive income from extraction. In simulating the effects of integration into labor markets for models 3 and 4, the dummy variables showed a particularly strong and negative effect on the percent of income from extractive income.

Thus, the analysis both accepts and rejects hypotheses H4 and H6, depending on the measure of market integration. The analysis accepts the hypotheses that integration into off-farm labor markets negatively affects both extractive income and percent of income from extraction. It also accepts the hypothesis that increases in product trade negatively affect extractive income, but rejects the hypothesis that increasing product trade negatively affects the percent of income from extraction. Finally, the hypotheses that greater market access, measured by travel time to the city, negatively affects both extractive income and percent of income from extraction are rejected.

Further, it seems important to consider the implication of the statistically significant findings for landholding size and membership in CAEX. First, landholding size was positively related to both measures of household income (models 1 and 2) and extractive income (model 3). With landholdings being subdivided in the reserve, this finding suggests that subdividing landholdings could lead to falling income and extractive income. Second, CAEX membership was also positively related to both net household income measures and extractive income. Here it is important to note that CAEX membership is found principally where it maintains an in-forest trading post, in this case, in the communities of Rio Branco and Terra Alta. Only 3 of 13 households in the community of São João de Guarani are members of CAEX, compared to 13 of 18 households in Rio Branco and 10 of 15 households in Terra Alta. Thus this positive relationship between CAEX membership and both productive income and extractive
income may reflect broader community development issues at work within these two communities, as well as the economic benefits of CAEX membership. These in turn, have brought economic gains to members.48

The detailed analysis of the wealth holdings and income earnings from both on and off-farm labor activities, of the 46 study households has provided both a broad and in-depth view of the rubber tapper economy. The description and analysis of how rubber tapper households invest in wealth, revealed not only the diverse wealth holdings of rubber tappers in the Chico Mendes Extractive Reserve, but also how asset holdings change as wealth holdings grow. For the least wealthy households, all wealth was held on-farm—they had no non-farm wealth. For this group, productive wealth was held primarily in equipment and animals, with a slightly lower percentage held in productive structures. Animal wealth was dominated by transport animals, fowl and small animals; the least wealthy households had no cattle.

The data also showed how wealth holdings shift as wealth increases. As wealth grows, on-farm investments shift into animal production, particularly cattle, and landholding structures that support livestock production, such as fencing and corrals, while the proportion of wealth held in equipment declines. In addition, as wealth grows, households increase their on-farm holdings in consumer goods, as well as their off-farm holdings in the city, including investments in land, houses, and consumer goods, such as televisions, stoves and refrigerators. Households with greater wealth actually hold a lower percent of total wealth in on-farm productive assets. The most notable shift in productive wealth is the higher investment in cattle found in the three wealthiest groups.

48 Dummy variables for each community were tested for significance in all regression models. None were significant so they were not included in the models.
with the most wealthy households holding the greatest percent of wealth in cattle. This shift in investments into livestock is reflected in income earnings; the three wealthiest groups earn a greater share (although not increasingly across wealth categories) of income from cattle, with the wealthiest group earning the greatest percent of income from cattle sales among the wealth groups.

But even as asset investments shift as wealth holdings rise, the data also demonstrated that extractive activities continue to play an important role in household production. Across all wealth categories, extraction is the major source of on-farm productive income, with even the wealthiest households earning incomes from extractive activities at values very similar to the poorest households. Although rubber production falls among the wealthier households, and extraction makes a proportionally smaller contribution to trade income among the wealthiest households, game hunting and Brazil nut production remain important to productive income for all wealth groups.

These findings were reflected in the statistical analysis. Wealth had a weak positive association (although not statistically significant) with the value of income from extraction. However, the analysis also found a modest negative and statistically significant relationship between wealth and the percent of income from extraction: as household wealth increases, extraction plays a declining role as a proportion of household productive income. This is a reflection of the growing income contribution of animal production in the higher wealth categories.

This study corroborates the varied findings of other studies examining the role of wealth on extractive activities. My findings suggest that extraction may help smooth consumptive activities of both poor and wealthy forest households (Pattanayak and Sills
2001) and that households with greater wealth spend more time in agriculture, and concomitantly, earn income from diverse sources (Demmer and Overton 2001), and are able to invest in riskier activities such as cattle production (Dercon 1998). The implications of increasing investment in cattle for the environment are clear. As rubber tappers invest in cattle production, this will require concomitant investments in structures, such as fencing and corrals, as well as transforming forestland to pasture.

Just as wealth is shaping household production activities, this chapter has also argued that integration into markets is bringing changes to rubber tapper household production. The statistical models demonstrated that as households integrate into off-farm labor markets and product markets, the value of income earned from extraction declines. Further, as integration into labor markets increases, the percent of productive income from extraction also falls. A closer look at the data revealed that skilled wage and salaried labor, rather than occasional unskilled wage labor, are the principal off-farm activities that are shaping productive activities.

The implications of these findings for conservation are less clear. Less extraction, or a falling contribution of extraction to income does not mean that households are carrying out other destructive land use practices. A quick examination of the association between measures of market integration and variables that proxy land conversion, such as land held in pasture, cattle wealth holdings, and the value of the production of basic food crops, provides some guidance. Table 4-6 on the following page suggests that only integration into product markets is positively correlated to cattle wealth and the value of basic crops, indicating a potentially weak negative impact on the environment. Travel
time and integration into off-farm labor markets showed slightly positive environmental effects for the variables cattle wealth and crop production, respectively.

Table 4-6. Correlations between measures of market integration and three proxies for deforestation.

<table>
<thead>
<tr>
<th>Measure</th>
<th>Land in Pasture</th>
<th>Cattle Wealth</th>
<th>Value of Basic Food Crop Production</th>
</tr>
</thead>
<tbody>
<tr>
<td>Percent of productive income from off-farm labor</td>
<td>0.03</td>
<td>0.02</td>
<td>-0.34</td>
</tr>
<tr>
<td>Percent of productive income from barter and trade</td>
<td>0.07</td>
<td>0.25*</td>
<td>0.27*</td>
</tr>
<tr>
<td>Travel time to Xapuri</td>
<td>0.04</td>
<td>-0.22</td>
<td>0.04</td>
</tr>
</tbody>
</table>

*Significant at the .10 level.

A closer examination of the association between off-farm labor – the indicator which showed the largest drop in the percentage of productive income from extraction at higher levels of market integration—and cattle wealth is also informative. The 21 households that held over R$1000.00 in cattle wealth (a total of 31 households held wealth in cattle), included only eight of the 17 households in the two highest off-farm labor market categories. In contrast, 13 of these 21 households were from the two highest product trade categories.

Thus, even as households integrate into off-farm labor markets, and the value and percent of income earned from extraction falls, households, as of yet, are not investing off-farm earnings into environmentally destructive activities. My findings corroborate previous research that found that integration into off-farm labor markets does not lead to increased deforestation (Godoy, Wilkie and Franks 1997) and may help stabilize forest stocks (Bluffstone 1995). This is an important finding, as a growing number of studies are documenting the increasing importance of off-farm labor, both agricultural and non-agricultural, on rural incomes (Deininger and Olinto 2001, Escobal 2001, de Janvry and Sadoulet 2001, Reardon, Berdegué, and Escobar 2001). However, the medium and long-
term effects of integration into off-farm labor markets will need to be monitored, as households earning substantial income from off-farm activities will be searching for ways to productively invest accumulated earnings on their landholdings.

Although a decline in extractive activities related to increasing integration into off-farm labor markets is not associated with greater investments in environmentally destructive activities, the conservation implications for increasing integration into product markets are less clear. Table 4-6 suggests a weak correlation between integration into product markets and cattle wealth and crop production. This suggests support for other studies that have argued that integration into product trade can lead to increased deforestation (Bedoya Garland 1995, Godoy, Wilkie, and Franks 1997) and increased crop cultivation (Henrich 1997).

Conclusion

Thus, this chapter finds that wealth and markets are bringing changes to rubber tapper productive activities and in particular, extractive activities. In the regression models, wealth appears to have a relatively moderate effect on household extractive activities. Even the wealthiest households produce substantial income from extractive activities. However, a breakdown of households into wealth rank groups indicates a growing importance of income from livestock production as wealth grows. In the short-term, household wealth is likely to grow slowly, thus the implications for conservation—large scale land conversion for pasture areas—may not be immediately seen. Indeed, the conversion of land will take place over years. However, in the medium and long-term, increasing wealth accumulation among households will bring greater need for pasture and thus, deforestation.
The regression models also found a strong, negative relationship of integration into labor markets on extraction. As noted above, the implications of this finding for conservation are encouraging, despite the strong negative relationship. Higher levels of integration into labor markets are related to falling income from extraction and a lower percent of income from extraction, but less income from the forest was not associated with more destructive land use practices. Yet, the story of Cleilson, and Daniela, does suggest concern.

Cleilson is a carpenter and his wife Dona Daniela is a schoolteacher. Together they earn a substantial income, and this is reflected in the new home they recently built and its furnishings. The house is beautifully constructed with sawn timber planks, thanks to Cleilson’s skill as a carpenter, and a Brasilit roof finishes off the structure. Inside they have a gas oven and steel sink. Gas ovens are still scarce in the forest, but are slowly growing in number. Sinks are rarely found. These acquisitions clearly came as a result of their high off-farm incomes.

But while off-farm labor has brought new acquisitions, it has also affected the household’s production strategy. Cleilson and Dona Daniela did not plant any crops the year prior to the research period and Cleilson rarely went hunting; this past year he had killed only one peccary, two pacas, one deer, two jacús, and one aracua. Animal production was also relatively low; the selling of a mule made up most of the households’ trade income. After my first round of interviews, the household had one steer and a few small animals. But this will soon change. As I was leaving their landholding at the end of my second visit, I noticed that a large area had recently been cut near their house. A fence would soon be in place. Cleilson and Dona Daniela were going to start investing
more in livestock production. When Cleilson told me about his plans for cattle during my visit, I could sense that he was not entirely comfortable with the idea of a growing cattle herd. Cleilson made it clear that they would respect the limits imposed by the reserve management plan. But while they were concerned about the increase in cattle raising in the forest, they also believed that cattle was a good investment, both in terms of their financial situation, and in terms of potential consumption.

I found that the largest decline in extractive activities occurs at only the highest levels of integration into labor markets. In the short-term, and even medium term, the demand for rural labor in these sectors will be limited—the forest economy will only support a few carpenters in a region and the need for teachers and cooperative managers is unlikely to grow substantially. But other off-farm labor opportunities are likely to emerge, especially with the continued building of feeder roads which provide better access to off-farm labor opportunities. An increase in development projects, such as community timber management projects now being considered for implementation in the reserve, may bring not only new forms of on-farm income that compete with extractivism, but also new opportunities for salaries and wages for community members. This study found that it is salaried and skilled wage positions, such as those held by Cleilson and Dona Daniella, which have the strongest negative effect on extractivism. Yet, using the forest less for extaction was not accompanied by the investment of earned income in more destructive activities. This is good news for conservation. But my conversation with Cleilson and Dona Daniela suggests that as households earn higher incomes, they eventually must make choices about how they invest their wealth. Their
decision mirrors the findings I have laid out in this chapter: as households accumulate wealth, they will invest in on-farm consumer goods, but also in cattle.

This chapter also briefly examined the effects of the Lei Chico Mendes, the state rubber subsidy designed to increase rubber tapper household incomes and concomitantly keep stem rural-urban migration. Although rubber tapper households are earning a higher price for rubber, a comparison of the production of 28 households both before and after the implementation of the subsidy found that the subsidy is not stimulating production, nor encouraging households to return to rubber tapping. Rubber production among these households fell dramatically from 1996 to 2001 and the number of households tapping rubber fell as well. Thus, at least among this small group of households in the reserve, the rubber subsidy is not stimulating a return to rubber production.

Having responded to the first set of questions directing this study, and examined the effects of wealth and market integration on rubber tapper household income, and more specifically, income from extractive activities, I now turn to respond to the second set of questions posed by this study. As households accumulate wealth, and integrate into markets, how might these changes affect the cultural knowledge of rubber tappers? In the following two chapters, I combine the results of cognitive research methods with data presented in this chapter to answer these questions.
CHAPTER 5
RUBBER TAPPER CULTURAL KNOWLEDGE OF EXTRACTIVE RESOURCES

After my research assistant and I finished up our second round of interviews with Roberto, Cibele and their family, we gathered with them for a few pictures in front of the house. This usually involved taking photographs of diverse combinations of parents, brothers, sisters and friends, sometimes with pets (particularly parrots and in one instance a peccary, but rarely the family dog) and farm animals. Household pets and farm animals I have photographed over the years include monkeys (one in its small hammock), ducks, pigs, parakeets, parrots and large animals, mainly cows and horses. However, one picture included the family mule—referred to affectionately as the Ministro de Transporte, the Minster of Transportation. Occasionally, members of the families would ask to be photographed sitting on top of a horse or mule. In one instance, I was asked to give up my slip-on boots (a style often worn by local ranch hands) so that the young man could be photographed in partial, if not full, cowboy regalia.

At Roberto and Cibele’s house, we snapped only a couple of pictures of their family. However, as I was packing my camera into my backpack for the hike back to a neighboring landholding, I was asked if I wanted to take a look at the small corral built just behind the house. In the year since my previous visit, the family had acquired a young steer and constructed a small corral to house it. The young men of the family had it penned up and wanted me to take a look. I grabbed my camera and walked back to find a single steer in a corral that measured approximately 9 feet by 9 feet. With everyone grinning widely, I was asked if I wanted to ride it. I declined, although indicated I would
be happy to take a picture of the others if they dared. I readied my camera as one of the brothers slid onto the animal’s back and the others held the animal steady against the corral fence. He secured his hand under a rope wrapped around the steer’s torso. The animal clearly did not like what was happening, or at least was excited about the possibility of throwing off the rider. I climbed up onto the fence to get a better view of the steer and rider and steadied myself, camera in hand. “Pronto,” I shouted, when I was focused on the rider and animal and ready for the shot. Released, the animal bucked wildly, trying to throw off the rider, and crashed into the side of the fence. The ride lasted a few seconds before the rider, falling to the side, was off the animal and clambering for safety on the fence. Eyes gleaming with laughter and excitement, the steer, snorting foamy saliva from its nostrils, was secured once again for another brother to take a short ride.

In many ways, Roberto, Cibeli and their family typify the household that one envisions when thinking about rubber tappers. Roberto and Cibele have eight children ranging in age from four to seventeen. Roberto and Cibele are both the children of rubber tappers; the family now lives on the landholding where Roberto grew up. Roberto has a brother who lives on a landholding nearby, who in turn is married to the daughter of another rubber tapper from the same forest area. The family just recently built a new house. Although the new structure is built of sawn wood planks substituting the more traditional planks of the paxiúba (Aracaeae) and açaí (Euterpe precatoria) palms, the roof remains composed of palm thatch rather than aluminum or Brasilit, that, as noted in Chapter 3, is becoming increasingly popular in new home construction among rubber tapper families.
In addition, the household still gains the majority of income from sales of extractive products—principally rubber and Brazil nuts. Small animal production is also important to income. The family only recently had the resources to invest in livestock. There are no chainsaws, no motorcycles, no motors for making manioc flour, no solar panels, no televisions, no houses in the city. The family has a canoe and motor to facilitate travel to Xapuri, not unlike a number of families that live along Riozinho. The sons continue to tap rubber, an occupation that many youth have given up.

Yet, the excitement at the small corral is a sign that the livelihood of the rubber tapper and the dreams of rubber tapper youth, even among those households that still rely heavily on rubber trade for income, are changing. Indeed, as noted in Chapter 3, many households no longer tap rubber, and for those who do, many are producing less than in previous years. This finding meshes well with the results of Campbell’s (1996) research in the Chico Mendes and nearby Cachoeira Extractive Reserves in the early 1990s. She found that from 1991 to 1994, the number of families that did not want their children to be rubber tappers increased from 31.0 % to 51.0 %, and some households referred to those who still tapped rubber with pity—“coitado do seringueiro” (Campbell 1996:172).

How then, might the cultural identity of the rubber tapper be changing? Can we identify variations in culture among rubber tapper households? What are the implications of culture change for the extractive reserve concept and, more generally, rainforest conservation in the Amazon?

Over the next two chapters I analyze the results of cognitive anthropological tests conducted with forest households to examine one aspect of rubber tapper cultural identity: cultural knowledge. In this chapter, I test for variation in cultural knowledge of
non-timber forest resources across rubber tapper households, comparing the knowledge of household heads, as well as the knowledge of individuals in different sub-groups of study participants. In the following chapter, I test for variation in cultural knowledge across households segmented by levels of wealth and market integration, as well as examining differences in knowledge among sub-groups of the study participants, including males and females, and youth, young adults and adults. Cognitive tests provide a unique window to view how rubber tappers “think” about the domain of non-timber forest resources—how they categorize items, and more specifically, the level of cultural consensus on this domain. They can help us understand how rubber tapper cultural knowledge of forest resources may be changing, or varying, across individuals, and sub-groups of individuals.

In this chapter I argue that despite differing livelihoods in the forest, rubber tappers maintain a high degree of cultural consensus on the domain of non-timber forest resources. Further, sub-groups of individuals, categorized by sex and age, also maintain a high degree of shared cultural knowledge on this domain. In the following chapter, I demonstrate that this high degree of shared knowledge is maintained, in general, across different levels of wealth and market integration. Thus, even as household wealth and levels of market integration increase, rubber tappers—both males and females and of all ages—widely share cultural knowledge of the forest resources that they use, and in turn, that shape their lives. However, two exceptions will be noted in the following chapter.

The next question is, what are the implications of this high degree of consensus for conservation? I argue that this bodes well for conservation for two reasons. First, the maintenance of cultural knowledge across wealth levels and age groups should facilitate
the continued use of forest resources despite diverse livelihood activities that will emerge as wealth increases. This maintains rubber tapper household ties to the forest, as a potential resource for consumptive (and commercial) use, should the household financial status change (cf. Pattanayak and Sills 2001). This is particularly true for cultural knowledge of the medicinal properties of plants. Second, cognitive tests can help us understand the subtle changes taking place in how people think about non-timber forest resources. Understanding even subtle variations in how individuals think about forest resources can help predict future resource use patterns and precipitate the need to develop management plans for resources that may be moving from consumptive use to market oriented use. They may also help us to identify who are the most appropriate candidates for development interventions. Concomitantly, we can also better understand the effects of new development activities in the reserve, and how they may be reshaping knowledge of these resources. In the following chapter, I will explore some of these subtle knowledge changes and consider their implications.

This chapter will begin with an analysis of the results of the free-list activity conducted during the first field visit in 2001. I then analyze the results of the pile-sorting exercise, including a close look at the different types of item groups created by participants. This discussion folds into an examination of the multi-dimensional scaling (MDS) and hierarchical cluster analysis carried out with pile sort data. I will then examine the results of the consensus analysis procedure, again generated by the pile-sort data. Finally, QAP is employed to examine the correlation of different sub-groups of the rubber tapper population. The following chapter will respond to hypotheses H7 through
H10, presented in Chapter 1, testing the effects of wealth and market integration on rubber tapper cultural knowledge of non-timber forest resources.

**Free-Listing of Non-Timber Forest Resources**

Free listing involves asking respondents to list all of the items they can think of with regard to a particular cultural domain (Bernard 1995). I asked households the following question: “Can you make a list of things of the forest that you use, other than animals and wood?”49 For this cognitive test, I worked with household members as a group, including adults and children, not individuals. I decided on this method based on my previous experience working with rubber tapper families in the reserve. I believed that working with all household members together, rather than individuals, would provide a healthy forum to elicit free list items: as one household member would list an item, another member would be encouraged to list items as well. This would also help bring younger household members into the activity, especially younger women and adolescent girls, who are sometimes reluctant to participate in research.50 Further, I planned to conduct pile sort tests with all teenage and older household members individually, on my second field visit. This would provide the opportunity to understand how individuals of different sex and age think about the domain of non-timber forest resources.

Before I begin the analysis, the question I asked to elicit free-lists, “Can you make a list all the things from the forest that you use, other than animals and wood?” deserves a brief comment. As noted above, I was interested in non-timber forest resources, so I

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49 The question phrased in Portuguese was “Pode fazer uma lista das coisas da floresta que usa, menos animais e madeireiros?”

50 It is possible that with some households, family members might have chosen to remain silent during the group interview, allowing the household head(s) to respond to questions. In conducting the free-lists, when a prolonged silence appeared to signal an end to the household’s free-list, I asked if anyone had any other items they would like to add to the list, addressing the questions to all household members.
specifically wanted to avoid the listing of forest resources used for timber. Asking households to not list wood resources (*madeireiras*) did not preclude them from noting the use of a particular part of a species, other than its use for timber, such as the tree bark for medicinal purposes. I also wanted to eliminate the listing of game animals. As noted in Chapter 3, households hunt a number of forest animals, and they are important for household consumption as well as providing meat, through sharing, to other families in the area. For nearly all households, game animals contributed substantially to productive income. However, I was interested primarily in plant resource use and knowledge, including items both consumed and traded, therefore these resources would take priority over the inclusion of other forest resources. Pre-testing of the pile sort test led me to limit the number of items to 24, and I felt this number was too low to include game animals.

I also asked households to list things of the forest that they “use.” This gave the household a more concrete framework for responding to the question rather than a more open question asking them to list “things,” or “things that they know.” However, it also put limits on what households might respond. For example, only 23 of 44 households listed either “seringa” or “borracha,” both referring to rubber. Given a more open question, more households may have listed rubber, an item that all households know and most likely extracted at some point in their past. Eleven households did not tap rubber, although four still placed it on their free-list. More interesting, only 19 of 33 households that tapped rubber in the 12 months prior to the research placed “seringa” or “borracha” on their free-list. This in itself is notable, as well as surprising, as rubber was a major source of income for many of these households.
One more clarification regarding the free-lists is important to make. In 1996 and 1997 I conducted research in the reserve with many of the same rubber tapper households in this study. During this period I carried out a study on three particular forest fruits, all palm species: *açaí*, *bacaba*, and *patauá*. This likely affected the response of households to the free-list exercise in two ways. First, my presence when asking the question almost certainly cued the response of some households, some of which immediately rattled off *açaí*, *bacaba* and *patauá* as free list items. Second, these items were often the first items stated by households, thus tainting any analysis of the order in which the items were listed. As evidence supporting this assertion, of all items listed more than two times among all households (29 items were on two or more household free-lists), only rubber and Brazil nuts maintained a higher average rank on the lists than *açaí*, *bacaba* and *patauá*.

