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School of Anthropology and Conservation
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**Agroforestry extension and protected areas conservation in the
Brazilian Amazon**

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To all those, local peoples and outsiders, who keep trying
to join conservation and development
and to get it right.

How to get them to be better than they think they can be?

That is very difficult, I find. Inspiration, perhaps.

How do we inspire ourselves to greatness, when nothing less will do?

How do we inspire everyone around us?

(Morgan Freeman, playing Mandela, in the film *Invictus*)

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Abstract

This thesis explored agroforestry extension's role in protected areas (PAs) conservation, focusing on extension activities conducted from 2010 to 2011 at Saracá-Taquera National Forest and Rio Trombetas Biological Reserve in the Brazilian Amazon. It relied on a mixed methods approach; data collected during an extended stay in four participating communities was complemented by interviews with PA and extension staffs. I suggest that agroforestry extension has limited potential to contribute to PA conservation at the study site. First, agroforestry was promoted by extensionists as a land use that would recover deforested areas, but their narratives tended to overlook empirical evidence. They plotted agroforestry against a 'crisis' background that reproduced, rather than critically assessed, policy discourses depicting shifting cultivation as an important driver of deforestation.

Second, even considering that some do participate in the agroforestry project and could extract livelihood benefits, the expectation that agroforestry can replace activities perceived as threats is unlikely to materialise. I suggest that locals' participation was influenced both by broader factors – e.g., past experiences with PAs and social ties to community gatekeepers – and by factors specifically regarding the project – e.g., local perceptions of agroforestry. I also argue that, considering a best-case scenario in which market constraints are overcome, agroforestry could potentially reduce local inequalities significantly. The engagement of both men and women would be important in the management of competition between agroforestry and other activities in mixed livelihoods. Finally, I suggest that main threats to PAs' biodiversity include turtle hunting and cattle ranching, but also mining – the third would not be addressed by agroforestry. Furthermore, I argue that the first two are unlikely to be reduced by agroforestry as cultural incentives to hunt are strong, and economic motivations would hinder the adoption of agroforestry by hunters and favour the combination (rather than replacement) of ranching with agroforestry.

Resumo

Esta tese examinou o papel da extensão agroflorestal na conservação de unidades de conservação (UCs), tendo como foco as atividades de extensão conduzidas de 2010 a 2011 na Floresta Nacional Saracá-Taquera e na Reserva Biológica do Rio Trombetas na Amazônia brasileira. Ela se baseou em uma abordagem de ‘métodos mistos’; dados coletados durante uma estadia prolongada em quatro comunidades participantes foi complementada por entrevistas junto a funcionários das UCs e extensionistas. Eu proponho que a extensão agroflorestal tem potencial limitado de contribuir para a conservação de UCs no local de estudo. Primeiramente, a agrofloresta foi promovida pelos extensionistas como uma forma de uso da terra que recuperaria áreas desmatadas, mas suas narrativas tendiam a ignorar evidências empíricas. Eles apresentavam a agrofloresta diante de um pano de fundo de ‘crise’ que reproduzia, ao invés de avaliar criticamente, discursos de políticas públicas retratando a agricultura itinerante como uma importante causa do desmatamento.

Em segundo lugar, mesmo considerando que algumas famílias participam do projeto agroflorestal e poderiam extrair benefícios sociais, a expectativa de que a agrofloresta poderia substituir atividades tidas como ameaças dificilmente se materializaria. Eu sugiro que a participação das famílias no projeto foi influenciada tanto por fatores mais amplos – e.g., experiências passadas com as UCs e relações sociais com o *gatekeeper* da comunidade – quanto por fatores especificamente ligados ao projeto – e.g., percepções locais sobre a agrofloresta. Também proponho que, considerando um cenário otimista em que restrições de mercado sejam superadas, a agrofloresta poderia reduzir a desigualdade social significativamente. O engajamento tanto dos homens como das mulheres seria importante na gestão da competição entre a agrofloresta e outras atividades que compõem os modos de vida locais. Finalmente, eu sugiro que as principais ameaças à biodiversidade das UCs incluem caça de tartarugas e criação de gado, mas também mineração – a última não seria enfrentada pela agrofloresta. Além disso, eu proponho que as duas primeiras dificilmente seriam reduzidas pela agrofloresta, pois as motivações culturais para caçar são fortes, e as motivações econômicas dificultariam a adoção da agrofloresta pelos caçadores e favoreceriam a combinação da criação de gado com a agrofloresta (e não a substituição de um pelo outro).

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List of abbreviations and acronyms

ARPA	Protected Areas of the Amazon Program (<i>Programa Áreas Protegidas da Amazônia</i>)
ARQMO	Association of the Slave Descendants of Oriximiná City (<i>Associação dos Remanescentes de Quilombo do Município de Oriximiná</i>)
ASB	Alternatives to Slash-and-Burn
BASA	Amazon Bank (<i>Banco da Amazônia</i>)
CBD	Convention on Biological Diversity
CEASA-PA	Supply Centre of Pará State (<i>Centrais de Abastecimento do Estado do Pará</i>)
CONAB	National Supply Company (<i>Companhia Nacional de Abastecimento</i>)
CI	Conservation International
CITES	Convention on International Trade in Endangered Species of Wild Fauna and Flora
CNCFLORA	National Center for Plant Conservation (<i>Centro Nacional de Conservação da Flora</i>)
CR	Coefficient of reproducibility
CS	Coefficient of scalability
CSR	Remote Sensing Centre (<i>Centro de Sensoriamento Remoto</i>)
DF	Degrees of freedom
EMATER/PA	Technical Assistance and Rural Extension Company of Pará (<i>Empresa de Assistência Técnica e Extensão Rural do Pará</i>)
FAO	Food and Agriculture Organisation of the United Nations
FNMA	National Fund for the Environment (<i>Fundo Nacional do Meio Ambiente</i>)
FNO	Constitutional Fund for the Financing of the North (<i>Fundo Constitucional de Financiamento do Norte</i>)
GDP	Gross domestic product
GEF	Global Environmental Facility
HDI	Human Development Index
IBAMA	Brazilian Institute of Environment and Renewable Natural Resources (<i>Instituto Brasileiro do Meio Ambiente e dos Recursos Naturais Renováveis</i>)
IBDF	Brazilian Institute for Forestry Development (<i>Instituto Brasileiro de Desenvolvimento Florestal</i>)
IBGE	Brazilian Institute of Geography and Statistics (<i>Instituto brasileiro de Geografia e Estatística</i>)
ICCO	Interchurch Organization for Development Cooperation (<i>Internationaal Maatschappelijk Verantwoord Ondernemen</i>)