The free-lists provided by study households open a unique window to understand rubber tapper use and knowledge of non-timber forest resource. Through analysis of these lists, we can begin to see not only the diversity of the plant (and non-plant) forest resources that rubber tapper households use, including, in some cases, the particular part of the plant utilized, but also the different Linnaean plant families that are important to forest households.

Table 5-1 on the following page contains a complete list of the 83 free-list items provided by 44 rubber tapper households. All but two items were common plant names or plant parts: households also listed two non-plant items—honey and water. Of the 81 plant-related items, all but two referred to a specific plant. In two cases, generic plant parts, rather than common plant names, were listed—*palha*, or palm leaf or frond
(literally, straw), and *palmito*, or heart of palm.\(^{51}\) In numerous cases, the common plant name was accompanied with the name of the specific plant part used. For example, *copaíba* was listed, as well as *copaíba* oil and *copaíba* bark. These are counted as three different items (of the total 83), but all refer to the same plant genus, *Copiafera*.\(^{52}\) Other plant parts noted along with common plant names included palm leaves, coconut, fruit, vines, and seeds.

Table 5-1. Extractive resource free-list items and frequency of occurrence for 45 rubber tapper households. Chico Mendes Extractive Reserve, 2001.

<table>
<thead>
<tr>
<th>Free-list Items</th>
<th>Frequency</th>
</tr>
</thead>
<tbody>
<tr>
<td>Açaí (33)</td>
<td></td>
</tr>
<tr>
<td>Castanha (29)</td>
<td></td>
</tr>
<tr>
<td>Patuá (28)</td>
<td></td>
</tr>
<tr>
<td>Bacaba (24)</td>
<td></td>
</tr>
<tr>
<td>Bacuri (17)</td>
<td></td>
</tr>
<tr>
<td>Cacau (17)</td>
<td></td>
</tr>
<tr>
<td>Copaíba (5)</td>
<td></td>
</tr>
<tr>
<td>Borracha (16)</td>
<td></td>
</tr>
<tr>
<td>Jabobá (10)</td>
<td></td>
</tr>
<tr>
<td>Cipó ambé (10)</td>
<td></td>
</tr>
<tr>
<td>Cipó timbó (8)</td>
<td></td>
</tr>
<tr>
<td>Seringa (7)</td>
<td></td>
</tr>
<tr>
<td>Jutaí (6)</td>
<td></td>
</tr>
<tr>
<td>Copaíba (5)</td>
<td></td>
</tr>
<tr>
<td>Pama (5)</td>
<td></td>
</tr>
<tr>
<td>Mel de abelha (5)</td>
<td></td>
</tr>
<tr>
<td>Palha (4)</td>
<td></td>
</tr>
<tr>
<td>Quina-quina (4)</td>
<td></td>
</tr>
<tr>
<td>Óleo de copaíba (4)</td>
<td></td>
</tr>
<tr>
<td>Palha de jatobá (4)</td>
<td></td>
</tr>
<tr>
<td>Buriti (3)</td>
<td></td>
</tr>
<tr>
<td>Casca de copaíba (3)</td>
<td></td>
</tr>
</tbody>
</table>

In two cases, the same plant species was referred to through the use of two different common names or in different forms—processed and unprocessed. In the first case, rubber tappers used the common names *cerejeira* and *cumaru de cheiro* in referring to the

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\(^{51}\) In Acre, heart of palm is extracted principally from two palm species, *açaí* (*Euterpe precatoria*), a single stemmed palm and peach palm, locally referred to as *pupunha* (*Bactris gisaeopes*), a multi-stemmed palm planted in agroforestry projects.

\(^{52}\) There are seven species of the genus *Copiafera* that occur in Acre.
single species, *Amburana cearensis* (Allemao) A.C. Sm. Timber from *A. cearensis* is used for construction while the bark is used for medicinal purposes. In the second case, rubber (*Hevea brasiliensis*) was listed in two different forms, *seringa* and *borracha*. *Seringa* refers to the latex that is extracted from the tree (no households listed *seringueira*, which would refer to the tree itself), while *borracha* refers to rubber, the product that the rubber tappers produce with *seringa* through the use of simple in-forest processing technologies. For pile-sorting purposes, in the former case, I chose to use the term *cerejeira*—neither common name (*cerejeira* and *cumaru de cheiro*) was used more often than the other. In the latter case I used the term *borracha*, as this term was free-listed more often than *seringa*.

Table 5-2 on the following page presents free-list items categorized by plant family. The number of genera, as well as the number of free-list items in each family, is included. Free-list items represent approximately 29 plant families. As some common plant names can be attributed to different genera and families, the exact number of plant families represented could not be determined. Arecaceae, the palm family, was the most common plant family found among free-list items. In this family, 19 different items were listed, representing 10 different genera. No other plant family came close to this number. It represents nearly 25.0 % of all plant items listed and approximately 20.0 % of all genera. Clearly palms are an important plant species to rubber tapper households. This is not surprising; scholars have christened the palm plant the “tree of life” (Balick 1988), due to the various uses that it serves, including food, construction, medicine, and handicraft production, among others.
Table 5-2. Free-list items categorized by plant family and genus.

<table>
<thead>
<tr>
<th>Family</th>
<th>Number of Genera</th>
<th>Number of Free List Items in Family</th>
</tr>
</thead>
<tbody>
<tr>
<td>Anacardiaceae</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>Annonaceae</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Apocynaceae</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>Areceae</td>
<td>10</td>
<td>19</td>
</tr>
<tr>
<td>Araceae</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>Bignoniaceae</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>Burseraceae</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Caesalpiniaceae</td>
<td>3</td>
<td>9</td>
</tr>
<tr>
<td>Caricaceae</td>
<td>1 or 2</td>
<td>2</td>
</tr>
<tr>
<td>Celastraceae/Hippocrateaceae</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Clusiaceae</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Cyclanthaceae</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>Euphorbiaceae</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>Fabaceae</td>
<td>1</td>
<td>4</td>
</tr>
<tr>
<td>Fabaceae/Caesalpiniaceae/Bignoniaceae</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Flacourtiaaceae/Caesalpiniaceae</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Lauraceae</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Lecythidaceae</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>Marantaceae</td>
<td>1</td>
<td>3</td>
</tr>
<tr>
<td>Mimosaceae</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>Mimosaceae/Caesalpiniaceae</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Bignoniaceae</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Moraceae</td>
<td>3-4</td>
<td>4</td>
</tr>
<tr>
<td>Musaceae</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Myrtaceae</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Rosaceae</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Rubiaceae</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>Rubiaceae/Apocynaceae</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Rutaceae</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Sapotaceae</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Sterculiaceae</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Verbenaceae</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Vochysiaceae/Menispermaceae</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Melastomataceae</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Flacourtiaaceae/Zaiaceae</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>52-54</td>
<td>81</td>
</tr>
</tbody>
</table>

Notes: aMultiple families indicate that the family could not be determined from Daly et al. (n.d.) and consultation with a botanist in Acre, Brazil. Without a botanical identification, the species could be attributed to more than one family. bGenera were determined by previous plant collections in Acre, Daly et al. (n.d.) and consultation with a botanist in Acre, Brazil. In some cases, the genus for the free list item could not be determined.

How do these data compare to previous ethno-botanical research among rubber tapper households in Acre? As noted in Chapter 3, Kainer and Duryea (1992) identified 145 plant species among 60 plant families that women in the Chico Mendes and
Cachoeira Extractive Reserves use. They carried out structured interviews with 14 women, although noted that they gathered information from key informants during the first phase of their study and carried out informal interviews with more than 30 additional informants. Kainer and Duryea (1992) noted that 35.0% of these plants were located in the forest, thus we can estimate that women listed approximately 51 forest plants. In another study, Ming and Amaral Junior (n.d.) interviewed 53 individuals who identified 158 species in 61 plant families for medicinal purposes. Of these 158, approximately 65.0% were native to the Amazon region, with approximately 53.0%, or 84, plants collected from the forest, and 11.8% domesticated.

My study included the participation of all household members, so the number of total participants involved in providing the free-lists was much greater than both of these studies. The free-list activity elicited approximately 47 forest plant species, 37 of which are native to Acre, below the 51 estimated for Kainer and Duryea (1992) and 84 identified by Ming and Amaral Junior (n.d.). Thus, in comparison, it appears that the free-list activity with 44 households captured at least some of the variety of native forest plants used by rubber tappers.

The number of items listed by households varied from 2 to 18 items. The average free-list length of all households was 7.2 items (s.d. = 3.23). Table 5-1 above displayed all of the items listed, including frequency. The most frequently listed item was açai (E. precatoria) noted by 34 of 44 households. Second was castanha, or Brazil nut (B.

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53 Kainer and Duryea (1992) broke down plant use into eight categories: food, beverages, spices, medicines, animal feed, firewood, construction materials, and miscellaneous.

54 Other plant sites included compound, crop field, fallow field and garden/raised bed.

55 I have assumed that all of the estimated 51 plant species for Kainer and Duryea’s (1992) study that were collected in the forest are native.
excelsa) listed by 29 households), followed by patauá (O. bataua) by 28 households and bacaba (O. mapora) by 24 households. As noted above, my prior research in the Chico Mendes reserve on the three palm species may have influenced the listing of these species. Only four items were listed by at least 50.0% of households while seven items were listed by 25.0% of the households. Twenty-nine items appeared on two or more free-lists, while 54 items were listed only once.

Table 5-3 on the following page combines all items related to a single common name. Most notable, copaiba (Copiapera spp.) listed previously as copaiba, copaiba oil and copaiba bark was listed in some form by 11 households. Combining common name items results in 28 items listed by two or more households and 31 items listed by only one household.

The results of the free list activity found that rubber tapper households use a diverse range of plants from many plant families. The frequency of listing of palm species reveals that palms are a particularly important plant family to rubber tapper households. Yet, households, as a whole, listed many items only once or twice, indicating that there may be considerable use differences across study households. And rubber (listed as borracha and seringa), an important resource to generations of rubber tappers, was listed by just over half of the households. These results suggest use differences among study households and this suggests that there may be differences in knowledge as well. This, in turn leads us to ask one of the central questions of this dissertation: do rubber tappers vary in their cultural knowledge of extractive resources? The remainder of this chapter and the following respond to this question.
Table 5-3. Free list results with common name items combined and listed by frequency.

<table>
<thead>
<tr>
<th>Common Name</th>
<th>Family</th>
<th>Frequency</th>
</tr>
</thead>
<tbody>
<tr>
<td>Açaí</td>
<td>Aracaceae</td>
<td>34</td>
</tr>
<tr>
<td>Castanha</td>
<td>Lecythidaceae</td>
<td>29</td>
</tr>
<tr>
<td>Patauá</td>
<td>Aracaceae</td>
<td>29</td>
</tr>
<tr>
<td>Bacaba</td>
<td>Aracaceae</td>
<td>24</td>
</tr>
<tr>
<td>Borrracha</td>
<td>Euphorbiaceae</td>
<td>23</td>
</tr>
<tr>
<td>Bacuri</td>
<td>Clusiaceae</td>
<td>17</td>
</tr>
<tr>
<td>Cacau</td>
<td>Sterculiaceae</td>
<td>17</td>
</tr>
<tr>
<td>Jatobá</td>
<td>Caesalpiniaenceae</td>
<td>13</td>
</tr>
<tr>
<td>Cipó timbó</td>
<td>Cyclanthaceae</td>
<td>11</td>
</tr>
<tr>
<td>Copaíba</td>
<td>Caesalpiniaenceae</td>
<td>11</td>
</tr>
<tr>
<td>Cipó ambé</td>
<td>Araceae</td>
<td>9</td>
</tr>
<tr>
<td>Jutái</td>
<td>Caesalpiniaenceae</td>
<td>7</td>
</tr>
<tr>
<td>Arumã</td>
<td>Marantaceae</td>
<td>7</td>
</tr>
<tr>
<td>Pama</td>
<td>Moraceae</td>
<td>5</td>
</tr>
<tr>
<td>Mel de abelha</td>
<td>NA</td>
<td>5</td>
</tr>
<tr>
<td>Jarina</td>
<td>Aracaceae</td>
<td>5</td>
</tr>
<tr>
<td>Palha*</td>
<td>Aracaceae</td>
<td>4</td>
</tr>
<tr>
<td>Ouricuri</td>
<td>Aracaceae</td>
<td>4</td>
</tr>
<tr>
<td>Quina-quina</td>
<td>Rubiaceae/Apocynaceae</td>
<td>4</td>
</tr>
<tr>
<td>Cerejeira</td>
<td>Fabaceae</td>
<td>4</td>
</tr>
<tr>
<td>Ingá</td>
<td>Mimosaceae</td>
<td>3</td>
</tr>
<tr>
<td>Buriti</td>
<td>Aracaceae</td>
<td>3</td>
</tr>
<tr>
<td>Paxiúba</td>
<td>Aracaceae</td>
<td>3</td>
</tr>
<tr>
<td>Mamão</td>
<td>Caricaceae</td>
<td>2</td>
</tr>
<tr>
<td>Pau d’Arco</td>
<td>Bignoniaceae</td>
<td>2</td>
</tr>
<tr>
<td>Unha de gato</td>
<td>Rubiaceae</td>
<td>2</td>
</tr>
<tr>
<td>Cajaraña</td>
<td>Anacardiaceae</td>
<td>2</td>
</tr>
<tr>
<td>Angico</td>
<td>Mimosaceae</td>
<td>2</td>
</tr>
</tbody>
</table>

Note: *Palha (palm leaf), listed by 4 households is not directly related to a specific species. It is included under the palm family, Arecaceae.

The Pile Sort Test

The pile sort test tells us how individual rubber tapper household members categorize items found in the domain of extractive forest resources. Rather than categorize items into pre-identified categories, the pile sort test gives respondents the opportunity to make categories that match their individual understanding of the resources. This is very different from more typical ethno-botanical research where researchers typically break out various categories of plant use, (Kainer and Duryea 1992 as noted above) or slight variations which might include identifying more specific use categories such as dyes and tannins and poisons (Coe and Anderson 1996: 71-107) or the lumping
of categories, such as identifying a “technological” category to describe species with general local use, including tools, varnishes, poisons, resins and crafts (Johnston and Colquhoun 1996: 183). The pile sort test allows individuals to create categories not tied to a general theme, such as “use.” For example, one group of items may be sorted by location in the forest, while another group might represent the utility of the items, while another group might represent plants that flower during the same season. However, the discussion to follow reveals that use is extremely important in understanding how rubber tappers categorize non-timber forest resources.

**The Selection of Pile Sort Items**

In Chapter 2, I described in detail how the pile sort test was implemented. However, before discussing the results of this activity I will briefly describe how I selected the items included in the pile-sort test.

As noted above, the free-list activity produced a list of 83 items. Of these, I selected 24 items for the pile sort test. In general, after consolidating items that were actually the same item (not of the same common name) I chose those items most frequently listed. This meant that I consolidated *casca de cerejeira* with *casca de cumaru de cheiro*, as they are the same item, but considered *copiaiba*, *óleo de copaiba*, and *casca de copaiba* as individual items. Of the 30 items listed two or more times, 22 items were selected for the pile-sort test. I included all items listed three or more times except as follows: I eliminated *palha* as it did not refer to a specific plant; I did not include *copiaiba*, as I chose to include the more specific items, *óleo de copaiba* and *casca de copaiba*; as noted above, I chose to use only *borracha*, and not *seringa*, as these I believed were too similar to include both; I did not include *buriti* as previous research in the area found that it is scarce if not completely absent in the three study communities; I
decided to leave out *paxiúba*, a palm of which the trunk is commonly used for
construction, as I had already decided to include other palms. Five items were selected
from the remaining items (*cajarana, palha de ouricuri, casca de cerejeira, unha de gato,*
and *cajá*).

Thus, all items selected were listed at least two times except for *unha de gato* and
*cajá*. I decided to include *unha de gato* (also listed as *cipó unha de gato*), a vine species
with medicinal properties, to see how it was sorted with other vine items. *Cajá* was
included as the fruit of this tree is a sister fruit of *cajarana* and is processed into a juice
and sold in the local market. I was interested in learning how rubber tappers would
categorize this item with regard to other items that produce fruits, as well as income
items.

**Results of the Pile Sort Test**

The pile sort data include the results of 118 individual respondents. The large
number of respondents provided the opportunity to analyze the pile sort results of sub-
groups of the sample to examine potential differences in how sub-groups—male and
female, and youth, young adult and adult respondents—categorize items in the domain of
non-timber forest resources. In this chapter I report the results of the pile sort tests for all
individuals and individuals categorized by sub-groups. In the following chapter I
summarize the results of the pile sort test for individuals and sub-groups across different
levels of household wealth and market integration, thus responding to hypotheses H7
through H10.

To examine the results of the pile sorts, I employed a number of analytical tools,
including consensus analysis, multidimensional scaling (MDS), Johnson’s Hierarchical
Clustering (hereon referred to as cluster analysis), and quadratic assignment procedure
Consensus analysis, discussed in Chapter 1, examines how knowledge is shared among individuals within a culture and in particular, the degree of knowledge each individual maintains (Romney, Weller and Batchelder 1986). Both MDS and cluster analysis output a figure that represents the cultural relationship of each item to all other items. MDS provides a multi-dimensional view of this relationship (Johnson and Griffith 1998) while cluster analysis tells us what groups cluster together as well as the strength of these clusters, i.e., the group relationships. Finally, I employ QAP to examine the correlation, or similarity, of cultural knowledge of two sub-groups within a culture.

In the discussion that follows, in particular with regard to the analysis of the MDS and cluster analysis results, I will refer to all items in Portuguese rather than English, i.e., I will refer to borracha, rather than rubber, castanha rather than Brazil nut, óleo and casca de copaiba rather than copaíba oil and bark, mel de abelha rather than honey, etc. I do this as all of the MDS scatterplots and cluster analyses results contain the Portuguese terms for the 24 pile sort items. This will hopefully make it easier for the reader to follow my interpretation of the figures.

**Initial Coding of Pile Sort Test Results**

The 118 individuals who completed the pile-sort test represent forty-five households. Within these 45 households, the number of individuals conducting pile sorts ranged from one to seven. Participants included 73 males and 45 females, with ages ranging from 13 to 71 years. As noted in Chapter 2, two visits were made to each household, the first to carry out a structured interview, the second to implement the pile sort test. During this second visit, in some cases, an individual 13 years or older declined to participate or was not at home. Ultimately, 32 individuals (of the 45 study households) who might have participated in the pile sort activity did not.
The pile-sort tests took place at the residence of respondents except in one case where the individual was working as a cook in the community center, so the test was conducted there. Although we did not note the time each individual needed to complete the test, the time ranged from approximately 5 to 30 minutes. When the respondent indicated that they had finished the test, I asked them if they had any final changes to make. I then asked them to explain the logic behind their sorting.

The number of “piles” or groups identified by individual respondents ranged from 2 to 19 groups. The average number of groups formed by respondents was 8.1, the mode 5.0, and the median 7.5. Sixty respondents or just over 50 % included at least one item on its own, as a unique group. The number of unique items “sorted” by these 60 respondents ranged from 1 to 16, meaning that one individual left 16 items without a partner. For those who created unique, or “singleton piles” (Bernard 1995: 250), this group was referred to in various ways, such as “separate,” “doesn’t have a group,” “doesn’t have a partner,” and “doesn’t know where it fits,” or “doesn’t know what it is used for,” the latter indicating that it was separated because of lack of knowledge of the item rather than lack of a partner. If the respondent sorted more than one unique group, they would sometimes refer to these piles as “todos separados” or “all separate.” In some cases, this single item group was given a name such as “medicine,” “good for remedy for diabetes,”“juice,” “not used at all, or “for eating by monkeys.” In one case, the respondent placed four items into their own unique groups (i.e., sorted each separately) but called two of these unique groups “juice” and the other two “only serves to eat.” So, unique items were “unique” for various reasons, not just because they didn’t

56 The wife of this respondent was living in the city of Xapuri receiving treatment for diabetes.
have a partner. The item sorted alone most often was *quina-quina*, placed in its own unique group by 32 respondents, or over 25.0% of pile sort participants. *Unha de gato*, *arumã* and *borracha* were each placed in their own unique group by 22 respondents. In contrast, *óleo de copaíba* was sorted alone only once, while *castanha, jatobá, jutai* and *patuá* were placed in their own unique group three times (See Table 5-4 below).

Asking respondents the names of the piles they created, i.e., the reason they sorted items together, was useful for understanding the item relationships that were identified in the results of the MDS and cluster analyses, to be presented below. By doing this, I was able to gain a much greater depth of understanding of the cognitive processes behind the sorted cards (cf. Bernard 1995: 252) and identify “themes” emerging from this process (cf. Ryan and Bernard 2003).

This process of discovering “themes” was simplified as the respondents gave very short responses in naming their groups, often only one or two words. However, some respondents gave multiple reasons for sorting items together, such as “eat fruit, bark is medicinal” and “we eat and serves as remedy.” In general, however, responses were very short and clear. To identify themes, I looked for repetitive words or phrases in the pile sort names and gave each a unique code (Ryan and Bernard 2003). I began by establishing a few key codes *a priori* based on previous experience working and living with rubber tapper households. These were: palm, *vinho*, eat, medicinal, income/sell, artisan and vine. However, as I began the coding process I soon realized that these codes were insufficient to capture the diversity of reasoning used to sort the 24 items. Nonetheless, these initial codes ultimately became the higher-level themes that emerged from the coding process.
The coding process resulted in establishing 131 codes. I constructed a 118 by 24 respondent by item matrix in an Excel® spreadsheet and coded the individual’s response for each item. In a number of instances, multiple codes were inserted in the matrix to reflect the multiple meanings given to the item. For example, a pile could be named both “vines” and “medicinal” by the respondent. I then recoded items to higher-level codes in which the original codes fell. For example, “remedy,” “syrup” and “lamedor” (i.e., home remedy) were recoded to the medicinal category; “makes brooms and baskets,” was recoded to the artisan category; “extractive product most sold” was recoded to the sell/income/market category; “better known fruits,” “bunch of fruits,” and “nuts” were recoded to the fruit category. Some items however, that one might infer are similar, I decided to keep separate. For example, a higher level “income” code, did not include “things we work with” and “products” or “productive” but did include codes such as, “give money,” “sell,” “gold” or “support cost of life.” To recode responses in the Excel® matrix, I ran the find and replace command. By tallying up the most frequent responses of the 24 item columns, I calculated the mode code, i.e., mode response, for each item. Table 5-4 provides a summary of the results, showing each item, its mode code, the second most common code and the number of times the items was sorted as unique. 57

Interestingly, for only three items—casca de cerejeira, casca de copaiba and cipó timbó—did the mode code represent over 50.0 % of the respondents. Thus, respondents

57 Many of the initial codes did not easily collapse into a higher-level code that I thought was on a comparable level to themes, or higher level codes noted in Table 5-4, such as eat, medicinal or artisan. Therefore, a number of initial codes were not recoded for calculating the mode response. Recoding initial codes such as “found in lowlands, stream edge” and “found in terra firm,” two very different forest environments, into a higher “forest location” code would not have changed the mode code for any of the 24 items.
did not overwhelmingly agree on what an item should be “named.” This does not mean that they did not sort items similarly, just that they have given them different names.