ICMBio	Chico Mendes Institute for Biodiversity Conservation (<i>Instituto Chico Mendes de Conservação da Biodiversidade</i>)
ICRAF	International Centre for Research in Agroforestry
IDRC	International Development Research Centre
INPA	National Research Institute of the Amazon (<i>Instituto Nacional de Pesquisas da Amazônia</i>)
INPE	National Institute for Space Research (<i>Instituto Nacional de Pesquisas Espaciais</i>)
IPT	Institute for Technological Research (<i>Instituto de Pesquisas Tecnológicas</i>)
IUCN	International Union for Conservation of Nature
MÃE	Agroecology <i>mutirão</i> (<i>Mutirão de Agroecologia</i>)
MCDM	Multiple criteria decision-making
MMA	Ministry of Environment (<i>Ministério do Meio Ambiente</i>)
MRN	Rio do Norte Mining (<i>Mineração Rio do Norte</i>)
MST	Movement of the Landless Rural Workers (<i>Movimento dos Trabalhadores Rurais Sem-Terra</i>)
NGO	Non-governmental organisation
NTFP	Non-timber forest product
PA	Protected area
PDA	Demonstration Projects (<i>Projetos demonstrativos</i>)
PADEQ	Alternatives to deforestation and burning project (<i>Projeto Alternativas ao Desmatamento e às Queimadas</i>)
PNMC	National Policy on Climate Change (<i>Política Nacional de Mudanças Climáticas</i>)
PNUD	United Nations Development Program (<i>Programa das Nações Unidas para o Desenvolvimento</i>)
PPG7	Pilot Program to Conserve the Brazilian Rain Forest (<i>Programa Piloto para Proteção das Florestas Tropicais do Brasil</i>)
RAPP	Rondônia Agroforestry Pilot Program
RECA	Association of Small Agroforestry Producers of the Economic Intercropped Dense Reforestation Project (<i>Associação dos Pequenos Agrossilvicultores do Projeto Reflorestamento Econômico Consorciado Adensado</i>)
RENTAS	National Network of Fight against Wildlife Traffic (<i>Rede Nacional de Combate ao Tráfico de Animais Silvestres</i>)
SD	Standard deviation
SSC	Species Survival Commission

UFSE Federal University of the Southeast²
UN United Nations

² Fictitious name

Glossary of Portuguese terms

açai	<i>Euterpe</i> spp.. Palm growing as a solitary stem or in clusters of several stems (according to the species). It produces edible fruits and palm heart. The dark purple fruit pulp is widely consumed in the Amazon as a thick 'juice', rich in fats, mixed with manioc <i>farinha</i> .
acari	^a Various Loricariidae species. Freshwater, usually herbivorous or detritivorous fish, with body covered with bony plates. ^b <i>Minquartia guianensis</i> . Tree reaching more than 20 m, with a grooved trunk, explored for timber. The wood is highly resistant to mechanical stress and soil organisms, and frequently used as poles and pillars (Camargo & Ferraz 2004).
acordo de gestão	Document containing the regulations defined by the traditional population of a protected area and by Chico Mendes Institute for Biodiversity Conservation (ICMBio) concerning the management of natural resources, the use and occupation of the area and the conservation of the environment ³ .
agente comunitário de saúde	"Community health agent". Person employed by the municipal government to offer basic health care to neighbouring rural communities.
Amazônia Legal	"Legal Amazon". Comprises the states of the North region of Brazil (Tocantins only in part) and its neighbour states of Mato Grosso, Goiás and Maranhão (the last two only in part).
apapá	<i>Pellona</i> sp.. Freshwater carnivorous fish.
aracu	Various Anostomidae species. Freshwater omnivorous fish.
área de preservação permanente	"Permanent preservation area". Areas that are protected due ecosystem services and biodiversity related concerns, including river margins, steep slopes and top of mountains. Only activities that are considered as of public interest, social interest or low impact may be carried out (e.g., public transportation infrastructure, small scale agroforestry production, small scale sustainable timber extraction).
área protegida	In Brazil, the term frequently implies a broad understanding, including not only <i>unidades de conservação</i> , but also other areas considered of conservation value such as indian territories and river margins (e.g., Medeiros 2006, pp. 49, 55, 59).

³ Instrução Normativa 29, 5 September 2012. *Disciplina a elaboração e aprovação de Acordo de Gestão*.

areia	Sand. A type of soil.
areia preta	Black sand. A type of soil containing a mix of sand and dark earth.
aroeira	<i>Hymenolobium</i> sp. and/or <i>Pithecolobium</i> sp.. Tree explored for timber.
assoalhamento	Pre-nesting basking behaviour of the South American river turtle. The act of gathering on <i>tabuleiros</i> during the day to benefit from the sun's heat.
azeitona	<i>Syzygium cumini</i> . Tree producing edible fruits. The small black fruits have a sweet and astringent flavour.
bacaba	<i>Oenocarpus bacaba</i> . Palm growing as a solitary stem, producing edible fruits. The fruit pulp is frequently consumed in the Amazon as a thick 'juice', richer in fats than the <i>açaí</i> juice, mixed with manioc <i>farinha</i> .
balata	<i>Manilkara</i> sp.. Latex producing tree. Latex is extracted by making cuts onto the standing or felled trunk. The processed latex is more rigid than rubber (Hammond 2005, p. 441). See also <i>seringa</i> .
barro	Clay. A type of soil.
benfeitoria	Work done in a property to improve it.
bolsa-família	Social service payment aimed at improving nutrition and education of poor families.
breu	<i>Protium</i> spp.. Tree producing a resin widely used in the Amazon to caulk boats and as medicine. The resin is expelled naturally by the tree trunk, after which it solidifies. It is collected from the ground, or from the trunk with a machete.
broca-do-fruto	<i>Conotrachelus humeropictus</i> . A pest that damages <i>cupuaçu</i> fruits. Eggs laid in the fruit originate larvae that feed from the fruit pulp and seeds (Silva & Alfaia 2004).
cadastrar	Register.
campinarana	Range of vegetation types with low plant diversity adapted to the isolated patches of sandy, nutrient poor, acidic soils within the Amazon Forest biome. It varies from open and dominated by herbaceous species to closed-canopy formations (Silveira 2003).
campo cerrado	A type of <i>cerrado</i> (known as the Brazilian savanna).
capoeira	Fallow
capoeira de fogo	"Fire fallow". Fallow where the understorey had recently been bunted by fire escaped from an adjacent field.
cará	<i>Dioscorea</i> sp.. Root crop consumed after boiling.
casa de farinha	A roofed and unwallled construction containing a stove and other equipments needed to make <i>farinha</i> .