Table 5-4. Frequency of higher-level codes for 24 pile sort items. (Number of respondents of 118 total in parentheses)

<table>
<thead>
<tr>
<th>Item</th>
<th>Mode Code</th>
<th>2nd Most Frequent Code</th>
<th>Unique</th>
</tr>
</thead>
<tbody>
<tr>
<td>Óleo de copaíba</td>
<td>Medicinal (58)</td>
<td>sell (26)</td>
<td>1</td>
</tr>
<tr>
<td>Cacau</td>
<td>eat (54)</td>
<td>fruit (20)</td>
<td>12</td>
</tr>
<tr>
<td>Jatobá</td>
<td>Medicinal (54)</td>
<td>eat (21)</td>
<td>3</td>
</tr>
<tr>
<td>Bacuri</td>
<td>eat (52)</td>
<td>fruit (23)</td>
<td>9</td>
</tr>
<tr>
<td>Unha de gato</td>
<td>Medicinal (47)</td>
<td>vine (14)</td>
<td>22</td>
</tr>
<tr>
<td>Casca de copaíba</td>
<td>Medicinal (68)</td>
<td>sell (8)</td>
<td>6</td>
</tr>
<tr>
<td>Cajaraí</td>
<td>Juice (42)</td>
<td>eat (36)</td>
<td>6</td>
</tr>
<tr>
<td>Quina quina</td>
<td>Medicinal (55)</td>
<td>eat (7)(^a)</td>
<td>32</td>
</tr>
<tr>
<td>Arumã</td>
<td>artisan (43)</td>
<td>vine (13)</td>
<td>22</td>
</tr>
<tr>
<td>Bacaba</td>
<td>Juice (44)</td>
<td>eat (22)</td>
<td>5</td>
</tr>
<tr>
<td>Cipó ambe</td>
<td>artisan (56)</td>
<td>vine (27)</td>
<td>5</td>
</tr>
<tr>
<td>Caja</td>
<td>Juice (41)</td>
<td>eat (36)</td>
<td>6</td>
</tr>
<tr>
<td>Palha de jarina</td>
<td>cover house (49)</td>
<td>palm leaf (36)</td>
<td>5</td>
</tr>
<tr>
<td>Castanha</td>
<td>sell (50)</td>
<td>eat (17)</td>
<td>3</td>
</tr>
<tr>
<td>Açaí</td>
<td>Juice (44)</td>
<td>eat (22)</td>
<td>4</td>
</tr>
<tr>
<td>Casca de cerejeira</td>
<td>Medicinal (76)</td>
<td>work with (5)(^b)</td>
<td>4</td>
</tr>
<tr>
<td>Mel de abelha</td>
<td>Medicinal (51)</td>
<td>sell (16)</td>
<td>9</td>
</tr>
<tr>
<td>Borracha</td>
<td>sell (55)</td>
<td>work with (9)</td>
<td>22</td>
</tr>
<tr>
<td>Jutai</td>
<td>Medicinal (48)</td>
<td>eat (23)</td>
<td>3</td>
</tr>
<tr>
<td>Ingá</td>
<td>eat (53)</td>
<td>fruit (19)</td>
<td>16</td>
</tr>
<tr>
<td>Patauá</td>
<td>Juice (44)</td>
<td>palm leaf (21)</td>
<td>3</td>
</tr>
<tr>
<td>Cipó timbó</td>
<td>artisan (59)</td>
<td>vine (26)</td>
<td>5</td>
</tr>
<tr>
<td>Palha de ouricuri</td>
<td>cover house (47)</td>
<td>palm leaf (31)</td>
<td>4</td>
</tr>
<tr>
<td>Pama</td>
<td>eat (52)</td>
<td>fruit (22)</td>
<td>19</td>
</tr>
</tbody>
</table>

Notes:\(^a\)The second most frequent code was “un-named,” as the group in which the item was placed was not named by nine respondents. I have placed the next most frequent code in its place.\(^b\)The second most frequent code was a tie between “un-named” and “work with.”

Throughout the rest of this chapter, as I analyze the results of the MDS and cluster analyses procedures, I will often refer back to the raw pile sort data, i.e., how respondents identified items, to better understand what respondents were “thinking” when they sorted items together. This will be particularly important when looking at results of sub-groups of individuals categorized by different levels of wealth and market integration. This
analysis will be presented in the following chapter. In this analysis, I went beyond the conclusion that the results of sub-groups were similar to explore further if different sub-groups were thinking the same thing when they sorted items similarly. This was especially useful in exploring the relationship of rubber and Brazil nuts, two items that have a strong economic (and historical, in the case of rubber) importance to reserve households. As noted in Chapter 3, the economic importance of rubber is changing for many households, and understanding how individuals within sub-groups of items identified items will help reveal subtle differences in rubber tapper cultural knowledge. The analysis of the MDS and cluster analyses results of sub-groups will have a particularly strong focus on these two items.

I now turn to examining the results of the MDS, cluster analysis, QAP and consensus analysis procedures. I begin by analyzing the results of all 118 respondents, followed by the results of males and females, and then the three generations of rubber tappers.

**Pile Sort Test Results For All Respondents**

To begin my analysis, I want to focus on the aggregate proximity matrix that results from inputting the raw pile sort data. Found in Table 5-5 on the following page, this matrix contains an item-by-item (24 x 24) matrix that details the correlation of each item with every other item. In other words, it tells us the strength of each item-to-item relationships based on the pile-sorts of all 118 individuals. I very briefly describe the strongest and weakest item correlations.

Table 5-5 reveals that the strongest correlations are found among palm items. The strongest relationship is between *açaí* and *bacaba*, at 0.87, followed by *palha de ouricuri*
Table 5-5. Aggregate proximity matrix generated from pile sort data of 118 respondents.
CAJAPALHACASTA
---- ---- ---0.03 0.02 0.30
0.40 0.04 0.18
0.11 0.02 0.26
0.42 0.04 0.14
0.08 0.04 0.04
0.06 0.05 0.14
0.71 0.04 0.21
0.05 0.04 0.08
0.06 0.14 0.05
0.11 0.39 0.08
0.05 0.08 0.09
0.98 0.03 0.14
0.03 1.00 0.03
0.14 0.03 1.00
0.08 0.41 0.08
0.06 0.03 0.09
0.10 0.03 0.22
0.06 0.02 0.63
0.14 0.03 0.19
0.36 0.05 0.13
0.11 0.42 0.08
0.05 0.07 0.08
0.03 0.85 0.03
0.36 0.02 0.09

ACAICASCAMEL-DBORRAJUTAI
---- ---- ---- ---- ---0.06 0.45 0.58 0.31 0.25
0.07 0.08 0.12 0.08 0.21
0.07 0.38 0.28 0.16 0.71
0.08 0.10 0.12 0.08 0.22
0.04 0.30 0.19 0.06 0.17
0.05 0.67 0.38 0.14 0.30
0.08 0.08 0.12 0.08 0.17
0.01 0.38 0.17 0.07 0.26
0.07 0.03 0.03 0.09 0.05
0.87 0.03 0.05 0.08 0.03
0.03 0.06 0.08 0.10 0.09
0.08 0.06 0.10 0.06 0.14
0.41 0.03 0.03 0.02 0.03
0.08 0.09 0.22 0.63 0.19
1.00 0.05 0.06 0.07 0.03
0.05 0.98 0.44 0.11 0.31
0.06 0.44 0.98 0.21 0.21
0.07 0.11 0.21 1.00 0.10
0.03 0.31 0.21 0.10 1.00
0.03 0.04 0.11 0.06 0.15
0.82 0.04 0.05 0.06 0.05
0.03 0.06 0.08 0.12 0.05
0.41 0.03 0.04 0.02 0.05
0.05 0.06 0.08 0.05 0.23

INGAPATAUCIPO PALHA
---- ---- ---- ---0.05 0.06 0.05 0.03
0.49 0.10 0.07 0.03
0.12 0.08 0.06 0.04
0.41 0.08 0.07 0.04
0.14 0.03 0.28 0.03
0.04 0.05 0.06 0.04
0.39 0.13 0.06 0.05
0.10 0.02 0.08 0.04
0.08 0.08 0.58 0.13
0.05 0.81 0.02 0.41
0.09 0.03 0.82 0.06
0.36 0.11 0.05 0.03
0.05 0.42 0.07 0.85
0.13 0.08 0.08 0.03
0.03 0.82 0.03 0.41
0.04 0.04 0.06 0.03
0.11 0.05 0.08 0.04
0.06 0.06 0.12 0.02
0.15 0.05 0.05 0.05
1.00 0.07 0.08 0.06
0.07 1.00 0.03 0.44
0.08 0.03 1.00 0.06
0.06 0.44 0.06 1.00
0.42 0.07 0.03 0.03

PAMA
---0.04
0.42
0.13
0.53
0.06
0.06
0.35
0.09
0.03
0.06
0.08
0.36
0.02
0.09
0.05
0.06
0.08
0.05
0.23
0.42
0.07
0.03
0.03
1.00

199

1
OLEO DE COPAIBA
2
CACAU
3
JATOBA
4
BACURI
5
UNHA-DE-GATO
6
CASCA DE COPAIBA
7
CAJARANA
8
QUINA-QUINA
9
ARUMA
10
BACABA
11
CIPO AMBE
12
CAJA
13
PALHA DE JARINA
14
CASTANHA
15
ACAI
16 CASCA DE CEREJEIRA
17
MEL-DE-ABELHA
18
BORRACHA
19
JUTAI
20
INGA
21
PATAUA
22
CIPO TIMBO
23 PALHA DE OURICURI
24
PAMA

OLEO CACAUJATOBBACURUNHA-CASCACAJARQUINAARUMABACABCIPO
---- ---- ---- ---- ---- ---- ---- ---- ---- ---- ---1.00 0.08 0.29 0.08 0.19 0.53 0.06 0.21 0.05 0.06 0.08
0.08 1.00 0.16 0.53 0.05 0.09 0.37 0.10 0.08 0.09 0.07
0.29 0.16 1.00 0.17 0.16 0.31 0.16 0.25 0.06 0.07 0.08
0.08 0.53 0.17 1.00 0.08 0.13 0.39 0.09 0.05 0.10 0.08
0.19 0.05 0.16 0.08 1.00 0.24 0.05 0.30 0.21 0.01 0.31
0.53 0.09 0.31 0.13 0.24 1.00 0.10 0.40 0.05 0.06 0.09
0.06 0.37 0.16 0.39 0.05 0.10 1.00 0.08 0.05 0.09 0.10
0.21 0.10 0.25 0.09 0.30 0.40 0.08 0.99 0.08 0.01 0.09
0.05 0.08 0.06 0.05 0.21 0.05 0.05 0.08 1.00 0.08 0.58
0.06 0.09 0.07 0.10 0.01 0.06 0.09 0.01 0.08 1.00 0.03
0.08 0.07 0.08 0.08 0.31 0.09 0.10 0.09 0.58 0.03 1.00
0.03 0.40 0.11 0.42 0.08 0.06 0.71 0.05 0.06 0.11 0.05
0.02 0.04 0.02 0.04 0.04 0.05 0.04 0.04 0.14 0.39 0.08
0.30 0.18 0.26 0.14 0.04 0.14 0.21 0.08 0.05 0.08 0.09
0.06 0.07 0.07 0.08 0.04 0.05 0.08 0.01 0.07 0.87 0.03
0.45 0.08 0.38 0.10 0.30 0.67 0.08 0.38 0.03 0.03 0.06
0.58 0.12 0.28 0.12 0.19 0.38 0.12 0.17 0.03 0.05 0.08
0.31 0.08 0.16 0.08 0.06 0.14 0.08 0.07 0.09 0.08 0.10
0.25 0.21 0.71 0.22 0.17 0.30 0.17 0.26 0.05 0.03 0.09
0.05 0.49 0.12 0.41 0.14 0.04 0.39 0.10 0.08 0.05 0.09
0.06 0.10 0.08 0.08 0.03 0.05 0.13 0.02 0.08 0.81 0.03
0.05 0.07 0.06 0.07 0.28 0.06 0.06 0.08 0.58 0.02 0.82
0.03 0.03 0.04 0.04 0.03 0.04 0.05 0.04 0.13 0.41 0.06
0.04 0.42 0.13 0.53 0.06 0.06 0.35 0.09 0.03 0.06 0.08


and palha de jariná at 0.85, açaí and patauá at 0.82, cipó timbó and cipó ambé at 0.82 and bacaba and patauá at 0.81. As noted above in Table 5-3, açaí, bacaba, palha de ouricuri, palha de jariná and patauá are from the palm family, Araceae. As noted in Chapter 3, the fruit of açaí, bacaba and patauá can be used for making vinho, a thick juice drink. The palm leaves of ouricuri and jariná are used for thatch. Cipó timbó and cipó ambé are vines, both used for the production of artisan (and utilitarian) items such as baskets, sifters and brooms (the brush head, not the handle).

Other strong relationships include: jutai and jatobá (0.71), both from the Caesalpiniaceae family, and eaten and used for medicinal purposes; cajá and cajarana (0.71), both of the genus, Spondias of the Anacardiaceae family, the fruits of which are used to make vinho; casca de copaiba and casca de cerejeira (0.67), both tree barks and used for medicinal purposes, and: castanha (Brazil nuts) and borracha (rubber) (0.63), items traditionally extracted and sold by rubber tapper households, although castanha is also consumed. The items with the weakest correlations with other items were unha de gato, which correlated with cipó ambe at 0.31, and quina quina, which correlated with casca de copaiba at 0.40.

I now turn to examining the results of the MDS and cluster analyses procedures. I spend considerable time describing and analyzing these two initial figures for all 118 respondents, as they lay out the general patterns that are seen in subsequent MDS scatterplots and cluster analyses figures for sub-groups of participants.

Figure 5-1 presents the two-dimensional MDS scatterplot for all 118 pile sort test participants. The MDS scatterplot is useful for identifying not only item-to-item relationships, but also the general grouping of items. In fact, Borgatti (1996b) cautions
not to read too much into the strength of item-to-item relationships among a group of items that are clumped together. The MDS procedure also calculates the stress level related to the scatterplot. Bernard (1995: 502) defines stress as the “measure of how far off the graph is from one that is perfectly proportional,” or what might be called a “goodness of fit” indicator. In other words, the lower the stress, the better the scatterplot fits the relationships found among all items. Bernard (personal comm.) notes that 0.30 should be considered the upper limit for a good fit, while Borgatti (1996b) advises that an upper limit of 0.15 should be considered. All of the MDS scatterplots discussed in this and the following chapter had a stress level of less than 0.20, and most less than 0.15, so in general, they portray a pretty good fit of item relationships.

Figure 5-1. MDS scatterplot for pile-sort test of 118 respondents.

There is one other important idea to remember when analyzing the MDS scatterplots. In addition to looking for groups of items clumped together, dimensions, or what Borgatti (1996b: 35) terms “item attributes that seem to order the items in a map
along a continuum . . . that are thought to “explain” the perceived similarity between items” might also be found. Thus, two items may be spatially spread across the scatterplot but still have a relationship along a dimension. Of course, items found at the far ends of one dimension, or opposite sides of the scatterplot, would not be considered strongly similar on this dimension, though they might be related in some way, i.e., one is not considered medicinal, and one is considered highly medicinal. I will consider dimensions in greater detail below.

I have chosen to display the items in two dimensions, as this is the simplest form for interpretation. A third dimension could be added with the output providing a third “depth” dimension, thus giving a better idea of the similarity of items. I use a two-dimensional scatterplot, as a third dimension, although “fitting” the items better, would provide limited assistance to the reader in viewing the results (Clark et al. 1998) while cluttering the plots with the coordinates for a third dimension.

The stress level for Figure 5-1 is 0.159, suggesting a reasonable fit for the 24 items. Because of space limitations, some items are partially, and in some cases wholly, concealed by another item. As the MDS scatterplot is generated from the aggregate proximity matrix (Table 5-5), item relationships reflect these correlations. On the far left of the scatterplot figure is palha de ouricuri, underneath which are açaí, bacaba and patauá. Palha de jarina is hidden beneath palha de ouricuri. Thus we can see a very

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58 Dimensions do not necessarily run vertically and horizontally, but could also be diagonal.

59 It would be possible to display the names of all items in full by altering the size of the output scatterplot. This can be done when inputting the aggregate proximity matrix file into the Anthropac* MDS command. However, this would result in a very large scatterplot, which, when reduced for placing in this document, would be very difficult to read. The scatterplots have been adjusted to a size that I thought best for presentation. The MDS procedure outputs the coordinates (not included here) of the exact location of partially or fully hidden items.
strong relationship among all palm family items, and in particular the two palm sub-groups: the palm leaf sub-group, and the remaining three palms, the fruits of which are used for making *vinho*. The palms are clearly separated from the rest of the items indicating they have weak ties with other items.

At the top of the figure is the vine/artisan group: *arumã, cipo timbó* and *cipó ambé; cipo timbó* and *cipó ambé*. On the right side of the figure things are a bit messier. A total of eight items, including *unha de gato, óleo de copaíba, casca de cerejeira, casca de copaíba* (partially hidden), *quina quina, mel de abelha, jatobá* and *jutaí* appear to be part of one group. However, within this group there are clearly sub-groups of stronger relationships: *jatobá* and *jutaí* are close together, as are *óleo de copaíba, casca de cerejeira, casca de copaíba, quina quina*, and *mel de abelha*. *Unha de gato*, slightly above and to the left of this group appears to be pulled by its relationship (although weak) with other vine species, *cipó timbó* and *cipó ambé*. All of the items on the right have medicinal properties and this was the modal code for each of these items (See Table 5-4 above).

At the bottom of the scatterplot, just to the right of the center are *cajá, cajarana, cacau, bacuri, ingá* and *pama*. All of these trees produce fruits that are consumed. *Cajá* and *cajaraná* are processed into *vinho*, while the others are eaten mainly in their raw harvest form.60 Finally, in the center-right of the scatterplot are *castanha* and *borracha*. *Castanha* appears close to *jatobá* and *jutaí; jatobá* and *jutaí* both produce a hard-shelled fruit, or nut, thus their association with *castanha*. *Borracha*, on the other hand sits somewhat alone, though its relationship with *castanha* is clear.

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60 Cacau is also processed into a fruit drink and the fruit’s seeds are used to make chocolate.
Figure 5-2 displays this same image with items grouped according to these relationships, but also based loosely on how respondents identified items. Groups that can be identified are palms, vines/artisan, medicinal, fruits, and income, or products sold.

In addition to the clumping of items, I identified what appear to be two dimensions in the MDS scatterplot, which I will call the “medicinal” and “eat” dimensions (See Figure 5-3 below). The medicinal dimension begins on the left side of the scatterplot, with the palm cluster, items identified as least medicinal, and runs horizontally across the scatterplot, passing through the cluster of medicinal items on the right side, including, *casca de cerejeira* and *quina quina* among others. Items become “more” medicinal as you move from left to right.

---

61 I state “loosely” as items can be sorted together for a number of reasons. For example, I have called one group “fruits” in Figure 5-2, although these items were identified and placed together for numerous reasons, such as “fruits,” “eaten,” and “juice,” among others. As noted in Table 5-4, the mode codes for these six “fruit” items were not the same.
A second dimension, “eaten,” can also be identified. The “eat” dimension starts at the top of the scatterplot and runs vertically down to the bottom of the plot. Moving downward, items were increasingly identified as things eaten. In the figure, the vine items at the top of the scatterplot, would be the least edible items, while fruit items, such as *cajá*, *pama* and *ingá*, found on the bottom, and would be the most edible. Items such as *castanha*, *jatobá* and *jutaí* sit in the center of the dimension, and palm items on the far left side of scatterplot, including *açaí*, *bacaba* and *patauá*, are also edible, although identified less so by respondents, than fruit items.

PROFIT (PROperty FITting) analysis provides a tool to test for the existence and strength of these dimensions across all items (Borgatti 1996b). To do this, I gave each item a “rating” which was the number of times an item was identified as “medicinal” or “eaten” by the 118 respondents. I then carried out the PROFIT analysis, using Anthropac. PROFIT analysis, in short, conducts a regression analysis, regressing the coordinates of each of the MDS scatterplot items (independent variables) onto the attribute ratings (dependent variable) (Borgatti 1996b). The output includes the calculation of the $R^2$ for the model, which indicates how good a fit the map did in relation to the attribute score.

The MDS scatterplot output with the PROFIT analysis arrays, which show the best fit of the attribute data, are presented on the following page in Figure 5-3. Both arrays run in the directions predicted, the “medicinal” horizontally, left to right and the “eaten” vertically, top to bottom. The distance from the array is not important, nor on which side of the array an item lies. What is important is where each item lies along the array if connected to the array by a perpendicular line. Thus, as you move across the “medicinal”
array, or down the “eaten” array, each item is more “medicinal” or more “eaten.” The R² for the medicinal and eaten arrays, respectively, are 0.66 and 0.80, indicating that coordinates for each item is a fairly good fit for the item ratings for each of these “attributes.” Borgatti (1996b) notes that an R² of 0.80 is required to conclude that the data supports your hypothesis with less than 20 items. Hence, with 24 items, the PROFIT analysis arguably supports the hypotheses that “medicinal” and, and to a lesser extent, “eaten,” attributes were shaping “perceived similarity between items” (Borgatti 1996b: 35). These dimensions are found in the MDS scatterplots for the male and female sub-groups, although they become less clear when respondents are divided into age groups. I will discuss this further when presenting these figures in the following sections of the chapter.