centro comunitário	Community centre. Community space where important social events – such as church service, school classes, football match, meetings and festivities – take place.
cipó-títica	<i>Heteropsis</i> sp.. Hemi-epiphyte plant (grows upon another plant, spending part of its life cycle rooted in the ground). Its long roots growing towards the ground are used in crafts and in construction.
código florestal	Forest code.
compadre	What a person's father and godfather are to each other.
coordenador	Coordinator. Elected representative of a community.
copaíba	<i>Copaifera</i> spp.. Tree reaching up to 36 m in height, producing a resin widely used in the Amazon as an antibiotic medicine. Annual resin production per tree varies from 0.1 to 60 L (Shanley <i>et al.</i> 2005, pp. 85-86). For resin extraction, a manual drilling tool (<i>trado</i>) is used to make a hole in the trunk, from which it drains. After extraction, the hole is closed and can be reopened some months later.
coquirana	<i>Chrysophyllum</i> sp.. Latex producing tree.
cupiúba	<i>Goupia glabra</i> . Tree reaching around 40 m, explored for timber. The wood is heavy and hard, moderately resistant to mechanical stress and to xylophagous organisms, and used in house construction (French Agricultural Research Centre for International Development/ Centre de Coopération Internationale en Recherche Agronomique pour le Développement – CIRAD 2012 ^a ; Gurgel <i>et al.</i> 2015).
cupuaçu	<i>Theobroma grandiflorum</i> . Shade tolerant tree of the cacao genus, usually ranging from 5 to 15 m in height (Fraife-Filho n/d). Its acidic and aromatic fruit pulp is widely consumed in the Amazon as juices and ice creams.
cupuí	<i>Theobroma subincanum</i> . Tree of the <i>cupuaçu</i> genus. It produces an edible fruit similar to, but smaller and sweeter than, <i>cupuaçu</i> .
derrubada	Clear cutting of the forest.
enxada	Hoe.
enxó	Carpentry tool for shaping wood. It consists of a curved and sharp metal plate attached to a cable.
espinhel	Hunting apparatus consisting in hooks tied along a line, at regular intervals from each other.
farinha	One of the products manioc roots are transformed into, after peeling, soaking, grating, draining, sifting and roasting. It is the major local staple food.

fibrocimento	Fibre cement. Composition of a type of house roof.
guariba	<i>Alouatta</i> sp.. Howler monkey.
haste de tapuá	Wooden spear ending in a small metal spike. The spike is tied to a rope and can be separated from the body of the spear.
inajá	<i>Maximiliana maripa</i> . Solitary, fire resistant palm producing an edible fruit.
ingá	<i>Inga</i> spp.. Leguminous tree. It produces 5 cm to 1 m long fruits (according to the species), with an edible white sweet pulp (Daly 2005, p. 231).
inverno	Winter. The rainy and cooler season, from January to June. See also <i>verão</i> .
itaúba	<i>Mezilaurus</i> sp.. Tree explored for timber. The wood is heavy, moderately resistant to mechanical stress, highly resistant to xylophagous organisms, and frequently used in boat and house construction (CIRAD 2012 ^b ; Centro Nacional de Conservação da Flora/ National Center for Plant Conservation – CNCFLORA 2012, Instituto de Pesquisas Tecnológicas/ Institute for Technological Research – IPT n/d).
jabuti	<i>Chelonoidis</i> sp.. Tortoise.
jangada	Raft.
jirau	Elevated small container, such as an old canoe or a wooden box, used to grow medicinals, spices and vegetables.
jutaicica	Resin produced by the <i>jatobá</i> tree (<i>Hymenaea</i> sp.). It is used as medicine.
louro	Various Lauraceae species. Tree explored for timber.
macaxeira	Sweet varieties of manioc (<i>Manihot esculenta</i>). Root crop consumed after boiling, dispensing the complex processing required by the bitter varieties.
machado	Axe.
madeireiro	Logger.
malhadeira	Fishing net.
mandioqueira	<i>Qualea</i> sp.. Tree explored for timber. The wood is medium weight, moderately resistant to mechanical stress, susceptible to certain xylophagous organisms and used in house construction (CIRAD 2012 ^c).
massa	“Mass”. Grated manioc roots.
maxixe	<i>Cucumis anguria</i> . Vegetable of the cucumber family, consumed after boiling.

merenda escolar	School meal.
merendeira	Person in charge of preparing the school meals.
mutirão (pl. mutirões)	Group of people that gather to perform a particular task collectively.
na espera	Hunting technique in which the hunter waits for and ambushes the game from a spot among tree branches, elevated from the ground.
ouriço	Brazil nut fruit. Each hard-shelled fruit contains 16 nuts, on average (Cymerys <i>et al.</i> 2005, p. 62).
pacu	Various Serrasalminae species. Freshwater, frequently disc-shaped fish.
paneiro	Woven basket.
paricá	<i>Schizolobium amazonicum</i> . Pioneer, rapid growth, emergent tree species. It is commonly cultivated for timber. The wood is light colour and light weight (Carvalho 2007).
pequiá	<i>Caryocar villosum</i> . Tree reaching 40 to 50 m of height (Shanley & Galvão 2005, p. 123). It produces an edible fruit, rich in fats, that is consumed after boiling.
pescada	<i>Plagioscion</i> sp.. Freshwater carnivorous fish.
piranha	Various Serrasalminae species. Freshwater, omnivorous, sharp-teethed fish.
pirarucu	<i>Arapaima gigas</i> . Freshwater fish reaching as much as 3 m in length. The need to periodically come up to breath air makes it particularly vulnerable to fishing.
proteção integral	“Strictly protected”. Type of protected area in Brazil in which only indirect or non-consumptive uses of natural resources, such as tourism and research, are allowed. See also <i>uso sustentável</i> .
pupunha	<i>Bactris gasipaes</i> . Palm with spiny stem growing in clusters of several stems. It is grown for the production of fruits or palm hearts. Fruits are starchy and rich in vitamin A and must be boiled for several hours before consumption.
quadra	Local unit of measure, approximately equivalent to 0.25 hectares.
quilombola	Constituent of the ‘ <i>comunidades remanescentes de quilombos</i> ’, which has been defined as “the territory where Africans and their descendants came to live during the transition period which culminated in the slavery abolition” in Brazil. (Leite 2008, pp. 965, 969).
rabeta	Small engine that can be used to power canoes or devices that grate manioc roots.

regatão (<i>pl. regatões</i>)	Intermediary travelling on boats who sells industrialised products and purchases extractive and agricultural products.
repiquete	Sudden short-term rises in the river level.
replantar	Replant (manioc) after harvest.
reserva legal	“Legal reserve”. Portion of a rural property that is set aside for conservation in Brazil. Economic activities that are seen as compatible with the conservation of forest cover, such as sustainable timber extraction, may be authorised in the area. In the <i>Amazonia Legal</i> region, it corresponds to 20 to 80% of the total property area.
ribeirinho	Nontribal, non-settler, lower-class rural people of the Brazilian Amazon. <i>Ribeirinhos</i> are mixed-blood, resulting from the intermarriage of Amerindians with early Portuguese settlers and later, in the XVIII and XIX centuries, with Northeasterns of African descent – African influence was, however, restricted to specific regions (Chibnik 1991).
roça	Agricultural field.
roçar/roçagem	To slash/slashing of the forest understory.
rodete	Large wooden wheel that is manually turned to power the device that grates the manioc roots.
salário mínimo	Minimum wage.
salário- maternidade	Remuneration received during maternity leave.
salsaparrilha	<i>Smilax</i> sp.. Medicinal plant.
seringa	<i>Hevea</i> sp.. Latex producing tree. Latex is extracted by making superficial cuts onto the standing trunk and used to make rubber.
servente	Person in charge of cleaning a building.
sevar	To grate (manioc roots).
tabuleiro	Sand bank used by river turtles to nest.
tartaruga-da- amazônia	<i>Podocnemis expansa</i> . The largest of the South American river turtles, some reaching as much as 90 cm in length. Adults lay eggs once a year, in groups.
tento	<i>Ormosia</i> sp.. Tree explored for timber. The wood is medium weight, moderately resistant to mechanical stress and xylophagous organisms, and used in furniture and house construction (CIRAD 2012 ^d).
terçado	Machete.
terra preta	Dark earth. Dark, highly fertile, anthropogenic type of soil.

território	Territory.
título da terra	Land title.
tracajá	<i>Podocnemis unifilis</i> . Yellow-spotted river turtle. Adults lay eggs twice (or more times) a year, usually individually.
trado	Manual drilling tool.
tucumã	<i>Astrocaryum</i> sp.. Palm with spiny stems, either growing as a solitary stem or in clusters of several stems (according to the species). It is fire resistant and produces an edible fruit, rich in fats and vitamin A (Cymeris 2005, p. 212; Costa <i>et al.</i> 2005, p. 218).
tucunaré	<i>Cichla</i> sp.. Freshwater carnivorous fish, with an eye-shaped spot on the tail.
unidade de conservação	Area defined as a “territory [...] with relevant natural characteristics, [...] conservation objectives and defined limits [...]” ⁴ . It is the only type of <i>área protegida</i> that has been classified by the government according to the International Union for Conservation of Nature (IUCN) typology of protected areas (IUCN 2014).
uso sustentável	Sustainable use. Type of protected area in Brazil in which direct uses of natural resources that are seen as compatible with conservation are allowed. See also <i>proteção integral</i> .
uxi	<i>Endopleura uchi</i> . Tree reaching 25 to 30 m of height (Shanley & Carvalho 2005, p. 147), producing an edible fruit.
verão	Summer. The drier and hotter season, from July to December. See also <i>inverno</i> .
vila operária	Company town.
voadeira	Aluminium boat propelled by an outboard motor.
zagaia	Wooden spear ending in a metal trident with barbed prongs.
zona populacional	“Population zone”. One of the zones of a protected area, established in its management plan, which includes the “spaces and land uses necessary to the reproduction of the way of life” of resident traditional peoples. Its general objective is to “reconcile the conservation of natural resources with the needs of those populations” (ICMBio 2009, p. 35-36).

⁴ *Lei Federal* 9985, 18 July 2000. *Institui o Sistema Nacional de Unidades de Conservação da Natureza*

CHAPTER 1 Introduction

1.1 Overview and rationale

The present study was motivated, in great part, by some difficult questions raised during my first work experience in biodiversity conservation in Brazil. My unease and subsequent curiosity was mainly related to the complex processes underlying local peoples' participation in conservation and development projects. Why did some people choose to participate and others decline? Did participation really make a difference to success? How should organizations interact with local residents to ensure ethical and effective programmes for conservation and development?

From 2006 to 2009, I was part of the staff of a protected area⁵ (PA) in the Brazilian Amazon and worked mainly with the rural communities living within its boundaries. That was to me a very unfamiliar part of my home country, and it was the first time I came into direct contact with that biome and with rural communities. After an initial period of getting to know people and their ways, I took part in two interventions that were relevant to the design of the present research. The first involved attempts to promote agroforestry or, more generally, the diversification of plant species in local farming systems. A few training sessions were conducted, but take up, or participation, was very low. In the second intervention, the construction of the headquarters for the local association and a community boat was facilitated. In that case, on the other hand, various households actively took part in the activities. It was my interest in the factors that lay behind that contrast and, particularly, my interest in

⁵ The term will be used in this work to refer to *unidades de conservação* or “conservation units”. Those areas are defined as “territories [...] with relevant natural characteristics, [...] conservation objectives and defined limits [...]” (*Lei Federal* 9985, 18 July 2000) and are the only ones that have been classified by the government according to the International Union for Conservation of Nature (IUCN) typology of protected areas (IUCN 2014). In Brazil, the term *áreas protegidas* frequently implies a broader understanding, including also other areas considered of conservation value such as indian territories and river margins (e.g., Medeiros 2006, pp. 49, 55, 59).

agroforestry and its potential – although not guaranteed – for positive social and environmental outcomes that shaped the present study.

Agroforestry has been defined as “an approach of integrated land use that involves deliberate retention or admixture of trees and other woody perennials in crop/animal production fields to benefit from the resultant ecological and economical interactions” (Nair 1985, p. 18). Departing from my personal experience and taking a broader perspective, it can be said that agroforestry is widely promoted nowadays in protected areas as a tool for reconciling livelihood and conservation concerns, but often with insufficient analysis of exactly what role it may play, either in terms of local people’s well being or in terms of biodiversity conservation (Russell *et al.* 2010, p. 454).

In fact, agroforestry systems around the world show that multiple species configurations are possible; some of them exhibit high levels of structural complexity and high agrobiodiversity. Those, in particular, can act as farming systems adaptable to local households’ needs and resilient to climatic and price fluctuations on the one hand, and as biological corridors and buffers reducing pressure to a PAs’ core zone on the other (Altieri 2002; Bhagwat *et al.* 2008; among others). However, the achievement of those social and environmental benefits in agroforestry extension⁶ efforts can be hindered by interconnected issues such as: over-optimism about agroforestry and its potential to contribute directly and indirectly to conservation, lack of participation of the intended beneficiaries, and constraints in local livelihood portfolios and markets.