Figure 5-3. PROFIT Analysis for all 118 respondents testing medicinal and eaten attributes.
Figure 5-4 presents the cluster analysis for all 118 respondents. This figure complements the MDS scatterplot by providing both a visual and numerical display of the strength of the item relationships. The 24 item names (and corresponding identification number that was written on the reverse side of pile sort cards) are listed across the top of the figure. The “x” wedged into the space between columns of items notes when two items cluster together. The number on the left side of the figure specifies

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Figure 5-4. Hierarchical cluster analysis for all 118 respondents.

the strength of the relationship when two items “meet.” This level, in general, reflects the correlation value found in the aggregate proximity matrix, although when groups of items are joining together, the correlation level between some items may be higher than
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indicated. Examining where items come together at the top of the figure reveals how strongly items correlate, i.e., the strength of the item in the cluster. Examining where groups of items come together at the bottom of the figure reveals the strength of the relationship of groups of items to other groups of items.\(^\text{62}\)

As seen in the MDS scatterplot, palms have the strongest relationship among all items. \textit{Bacaba} and \textit{açaí} cluster together at 0.8729 with \textit{patauá} joining shortly after. \textit{Palha de ouricuri} and \textit{palha de jarina} also have a strong relationship, although they do not join the other palms until the 0.4230 level. The group of palm items does not join the other 19 items until the 0.05 level, noted by the sole “x” connecting \textit{palha de ouricuri} with \textit{arumã}. This reveals the strong group relationship among palms as well as the weak relationship the palms maintain with other items.

The artisan/vine group is also tightly bound; \textit{cipó timbó} and \textit{cipó ambé} have a strong relationship with \textit{arumã} joining this pair at the 0.5847 level. Together as a cluster they join the palms at the 0.05 level and \textit{castanha} at the 0.0678 level, indicating weak ties with these items. The six items on the right side of the figure, all of which produce fruits and are consumed, also form a strong cluster. \textit{Cajá} and \textit{cajarana} display a particularly strong relationship, joining at the 0.7119 level and connecting to the other fruits at the 0.3763 level. This group only joins the group of medicinal items (see below) at the 0.1191 level.

In the center of the figure sits a large cluster, bordered by \textit{castanha} and \textit{jutai}, which includes strong sub-clusters of items. \textit{Borracha} and \textit{castanha} have a strong relationship,

\(^{62}\) It is important to remember that the cluster analysis procedure provides the best fit to demonstrate how items cluster together and the strengths of the items within the clusters; however, this does not mean that items in a cluster do not correlate with other items outside the cluster.
joining together at the 0.6271 level and connecting with *unha de gato* and other medicinal items only at the 0.1515 level. Their joining of the medicinal group before any other items (i.e., non-medicinal items) appears to be a product of its ties with *óleo de copaíba* and *mel de abelha*, which were also identified as income items (though less frequently than as medicinal items) during the pile sort test. *Jutai* and *jatobá* also form a pair, joining other items in the medicinal cluster near the bottom of the figure. A strong sub-cluster also exists among *óleo de copaíba*, *mel de abelha*, *casca de cerejeira* and *casca de copaíba*. *Unha de gato* and *quina quina* have a weak relationship with each other as well as all other items.

The cluster analysis reveals four major item groups – fruits consumed, medicinal, vines/artisan and palms; however *borracha* and *castanha* maintain a very strong independent cluster within the medicinal group. Examination of the cluster analyses of sub-groups will reveal that *borracha* and *castanha* form their own cluster in some sub-groups, or cluster with a group of items other than the medicinal group.

Together, the tight grouping, or clustering, of items in the MDS scatterplot and cluster analysis reveals that rubber tapper respondents think about these items in very similar ways and suggests a high level of agreement among respondents regarding “what goes with what.” But just how strong is the agreement among rubber tappers? Consensus analysis helps us better understand the uniformity of rubber tapper cultural knowledge on this domain.

**Consensus Analysis**

As noted in Chapter 1, consensus analysis examines the degree of agreement among the respondents, and calculates the knowledge of each participant based on what are the “culturally correct” answers (Weller 1987: 179). Romney, Weller and Batchelder
(1986: 316) explain that if we assume there is a high degree of shared information on a domain, and that knowledge on the domain varies, then we can identify how competent each individual is in terms of their knowledge. By knowing these competency levels, the answer key can be developed “by weighting each informant’s input and aggregating to the most likely answer,” with those most knowledgeable carrying more weight in determining what is the “culturally correct” response.

The results of the consensus analysis procedures with all 118 respondents revealed that there is strong consensus on the domain of non-timber forest resources among study participants. Table 5-6, containing the procedure output, indicates that three factors influenced rubber tappers in carrying out the pile-sorting activity. However, as factor 1 had a value over three times (in this case nearly 19 times) the value of factor 2 (see the ratio column), there is strong “cultural level of agreement” on this domain (Caulkins 1998: 179), and therefore, the respondents represent a single culture.

Table 5-6. Consensus analysis eigenvalues for all 118 respondents

<table>
<thead>
<tr>
<th>Factor</th>
<th>Value</th>
<th>Percent</th>
<th>Ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>76.185</td>
<td>91.5</td>
<td>18.824</td>
</tr>
<tr>
<td>2</td>
<td>4.047</td>
<td>4.9</td>
<td>1.341</td>
</tr>
<tr>
<td>3</td>
<td>3.017</td>
<td>3.6</td>
<td></td>
</tr>
<tr>
<td></td>
<td>83.250</td>
<td>100.0</td>
<td></td>
</tr>
</tbody>
</table>

I will use the results of consensus analysis in the following chapter in calculating gamma to test how wealth and market integration influence knowledge scores. But first I will analyze the pile sort test results of all respondents categorized by sex (males and females) and age (young-young adult-adult).

**Male and Female Cultural Knowledge**

Prior research in the Chico Mendes Reserve found that men and women rubber tappers carry out different roles in the forest household (Campbell 1996, Kainer and
Duryea 1992) and work with different plant materials (Kainer and Duryea 1992). Do these different roles and experiences with plants lead to differences in cultural knowledge? By separating the respondents by sex, I test whether these different roles and contact with plants reveal themselves in the cultural knowledge of these items.

Table 5-7 provides a breakdown of the 118 respondents by sex and age. Forty-five females and 73 males participated in the pile sort test. In addition to examining the separate results of MDS and cluster analysis procedures, I also ran the QAP analysis to statistically test for knowledge differences between these sub-groups. The QAP analysis showed a very high and statistically significant correlation (0.957, p-value = 0.00) between male and female respondents. Thus males and females maintain a very high degree of shared knowledge on this domain. This is not surprising given the high consensus found among all 118 respondents. Yet, a closer look at the results of MDS and cluster analysis reveals subtle differences in regards to how the different sexes think about extractive resources.

Table 5-7. Categorization of 118 respondents by sex and age.

<table>
<thead>
<tr>
<th></th>
<th>Age 1 (&lt; 25)</th>
<th>Age 2 (25 – 49)</th>
<th>Age 3 (≥ 50)</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Males</td>
<td>24</td>
<td>31</td>
<td>18</td>
<td>73</td>
</tr>
<tr>
<td>Females</td>
<td>12</td>
<td>25</td>
<td>8</td>
<td>45</td>
</tr>
<tr>
<td>Total</td>
<td>36</td>
<td>56</td>
<td>26</td>
<td>118</td>
</tr>
</tbody>
</table>

Figures 5-5 and 5-6 display the results of the MDS procedure for males and females. Although the two figures initially appear very different with regard to item relationships, spatially the items are similarly placed. Both scatterplots show a strong grouping of the five palm items, with sub-groups of palm leaves and the three palms that produce a juice drink. For both males and females, the six fruit items are clumped

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63 The stress values for the male and female MDS scatterplots were 0.159 and 0.152, respectively.
together, as are the vine/artisan items. Again, *unha de gato* is pulled between the vine/artisan group and the medicinal group, and *jatobá, jutai* and *castanha* form a “nut” sub-group. One notable difference is the separation of *borracha* from *castanha*. In the female MDS scatterplot, *borracha* is more distant from *castanha*. However, an examination of the aggregate proximity matrices of both males and females reveals that both sexes have a correlation of 0.62 between these two items.

The “medicinal” and “eat” dimensions are found in both scatterplots: the medicinal dimension moves horizontally from right to left for females, and left to right for males, while the “eat” dimension moves vertically, from top to bottom for females, and bottom to top for males. The PROFIT analysis calculated robust $R^2$ for both females and males for both the medicinal and eaten attributes. For males, the $R^2$ for the medicinal attribute was 0.64 while that for the eaten attribute was 0.79. For females, the $R^2$ for the medicinal attribute was 0.61 and for the eaten attribute, 0.70. The findings suggest that among both males and females the eaten attribute was influencing the sorting of items more than the medicinal attribute.

Figures 5-7 and 5-8 on the following pages present the cluster analyses for female and male respondents. The clusters of items identified in the MDS scatterplots can easily be found in the cluster analyses, although subtle differences regarding the strength of relationships can be found. First, comparing the palm clusters for males and females, the female cluster displays a particularly strong relationship among the three palms used to make *vinho*, while the males shows a stronger relationship (albeit slight) between the two palm leaves. This reflects the findings of Kainer and Duryea (1992) that women do the
food processing in the household, while men carry out different activities including building of landholding structures, which would include the use of palms for thatching.

Figure 5-5. MDS and PROFIT analysis for 73 male respondents with medicinal and eat attributes.

Figure 5-6. MDS and PROFIT analysis 45 female respondents with medicinal and eat attributes.
The cluster analyses figure also supports Kainer and Duryea’s (1992) argument that women, in particular, maintain important knowledge of medicinal plants. Females clustered numerous items in the medicinal group stronger than males: pairings between *óleo de copaíba* and *mel de abelha*, and *casca de copaba* and *casca de cerejeira*, as well as the single item *quina quina* demonstrated stronger clustering within this group. *Jatobá* and *jutaí* showed a slightly stronger cluster among male respondents, although they were similar.
Close inspection of the borracha/castanha cluster for the different sexes also reveals a slight difference. For females, the castanha/borracha has separated itself from the medicinal group, creating its own group. For males, the borracha/castanha cluster joins the medicinal group before joining the fruit group.

Two points may help explain this. First, data from females exhibit a stronger relationship between óleo de copaíba and mel de abelha than males and this may be due to their more frequent use of these items for medicinal purposes. Examining the pile-sort data finds that a greater proportion of females identified óleo de copaíba (26 of 45) and...
mel de abelha (24 of 45) as medicinal items than male respondents (32 of 73 and 27 of 73, respectively). Conversely, a greater proportion of males identified óleo de copaiba (19 of 73) and mel de abelha (11 of 73) as income items than females (7 of 45 and 5 of 45, respectively). Second, a greater proportion of males identified castanha (33 of 73) and borracha (36 of 72) as income items than females (17 of 45 and 19 of 45, respectively). Thus, a strong income association among these items by males would help create stronger ties among óleo de copaiba, mel de abelha, borracha and castanha, and this may explain why they are found in the same cluster.

Notwithstanding these differences, males and females maintain a high degree of shared knowledge of extractive resources. This is shown statistically in the results of the QAP procedure, and in the similarities of the MDS scatterplots and cluster analyses figures. The PROFIT analysis found that the “medicinal” and “eaten” qualities of items helped shape how both female and male respondents sorted items, with the medicinal dimension displaying a particularly good fit for both sexes.

But although the results for females and males are similar, slight variations in knowledge were identified through a closer examination of how individuals identified items. Underneath a similar visual display of items, males identified not only traditional extractive items—rubber and Brazil nuts—as income items in greater proportion than females, and also items considered to be medicinal—copaiba oil and honey—as income items. These findings reflect different gender roles in resource use in the forest (i.e., Kainer and Duryea 1992), but also suggest that government policies, such as the state government’s efforts to promote the extraction and sale of copaiba oil, may be reshaping cultural knowledge in different ways for different groups.
Age and Cultural Knowledge

As noted above, Campbell (1996) found that a growing number of mothers do not want their children to tap rubber, while Esteves (n.d.) argued that a new generation of rubber tappers holds different ideas about the forest and its resources. To test for differences in cultural knowledge across generations of rubber tappers, I divided respondents into three age categories: less than 25 years, 25 to 49 years, and 50 years and older (See Table 5-7 above). These categories were identified in the same manner employed to divide households by wealth and market integration, as noted in Chapters 3 and 4. I produced a histogram of all 118 respondents by age, ranked from youngest to oldest, and then examined the figure for natural breaks in the age of respondents to capture the generational changes, at the same time attempting to keep a minimum number of respondents in each age category.64

Despite age differences, the results showed a high degree of shared knowledge across the three generations of rubber tappers. The QAP analysis found strong and statistically significant correlations among all three age group combinations: age 1 and age 2 correlated at 0.92, age 1 and age 3 at 0.86, and age 2 and age 3 at 0.93 (p-value = 0.00 for all three QAP procedures). The MDS scatterplots65 and cluster analysis figures for the three age categories, found in Figures 5-9 through 5-14, also displayed the high degree of shared knowledge across generations. As found in the above MDS scatterplots for all respondents, and those for males and females, a general grouping of items—palms,

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64 The last age category, 50 and older, has only 26 respondents. This is a small number in comparison to the other two categories. However, it was important to establish a category that would capture an older generation of rubber tappers. Thus I have sacrificed an equally divided population to better capture three generations of rubber tappers.

65 Stress values for the two-dimensional MDS scatterplots for age categories 1, 2 and 3, were 0.166, 0.142, and 0.139, respectively.
Figure 5-9. MDS and PROFIT analysis for 36 respondents in the youngest age group (age 1) with medicinal and eat attributes.

Figure 5-10. MDS and PROFIT analysis for 56 respondents in the young adult age group (age 2) with medicinal and eat attributes.
Figure 5-11. MDS and PROFIT analysis for 26 respondents in the adult age group (age 3) with medicinal and eat attributes.

Vine/artisan, medicinal, and fruits—is present in all age categories. Yet, a closer examination reveals subtle, though important, distinctions across the three age groups.

First, in the youngest age group’s scatterplot and cluster analysis figures, jutai and jatobá have moved from the medicinal group and are now found closer (or clustered with) the fruit group. An examination of how respondents identified these items finds that moving from the youngest age group to the oldest age group, respondents proportionally decrease their identification of these items as fruits or things to eat, and increase their identification of them as medicinal items. This would corroborate findings by Kainer and Duryea (1992); younger household members are more likely to be eating these items in the forest, and arguably, less likely to be familiar with their medicinal properties.
Figure 5-12. Hierarchical cluster analysis for 36 respondents in youngest age group (age 1).

Second, *unha de gato* has also moved from a close association with the vine/artisan cluster among the youngest respondents (age 1), to firmly part of the medicinal group among the oldest respondents (age 3). Again, how they identified these items helps explain this movement; a greater proportion of age 1 respondents identified *unha de gato* as a vine (a morphological characteristic) or artisan item than age 2 and 3 respondents.
Figure 5-13. Hierarchical cluster analysis for 56 respondents in adult group (age 2).

Conversely, a greater proportion of age 3 respondents identified this item for its medicinal properties than age 1 and 2 respondents.

A third difference among age categories, regarding the *borracha/castanha* relationship, may be the most interesting. Both the MDS scatterplots and cluster analyses figures display a strengthening of this relationship moving from youngest (age 1) to oldest (age 3) respondents. Thus, younger respondents found other items with which to
Figure 5-14. Hierarchical cluster analysis for 26 respondents in adult group (age 3).

identify *borracha*. An examination of how respondents identified these items reveals important differences. First, not only did a smaller proportion of age 1 respondents sort these items together, but, when they placed them together, a smaller proportion tied them together as income items. Of age 1 respondents, 12 of 36 identified them together as income items, compared to 23 of 56 of age 2 respondents, and 12 of 26 age 3
Second, and concomitantly, the proportion of respondents who identified *borracha* as an income item fell (albeit very slightly) moving from older to younger respondents, from 13 of 26 (50.0 %) age 3 respondents, to 27 of 56 (48.2 %) age 2 respondents, to 15 of 36 (41.7 %) age 1 respondents. Finally, a greater proportion of age 1 respondents (8 of 36) identified *borracha* as a unique item compared to age 2 respondents (10 of 56) and age 3 respondents (4 of 26). The findings suggest that the youngest generation of rubber tappers may hold different ideas about rubber, in particular its role as an income-earning product for the household.

Results of the PROFIT analysis were less conclusive for the three age categories than seen above among all respondents, as well as males and females. Looking first at the youngest group, age 1, the $R^2$ for the medicinal and eaten attributes, respectively, were 0.56 and 0.46. Neither attribute showed a good fit, indicating that perceived similarities among items for the youngest respondents were not driven by these two attributes. For young adults, age 2, the $R^2$ for the medicinal attribute was 0.81 and for the eaten attribute, 0.57. For the young adults, the medicinal dimension shows a robust fit with the item coordinates, indicating that this attribute helped shape the sorting of items. Finally, for the oldest group, age 3, the $R^2$ for the medicinal dimension was a fairly robust 0.70, while the eaten attribute was a very poor fit, with an $R^2$ of only 0.18. Thus, as I expected, for the two older generations the medicinal dimension showed a good fit with

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66 A stronger relationship between *castanha* and some of the eaten fruits, such as *pama* and *ingá* (and *cacau* in comparison to only age 3 respondents) might also help explain this difference, with younger respondents viewing *castanha* as a fruit to be eaten rather than as an income item. A greater percentage of respondents in age category 1 identified *castanha* as a “fruit” or “to eat” item than age categories 2 and 3. This would fit with the observation made by Kainer and Duryea (1992) regarding the fruit eating habits of younger children. However, age 2 and age 3 categories showed similar relationships found in age 1 with regard to correlations between *castanha* and *cajá* and *cajarana*. Indeed, adults were more likely to identify *castanha* as a “vinho” item, or as *leite*, or milk, as the oil from Brazil nuts is commonly referred, which is mixed with juice from *cajá* and *cajarana* to make a fruit drink.
the MDS coordinates. However, surprisingly, for the youngest generation, the eaten
dimension was not a good fit for the MDS coordinates.

Although rubber tappers of different generations have very similar knowledge of
the domain of extractive resources, subtle differences across age categories were noted.
In the MDS and cluster analysis procedures, differences across age categories with regard
to the identification of items as medicinal items or as items to be eaten support the
findings of Kainer and Duryea (1992). Concomitantly, differences in how rubber was
identified suggest support for the arguments of Campbell (1996) and Esteves (n.d.), that
new generations of rubber tappers may have different ideas about the source of future
income. Results of PROFIT analysis argue that the perception of “medicinal” and
“eaten” qualities of all 24 items was not shaping item identification similarly across age
categories. For example, for each age category, the “eaten” attribute was not a robust fit,
suggesting that this attribute was not shaping rubber tapper thinking among all items.
However, the “medicinal” attribute found a good fit for the young adult group, and was
fairly strong for oldest respondents as well. This does not contradict the finding that
groups of items were strongly identified for their medicinal or eat properties by these age
groups, but indicates that these item attributes were not shared across items. The poor fit
of the “eaten” attribute among age 1 respondents was somewhat surprising. I believed
the eaten attribute would provide a stronger fit among the youngest generation, based on
the findings of Kainer and Duryea (1992), as well as my own experience working with
forest households.

Conclusion

In this chapter I examined how rubber tappers think about the domain of non-
timber forest resources. By employing cognitive anthropological methods, including free
lists and pile sorts, and analyzing the results of respondents categorized by sex and age, a picture has emerged regarding how rubber tappers understand this group of extractive resources.

The first part of this chapter examined the results of the free list activity. Simply asking rubber tapper households to list extractive items found that they use a range of forest plants from a number of plant families. Households listed 83 items that fell into approximately 29 plant families. Plants in the palm family, Arecaceae, were listed most often, attesting to their importance for a variety of consumptive uses, such as food, construction and medicine. Indeed, three of the top four items listed were palm species. Although this may be partially attributed to my previous research in the reserve, it nonetheless indicates that palms have a diverse role in household subsistence. Brazil nuts and rubber were also noted frequently. But curiously, rubber was noticeably absent from many lists. This was true even among households that still tap rubber. In fact, rubber was listed by only 23 households, just over half of all households. That a number of households that collect and sell rubber, and gain a sizeable portion of their income from it, did not list this item suggests a different understanding of this resource. It seems possible that households did not list rubber because they don’t “use” it, but rather extract and sell it. Regardless of why, its absence is notable.

One other finding is particularly interesting. Although households listed many items from a number of different plant families, a great proportion of these items, 54 of 83, approximately 65 %, were listed only once or twice. This suggests that there are considerable differences in the use of extractive items, even as households might hold similar knowledge about medicinal remedies or food preparation.
The analysis of the results of the cognitive tests run with the pile sort data comprised the second portion of this chapter. Most striking about the results of the pile sort activity was how similar all respondents, as well as respondents divided into different sub-groups, sorted the 24 extractive items. The MDS and hierarchical cluster analysis figures for the sub-groups of the sample—male, female and three age groups—displayed a strong similarity in thinking about this domain. Cultural consensus analysis found a high degree of shared knowledge.

Further, the results of the QAP analysis demonstrate that cultural knowledge is also shared across sub-groups of the rubber tapper population; strong and significant correlations were found in comparing the results of males and females, as well as three different generations of rubber tappers. This high correlation across the three generations seems to contradict Esteve’s (n.d.) contention that a new generation of rubber tappers is placing new values on the forest.

Yet, a closer examination of the results of the different tests lends support to her argument. Although the cluster analysis figures across age groups were very similar, greater scrutiny of the relationship between rubber and Brazil nuts found that as age fell, the strength of this pair weakened, and concomitantly, the youngest generation associated these items less than the other age groups with income.

The above discussion leads us to two different conclusions, though they are not necessarily contradictory. On one hand, a high degree of agreement of all respondents, as seen in the high level of consensus, showed that rubber tappers widely share cultural knowledge of extractive resources. Indeed, respondents of different sexes and different age groups held very similar ideas of how these 24 extractive items should be grouped.
On the other hand, a closer examination of how male and female respondents, and respondents across generations, suggests subtle differences. Most interesting are the findings across age categories. Here we begin to see changes across generations, with implications for future market-oriented resource use in the reserve. Most notable is the falling identification of rubber as an income item among younger rubber tappers, and the concomitant weakening of its relationship to Brazil nuts, another item traditionally extracted and sold in the reserve. This suggests that this new generation of rubber tappers may be looking for new “items” to bring income into the household. But these items will also include non-extractive items, such as low-impact logging, increased crop production, and the steer that the children of Roberto and Cibele rode during my last visit.