In an effort to justify the promotion of agroforestry, discourses of institutions dealing with conservation on the ground frequently propose agroforestry as an alternative to ‘shifting agriculture’ (*sensu* Conklin 1954; *a.k.a.* shifting cultivation, rotational agriculture, swidden cultivation, slash and burn). It is implied that the former will always be a solution for both social and environmental issues and

⁶ I adopt in this thesis the broad definition of ‘extension’ proposed by Oakley and Garforth (1985): informal educational process directed toward the rural population.

that the latter will always be environmentally destructive, despite the accumulation over the last 60 years of substantial evidence to the contrary (Sunderlin & Resosudarmo 1996; Siebert & Belsky 2014). Since the 1950s, studies have indicated that agroforestry and shifting agriculture are not as distinct as is often implied (e.g., Conklin 1954; Denevan & Padoch 1987a). It has also long been recognised that agroforestry projects sometimes fail to provide expected livelihood and conservation benefits, for a number of reasons (e.g., Brookfield & Padoch 1994). I would argue therefore that such biased generalisations about shifting cultivation systems and the expected benefits of agroforestry interventions should be identified at the outset, as they can undermine even the most well-intentioned efforts of conservation projects to introduce agroforestry practices in rural areas. This can happen because such biases can cause relevant local practices to be overlooked and inappropriate techniques to be implemented, all of which can reduce the participation of intended beneficiaries and contribute to failure.

Low participation rates are also related to extensionists not considering or addressing appropriately other factors, such as local peoples' livelihoods, interests and perceptions of the promoted practices, as well as their past experiences with development and power relations within communities. The literature on the adoption of agricultural innovations (e.g., Pattanayak *et al.* 2003 and Mercer 2004) and on participation in development (e.g., Cleaver 2001; Vincent 2004) has extensively explored the relevance of those multiple factors on local people's participation. However, the contributions of those two fields of study have rarely been considered concomitantly.

Promises of positive social and environmental outcomes following local peoples' participation in agroforestry projects remain largely unfulfilled (e.g., Millikan *et al.* 2002). First, accessing markets for agroforestry products may prove challenging, particularly in remote areas. Second, cultural and economic factors may hinder the substitution of livelihood activities viewed as environmentally unfriendly. Those issues are still underexplored in the recent literature on agroforestry's contribution to local livelihoods, as are the indirect effects of that contribution on conservation in terms of reducing pressure on adjacent areas'

resources (e.g., Murniati *et al.* 2001; Browder *et al.* 2005; Essa *et al.* 2011; Hoch *et al.* 2012).

1.1.1 Aim and objectives

The issues examined above will be explored in this thesis through a case study at Saracá-Taquera National Forest and Rio Trombetas Biological Reserve. The two federal PAs are contiguous and lie in the Brazilian Amazon, relatively isolated from major road networks. With the creation of the PAs, conflicts have emerged between PA staff and local communities over the use of natural resources.

Based on that case study, this thesis aims to explore the role of agroforestry as a tool for protected areas' conservation. It focuses on the agroforestry extension activities carried out from 2010 to 2011 by Federal University of the Southeast (UFSE)⁷ among communities located within or nearby the two PAs. The study's objectives were to:

- a) Document the extension process: what practices had been/were being promoted, how had this been done, what were the outcomes in terms of local people's participation;
- b) Explore the perspectives and motivations of the actors involved (local households, extensionists, PA managers), with particular emphasis on perceived links to protected areas' conservation;
- c) Based on the above, identify and analyse the different factors that influence local people's participation;
- d) Examine the potential contribution of agroforestry to local livelihoods;
- e) Analyse the potential direct and indirect values of agroforestry to protected areas' conservation.

⁷ Fictitious name.

The specific objectives of this research, which build upon the previous general objectives, were to:

- a1) Document all phases of extension process and investigate, in this process, the role of extensionists and how locals are involved;
- a2) Document who had participated and who had not;
- b1) Explore external actors' explanations for their own decisions and for those of local people', and perspectives about agroforestry's ecological and socio-economic significance, particularly in the context of PA conservation;
- b2) Explore local people's: explanations for their decisions; objectives and aspirations; perceptions of local institutions and of past experiences with external actors; views on the agroforestry extension process;
- c1) Analyse the influence on participation of household-level, community-level and extension-related factors.
- d1) Examine whether and the extent to which agroforestry may contribute to local livelihoods mainly in terms of income generation.
- e1) Analyse whether and how external actors perceive a potential direct value of agroforestry to conservation, as a land use that, arguably, contributes to forest cover conservation, particularly within PAs.
- e2) Analyse whether and how local people's views indicate a potential indirect contribution of agroforestry to biodiversity conservation, as a land use that could alleviate pressure on PAs' wild resources by means of its contribution to reducing activities perceived as threats.

1.1.2 Thesis' overall framework

The broad theme of agroforestry's role as a tool for PA conservation can be decomposed into different sets of factors. Those sets of factors are explored in this thesis in turn and include: extensionists' discourses on agroforestry's conservation outcomes, local people's participation, and agroforestry's potential livelihood and conservation outcomes.

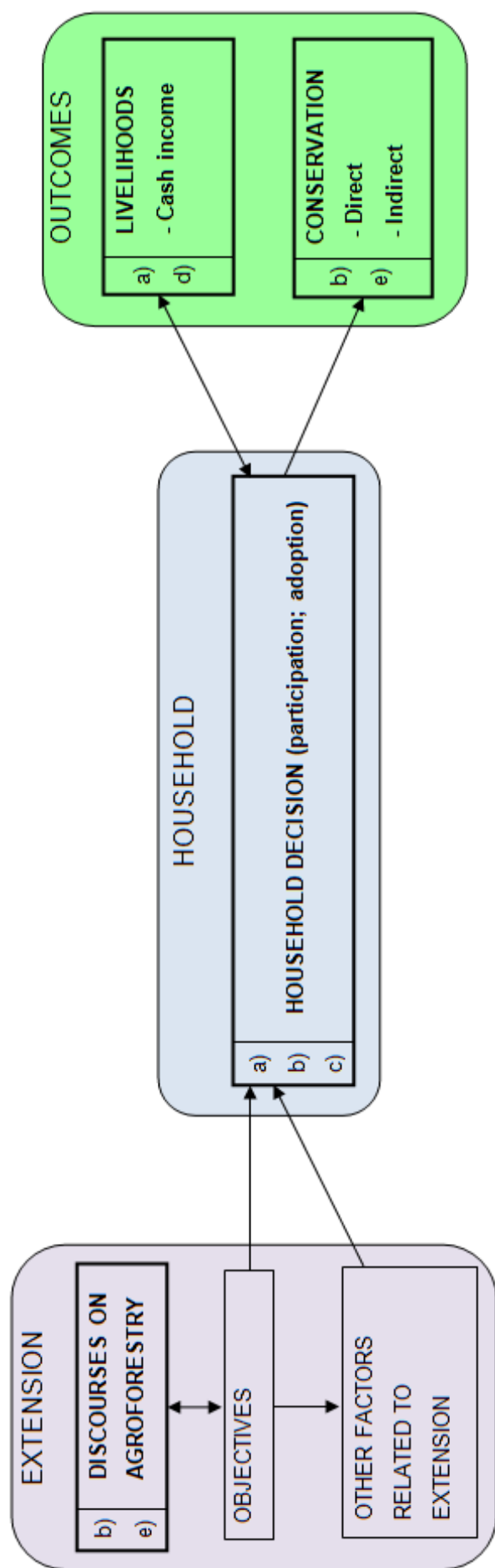


Figure 1.1 Thesis' general framework showing the relationship among the different sets of factors explored for their relevance in terms of agroforestry's role in PA conservation.

Each of the main elements of the framework (in bold) corresponds to an objective of the present research and is lettered accordingly.

Figure 1.1 shows the framework used in this study to represent how those issues are interrelated. The main elements of the framework appear in bold; each corresponds to an objective of the present research and is lettered accordingly. First, the manner in which agroforestry is represented in extensionists' discourses influences the design of the extension program and the definition of its objectives and vice-versa; for instance, an extension program can be designed to suit funding requirements and this can dictate how supporting discourses are to be crafted. As a result, expected conservation outcomes can be framed in an overoptimistic and unrealistic way, as they fail to consider relevant literature and empirical evidence.

Second, households can respond to the stated objectives directly or to aspects of the extension approach that are consistent with those objectives. For example, the extent to which conservation outcomes are emphasised at the expense of livelihood ones in extensionists' discourses can affect households' decision to participate in the extension program or to adopt the recommended practices. Their decision-making process can also be influenced by other sets of factors relevant at the household and community levels (this part of the general framework will be discussed in detail in subsection 1.4.3).

Finally, both livelihood and conservation outcomes can follow households' participation. The former is likely to have a feedback effect either by hindering or driving the continuity of participation over the longer term. The latter, on the other hand, depends on that continuity. Outcomes in both respects are influenced by the species composition of the agroforestry areas implemented. For instance, certain agroforestry secondary species can act as important sources of income (e.g., Lehébel-Péron *et al.* 2011; Rice 2011). Moreover, it has been argued that agroforestry areas, particularly those with higher end levels of native plant diversity, can make a relevant contribution in terms of in-situ biodiversity conservation and connectivity enhancement (Schroth *et al.* 2004a; Bhagwat *et al.* 2008). The last two can be considered *direct* conservation outcomes as they derive directly from agroforestry's biophysical characteristics. Conservation outcomes can also include indirect aspects such

as the alleviation of pressure on wild resources through the substitution of agroforestry for livelihood activities posing threats (Murniati *et al.* 2001). Protected areas can benefit in cases where agroforestry is practiced within those areas, in their buffer zone or along corridors linking disconnected ones.

In the next three sections, I review the literature pertinent to three of the main themes pervading this study: contested meanings of agroforestry and shifting agriculture, the role of agroforestry in PA conservation, and local people's participation in agroforestry extension efforts. In the last section, I present an outline of the present thesis' chapters.

1.2 Agroforestry and shifting agriculture under dispute – conceptualisations and links with deforestation

Shifting cultivation has historically been widely condemned as one of the major drivers of deforestation, whereas agroforestry has been unquestioningly promoted as a solution to the conflict between agricultural production and forest conservation. In this section, I explore how those contrasting discourses have evolved based on the analysis of policy documents. I then turn to alternative perspectives which question the portrayal of the two land use systems as distinct and challenge the supposed link between shifting cultivation and deforestation. Finally, I discuss how the historical context may have contributed to shape policy discourses.

1.2.1 Agroforestry versus shifting agriculture in policy discourses

Agroforestry has been promoted in international and national policy as part of strategies aimed at enhancing food production, conserving biodiversity and reducing deforestation. On the other hand, different forms of shifting agriculture have been portrayed as important contributors to deforestation. Two forms of the latter are distinguished: the one practiced by local people in remote areas and the one carried out by migrants in forest margins. The few analyses of the place of those two land uses in policy discourses focusing on Latin America tend to exclude the post-military period; the present thesis adds to that underexplored niche.

At the international level, signs of the incorporation of agroforestry into the agenda of development agencies began to appear in the 1970s – for example, in the forestry policy of the World Bank and the Food and Agriculture Organisation of the United Nations (FAO) (King 1989). The former’s social forestry programme was “designed to assist the peasant [...] to increase food production and to conserve the environment” and the latter’s policies “emphasised [...] the beneficial effects of trees and forests on food and agricultural production” (King 1989, p. 7-8). It was also in the 1970s that the World Agroforestry Centre (then known as the International Centre for Research in Agroforestry or ICRAF) was established, following a recommendation derived from an assessment of the interdependence of forestry and agriculture in low-income⁸ tropical countries. It developed a programme “which would support, plan and co-ordinate, on a world-wide basis, research in combined land-management systems of agriculture and forestry” (King 1989, p. 8-9). Agroforestry also features in World Bank and FAO’s more recent policy documents, where conservation and livelihood concerns are again stressed, but now in the context of climate change. In the World Bank’s agriculture action plan for 2013-2015, agroforestry is highlighted as one of the institution’s targets for support as it increases productivity, carbon storage in farmland and resilience to climate change, enhances biodiversity, and can reduce forest degradation by reducing dependence on natural forests (The World Bank Group 2013, pp. 26, 51-52). In FAO’s forestry strategy, the implementation of agroforestry is mentioned as one of the indicators under the strategic objective encompassing the conservation of forest biodiversity, climate change mitigation and adaptation, and rehabilitation of degraded lands (FAO 2010, pp. 6-7).

Building on its promotion in development, agroforestry has become an increasingly common and positively viewed element of PA conservation. Agroforestry features in relevant environmental policy documents, products of the landmark 1992 Rio Earth Summit⁹. In Agenda 21, an action plan adopted

⁸ In this study, the term ‘income’ will be used to refer specifically to ‘cash income’.

⁹ United Nations Conference on Environment and Development (UNCED) held in Rio de Janeiro, Brazil in 1992.

globally at that event, agroforestry is explicitly portrayed as a sustainable activity that contributes to biodiversity conservation (United Nations Division for Sustainable Development 1992, chapter 15). In the policy of the Global Environmental Facility (GEF) – a financial mechanism of the United Nations (UN) Convention on Biological Diversity (CBD), one of the three conventions also adopted at that event – agroforestry is recommended as part of a strategy to address land degradation and, specifically, deforestation and desertification (GEF 2011, p. 57-58). In the specific context of PA conservation, explicit references to agroforestry are apparently rare in international environmental policy.