Having explored changes in cultural knowledge of rubber tappers by sex and age, I now return to one of the central questions of this dissertation—how might wealth and markets be shaping rubber tapper livelihoods and knowledge? In the following chapter, I examine rubber tapper knowledge of extractive resources across levels of wealth and market integration. This will include analyzing the results among all respondents, as well as separating individuals into sub-groups of the sample—males and females, and three generations.
CHAPTER 6
WEALTH, MARKETS AND CULTURAL KNOWLEDGE

In the previous chapter, I found that rubber tappers have a high degree of shared knowledge on the domain of non-timber forest resources. This was demonstrated in the results of the QAP analysis and the strong cultural consensus on this domain. However, a close examination of the data also revealed subtle variations in knowledge among sub-groups of rubber tappers divided by sex and age. The variations were slight, but they suggest that individuals of different sex or generations hold varying ideas about particular extractive resources. In particular, the data indicated that rubber tapper youth hold different ideas about the role of rubber in the household economy, and this hints that they may have different ideas about future production activities in the reserve.

In this chapter, I build on this discussion, now examining how wealth and integration into the market economy may affect cultural knowledge of extractive resources. I test for differences in cultural knowledge of all individuals, categorized by level of household wealth and market integration, as well as sub-groups of individuals, also categorized by level of household wealth and market integration. To do this, I use the results of the cognitive tests in two different ways. First, I use the non-parametric statistic gamma to test if there is an association between level of wealth and market integration with individual consensus analysis scores. Second, I employ QAP to test the degree of fit of the pile sort results for individuals, and sub-groups of individuals, categorized by level of wealth and market integration. In addition, I will examine in
some detail the results of the MDS and cluster analysis procedures for individuals and sub-groups of individuals categorized by level of wealth and market integration.

In this chapter I demonstrate that cultural knowledge of extractive resources is shared widely among rubber tappers from households of different levels of wealth and market integration. Results of the statistical test gamma and QAP analysis largely confirm that rubber tappers in this study, first as a group, and also divided into sub-groups, maintain a high degree of shared knowledge on the domain of extractive resources. However, despite the strong consensus on this domain, the gamma test found two instances of a negative relationship between level of market integration and cultural knowledge. Further, a close examination of the pile sort data suggests that economic factors may be creating subtle knowledge differences. Together, these findings suggest that while cultural knowledge on this domain is widely shared, subtle differences associated with wealth and market integration are emerging, with implications for conservation and development in the reserve.

**Statement of Hypotheses**

In Chapters 3 and 4, I explored the relationship between household wealth and market integration on income, and in particular income from extraction. I argued that greater levels of material wealth and market integration would result in an increase in income, but a fall in income from extraction, and the percent of income from extraction. In this chapter, I build on these hypotheses in testing how wealth and market integration affect cultural knowledge of extractive resources. For hypotheses H7 and H8, I argue that higher levels of wealth and greater integration into markets (or better access to markets), will lead to lower knowledge levels. I hypothesize that: H7, as the level of household wealth increases, the cultural knowledge of non-timber forest resources of all
respondents, the household head, and sub-groups of individuals within the household (men, women, youth, young adults, adults) will fall, and; H8: as the level of household market integration increases, the cultural knowledge of non-timber forest resources of all respondents, household head, and knowledge of sub-groups of individuals within the household (men, women, youth, young adults, adults) will fall. To test these hypotheses, I calculate the non-parametric statistic gamma and measure the association of level of cultural knowledge with levels of wealth and market integration.

I conduct similar tests in hypotheses H9 and H10, employing QAP to examine the similarity, or degree of fit, of cultural knowledge of different sub-groups, categorized by levels of wealth and market integration. I hypothesize that: (H9) the knowledge of sub-groups of individuals (men, women, youth, young adults, adults) in wealthier households will be significantly different from the knowledge of sub-groups of individuals in poorer households, and; (H10) the knowledge of sub-groups of individuals in households (men, women, youth, young adults, adults) with a higher level of market integration will be significantly different from the knowledge of sub-groups of individuals in households with a lower level of market integration.

I will begin by presenting the results of hypotheses H7 and H8. This will be followed by a discussion of the results of the pile sort test for individuals and sub-groups of individuals, categorized by level of wealth and market integration. This would ordinarily follow with a discussion of the results of the QAP analyses for individuals, and sub-groups of individuals, categorized by level of wealth and market integration. However, the results of the QAP analysis found that for all individuals and sub-groups of individuals across levels of wealth and the different indicators of market integration were
highly correlated and statistically significant. This is important, as it means that hypothesis H9 and H10 are rejected. I argued that the QAP test would show significant differences in cultural knowledge among all respondents categorized by level of wealth and market integration, and among sub-groups of respondents categorized by level of wealth and market integration. This was not the case: all were highly correlated and statistically significant. I have placed the results of the QAP analysis in Appendix C.

In Chapters 3 and 4, I explained how I categorized households by level of net wealth per capita and level of market integration into labor markets. I created histograms of households ranked from lowest to highest net wealth per capita (and percent of productive income from off-farm labor) and identified natural breaks in the plots and established rank categories for each measure. I categorized households by the other two market integration variables, percent of productive income from barter and trade, and travel time to the city using this same method. Tables 6-1 through 6-4 summarize the different categories and number of respondents that fall into each category for each variable. These categories were used for calculating gamma as well as conducting the QAP analysis. The tables include only 45 households, as one household moved before I conducted the cognitive tests in my last field visit.

Finally, as gamma measures the level of association of two ordinal ranked variables, I also categorized individual cultural knowledge scores obtained through the consensus analysis procedure. To do this, I first generated a cultural knowledge score for each individual, which was calculated by running the consensus analysis procedure with all 118 study participants. I then separated individuals into groups, by household heads, and by sub-groups of individuals by sex and age, and categorized individuals within these
Table 6-1. Households and individual respondents grouped by sex and age, and categorized by net wealth per capita.

<table>
<thead>
<tr>
<th>Wealth Category 1 Less than R$500</th>
<th>Wealth Category 2 R$500 – R$999</th>
<th>Wealth Category 3 R$1000 to R$1999</th>
<th>Wealth Category 4 Greater than R$2,000</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Households</td>
<td>11</td>
<td>15</td>
<td>8</td>
<td>11</td>
</tr>
<tr>
<td>Individuals</td>
<td>22</td>
<td>46</td>
<td>21</td>
<td>29</td>
</tr>
<tr>
<td>Females</td>
<td>9</td>
<td>17</td>
<td>10</td>
<td>9</td>
</tr>
<tr>
<td>Males</td>
<td>13</td>
<td>29</td>
<td>11</td>
<td>20</td>
</tr>
<tr>
<td>Age 1</td>
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<td>Age 3</td>
<td>3</td>
<td>10</td>
<td>0</td>
<td>13</td>
</tr>
</tbody>
</table>

Table 6-2. Households and individual respondents, grouped by sex and age, and categorized by percent of household productive income from off-farm labor.

<table>
<thead>
<tr>
<th>Pct. Off-farm Category 1 0 %</th>
<th>Pct. Off-farm Category 2 0-10 %</th>
<th>Pct. Off-farm Category 3 11 – 45 %</th>
<th>Pct. Off-farm Category 4 Greater than 45 %</th>
<th>Total</th>
</tr>
</thead>
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<tr>
<td>Households</td>
<td>13</td>
<td>15</td>
<td>12</td>
<td>5</td>
</tr>
<tr>
<td>Individuals</td>
<td>32</td>
<td>40</td>
<td>36</td>
<td>10</td>
</tr>
<tr>
<td>Females</td>
<td>11</td>
<td>17</td>
<td>13</td>
<td>4</td>
</tr>
<tr>
<td>Males</td>
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<td>23</td>
<td>23</td>
<td>6</td>
</tr>
<tr>
<td>Age 1</td>
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<td>7</td>
</tr>
<tr>
<td>Age 3</td>
<td>13</td>
<td>6</td>
<td>7</td>
<td>0</td>
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</tbody>
</table>

Table 6-3. Households and individual respondents, grouped by sex and age, and categorized by percent of productive income from barter and trade of agriculture and extractive products.

<table>
<thead>
<tr>
<th>Pct. Trade Category 1 0 – 20 %</th>
<th>Pct. Trade Category 2 21 - 35 %</th>
<th>Pct. Trade Category 3 36 – 49 %</th>
<th>Pct. Trade Category 4 50 % or greater</th>
<th>Total</th>
</tr>
</thead>
<tbody>
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<td>Households</td>
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<td>11</td>
<td>9</td>
<td>11</td>
</tr>
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<td>Individuals</td>
<td>35</td>
<td>31</td>
<td>24</td>
<td>28</td>
</tr>
<tr>
<td>Females</td>
<td>11</td>
<td>12</td>
<td>10</td>
<td>12</td>
</tr>
<tr>
<td>Males</td>
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<td>19</td>
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<td>16</td>
</tr>
<tr>
<td>Age 1</td>
<td>11</td>
<td>11</td>
<td>8</td>
<td>6</td>
</tr>
<tr>
<td>Age 2</td>
<td>16</td>
<td>14</td>
<td>13</td>
<td>13</td>
</tr>
<tr>
<td>Age 3</td>
<td>8</td>
<td>6</td>
<td>3</td>
<td>9</td>
</tr>
</tbody>
</table>

sub-groups by their knowledge scores into two equally divided rank categories using the “categorize variables” command in SPSS®. Thus, one category represents respondents with the highest knowledge scores, and a second category represents respondents with the lowest knowledge scores. I now turn to respond to hypotheses H7 and H8, which will be
Table 6-4. Households and individual respondents, grouped by sex and age, and categorized by travel time from household to city of Xapuri.

<table>
<thead>
<tr>
<th>Travel Time Category 1 2 hours or less</th>
<th>Travel Time Category 2 Greater than 2, but less than 4 ½ hours</th>
<th>Travel Time Category 3 4 ½ hours or more</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Households</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Individuals</td>
<td>11</td>
<td>18</td>
<td>16</td>
</tr>
<tr>
<td>Females</td>
<td>14</td>
<td>15</td>
<td>16</td>
</tr>
<tr>
<td>Males</td>
<td>21</td>
<td>31</td>
<td>21</td>
</tr>
<tr>
<td>Age 1</td>
<td>11</td>
<td>14</td>
<td>11</td>
</tr>
<tr>
<td>Age 2</td>
<td>18</td>
<td>21</td>
<td>17</td>
</tr>
<tr>
<td>Age 3</td>
<td>6</td>
<td>11</td>
<td>9</td>
</tr>
</tbody>
</table>

followed by a discussion of the pile sort tests of individuals and sub-groups of individuals categorized by level of wealth and market integration.

**Wealth, Market Integration and Cultural Consensus**

I have argued that wealth and integration into markets not only affect household production activities, and in particular extractive activities, but can also lead to changes in how individuals think about extractive resources. In this section I respond to hypotheses H7 and H8 to test how wealth and markets may be influencing cultural knowledge. I do this by calculating the gamma statistic to test for associations between level of household net wealth per capita and different indicators of market integration, and level of cultural knowledge, measured by the individual’s consensus analysis score. The gamma statistic is between -1.0 and 1.0, with -1.0 being a strong negative association and 1.0 being a strong positive association. A score of 0 indicates there is no association.

Table 6.5 on the following page presents the gamma statistic for all respondents, heads of households, and sub-groups of individuals, including males and females, and the three age groups. Among the tests run, only three statistically significant and

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67 For heads of household I used the score of the male head of household in all but two cases. For one household, the female was the owner of the landholding while for another, the male household head did not complete the pile sort test so the female household head’s score was used. In another household, the male’s score was negative, so it is not included in the analysis.
negative relationships were found. For all respondents, a weak, negative, association was found between percent of income from product trade, and cultural knowledge. For the youngest respondents (age 1), a moderately strong negative association was found between percent of productive income from product trade, and cultural knowledge. For young adults (age 2), a moderately strong negative association was found between percent of productive income from off-farm labor, and cultural knowledge. These findings confirm, in part, hypothesis H8, suggesting that greater levels of market integration lead to lower cultural knowledge scores among these variables and respondent categories.

However, the results of gamma, in general, do not confirm hypotheses H7 and H8. For wealth, very slight negative associations with cultural knowledge were found for household heads, males and the youngest age group, although the gamma statistic was near zero for each and not statistically significant. Therefore, hypothesis H7 must be rejected. For percent of productive income from off-farm labor, other than the results of for the age 2 sub-group which confirmed hypothesis H8, the results reject the hypothesis for other sub-groups. Household heads did show a weak negative association with cultural knowledge, but it was not significant. For percent of income from trade, in addition to a statistically significant and weak negative association for all respondents, and significant and moderately strong negative association noted for rubber tapper youth, weak negative associations were also found for household heads, males, females and the oldest age group. However, these associations were not significant, nor strong enough to confirm hypothesis H8. Interestingly, travel time had a negative association—opposite of that hypothesized—with cultural knowledge in all groups except for the oldest adults,
which showed a slight positive association for this factor. Therefore, the findings for this variable also reject hypothesis H8.

Table 6-5. Gamma statistic measuring the association between level of wealth and market integration and level of cultural knowledge for all respondents and sub-groups of rubber tappers.

<table>
<thead>
<tr>
<th>Respondent</th>
<th>Net Wealth per Capita</th>
<th>Pct. Income from Off-farm labor</th>
<th>Pct. Income from Trade</th>
<th>Travel Time to Xapuri</th>
</tr>
</thead>
<tbody>
<tr>
<td>All respondents</td>
<td>0.077</td>
<td>-0.123</td>
<td>-0.229*</td>
<td>-0.175</td>
</tr>
<tr>
<td>Household head</td>
<td>0.086</td>
<td>-0.179</td>
<td>-0.152</td>
<td>-0.244</td>
</tr>
<tr>
<td>Males</td>
<td>0.026</td>
<td>0.050</td>
<td>-0.278</td>
<td>-0.118</td>
</tr>
<tr>
<td>Females</td>
<td>0.057</td>
<td>-0.018</td>
<td>-0.188</td>
<td>-0.272</td>
</tr>
<tr>
<td>Age 1</td>
<td>0.00</td>
<td>0.220</td>
<td>-0.474**</td>
<td>-0.33</td>
</tr>
<tr>
<td>Age 2</td>
<td>0.037</td>
<td>-0.413**</td>
<td>0.052</td>
<td>-0.164</td>
</tr>
<tr>
<td>Age 3</td>
<td>0.180</td>
<td>-0.153</td>
<td>0.00</td>
<td>-0.169</td>
</tr>
</tbody>
</table>

Notes: ** Significant at the 0.05 level. * Significant at the 0.10 level.

The results of the statistical tests to measure the association between household wealth and market integration with rubber tapper cultural knowledge of extractive resources, in general, were not strong enough to confirm hypotheses H7 and H8. Only three statistically significant associations were found: for all respondents and age 1 respondents, percent of productive income from trade did show a weak and moderately strong and statistically significant association, respectively, with cultural knowledge, and a negative and moderately strong association was found for age 2 respondents between percent of productive income from off-farm trade and knowledge. Yet, while hypotheses H7 and H8 are generally rejected, it is important to note that gamma showed weak negative associations (as hypothesized) between the market integration variables for off-farm labor and trade and cultural knowledge for a majority of the statistical tests. Although these associations are very weak, the consistency of findings for these two variables across the majority of sub-groups suggests that changes in cultural knowledge may be emerging. I explore this in the remainder of this chapter.
Wealth, Market Integration and Cultural Knowledge

In the previous chapter I discussed in detail the results of the pile sort activity, analyzing first how all respondents as a group identified items, and then examining in detail how sub-groups of respondents identified items, pointing out subtle differences in cultural knowledge. Respondents across sex and age categories maintained a high degree of shared knowledge on this domain, as demonstrated by the consensus analysis and QAP procedures. Yet, subtle differences in how individuals understand these items emerged through a closer analysis of the pile sort data. In this section, I examine the results of the pile sort activity by individuals and sub-groups of individuals categorized by level of wealth and market integration, following a similar line of research.

As noted above, QAP analysis rejected both hypotheses H9 and H10. The testing of cultural knowledge of individuals and sub-groups of individuals across different levels of household wealth and market integration showed strong and statistically significant correlations: there was no statistical difference in the responses among any of the groups of individuals that are compared in the remainder of the chapter. Therefore, the reader should bear in mind throughout the discussion in the following pages, that even as I identify subtle differences in knowledge across sub-groups of individuals, the respondents maintain a high degree of shared knowledge on this domain.

In the discussion that follows, I summarize the subtle changes across different wealth and market integration categories drawn from the MDS and cluster analyses figures, often referring back to the raw pile sort data to examine how respondents identified items.68 In this analysis, I focus almost exclusively on two items—rubber and

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68 I have not included the MDS scatterplots and cluster analysis figures, as there are nearly 200 total figures across the sub-groups.
Brazil nuts—extractive items with which rubber tappers have strong economic and cultural (and historical, in the case of rubber) ties, and the two principal income-earning products among these items. I examine the strength of this tie across levels of wealth and market integration, and how groups identified these items at the completion of the pile sort test. The discussion of copaíba oil, another product emerging as an income-earning item for rubber tapper households, as well as other items, are also introduced into the discussion where relevant.

**Cultural Knowledge and Wealth**

In Chapter 4, in testing the effects of wealth on income from extractive resources, I found a positive relationship between wealth and income from extraction—opposite of that hypothesized—although this relationship was not statistically significant. However, I found a negative and statistically significant relationship between household wealth and the percent of income from extraction. In this section, I examine how different levels of household wealth may lead to variations in rubber tapper cultural knowledge of extractive forest resources.

I begin by examining the results for all respondents categorized into the four wealth rank categories. I then separately examine the results of female and male respondents, and respondents grouped by age, with each sub-group categorized by wealth level as per Table 6-1 above. When the division of sub-groups by wealth category resulted in a small number of respondents in a wealth category (less than 9 individuals), I combined adjoining wealth categories. I summarize the principal findings for each group.

**Wealth and cultural knowledge: all respondents.** The four wealth categories exhibited very similar groupings of items. However, an initial examination of the pile sort results led to a closer analysis of the rubber and Brazil nut pairing, and the copaíba
oil and honey pairing. As noted in Chapter 3, each of these products was commercialized by study households. Contrary to what I expected, respondents with the greatest wealth demonstrated the strongest pairing of rubber and Brazil nuts, while the lowest wealth group showed the weakest pairing of these two items. I expected the least wealthy respondents to show a stronger tie between these two items and wealthier respondents to show weaker ties, reflecting a decline in the importance of these items to household production and income as wealth increased. However, a closer examination of how respondents identified rubber and Brazil nuts revealed slightly different results across wealth categories. Although the least wealthy respondents showed the weakest pairing of these items, nearly all of those who did pair them identified them as income items. This proportion fell through the middle wealth categories, although increased in highest wealth category, although not to the level found in the lowest wealth group. A similar pattern was found in examining rubber individually, with the lowest wealth group identifying this item in greater proportion to all other wealth groups.

Findings for copaiba oil and honey also suggested subtle knowledge differences across wealth levels, again indicating a higher association of these two items with income among less wealthy respondents. As noted in Table 5-4 in the previous chapter, the mode code for these two items was medicinal, and this was true for each of the wealth categories. However, a closer examination of this pair found that the two least wealthy categories not only placed these items together more often, but they also identified them with income more frequently than wealthier respondents (with the exception of honey in the wealthiest category).
Thus, least wealthy respondents identified traditional extractive items—rubber and Brazil nuts—as well as other items—copaiba oil and honey—with income most often among the wealth categories. The findings suggest that the lowest wealth category ties these items more tightly to production and income. However, lack of a pattern across wealth categories indicates that wealth is a weak predictor of even subtle variation in cultural knowledge of extractive resources.

**Cultural knowledge and wealth: females and males.** The results of the pile sort activity revealed strong similarities for female and male rubber tappers across the four wealth categories. For females, I began by examining the medicinal grouping, an area in which females have been noted to have particular expertise (Kainer and Duryea 1992). However, little variation was found across wealth categories, with the exception of the pairing of copaiba oil and honey. Although females in both the least and most wealthy households had similarly strong associations between these two items, those in less wealthy households associated them with income in greater proportion.

An examination of the tie between rubber and Brazil nuts also revealed minor differences across wealth categories. Interestingly, the wealthiest category formed the strongest bond of these two items while those least wealthy showed the weakest tie. As noted above, I expected least wealthy households to show a stronger tie between these items. Near equal proportions of the least wealthy and most wealthy respondents placed this pair together as income items. However, examining the results for only rubber found that females in the two least wealthy categories together associated rubber with income in greater proportion than the two highest wealth categories.
The findings for males across wealth categories mirrored those found for females. Although the least and most wealthy males showed similar strengths in the tie between rubber and Brazil nuts, the least wealthy males more strongly associated rubber and Brazil nuts with income. Further, copaíba oil and honey were also more strongly associated with income among the least wealthy male respondents in comparison to other groups. This strong tie of rubber, Brazil nuts, copaíba oil and honey with income was most notably seen in the cluster analysis figure for the least wealthy respondents, with these items forming a small cluster before joining other medicinal items, a result in part due to their association with income.

Thus, for both males and females, despite generally similar patterns of sorting across wealth categories, subtle differences emerged, particularly with regard to how extractive items were identified. Least wealthy households associated rubber, Brazil nuts, copaíba oil and honey with income in greater proportion than other wealth categories. However, the data did not yield distinct trends for males and females across wealth groups.

**Cultural knowledge and wealth: youth, young adults and the older generation.**

The examination of the results of the three age groups found that only the young adult and adult groups, ages 2 and 3, displayed slight variations in knowledge of extractive resources by wealth category. For the age 2 group, although all wealth categories showed similar strengths in the relationship between rubber and Brazil nuts, respondents in the least wealthy category identified this pair proportionally more frequently with income than greater wealth categories. Further, the two least wealthy categories demonstrated a much stronger identification of copaíba oil and honey with income than the two higher
wealth groups, suggesting that the poorest households view these items not only as medicinal items, but also as potential income earners.