Brazilian national policy has reflected that international scenario. Since the mid-1990s, international funds have been allocated to agroforestry as part of large scale initiatives of the Brazilian government aimed at the conservation of the Amazon Forests, such as the National Fund for the Environment (FNMA), the Demonstration Projects Subprogram of the Pilot Program to Conserve the Brazilian Rain Forest (PPG7/PDA), the Protected Areas of the Amazon Program (ARPA) and the Amazon Fund. Populations living within the limits or in the buffer zone of PAs were specifically targeted by some of the agroforestry projects under those programs. In Amazon Fund's guidelines for funding proposals (Eringhaus 2012, p. 90), agroforestry is portrayed as an alternative to deforestation and as a way to recover degraded areas, and PAs are mentioned as one of the priority areas to be supported. Since at least the 2000s, the promotion of agroforestry came to be explicitly recommended in national environmental policy documents as a sustainable activity in the context of deforestation and carbon emissions reduction and biodiversity conservation (Grupo Permanente de Trabalho Interministerial 2004, p. 18; Dias 2006, p. 21¹⁰).

¹⁰ These documents present governmental action plans for the implementation of the national policy on biodiversity (PANBio) and for the prevention and control of the deforestation in the Legal Amazon (PPCDAm). PPCDAm was incorporated to the National Policy on Climate Change (PNMC) in 2008.

At a more local level, agroforestry has been mentioned in management plans of certain Amazon PAs in the 1990s and 2000s (e.g., Imaflora 1996; Cordeiro 2004, p. 60; Curtis-Júnior 2006, p. 61). The activity is included as part of strategies aimed at recovering degraded areas.

Discourses on shifting agriculture follow quite a contrasting pattern. Evidence of explicit reference to that activity in policy documents prior to the 1990s is scarce. However, some works have examined how government officials have enforced bans on the practice of shifting agriculture by local people, following the implementation of PAs both at the international and national levels (e.g., Dressler 2006, Diegues 2011). In the 1990s, shifting agriculture features in international environmental policy. In the “Combating deforestation” chapter of Agenda 21, it is recommended that governments “halt destructive shifting cultivation”, recognising that not all cases are destructive. With the explicit objective of addressing that recommendation, the “Alternatives to slash-and-burn” (ASB) consortium was established in the same year. An ASB report explicitly contrasts shifting agriculture practices carried out by indigenous peoples, viewed as benign, to those conducted by migrant small farmers in areas with high rates of deforestation, and argues that the consortium target the latter (Palm *et al.* 2005, pp. 5, 9). The former are pictured as “knowledge-intensive”, comprising “short cropping periods” and “long secondary forest fallow periods”, and as commonly practiced by “communities disconnected from the national economy”, while the latter is portrayed as more destructive due to a lack of familiarity with the humid tropics and the use of “short-term fallows or no fallow at all”.

Hecht (1985, p. 673) constitutes one of the few works that explores Brazilian government discourses on shifting agriculture during colonisation of the Amazon. According to the author, in the 1970s, migrant settlers were portrayed as the drivers of predatory occupation, soil exhaustion and deforestation. From the 2000s on, evidence of references to “slash-and-burn” practices in national policy documents are more common. In those documents, the distinction between practices conducted by locals and by migrants is not as clear as at the international level. In the 2000s, the Brazilian government set forth a national

strategy to address deforestation: the “Action plan for the prevention and control of deforestation in the Legal Amazon” (PPCDAm) (Grupo Permanente 2004). In that document, the use of fire in agricultural activities is considered to contribute to forest fires and to the expansion of deforestation. One of the Plan’s expected impacts is a “strong increase in the adoption of fire prevention and control practices” (Grupo Permanente 2009). It was in that context that, also in the 2000s, the component “Alternatives to deforestation and burning project” (PADEQ) was launched within PPG7/PDA. In documents setting guidelines for funding proposals (PADEQ 2005, p. 8; PADEQ 2013, p. 4), it is stated that “projects are to propose activities that: eliminate or reduce significantly the use of fire in the process of agriculture production; promote the recovery of areas, inhibiting the clearance of new areas” in the Amazon region. In both PPCDAm and PADEQ documents, it is recognised that Amazon deforestation and burning is concentrated in a “deforestation arc”, located along the forest margins. However, it does not make explicit which fire-using activities exactly are to be targeted – whether large or small scale ones. It is not made clear either whether initiatives should focus on the deforestation arc area, or on local peoples living in more remote areas.

At a more local level, PA management plans are also ambiguous. When setting priority actions aimed at the recovery of degraded areas, some of those documents are unclear about whether shifting agriculture and/or cattle raising are to be targeted (Cordeiro 2004, p. 60; Curtis-Júnior 2006, p. 61).

1.2.2 Alternative perspectives

Contrary to what is implied in the opposing discourses explored in the previous subsection, both shifting agriculture and agroforestry comprise a wide spectrum of land uses. Rather than representing clearly distinct categories, both share an area of overlap. In addition to that conceptual issue, some authors have contested the depiction of shifting cultivation as a major driver of deforestation and proposed counternarratives.

1.2.2.1 Conceptual overlap – swidden fallow agroforestry

Conklin (1954), Posey (1985) and Denevan and Padoch (1987a) focused on examples of swidden-fallow agroforestry, an area of overlap between shifting agriculture and agroforestry. Fallows are managed rather than simply abandoned in that system, at times involving “both purposeful and unintended human manipulation (...) of both wild and domesticated or semi-domesticated” species by “protecting useful plants from the original forest or invaders in the swiddens or fallows, weeding (...) undesirable species, shade/sun light control, plantings in the original field or in the fallow, transplanting and sometimes fertilisation” (Denevan 2001, p. 84).

Conklin (1954) can be considered one of the pioneer studies that recognised, in shifting agriculture, a land use system that could today be labelled as ‘agroforestry’ – a term to be coined only a couple of decades later by Bene *et al.* (1977), according to Torquebiau (2000). Conklin’s (1954) analysis of the Yagaw Hanunóo people of the Philippines revealed the use of practices like the sowing of the main crop (rice) together with other species as a mixture of seeds, the planting of some dry season crops in the main swiddens a few weeks before rice harvest, and the interplanting, between the grain staples, of fruit trees which continue to provide food for some years if systematically weeded and cleaned.

The works derived from the ‘Bora Agroforestry Project’ in Peru and the ‘Kayapó Project’ in Brazil began in the 1980s, filling a gap in research on the Amazon region. They contributed greatly to our understanding of the use and management of fallow plant diversity, due to their long term approach and the multidisciplinary character of the research team involved.