An examination of the results for the oldest group of respondents also revealed slight differences in knowledge, but opposite of what I expected. In combining the two least and most wealthy categories and comparing them, both combined groups showed a strong pairing of rubber and Brazil nuts. However, the wealthiest category not only showed the strongest tie, but also a slightly greater proportion of this group tied these items together as income. Further the wealthiest respondents also identified rubber as an income item in slightly greater proportion.

The discussion in Chapter 3 demonstrated that rubber tapper households range widely in wealth holdings, and the type of assets they hold varies as wealth increases. Wealthier households hold a greater percent of their productive wealth in cattle, but also invest more in off-farm assets. Despite these wealth differences, the results of the QAP procedure showed that rubber tappers widely share knowledge on the domain of extractive resources. However, a closer examination of the results of the pile sort activity among sub-groups of individuals categorized by wealth found subtle variations in cultural knowledge, particularly in their understanding of rubber and Brazil nuts. Most notable, across nearly all sub-groups (except age 3), the least wealthy respondents more strongly identified rubber and Brazil nuts as income items. But curiously, across many of these same groups, it was also the wealthiest respondents who were most similar to the poorest group. Further, among all respondents, as well as males, females and the age 2 sub-group, the least wealthy respondents identified copaiba oil with income in greater proportions than the wealthiest respondents.
Although the lack of a clear pattern across categories suggests that wealth is a weak predictor of variation in rubber tapper knowledge on this domain, these findings hint at subtle differences in the cultural knowledge of extractive resources that may be useful to policymakers. For copaiba oil, the findings lightly imply that the poorest respondents may see greater market potential in this item than wealthier respondents of the same sex and age, while the findings for rubber and Brazil nuts suggest that the least wealthy households hold stronger economic ties with these items. These variations hint that the poorest households may be more receptive to projects that promote extractive activities in the reserve.

**Cultural Knowledge and Market Integration**

In Chapters 3 and 4, I discussed the rubber tapper economy in detail, examining the diverse trade and off-farm labor activities that households undertake, noting how these activities vary in importance to household income. I then tested how integration into trade and labor markets, as well as travel time to the city, affect household income and income from extraction. Here I examine how differences in level of market integration may affect rubber tapper cultural knowledge of extractive resources. As above, I look for subtle variations in patterns of knowledge across different levels of market integration by examining more closely the results of the pile sort activity.

I begin by analyzing how knowledge may vary due to household integration into off-farm labor activities, and then follow with a similar discussion on how knowledge may vary by integration into product markets and travel time. As in the analysis of wealth above, for each measure of market integration, I examine results of all respondents, and then sub-groups of respondents. As noted above, when a market integration category had few individuals, I consolidated respondents into adjacent categories.
Cultural knowledge and off-farm labor

Income from off-farm labor makes an important contribution to the income of many reserve families. Off-farm income comes from diverse sources, from unskilled manual wage labor on nearby landholdings, to skilled salaried positions as teachers and health agents at the community center. For a few households, off-farm income comprises nearly all of the household’s productive income. Conversely, 13 households earned no income from off-farm labor. In Chapter 4, I tested the effects of integration into off-farm labor markets on extractive income and found that as households gained a greater proportion of productive income from off-farm labor, both extractive income and percent of productive income from extraction fell. In this section I address how integration into off-farm labor markets may be subtly shaping rubber tapper knowledge of extractive resources, again focusing particularly on their understanding of rubber and Brazil nuts, as well as copaiba oil.

**Cultural knowledge and off-farm labor: all respondents.** Respondents categorized by level of market integration showed few visible differences in cultural knowledge on this domain. The most notable difference across the four market integration categories was found in the rubber and Brazil nut pairing in the cluster analyses: as the percent of income from off-farm labor increased, the strength of this pairing declined. This suggested a relationship that I expected: respondents from households more integrated into labor markets would associate rubber and Brazil nuts less with income. However, a closer examination of the pile sort data found that while the strength of this relationship declined as percent of income from off-farm labor increased, similar proportions of respondents tied them together as income items. An examination of the results for rubber separately found that a slightly greater proportion of
the least market integrated respondents identified rubber as an income item, and this proportion fell through the middle categories, although increased for the most market-integrated respondents. A similar pattern was found for copaiba oil.

The results for respondents categorized by level of integration into off-farm labor hint at subtle differences in cultural knowledge of extractive resources among the different market integration categories. However, they do not reveal any clear patterns, and this suggests that among all respondents, level of integration into off-farm labor markets is a weak factor in predicting cultural knowledge on this domain.

**Cultural knowledge and off-farm labor: females and males.** The results of the pile sort activity revealed strong similarities for female and males across the market integration categories. However, females, in particular, displayed slight differences in knowledge across categories, not found among males, which suggest that integration into off-farm labor markets may be varying their cultural knowledge of this domain. Most notable was the clustering of rubber, Brazil nuts, copaiba oil, and honey by the least integrated female respondents, those from households with no off-farm income. The grouping of copaiba oil and honey with rubber and Brazil nuts suggested that they associated these two items with income rather than medicinal properties. The raw pile sort data showed that a higher proportion (though a very small number) of those least integrated into off-farm labor markets identified copaiba oil as an income item.

A closer examination of the rubber and Brazil nut pairing also suggests that females from households less integrated into labor markets more strongly identify these items with income. First, the strength of this pairing weakened as market integration increased. Second, as market integration increased, these two items together were identified less
with income. And third, focusing solely on rubber, a falling proportion of respondents identified rubber with income as income from off-farm labor increased. Further, a growing number of respondents categorized rubber as a unique item as market integration increased. Thus, females at increasingly higher levels of integration into off-farm labor markets not only associated rubber less with income, but increasingly did not know where to place it.

Together, these findings for female respondents suggest a subtle variation in cultural knowledge of extractive resources across different levels of integration into off-farm labor markets. Females with weak ties to off-farm labor markets associated traditional extractive items—rubber and Brazil—as well as copaiba oil, more frequently with income, and conversely, females from households with stronger ties to off-farm labor markets associated these items less in income terms.

Cultural knowledge and off-farm labor: youth, young adults and the older generation. Among the three age groups, only the results of the youngest and middle age groups suggested a variation in knowledge across levels of market integration. To analyze the results for the youngest age group, I combined the two lowest and two highest categories and compared them. Youth from households less integrated into off-farm labor markets displayed a slightly stronger pairing of rubber and Brazil nuts, and a slightly higher proportion also identified them as income items. This category also identified rubber alone as an income item in greater proportion. Curiously, few youth in either category identified copaiba oil with income. I expected the least market-oriented group to demonstrate a stronger association of copaiba oil with income, reflecting a greater interest in increasing income through extractive sector trade.
The results for the middle age group were similar to those of the youngest group. Although the rubber and Brazil nut pairing was strong for all market integration categories, as level of market integration increased, a declining proportion of respondents identified this pair with income. A similar pattern was found in examining how respondents identified rubber alone, as well as with copaíba oil and honey.

Many of the households in this study earned a portion of income from off-farm labor. However, household off-farm income varied widely. Over one-quarter of the households in this study earned no off-farm income, while others earned a few reais from day labor in the forest. A few households earned large sums off-farm through highly paid work as a carpenter and salaried positions as teachers. The examination of how integration into off-farm labor markets may vary rubber tapper knowledge of extractive resources found that female respondents, as well as youth and young adults, displayed subtle knowledge variations in their understanding of rubber and Brazil. For these subgroups of respondents, as integration into labor markets increased, the tie between these items weakened, and they identified them less with income. This finding is particularly notable for the youngest generation of rubber tappers. As rural to urban linkages strengthen, more off-farm labor opportunities are likely to emerge, suggesting that rubber and Brazil may have a declining role in the landholding production activities for these young and future household heads. However, the findings also suggest that households poorly linked to off-farm labor markets may be more responsive to projects that promote extractive activities.

**Cultural knowledge and product trade**

Rubber tapper households engage in the barter and trade of a variety of agricultural and extractive products with a diverse group of buyers, including itinerant traders in the
forest, CAEX—both in the forest and in the city—and merchants and restaurants in the city of Xapuri. For many households, product trade is the only source of income for buying essential supplies, such as kerosene, sugar and ammunition. In Chapter 4, in examining the effects of integrating into product markets on income, I found a negative and statistically significant relationship between percent of productive income from product trade and income from extraction. I also found a negative relationship between percent of productive income from product trade and percent of income from extraction, although this relationship was not significant.

Here I examine the effects of integration into product markets on cultural knowledge of extractive resources. Table 6-3, presented above, displays the four categories that represent the different categories of integration into product markets. I begin with an analysis of the results of all respondents, and then examine the results of females and males, followed by an analysis of the three age groups.

**Cultural knowledge and product trade: all respondents.** Respondents across all levels of integration into product markets showed very similar groupings of items. An initial analysis of the sorting of traditionally extracted and commercialized items—rubber and Brazil nuts—revealed a strong clustering of these two items across market integration categories. A closer examination of how respondents across level of product trade identified these items found that very similar proportions of respondents identified them with income, although those from households least integrated into product markets did

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69 One important point to remember throughout the analysis is that households least integrated into product markets are not necessarily the lowest income households. A high income household that received a large proportion of its income from off-farm labor and did not extract or produce for the market would also be in the lowest market integration category, as would a low income household that produced mainly for consumption and sold only a small portion of total production.
this in a slightly higher proportion. This was also true for rubber alone, as well as copaiba oil. This suggests that households least integrated into product markets tie these items more closely with economic benefits. However, the analysis did not reveal a trend across the four market integration categories, and even as slight differences emerged, the data argue that cultural knowledge of extractive resources varies very little across level of product trade.

**Cultural knowledge and product trade: females and males.** The analysis of the pile sort data for males and females categorized by level of integration into product markets revealed similar results, with neither group displaying a pattern that would suggest that cultural knowledge varies with increasing market integration. For females, maybe most notable is how similar they were in grouping items, both those which they are known to process, such as medicinal items, as well as production items, such as rubber and Brazil nuts. For males, results of the pile sorts showed slight differences across different levels of market integration, but no particular pattern. Strong ties between rubber and Brazil nuts were found at all levels of market integration except for one middle category. Interestingly, a greater proportion of the least and most market-integrated respondents identified this pair as income items. This was also found in examining the results for rubber alone.

Thus for males, minor variations in cultural knowledge of rubber and Brazil nuts were found among market integration categories, but they did not present trends that would suggest variation in cultural knowledge as households integrate into product markets. Females showed a very high degree of shared knowledge across market
integration categories, and even a closer examination of the data did not reveal
differences.

**Cultural knowledge and product trade: youth, young adults and the older
generation.** Upon closer examination of the data of the three age sub-groups, only the
youngest respondents displayed slight variations in cultural knowledge of rubber and
Brazil nuts. For the youngest age group, although the least and most market integrated
categories (the most market integrated category combines the two highest levels) showed
similar strength in the tie between these items, a greater proportion of respondents least
integrated into product markets tied rubber and Brazil nuts together as income items, and
this proportion fell as market integration increased. A similar trend was found in
examining the results for rubber alone, as well as copaíba oil.

A closer examination of the results for the two adult sub-groups (age groups 2 and
3) revealed that the least and most market integrated categories held the most similar
cultural knowledge of rubber and Brazil nuts, although a pattern of knowledge variation
across market integration categories was not found.

Many households in the reserve are diversifying production and trade activities as a
means to increase incomes. The improved feeder road and regular transportation to the
city during the dry season, currently highly subsidized by the local government, have
facilitated access to markets in the city. As noted in Chapter 2, trade activities are also
being stimulated by the government projects to support the expansion of the extractive
sector. In this section I examined more closely how integration into product markets
might be creating subtle knowledge differences in the domain of non-timber forest
resources. Only the youngest group displayed a subtle pattern across categories market
integration that suggests that increasing integration into product markets may be varying cultural knowledge of the two principal extractive products, rubber and Brazil nuts. Females displayed a strong and similar relationship for rubber and Brazil nuts, and medicinal items as well, across market integration categories, while the results for both adult age groups, as well as male respondents did not show any clear patterns. The findings for youth hint that the increased integration into product markets may bring increased interest in identifying new sources of income, beyond traditional extractive products. Concurrently, they suggest that youth from households poorly integrated into trade markets may be more receptive to development activities that promote income growth through extraction.

**Cultural knowledge and travel time to the city**

Distances in the forest are becoming closer. Road building is forging new links between forest populations and urban areas. These new rural-urban linkages come in the form of market transactions, new professors for schools, and better communication between forest settlements and the city. In Chapter 4, I examined how travel time to the city of Xapuri affects income from extractive activities. I found a negative and statistically significant relationship between travel time and extractive income; as household travel time to Xapuri increased, income from extractive activities fell. This relationship was opposite of that hypothesized, indicating that households with longer travel times to the city earned less income (combined consumption and trade income) from extraction. A negative relationship was also found between travel time to Xapuri and percent of income from extraction, although it was not statistically significant.

In this section, I examine how market access, measured by travel time from the landholding to the city of Xapuri, may be changing rubber tapper cultural knowledge of
extractive resources. Again, I begin by examining the results of all respondents categorized by the three market integration categories, then of each of the sub-groups of respondents, as carried out above.

**Cultural knowledge and travel time: all respondents.** The results of the pile sort test suggested subtle differences in cultural knowledge of extractive resources as travel time varies. Although all categories of travel time displayed a strong tie between rubber and Brazil nuts, this tie was strongest for respondents with longer travel times to Xapuri, and declined as travel time fell. In addition, an increasing proportion (though slight) of respondents identified these items with income as travel time increased. Thus, respondents with shorter travel times to the city not only sorted these items together less, but, when they did, they increasingly identified non-income reasons for doing so. This pattern was not found for rubber alone, although approximately half of respondents in the two categories with greater travel times identified rubber as an income item versus approximately one-third of those with shorter travel times.

Interestingly, respondents with the shortest travel time to the city also showed a slightly stronger association of copaíba oil with rubber and Brazil nuts. This category of respondents is comprised mainly of residents of the community of Rio Branco, where copaíba oil is now being extracted and sold with the support from the state government. Yet, a closer examination of how respondents identified copaíba oil revealed unexpected results: a slightly greater proportion of respondents with longer travel times identified copaíba oil with income in comparison to the other two categories. This is likely explained by the fact that residents of all three communities are aware of the government-
sponsored project to promote the extraction of copaiba oil, leading even individuals from households with longer travel times to associate this item with income.

Although these findings are subtle, they hint that respondents with longer travel times to the city may hold slightly different ideas about rubber and Brazil nuts, as well as copaiba oil. As travel times falls, residents may be rethinking their ideas about the role rubber and Brazil nuts play in the household economy, and be more open to new forms of production and income-earning activities not based on extraction.

**Cultural knowledge and travel time: females and males.** A closer examination of the results for females and males categorized by travel time to the city found that only females displayed a slight variation in cultural knowledge of extractive resources as travel time increased. This variation was found in the results of the medicinal group as well as the rubber and Brazil nut pairing. First, female respondents with the greatest travel time grouped medicinal items more tightly, and the relationship among the grouping of medicinal items weakened as travel time to the city fell. This pattern held true for three different pairs of items found in the medicinal group. Second, as travel time increased, the proportion of respondents that identified rubber and Brazil nuts with income increased. Together, these findings suggest that as travel time varies, females have subtle differences in cultural knowledge of these extractive resources.

**Cultural knowledge and travel time: youth, young adults and the older generation.** Among the three age categories, only the youngest and oldest age groups displayed subtle variations in cultural knowledge of rubber and Brazil nuts with a change in travel time. For youth, the pairing of rubber and Brazil nuts was weakest for respondents with the shortest travel time and strengthened as travel time increased.
Concomitantly, an increasing proportion, though slight, of respondents identified these items with income as travel time grew. An examination of rubber alone also found this same pattern. A similar pattern was found for the oldest age group: individuals from households with greater travel times identified rubber and Brazil nuts more frequently with income than those from households with shorter travel times to the city. In addition, those with longer travel times also identified copaiba oil with income in slightly greatly proportion than those with shorter travel.

As feeder roads are improved and extended, distances between forest communities and urban areas are becoming increasingly closer. New modes of transportation are appearing, such as motorcycle taxis, which will strengthen the ties between forest households and urban areas. In testing how knowledge varies as travel time to the city changes, a more in-depth analysis of the domain of non-timber forest resources, for which rubber tappers of all ages and sex share knowledge widely, revealed subtle differences in cultural knowledge. In particular, a close examination of two extractive items—rubber and Brazil nuts—found that among all respondents, as well as females, and the youngest and oldest groups, as travel time increased, a greater proportion of respondents identified these two items with income. Although these differences were slight, they hint that respondents with better access to the city hold different ideas about these two items. This in turn suggests that households with better access to markets may be identifying new sources of income. This finding among rubber tapper youth seems particularly important, as they will be the household heads in the coming decades, prioritizing activities among different production alternatives, both in the extractive and non-extractive sectors. Youth with greater market access to the city may be more
inclined to pursue non-extractive productive alternatives, while youth with longer travel
times to the city may be more responsive to development activities that promote
extractive activities. Therefore households without access to transportation, or deeper in
the forest may be the best targets for government policies aimed at improving household
incomes by fostering extractive resource use.

Conclusion

In this chapter, I employed cognitive anthropological tools, such as free lists, pile
sorts, and related tests, such as MDS and cluster analysis, to analyze cultural change
taking place part in the Chico Mendes Reserve. More specifically, I examined how
rubber tappers think about the cultural domain of non-timber extractive resources, an area
of study of particular importance to understanding change in the Chico Mendes
Extractive Reserve as extraction has played an integral part in the lives of the rubber
tapper population. Variations in cultural knowledge of non-timber forest resources
among rubber tappers represent different ideas regarding how individuals understand the
forest in a changing economy. These variations, in turn can signal changes in the future
role of extraction, and the path of development, in the reserve. This in turn, has
implications for the extractive reserve concept, as well as conservation.

The results of the cognitive tests presented in this chapter, as well as the previous
chapter, show that rubber tappers maintain a high degree of shared cultural knowledge on
the domain of non-timber extractive resources. This argues that despite the economic
changes in the reserve, rubber tappers of both sexes, and of all ages, have very similar
ideas about extractive items, and cultural bonds are strong despite accelerating change.
However, the results also contend that rubber tappers demonstrate subtle variations in
knowledge that suggest that sub-groups of the rubber tappers, in particular rubber tapper
youth, the future household heads, hold different ideas about some extractive items, in particular, rubber and Brazil nuts, and this may carry implications for future livelihood practices in the reserve.

At the beginning of this chapter I laid out the four hypotheses I would test to examine the impact of wealth and market integration on rubber tapper knowledge of extractive resources. For the first set of hypothesis, I argued that as household wealth (H7) and market integration (H8) increased, the cultural knowledge of non-timber forest resources (measured by the cultural consensus score) of the household head, and knowledge of sub-groups of individuals within the household (men, women, youth, young adults, adults) would fall. The statistical test gamma found that higher levels of wealth were not related to higher levels of knowledge, therefore H7 must be rejected. For H8, three statistically significant associations were found among the three market integration variables that confirm in part this hypothesis: for all respondents and age 1 respondents, percent of productive income from trade had statistically significant and weak, and moderately strong, negative associations, respectively, with cultural knowledge; and for age 2 respondents, percent of productive income from off-farm trade had a moderately strong and statistically significant negative association with cultural knowledge. I will discuss the implications of these findings below.

However, although no other variables were significant among the sub-groups of individuals, the results of the gamma showed weak negative associations between off-farm labor and product trade indicators and cultural knowledge for a majority of the sub-groups of respondents. This suggests that something is going on, and future research
should continue to explore and monitor how integration into labor and product markets may be shaping knowledge.

For the second set of hypotheses, I employed QAP analysis to test for differences in knowledge of sub-groups, categorized by level of wealth (H9) and market integration (H10). I argued that knowledge of individuals, as well as sub-groups of individuals, in households at lower levels of wealth or market integration would be significantly different from individuals in households at higher levels of market integration. As noted in the discussion above, both hypotheses H9 and H10 are rejected; a comparison of individuals, as well as sub-groups of individuals, categorized by levels of wealth and market integration found highly correlated and statistically significant relationships across wealth and market integration categories.

These results argue that even as rubber tapper households become wealthier, integrate into labor and product markets, or have better access to urban markets, rubber tappers still maintain a very high-degree of shared cultural knowledge of extractive resources. More specifically, males and females, as well as different generations of rubber tappers, continue to think very similarly about extractive resources as sub-groups of respondents, despite differences in wealth and market integration. Thus, even as the household economy may be undergoing changes, rubber tappers share ties with the forest.

Notwithstanding this great similarity in knowledge across levels of wealth and market integration, I carried out a more detailed analysis to explore minor differences and trends that might suggest subtle variation in knowledge within sub-groups. Although respondents categorized by level of net wealth per household member showed differences in knowledge among wealth categories, patterns across categories that would indicate
trends in changing knowledge as household wealth increased were not found. Interestingly, the least wealthy respondents (combined responses of the two least wealth categories) did associate two extractive items—cocaiba oil and honey—with income with greater frequency than more wealthy respondents, suggesting that the least wealthy may be more receptive to projects promoting new extractive items. However, the analysis of the sub-groups of respondents categorized by wealth revealed that wealth was a weak predictor of knowledge variation. In fact, in many cases, the findings in sub-groups revealed that as household wealth increased, association of rubber with income would initially fall, then once again increase as wealth rose to the highest level. This would indicate that the respondents in the least and most wealthy households hold similar ideas about rubber’s role in household income.

A detailed examination of the pile sort data of the three indicators for market integration found mixed results regarding the effects of increasing integration into markets on cultural knowledge of extractive resources. For the first indicator, market integration measured as percent of household income from off-farm labor, results differed across the sub-groups of respondents. For males and the oldest generation of respondents categorized by level of integration into labor markets, no patterns emerged. However, for females and rubber tapper youth, a slight trend emerged across categories: for these sub-groups, as integration into labor markets increased, sub-groups of females, youth and young adults demonstrated a weakening of the tie between rubber and Brazil nuts. In addition, females, males, age 1 and age 2 respondents from more market-integrated households all associated this pair, and rubber individually, less with income, with the results for age 1 and age 2 respondents showing a declining trend across categories. This
finding for age 2 respondents supports the results of the gamma test, which found a negative and statistically significant association between level of integration into labor markets and cultural knowledge. They also mesh well with the findings of the regression analyses conducted in Chapter 4, where I found that integration into off-farm labor markets had a strong negative effect on income from extraction, and the percent of productive income earned from extraction. Together the results of the cognitive tests and the economic analysis suggest that integration into labor markets is shaping both cultural knowledge and productive activities of the middle generation.

An examination of the second market integration indicator, percent of household productive income from the sale of agricultural and extractive products, showed similar results found above, but only for rubber tapper youth. As households gained an increasing share of income from product trade, a smaller proportion of the youngest household members associated this pair, and in particular rubber, with income. Again, the finding for youth supports the results of the gamma test for youth respondents, which found that higher levels of integration into product markets was associated with a lower level of cultural knowledge. The gamma test for all respondents, which showed a weak negative association between cultural knowledge and level of integration into product markets, was not supported by a pattern across all market integration categories, although the least integrated category did identify rubber, as well as other extractive items, with income in slightly greater proportions than the other categories.

These associations are further informed by the discussion of the trade data in Chapter 4, where I noted that households in the two highest rank product trade categories include 13 of the 21 households that hold cattle wealth valued at R$1,000.00 or more.
This indicates that a majority of respondents more integrated into product markets are also from households with the greatest cattle wealth. Together, these findings suggest that as households integrate into product markets, youth in particular, may be thinking differently—beyond rubber and Brazil nuts—about future production activities in the reserve.

The third indicator of market integration, or market access in this case, measured by travel time to the city of Xapuri, also revealed subtle variations in how rubber tappers think about extractive items. Among all 118 respondents, those from households with the shortest travel time displayed a much weaker association of Brazil nuts and rubber, as well as rubber individually, with income. In addition, for sub-groups of females and the three age groups, households with the shortest travel time to the city displayed the weakest association of these items with income. Further, youth with the shortest travel time displayed the weakest relationship between Brazil nuts and rubber among all sub-groups of respondents. Notably, it was the weakest relationship found between rubber and Brazil nuts for all sub-groups of individuals categorized by level of wealth or the three measures of market integration.

This falling tie between rubber and Brazil nuts, combined with a weakening association of these two items with income as rubber tappers integrate into markets, suggests that rubber tapper ideas about the role of extractive activities in household livelihoods is evolving. It is not a drastic change of thinking, but rather one that hints that new employment opportunities, new opportunities for product trade, and better access to urban areas may be altering how rubber tappers understand these two traditional products. This change does not suggest a diminished role for these items in formation of
rubber tapper identity, but rather the changing role that extraction now plays in the forest economy. Among these findings, the subtle variations in cultural knowledge of rubber and Brazil nuts as travel time to the city falls seems particularly important to highlight. Feeder road construction and more frequent and reliable transportation are reaching more distant populations in the reserve. This suggests that in the near future, residents deeper in the reserve may be rethinking household production strategies. The findings hint of a falling economic role for rubber, and the identification of new production activities.

The most suggestive finding here is for rubber tapper youth. First, as noted in the previous chapter, youth displayed a slight difference in thinking about rubber and Brazil nuts when compared to the two older age groups, one that revealed a weakening association of these items to income. This suggests that future household heads are already developing different ideas about the role rubber might play in future production, and the findings point toward a diminished role for rubber as an income earner. Second, as households integrated into off-farm labor or product markets, or had better market access, youth, as a sub-category of respondents, consistently showed this same pattern of thought. This suggests not only that youth in general, in comparison to other age groups, associated these items less with income, but also that among youth, increasing integration into markets may also be altering their ideas about extraction. This does not necessarily mean that youth will turn to more destructive land use practices as households become wealthier or integrate into markets. New extractive items, such as copaiba oil, may provide an income-earning alternative, and a number of youth, as well as young adults, associated this item with income. This suggests that extractive items can move along the production path from consumption to market and have a continued role in household
market strategies. In particular, youth from households least integrated into product markets may be most responsive to initiatives that promote these activities. However, youth, in general, might be most interested in pursuing new extractive activities as a means to increase household income.

Campbell (1996: 115) stated that there is a “changing cultural identity within the seringal.” The afternoon I spent with Roberto, Cibele and their children was one more experience in the reserve that points toward change. This and the previous chapter argued that if we think of culture as shared knowledge, then rubber tapper culture, at least in terms of how people think about the extractive forest resources, is widely shared among diverse rubber tapper households—poor and wealthy, those that participate in labor and product markets and those that don’t, those with short and longer travel times—as well as among males and females, and across generations. Yet, a closer examination of the data revealed subtle variations in cultural knowledge that suggest that respondents do hold different ideas, if only slight, about extractive resources, in particular with regard to their role in the household economy. I do not think that these findings fully support the idea that cultural identity of the rubber tapper is changing; the cultural consensus on this domain was very high, and even the variations that I explored were subtle. I do think, nonetheless, that these findings, combined with the findings noted in the Chapters 3 and 4 on the rubber tapper household economy, have implications for future livelihood strategies in the reserve, and conservation and development. I have discussed these implications separately above and in Chapters 3 and 4. I now bring these findings together in the concluding chapter, and consider them in the context of the site of this study, the Chico Mendes Extractive Reserve.
“Previously, people survived only by these; today it is different.”

That was how Dona Leiticia, 31-year old daughter and wife of a rubber tapper, mother of four children, and living in the Chico Mendes Extractive Reserve described for me why she placed rubber and Brazil nuts together in a group during the pile sort test. There might not be a better description of life in the Chico Mendes Extractive Reserve today. Livelihoods of the rubber tapper are changing, and I believe these changes are arriving at households at an accelerating pace. For the decades following World War II, the rubber tapper plied his trade in the forest, selling rubber to his *patrão*. In the 1970s, the organization of local unions of rural workers aided the rubber tappers in their struggle for land rights, now challenged by ranchers determined to convert natural rubber stands into pasture. This workers’ movement led to the establishment of CAEX, which opened in the late 1980s, helping to free rubber tappers from their debt bonds with itinerant traders and local trading houses. Through the 1990s and until today, CAEX continues to assist rubber tappers as they seek new ways to add value to their products alongside their fight for better prices. In 1990, the establishment of the Chico Mendes Extractive Reserve provided rubber tappers long-term land use rights to maintain their livelihoods in the forest, still largely based on the extraction and sale of rubber and Brazil nuts. These changes were slow, and cost many lives, but together they provided rubber tappers with a more secure and dignified life in the forest, one that made rubber tappers proud of their history, one that was beginning to provide a life beyond simply subsistence.
I believe that the days of slow change may be over. In just the past few years, the 
Acre government has implemented new programs as well as construction projects that 
have dramatically altered life in the forest. Many of these programs have focused on the 
extractive sector, as discussed in Chapter 1, such as the state rubber subsidy, as well as 
programs to diversify incomes through the marketing of other extractive resources. But 
other programs are also bringing change to the households in the reserve. New projects 
focusing on the community management of timber are now nearing implementation. 
Feeder roads have been constructed providing greater access to urban areas and markets, 
and rubber tappers in more remote areas will almost certainly be demanding new roads as 
well. Together, these policies and programs are bringing dynamic change to life in the 
forest.

This dissertation captures part of this change. Working with 46 households in the 
Chico Mendes Extractive Reserve, I employed microeconomic and cognitive 
anthropological methods to better understand the changes now taking place in reserve. I 
set out to document not only the how the rubber tapper economy is changing, but to 
examine how economic changes may be shaping rubber tapper cultural knowledge of the 
forest, and consider the implications of these changes for conservation and development 
in the reserve. To do this, I tested 10 hypotheses to examine how wealth and integration 
into markets affect rubber tapper use and knowledge of non-timber extractive resources. 
My hypotheses argued that as wealth increased, and households integrated into product or 
off-farm labor markets, or had better market access, measured by travel time to the city, 
household incomes would increase, but income from extraction would fall, and more 
specifically households would earn a lower proportion of income from extraction.
Concomitantly, I argued that an increase in wealth, or integration into markets would lead to differences in cultural knowledge of non-timber forest resources. In this concluding chapter, I summarize the principal findings of this study, including the results of my hypotheses, and discuss their implications for forest livelihoods, and conservation and development in the reserve.

**Summary of Key Study Findings**

In the Introduction of this dissertation I argued that one only needs a short time in the forest to observe that rubber tappers are not an economically homogenous group. In Chapters 3 and 4, I explored the economic changes taking place in the reserve, examining in detail rubber tapper wealth holdings and production activities, and tested six hypotheses to examine the effects of wealth and market integration on household income and extractive income. In my analysis of how rubber tapper households invest in wealth, I found that as household wealth increases, differences emerge regarding how households invest in assets. As households accumulate wealth, even as the value of wealth held in on-farm productive assets increases, a greater proportion of wealth is held in on-farm non-productive assets and non-farm wealth. On-farm, households invest a greater proportion of wealth in consumer items, while off-farm, households invest in assets in the city, including land, homes and consumer items. However, most notable is the contrasting productive wealth holdings of the poorest and wealthiest households: poor households held a greater proportion of wealth in equipment and a lower proportion in animal wealth, while the wealthiest households held a greater proportion of wealth in animals, and more specifically cattle, and concomitantly, the structures that support livestock production, such as fencing and corrals. For two of the three wealthiest groups, cattle held the greatest proportion of productive wealth while the lowest wealth group
held no wealth in cattle. This indicates that as household wealth increases (although there was not a clear pattern across wealth categories), the wealthiest households invest a greater proportion of wealth in productive assets related to conversion of forest to pasture. This finding was further supported by positive correlation between wealth and pasture. This suggests that as household wealth increases, the rainforest environment is negatively affected.

Following my discussion of wealth, I examined in detail the productive activities of rubber tapper households, analyzing on-farm consumption and trade activities, as well as off-farm skilled and non-skilled labor activities. Notable is how important extractive activities are to reserve households, playing a critical role in both consumption and trade activities. Among all study households, extractive activities made the single largest contribution to mean household income, and claimed the largest proportion of both household consumption and trade income. Rubber, Brazil nuts, and game accounted for the greatest proportion of productive income; medicinal plants, fibers for making artisan items, fruits, and copaiba oil and honey contributed very low values to income. Rubber and Brazil nuts were collected and sold by 33 and 36 households. Yet, few households sold extractive goods beyond these two items, demonstrating that that extractive trade is concentrated on these two products. This is a symptom of the rubber tapper economy in general, with households trading few products: of those households that earned the majority of their cash income from trade, all earned more than 50.0% of productive income from one or two products. Fifteen households, nearly one-third of study households, earned at least half of their trade income from rubber or Brazil nuts. In contrast, only five households earned at least half of their trade income from cattle
production. Thus, extractive products still dominate forest trade. Indeed, this study found that for many households these products still play a critical role in barter trade for basic supplies.

Although on-farm production dominates income earnings, I also found that off-farm income makes an important contribution to productive income for many households. Thirty-three households earned at least a portion of income from off-farm labor, and 13 households earned at least 50.0% of cash income (income from trade and off-farm labor) from off-farm labor. Skilled labor (salaried or wage) had by far the greatest impact on earnings, accounting for 31.0% of productive income for households undertaking these activities. In contrast, unskilled wage labor accounted for only 4.0% of productive income for households engaged in these activities. This suggested that income from skilled labor will have the greatest effects on on-farm production activities, a finding that was confirmed by the results of the statistical analysis.

In Chapter 4, I brought together the discussion of wealth and income to analyze how production activities varied across different wealth holdings and then tested my hypotheses on the effects of wealth and integration into markets on household income, and in particular extractive income. In my initial analysis of household income across wealth rank categories, I found that extractive activities played an important role in productive income across wealth categories, with comparable extractive income values in all wealth groups. Notable were the importance of Brazil nuts and game remain across wealth groups; however, there was also a clear fall in rubber production in the two highest wealth groups. And, while the value of extraction was maintained across wealth groups, extractive income as a proportion of productive income fell. Other differences
between poor and wealthy households emerged: cattle sales were important to all wealth
groups except for the lowest wealth group which sold no cattle, a reflection of the
divergence in animal wealth holdings; the three highest wealth groups earned a much
greater proportion of income from off-farm labor, suggesting that they are engaged in
skilled labor activities; and finally, the two highest wealth groups also earned a higher net
productive income return per day labor than the two lowest wealth groups. The
wealthiest households earned more than 33.0% more per day labor than the poorest
group, suggesting a more efficient use of labor resources.

The above findings hint at the results of the statistical analysis conducted to test my
hypotheses on the effects of wealth and market integration on household income, and
extractive income. For hypotheses H1 through H3, I argued that as wealth increased, net
income would also rise, but income from extraction and the proportion of proportion of
income earned from extraction would fall. Both H1 and H3 are confirmed: I found that
wealth had a positive and statistically significant effect on both net income and net
productive income, and wealth had a negative and statistically significant effect on
percent of income from extraction. However, I found that wealth has a slightly positive,
although not statistically significant effect on income from extraction, and thus H2 is
rejected.

For hypotheses H4 through H6, I argued that as households integrate into markets,
earning a greater proportion of income from product trade or off-farm labor, or gaining
better market access through lower travel times to the city, household income would rise,
but income from extractive activities, and extractive income as a proportion of productive
income would fall. The results of the testing of these three measures found mixed results
across the three hypotheses. For H4, none of the measures of market integration had a positive association and were statistically significant with net income or net productive income. The travel time variable was statistically significant in one of the regressions with net household income, but the coefficient was positive, opposite the direction hypothesized. Thus, being close to the market, or having access to transport to get you there faster, was not helping households earn higher incomes. As noted earlier, the findings for the travel time variable may be in part due to recent road building and differential access to transportation by both geographically close and distant households.

For H5, both integration into product markets and off-farm labor markets were statistically significant and negatively associated with income from extraction, thereby confirming H5 for these two measures. The increasing values of the coefficients of the three dummy variables representing increasing levels of integration into off-farm labor markets argues that the greatest effects of market integration are felt at the highest levels of market integration. As noted above, the higher levels of integration represent households undertaking skilled labor activities, rather than wage labor, suggesting that these activities have a much stronger negative effect on extractive income. The third measure, travel time to the city was statistically significant, but again, in the opposite direction hypothesized. Thus, H5 is rejected for this measure.

For H6, only integration into off-farm labor markets was statistically significant and negatively associated with percent of income from extraction, and thus confirming H6 for only this variable. Again, the increasing values of the regression coefficients for these three dummy variables argues that integration into labor markets has an increasingly negative effect on the dependent variable. Integration into product markets
was negatively associated with percent of income from extraction, although not statistically significant. Again, the travel time variable, although not statistically significant, was opposite the hypothesized direction, suggesting that households with better market access earned a greater percent of income from extraction.

In Chapters 5 and 6 I employed cognitive tests to examine rubber tapper cultural knowledge of extractive resources. I first examined the results of the free lists and pile sort tests for respondents, and then tested four hypotheses to examine the effects of wealth and market integration on rubber tapper cultural knowledge of extractive resources. The palm family accounted for the largest number of items listed, reflecting the importance of palm species to forest households for construction and consumption, among other uses. Rubber and Brazil nuts were also listed frequently. However, many items were listed only once or twice, suggesting that households use the forest in different ways.

The results of the cognitive tests found that rubber tappers have a very high degree of shared knowledge on the domain of non-timber forest products. The cultural consensus analysis showed that rubber tapper knowledge is widely shared, and the QAP analysis found that pile sort results of sub-groups of study participants, divided by sex and age were highly correlated. However, a closer examination of the data did reveal subtle differences in knowledge. Most notable was the falling association of rubber with income moving from the oldest to youngest age group. This suggests not only that the importance of rubber to income may be falling across the three generations, but also hints that the youngest generation may be identifying, or open to, new productive activities in
the forest. However, their receptiveness to new projects may vary depending on their household economic situation, which I explore below.

In Chapter 6 I tested four hypotheses to examine the effects of wealth and market integration on rubber tapper cultural knowledge of extractive resources. For hypotheses H7 and H8, employing the gamma statistic, I argued that higher levels of wealth (H7) and integration into markets (H8) would be associated with lower levels of cultural knowledge, as indicated by the individual’s cultural consensus analysis score. I tested all respondents, the household heads, and sub-groups of individuals sub-divided by sex and age. The results of gamma showed no statistically significant associations between wealth and cultural knowledge for any of the groups of respondents, therefore H7 is rejected. For H8, three statistically significant and negative associations were found, one weak, the other two moderately strong. For all respondents, I found a weak negative relationship between level of product trade and level of cultural knowledge. For the youngest age category, level of integration into product markets showed a moderately strong negative association with level of cultural knowledge. For the middle age category, level of integration into labor markets also showed a moderately strong negative association. Thus, for these three groups and measures of market integration, H8 is confirmed.

Hypotheses H9 and H10 I employed QAP analysis to examine differences in knowledge across levels of wealth and market integration. I argued that cultural knowledge of individuals and sub-groups with greater wealth and higher levels of market integration would be different from individuals and sub-groups at lower levels of wealth and market integration. The results of the QAP analysis showed strong correlations
across wealth and market integration categories, and thus both hypotheses H9 and H10 were soundly rejected.

However, a closer examination of the raw pile sort data did indicate differences in cultural knowledge across levels of wealth and market integration that suggest subtle differences in how individuals understand extractive resources. A number of findings are notable. First, females, youth and middle age respondents displayed a falling association of rubber with income as they integrated into off-farm labor markets. The finding for age 2 respondents fits well with the results of the gamma test for this group which found that as young adults integrate into off-farm labor markets, they have a different understanding of extractive resources. Further, this meshes well with the results of the economic analysis, which found that integration into off-farm labor markets resulted in a negative and statistically significant relationship with income from extraction, and percent of productive income from extraction. Second, all sub-groups except for males displayed a falling association of rubber with income as travel time to the city fell. This suggests that as new roads are built and new methods of transportation facilitate access to the city, other households may be changing their ideas about the role of rubber in production activities.

The findings for rubber tapper youth are most notable. Youth, categorized by the three measures of market integration, showed a falling association of rubber with income as market integration increased for all three measures. The gamma statistic for the market integration variable percent of income from trade also revealed a statistically significant and negative association between cultural knowledge and level of market integration, also suggesting knowledge variation on extractive resources. These findings
are particularly important, as youth will be directing household decision-making over the coming decades. Their lower association of rubber with income with integration into markets suggests that markets may be reshaping ideas about production activities in these households, and hints that traditional activities such as rubber extraction may be replaced by other production activities.

**Implications of Findings for Conservation**

The implications of these findings for conservation in the reserve can be interpreted as both good and bad. On the positive side, although I found that increasing integration into off-farm labor markets leads to falling income from extraction, as well as percent of income from extraction, there was no correlation between integration into labor markets and cattle wealth. Further, integration into labor markets showed a negative correlation with income from basic crop production. This indicates that households earning high incomes from skilled labor activities are not investing income into cattle production activities and they are producing a lower value of basic crops, suggesting less slash and burn agriculture. This argues that household integration into labor markets may be good for the conservation of tropical rainforests—households not only use the forest less, for trade and consumptive activities, such as hunting, but they are not converting it to pasture or crop areas.

The findings for integration into trade markets are less clear. I found that integration into product trade markets resulted in only a moderate fall in income from extraction, suggesting that extraction remains important to all households regardless of level of product trade. However, I also found that percent of income from trade showed a weak, but positive and statistically significant correlation with both cattle wealth and income from crop production. This suggests that income from integration into product
markets is being at least partially invested in cattle wealth and crop production, both involving land conversion. Thus, integration into product markets may not dramatically reduce extractive activities, but production activities that accompany integration into trade markets—investment in cattle and slash and burn agriculture—do have negative implications for conservation.

The findings for wealth present the largest challenge for conservation. Although households continue to use the forest as wealth increases, they concomitantly invest a greater percent of wealth in cattle production. This argues that as households emerge from poverty they invest a greater percentage of wealth in destructive land use practices. It also suggests that development projects focused on improving production activities to lift households out of poverty may, in turn, result in the investments of profits in environmentally destructive activities.

**Implications for Policy Development**

The findings of this study also provide guidance for policymakers and development practitioners. The results of the cognitive tests found that cultural knowledge of extractive resources is widely shared, not only among all individuals, but also by sub-groups of individuals, and by sub-groups of individuals categorized by different levels of wealth and market integration. However, the subtle differences in knowledge, particularly with regard to how respondents identified extractive items during the pile sort test, most notably a falling association of rubber with income as market integration increased for some groups, indicate that certain individuals in households less integrated into off-farm labor markets and product markets, as well as with longer travel times to the city, may be more receptive to development projects that promote extractive activities. This was especially true for rubber tapper youth. My findings suggest that youth least
integrated into labor and product markets, or with longer travel times to the city may be more inclined to enter projects that promote income growth through development of non-timber extractive resources. In addition to youth, I found that that females and middle age adults least integrated into labor markets and with longer travel times may also be more receptive to projects that promote trade in extractive products.

The findings regarding the effects of the rubber subsidy on rubber production of 28 reserve households also inform policy development in the region. First, the findings argue that the additional payment per kilogram of production was not sufficient to stimulate rubber production among households that have left rubber tapping. Second, the findings argue that a higher price will not necessarily lead to production increases among households that do undertake this activity – only four households showed an increase in production in comparing 1996 data with data collected for this study. However, the findings do suggest that households with the lowest wealth holdings may benefit more from this policy, as the two least wealthy household categories earned the greatest share of income from rubber production. By this measure, the rubber subsidy has helped increase the incomes of the poorest of rubber tapper households in this study. Thus, my research argues that it is a very effective policy in targeting the poorest households in the forest.

Finally, study findings indicate that government policy can have a great effect on trading patterns in the forest. The subsidy basically eliminated rubber trade with itinerant traders in the region, and resulted in the concentration of rubber sales to CAEX, which channels production into local processing facilities now managed by a private sector
entrepreneur. Thus, the policy brings the potential to concentrate regional production into local processing facilities and facilitate economies of scale.

Further, the study findings also inform the debate on the potential of the extractive reserve concept as a conservation and development strategy. My findings demonstrate that households across levels of wealth, integration into product trade markets, and households with better access to the city and those with longer travel times rely on the forest for their livelihoods. The importance of both rubber and Brazil nuts for trade income, and the heavy reliance on game for consumption, argue that households are using the large areas of land that they are provided under the extractive reserve management regime. However, the findings of this study indicate that integration into off-farm labor markets leads to a decline in extractive resource use. Those households most integrated into skilled off-farm labor activities, and in particular salaried positions, showed the most dramatic decline in extractive resource use. The construction of feeder roads will facilitate access to off-farm labor activities, and development projects, such as community timber management projects now nearing implementation in the reserve which will create employment opportunities, some of which will likely bring substantial returns to forest households. However, it seems unlikely that a large number of high paying salaried and skilled labor positions will appear even in the short or medium term. Thus, while Homma’s (1992) contention that labor opportunities would siphon rural workers out of low-return extractive activities into better return off-farm labor markets has occurred, a parallel reduction in extractive income is found only among those households most integrated into labor markets. Households pursuing unskilled wage
labor activities, and even households gaining close to half of their income from wage or salaried labor still earn a sizeable portion of productive income from extractive activities.

While one of the principal findings of this study was the importance of extractive activities to household income, and that households with diverse economic situations rely heavily on the forest, this study also found that reserve households invest a greater proportion of wealth in cattle production as wealth increases. While households may justify their large landholdings as critical to carrying out extractive activities that are fundamental to their livelihoods, increasing investments in cattle production and concomitant deforestation (cf. Gomes 2001) are likely to raise concerns regarding the long term sustainability of the overall productive practices that rubber tappers employ, and the benefits of the extractive reserve concept for conservation. As households continue to invest in cattle production, the benefits of providing large usufruct rights to rubber tapper households as a strategy to conserve tropical forests may face tough questions.

**Study Contribution to Research Methods**

This study also makes a contribution to social science research methodology. First, I found that the use of participatory methods for the collection of economic data—in this case diagrams of wealth items and productive activities—can facilitate household recall of production and extraction activities, a difficult activity, especially when asking households to recall activities undertaken over the past year. Further, the diagrams facilitated the participation of the youngest households members, who at times, would correct the responses of household heads. The formal questionnaire lasted over two hours in a few cases, and the diagrams appeared to make the interview less tiresome for respondents.
On another scale, this study contributes to research methodology by demonstrating how microeconomic and cognitive anthropological research methods can be combined to better understand how forest households both use and think about the forest. By employing diverse tools to ask similar questions, such as QAP analysis, and the use of the gamma statistic to test for the association of the cultural consensus scores and household data for wealth and market integration, the analysis was able to illuminate both the high degree of shared knowledge across these variables, but also isolate differences in cultural knowledge across these same variables. In addition, by collecting information on why individuals sorted items in certain ways, I was able to examine the data for subtle variations in cultural knowledge across levels of wealth and market integration. These findings provide insight into how members of a cultural group think about the extractive resources that have shaped their livelihoods for more than a century, and how this understanding may vary across individuals sub-divided by age and sex.

Finally, for part of the analysis, this study measured cultural knowledge by the individual’s consensus analysis score: the individual’s knowledge in comparison to the norm. Therefore, individuals who have the lower cultural consensus score may share more or less knowledge with their cultural peers (Reyes-Garcia 2001). So, while researchers need to be aware of the “shaman effect”—individuals in the sample who maintain specialized knowledge, and thus fall out of the consensus—they must also be aware that cultural consensus analysis does not measure the level of agreement on “traditional” knowledge, but what is the norm at that particular time. Reyes-Garcia (2001) suggested the need to construct a “benchmark” of knowledge from which change can be measured. This is a useful suggestion, particularly for documenting changes in
ethnobotanical knowledge, which was a focus of her study. However, I would argue that it poses methodological challenges: it assumes that we are able to identify a particular point in time to serve as a benchmark for shared knowledge. As cultural knowledge is a moving target, this may be difficult. Speaking with shamans will reveal knowledge of medicinal plants and healing rituals, but this may not be the knowledge that was widely shared in years past. Thus, maybe we need to consider two types of knowledge—more specialized ethnobotanical knowledge, and cultural knowledge in general. For the latter, I would suggest the need to document changes in knowledge over time, examining how people’s understanding of the forest changes, and identifying the varying richness of knowledge that passes across generations. This can be examined either qualitatively or quantitatively.

**Study Contribution to Anthropology**

In the Introduction, I noted that anthropologists have been studying how economic factors shape livelihood activities and culture for decades. Indeed one of the earliest studies examined how the introduction of rubber tapping in the Amazon region among Amerindians dramatically altered the economy and cultural ties of the indigenous peoples and their leaders (Murphy and Steward 1956). My research follows in this tradition, examining how economic factors may be shaping resource use, but also how a changing economy affects cultural knowledge of the natural environment.

Thus, this study makes a theoretical contribution to the fields of economic anthropology and cognitive anthropology. Through an analysis of both household wealth and productive activities, as well as rubber tapper cultural knowledge of extractive resources, and subsequently linking these two lines of research, my study informs not only our understanding of the rubber tapper household economy and cultural knowledge
of extractive resources independently, but also how the economy may be shaping cultural knowledge. This study argues that wealth and integration into markets do shape use of forest resources. Yet, the QAP analysis found that cultural groups are able to maintain their understanding of natural resources despite changing livelihoods and stronger market ties. However, concomitantly, a different statistical test revealed a moderate correlation between level of cultural knowledge and level of market integration for some sub-groups of the study respondents. Thus this study suggests that cultural knowledge may be widely shared, but variations in knowledge can be identified and measured by looking more closely at sub-groups of the population and the role of specific factors that may be shaping cultural processes.
APPENDIX A  
MULTIPLE REGRESSION MODELS

Model 1

\[
Y_1 = \hat{\beta}_0 + \hat{\beta}_1(NWPER) + \hat{\beta}_2(PISV) + \hat{\beta}_3(MKT1RNK2) + \hat{\beta}_4(MKT1RNK3) + \\
\hat{\beta}_5(MKT1RNK4) + \hat{\beta}_6(TRAVTIME) + \hat{\beta}_7(TOTLABOR) + \hat{\beta}_8(LANDSIZE) + \hat{\beta}_9(YREDP8UP) + \\
\hat{\beta}_{10}(YRSHEAD) + \hat{\beta}_{11}(SOCSAL) + \hat{\beta}_{12}(BNUTS) + \hat{\beta}_{13}(CAEX) + \mu_i
\]

\[Y_1 = \text{Net household income (R$)}\]

\[NWPER = \text{Net wealth per capita (R$)}\]

\[PISV = \text{Percent of income from barter or trade of products}\]

\[MKT1RNK2 = \text{Percent of income from off-farm labor from greater than 0.0 to 10.0% (Base = 0.0% Percent income from off-farm labor)}\]

\[MKT1RNK3 = \text{Percent of income from off-farm labor from 11.0 to 45.0%}\]

\[MKT1RNK4 = \text{Percent of income from off-farm labor greater than 45.0%}\]

\[TRAVTIME = \text{Travel time to city of Xapuri (minutes)}\]

\[TOTLABOR = \text{Total labor available including family and hired labor (days)}\]

\[LANDSIZE = \text{Landholding size (hectares)}\]

\[YREDP8UP = \text{Education per capita 8 years of age and older (years)}\]

\[YRSHEAD = \text{Years male household head on landholding (years)}\]

\[SOCSAL = \text{Household received a monthly social payment (Base = Household did not receive a monthly social payment)}\]

\[BNUTS = \text{Household sold Brazil nuts over past 12 months (Base = Household did not sell Brazil nuts)}\]

\[CAEX = \text{Household member is a member of the Agro-Extractive Cooperative of Xapuri (CAEX) (Base = No household member is a member of CAEX)}\]

See Tables 4-3 and 4-5

Model 2

\[
\text{Log}Y_2 = \hat{\beta}_0 + \hat{\beta}_1(NWPER) + \hat{\beta}_2(PISV) + \hat{\beta}_3(MKT1RNK2) + \hat{\beta}_4(MKT1RNK3) + \\
\hat{\beta}_5(MKT1RNK4) + \hat{\beta}_6(TRAVTIME) + \hat{\beta}_7(TOTLABOR) + \hat{\beta}_8(LANDSIZE) + \hat{\beta}_9(YREDP8UP) + \\
\hat{\beta}_{10}(YRSHEAD) + \hat{\beta}_{11}(SOCSAL) + \hat{\beta}_{12}(BNUTS) + \hat{\beta}_{13}(CAEX) + \mu_i
\]

\[\text{Log}Y_2 = \text{Natural log of net productive household income (R$)}\]

All other variables as defined in Model 1
Model 3

\[ Y_3 = \hat{\beta}_0 + \hat{\beta}_1(NWPER)_i + \hat{\beta}_2(PISV)_i + \hat{\beta}_3(MKT1RNK2)_i + \hat{\beta}_4(MKT1RNK3)_i + \hat{\beta}_5(MKT1RNK4)_i + \hat{\beta}_6(TRAVTIME)_i + \hat{\beta}_7(TOTLABOR)_i + \hat{\beta}_8(LANDSIZE)_i + \hat{\beta}_9(YREDP8UP)_i + \hat{\beta}_{10}(YRSHEAD)_i + \hat{\beta}_{11}(SOCSAL)_i + \hat{\beta}_{12}(BNUTS)_i + \hat{\beta}_{13}(CAEX)_i + \tilde{\mu}_i \]

\( Y_3 \) = Income from on-farm extractive activities
All other variables as defined in Model 1

Model 4

\[ Y_4 = \hat{\beta}_0 + \hat{\beta}_1(NWPER)_i + \hat{\beta}_2(PISV)_i + \hat{\beta}_3(MKT1RNK2)_i + \hat{\beta}_4(MKT1RNK3)_i + \hat{\beta}_5(MKT1RNK4)_i + \hat{\beta}_6(TRAVTIME)_i + \hat{\beta}_7(TOTLABOR)_i + \hat{\beta}_8(LANDSIZE)_i + \hat{\beta}_9(YREDP8UP)_i + \hat{\beta}_{10}(YRSHEAD)_i + \hat{\beta}_{11}(SOCSAL)_i + \hat{\beta}_{12}(BNUTS)_i + \hat{\beta}_{13}(CAEX)_i + \tilde{\mu}_i \]

\( Y_4 \) = Percent of household productive income from on-farm extraction
All other variables as defined in Model 1
APPENDIX B
RESULTS OF MULTIVARIATE REGRESSION WITH ALL HOUSEHOLDS

Table B-1 Multivariate regression model findings for all 46 study households in Chico Mendes Extractive Reserve.

<table>
<thead>
<tr>
<th>Variable</th>
<th>Model 1: Household Net Income</th>
<th>Model 2: Household Net Productive Income&lt;sup&gt;a&lt;/sup&gt;</th>
<th>Model 3: Household Extractive Income</th>
<th>Model 4: Percent of Productive Income from Extraction</th>
</tr>
</thead>
<tbody>
<tr>
<td>Net wealth per capita (R$)</td>
<td>0.56***</td>
<td>0.00014***</td>
<td>0.013</td>
<td>-0.00004**</td>
</tr>
<tr>
<td>Pct. of productive income from barter or trade</td>
<td>992.24</td>
<td>-0.29959</td>
<td>-479.60</td>
<td>-0.18352</td>
</tr>
<tr>
<td>Percent productive income from off-farm labor (1-10%)&lt;sup&gt;c&lt;/sup&gt;</td>
<td>721.25</td>
<td>-0.08599</td>
<td>-255.68</td>
<td>-0.16628**</td>
</tr>
<tr>
<td>Percent productive income from off-farm labor (11-45%)&lt;sup&gt;c&lt;/sup&gt;</td>
<td>446.41</td>
<td>-0.02883</td>
<td>-959.35**</td>
<td>-0.24914***</td>
</tr>
<tr>
<td>Percent productive income from off-farm labor (&gt; 45%)&lt;sup&gt;c&lt;/sup&gt;</td>
<td>1,203.04</td>
<td>0.28560</td>
<td>-1,038.73</td>
<td>-0.41360***</td>
</tr>
<tr>
<td>Travel time to city (minutes)</td>
<td>3.57</td>
<td>-0.00015</td>
<td>-1.81*</td>
<td>-0.00023</td>
</tr>
<tr>
<td>Total Labor available (days)</td>
<td>3.21***</td>
<td>0.00070***</td>
<td>0.50</td>
<td>0.00009</td>
</tr>
<tr>
<td>Landholding Size (hectares)</td>
<td>2.28</td>
<td>0.00080**</td>
<td>2.87***</td>
<td>0.00023*</td>
</tr>
<tr>
<td>Education per capita 8 yrs and older (years)</td>
<td>110.94</td>
<td>-0.00746</td>
<td>-0.87.09</td>
<td>-0.00670</td>
</tr>
<tr>
<td>Years Head on Landholding</td>
<td>-5.62</td>
<td>-0.00804</td>
<td>-10.10</td>
<td>-0.00068</td>
</tr>
<tr>
<td>Monthly social payment&lt;sup&gt;b&lt;/sup&gt;</td>
<td>2,139.10**</td>
<td>-0.44801**</td>
<td>-778.02**</td>
<td>-0.03129</td>
</tr>
<tr>
<td>Sold Brazil nuts&lt;sup&gt;b&lt;/sup&gt;</td>
<td>-463.63</td>
<td>-0.15757</td>
<td>-175.80</td>
<td>0.06929</td>
</tr>
<tr>
<td>CAEX membership&lt;sup&gt;b&lt;/sup&gt;</td>
<td>1,190.36*</td>
<td>0.12035</td>
<td>426.24</td>
<td>0.04151</td>
</tr>
<tr>
<td>Observations</td>
<td>46</td>
<td>46</td>
<td>46</td>
<td>46</td>
</tr>
<tr>
<td>R-squared</td>
<td>0.65</td>
<td>0.49</td>
<td>0.51</td>
<td>0.50</td>
</tr>
<tr>
<td>Pr &gt; F</td>
<td>&lt;0.0001</td>
<td>0.0004</td>
<td>0.0002</td>
<td>0.0003</td>
</tr>
</tbody>
</table>

Notes:  
<sup>a</sup> Used natural log transformation.  
<sup>b</sup> Dummy variable. Membership in AMOREX and the STR were also tested for possible inclusion in the model but were not significant and thus not included. CAEX better captures the economic influence of social organizations working with rubber tapper households in the reserve. The base is do not sell Brazil nuts, or not a member of CAEX.  
<sup>c</sup> Dummy variable. The coefficient represents the change compared to the intercept base. The base is no income from off-farm labor.  
*Significant at ≤.010; ** significant at ≤0.05; *** significant at ≤0.01.
# APPENDIX C

## QUADRATIC ASSIGNMENT PROCEDURE RESULTS

Table C-1. Quadratic Assignment Procedure (QAP) correlations for wealth for all respondents and respondents sub-divided by sex and age.

<table>
<thead>
<tr>
<th>Wealth Groups Compared</th>
<th>Correlation</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>All Respondents</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Wealth 1 and Wealth 2</td>
<td>.911</td>
<td>.00</td>
</tr>
<tr>
<td>Wealth 1 and Wealth 3</td>
<td>.824</td>
<td>.00</td>
</tr>
<tr>
<td>Wealth 1 and Wealth 4</td>
<td>.898</td>
<td>.00</td>
</tr>
<tr>
<td>Wealth 2 and Wealth 3</td>
<td>.852</td>
<td>.00</td>
</tr>
<tr>
<td>Wealth 2 and Wealth 4</td>
<td>.920</td>
<td>.00</td>
</tr>
<tr>
<td>Wealth 3 and Wealth 4</td>
<td>.868</td>
<td>.00</td>
</tr>
</tbody>
</table>

| **Females**            |             |         |
| Wealth 1 and Wealth 2  | .820        | .00     |
| Wealth 1 and Wealth 3  | .739        | .00     |
| Wealth 1 and Wealth 4  | .758        | .00     |
| Wealth 2 and Wealth 3  | .744        | .00     |
| Wealth 2 and Wealth 4  | .783        | .00     |
| Wealth 3 and Wealth 4  | .674        | .00     |

| **Males**              |             |         |
| Wealth 1 and Wealth 2  | .835        | .00     |
| Wealth 1 and Wealth 3  | .761        | .00     |
| Wealth 1 and Wealth 4  | .801        | .00     |
| Wealth 2 and Wealth 3  | .814        | .00     |
| Wealth 2 and Wealth 4  | .894        | .00     |
| Wealth 3 and Wealth 4  | .823        | .00     |

| **Age 1**              |             |         |
| Wealth 1 & 2 and Wealth 3 & 4 | .831 | .00 |

| **Age 2**              |             |         |
| Wealth 1 and Wealth 2  | .843        | .00     |
| Wealth 1 and Wealth 3  | .726        | .00     |
| Wealth 1 and Wealth 4  | .768        | .00     |
| Wealth 2 and Wealth 3  | .762        | .00     |
| Wealth 2 and Wealth 4  | .861        | .00     |
| Wealth 3 and Wealth 4  | .685        | .00     |

| **Age 3**              |             |         |
| Wealth 1 & 2 and Wealth 4 | .843 | .00 |
Table C-2. Quadratic Assignment Procedure (QAP) correlations for integration into off-farm labor for all respondents and respondents sub-divided by sex and age.

<table>
<thead>
<tr>
<th>Market Integration Groups Compared</th>
<th>Correlation</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>All Respondents</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Category 1 and Category 2</td>
<td>.911</td>
<td>.00</td>
</tr>
<tr>
<td>Category 1 and Category 3</td>
<td>.900</td>
<td>.00</td>
</tr>
<tr>
<td>Category 1 and Category 4</td>
<td>.855</td>
<td>.00</td>
</tr>
<tr>
<td>Category 2 and Category 3</td>
<td>.928</td>
<td>.00</td>
</tr>
<tr>
<td>Category 2 and Category 4</td>
<td>.884</td>
<td>.00</td>
</tr>
<tr>
<td>Category 3 and Category 4</td>
<td>.886</td>
<td>.00</td>
</tr>
</tbody>
</table>

| Females                           |             |         |
| Category 1 and Category 2         | .813        | .00     |
| Category 1 and Category 3 & 4     | .733        | .00     |
| Category 2 and Category 3 & 4     | .863        | .00     |

| Males                             |             |         |
| Category 1 and Category 2         | .855        | .00     |
| Category 1 and Category 3 & 4     | .899        | .00     |
| Category 2 and Category 3 & 4     | .893        | .00     |

| Age 1                             |             |         |
| Category 1 & 2 and Category 3 & 4  | .854        | .00     |

| Age 2                             |             |         |
| Category 1 and Category 2         | .900        | .00     |
| Category 1 and Category 3 & 4     | .885        | .00     |
| Category 2 and Category 3 & 4     | .890        | .00     |

| Age 3                             |             |         |
| Category 1 and Category 2 & 3     | .833        | .00     |
Table C-3. Quadratic Assignment Procedure (QAP) correlations for integration into product markets all respondents and respondents sub-divided by sex and age.

<table>
<thead>
<tr>
<th>Market Integration Groups Compared</th>
<th>Correlation</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>All Respondents</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Category 1 and Category 2</td>
<td>.937</td>
<td>.00</td>
</tr>
<tr>
<td>Category 1 and Category 3</td>
<td>.829</td>
<td>.00</td>
</tr>
<tr>
<td>Category 1 and Category 4</td>
<td>.936</td>
<td>.00</td>
</tr>
<tr>
<td>Category 2 and Category 3</td>
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<td>.00</td>
</tr>
<tr>
<td>Category 2 and Category 4</td>
<td>.895</td>
<td>.00</td>
</tr>
<tr>
<td>Category 3 and Category 4</td>
<td>.842</td>
<td>.00</td>
</tr>
<tr>
<td>Females</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Category 1 and Category 2</td>
<td>.857</td>
<td>.00</td>
</tr>
<tr>
<td>Category 1 and Category 3</td>
<td>.682</td>
<td>.00</td>
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<tr>
<td>Category 1 and Category 4</td>
<td>.834</td>
<td>.00</td>
</tr>
<tr>
<td>Category 2 and Category 3</td>
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<td>.00</td>
</tr>
<tr>
<td>Category 2 and Category 4</td>
<td>.783</td>
<td>.00</td>
</tr>
<tr>
<td>Category 3 and Category 4</td>
<td>.659</td>
<td>.00</td>
</tr>
<tr>
<td>Males</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Category 1 and Category 2</td>
<td>.900</td>
<td>.00</td>
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<tr>
<td>Category 1 and Category 3</td>
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<td>Category 2 and Category 4</td>
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<tr>
<td>Category 3 and Category 4</td>
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<td>.00</td>
</tr>
<tr>
<td>Age 1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Category 1 and Category 2</td>
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<td>.00</td>
</tr>
<tr>
<td>Category 1 and Category 3 &amp; 4</td>
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<td>.00</td>
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<td>Category 2 and Category 3 &amp; 4</td>
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<td>.00</td>
</tr>
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<td>Age 2</td>
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<tr>
<td>Category 1 and Category 2</td>
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<td>Category 1 and Category 3</td>
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<td>Category 1 and Category 4</td>
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<td>Category 2 and Category 4</td>
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<td>.00</td>
</tr>
<tr>
<td>Age 3</td>
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<td></td>
</tr>
<tr>
<td>Category 1 &amp; 2 and Category 3 &amp; 4</td>
<td>.808</td>
<td>.00</td>
</tr>
</tbody>
</table>
Table C-4. Quadratic Assignment Procedure (QAP) correlations for travel time to the city of Xapuri for all respondents and respondents sub-divided by sex and age.

<table>
<thead>
<tr>
<th>Market Integration Groups Compared</th>
<th>Correlation</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>All Respondents</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Category 1 and Category 2</td>
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<tr>
<td>Category 1 and Category 3</td>
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<tr>
<td>Category 2 and Category 3</td>
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<td>.00</td>
</tr>
<tr>
<td>Females</td>
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<td></td>
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<td>Category 1 and Category 2</td>
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</tr>
<tr>
<td>Category 1 and Category 3</td>
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<tr>
<td>Males</td>
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<td></td>
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<td>Category 1 and Category 2</td>
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<td>Category 1 and Category 3</td>
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</tr>
<tr>
<td>Category 2 and Category 3</td>
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<td>.00</td>
</tr>
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BIOGRAPHICAL SKETCH

Richard Hood Wallace was raised in Lancaster, Ohio. He received a B.S. in marketing with a minor in international business from Miami University in Oxford, Ohio, in 1984, where he also attended the Miami University Luxembourg Program. After a brief international banking career with Lloyds Bank Plc. in Chicago, he received an M.A. in international development from The American University in Washington, D.C., in 1994. After finishing his master’s degree, he conducted research in Acre, Brazil, from 1995-1997 under the Rainforest Alliance Kleinhans Fellowship. Upon completion of his doctoral studies in anthropology at the University of Florida, he will work as a post-doctoral research associate in Acre, Brazil.