Posey (1985) describes some of the findings of the Kayapó Project. It was observed that the practice of tree planting and transplanting was conducted by the Kayapó in many different habitat types, which was considered by the author as evidence of remarkable ecological knowledge. Among those habitat types were swidden fields, fallows, forest fields, trail sides, forest openings and house gardens. The author stresses that the swidden fields were not abandoned after

the peak production of main domesticated crops in the second and third year after clearing, but instead were consistently revisited for other plants that were productive throughout the fallow stage. These plants would include both planted ones and ones emerging as part of the natural succession process¹¹.

Denevan and Padoch (1987a) present some of the outcomes of the Bora Agroforestry Project. While the focus of Posey's (1985) discussion was on Kayapó's knowledge (recognition, classification) about plant ecological requirements and about the different vegetation types and successional stages, Denevan and Padoch (1987a) concentrated their efforts on fallows and carried out a more systematic approach in the botanical data collection (using a control area and specific collection methods of transect and quadrant). Among the conclusions reached is that the younger fallows evidenced more variety and quantity of useful plants and were objects of higher management effort per useful plant than older ones, varying in a continuum in the examined fallows aged three to 35 years (Padoch and Denevan 1987, pp. 97-98). They observed a "shift in management strategy, from entire zones in the younger fallows to a few productive fruit species and a greater potential use of construction materials and fuel in older fallows" (Padoch and Denevan 1987, p. 98). This would corroborate the initial hypothesis that "Indian fields are only gradually given up to forest regrowth and not suddenly abandoned" (Denevan & Padoch 1987b, p.1).

¹¹ One particular finding of Posey (1985, 1989) has been a matter of controversy: the *apêté*, or tropical forest patches in the *campo cerrado* (Brazilian savanna). While for Posey (1985) they are a result of the Kayapó active intervention through fertilising and transplanting, for Parker (1992, 1993) their plant composition would be in fact of natural origin. Parker (1992, 1993) argued that: a) *apêté* and unmanaged forest did not differ significantly and b) informants denied that any planting was carried out in the *apêté*, contradicting the information obtained from them by Posey (1985). In a reply to that, Posey (1992) claim the control site used by Parker was in fact a managed area and questioned the reliability of the information gathered by Parker from the informants based on the assumption that concepts like 'management' and 'planting' are not easily articulated, and so no detection doesn't necessarily mean non-existence. That discussion illustrates the difficulties and complexity involved in the study of indigenous management practices and suggests the need of further studies to clarify the dispute.

In fact, swidden-fallow agroforestry represents only part of a huge range of agroforestry and shifting cultivation practices. According to the 30-type classification of aboriginal agricultural fields in South America proposed by Denevan (2001; p. 15-16, 68-70), shifting or swidden agriculture can be defined as “the rotation of few years of cropping with usually a moderate to long period of forest or bush fallow” and agroforestry, as “the combination of annual crops with perennial tree crops and/or natural vegetation”. However, there is no “typical” shifting agriculture or agroforestry.

The wide range of variation in shifting agriculture practices can be seen in the: use or non-use of fire in field preparation, field architecture (layering, zonation, intercropping, spacing), cropping cycle (one to 15 years of cultivation followed by fallows lasting from eight to 70 years, or even indefinitely, in the case of non-cyclical migrant/nomadic people) (Denevan 2001, p. 66-67), as well in the use or non-use of irrigation, tillage or drainage (Brookfield & Padoch 1994, p. 10). Klappa (2005, p. 49-51, 54) describes some practices that would be less variable such as: the plot size (rarely larger than 1ha), the sequence of events involved in plot preparation and the heavier reliance on vegecrops (e.g., tubers) rather than seed crops (e.g., grains).

As can be noted with ‘shifting agriculture’, the term ‘agroforestry’ is also used to refer to a wide range of diverse systems. According to Egg (1994) and Nair (1985) they vary in terms of:

- the system’s composition (e.g., number of species; type of species, according to which they can be classified as agrisilviculture, silvopastoral and agrosilvopastoral systems);
- its temporal (e.g., different levels of overlapping and dominance among species) and spatial (e.g., the tree component can: be dense or sparse; be concentrated in zones, strips, boundaries; form different numbers of vertical layers) arrangement;

- the role of the main output and other components (e.g., satisfaction of farmer's basic and/or cash needs, protection of soil);
- the more or less specific geographic region where they are found or are suitable to (e.g., tropical highlands);
- the management practices involved (e.g., selective tree cutting during field preparation, sowing, planting, transplanting, coppicing, selective weeding).

Besides the variation of the practices involved in shifting agriculture and agroforestry, there is also variation in the relative importance given to those two systems within the subsistence¹² and marketing strategies adopted by farmers of a given ethnic group or region. That variation in their relative importance can be seen in the context of farmers' diverse land use systems, or in the wider context of farmers' livelihoods¹³ (as will be further discussed in subsection 1.3.2.1). Brookfield and Padoch (1994, p.10) remind us that "many cultivators who rotate some of their fields also practice permanent cultivation on part of their land". Studies have observed a diversity of practices within and between households associated with their land use systems, concerning the management of crops, land, water and biota as a whole (e.g., Padoch & de Jong 1992). That represents one of the aspects of agrodiversity, as discussed by Brookfield (2002, p. 9-10). The other three aspects of this concept, according to that author, would be agrobiodiversity (agricultural biodiversity or the biodiversity maintained by the farmer *in situ* on farm), biophysical diversity ("natural diversity of the physical environment") and organisational diversity ("socioeconomic aspects" or "the manner in which farmers and communities organise the use and allocation of their resources and also their workforce"). The fundamental role of the two first aspects – diversity of management

¹² In this study, the term 'subsistence' will be used in opposition to monetary needs and activities aimed at the market. 'Subsistence' will relate not only to the very minimum needed for physical survival, but also to other non-monetary needs.

¹³ Livelihoods would include not only agriculture, but all other activities and sources of income that determine the living gained by an individual or household (according to 'livelihood' concept of Ellis (2000))

practices and agrobiodiversity – in shaping agroforestry's outcomes will be discussed in subsection 1.3.2.1.

1.2.2.2 Links with deforestation

Some studies have questioned the association of specific types of shifting cultivation with deforestation in international and national policy.

At the international level, a meta-analysis of 152 cases of tropical deforestation in Africa, Asia and Latin America (Geist & Lambin 2001, pp. 85-86) challenges the notion that shifting cultivators are the main agents responsible for forest losses. The study suggests that expansion of agricultural land accounted for nearly all (96%) cases analysed. However, permanent cultivation (48%) and cattle ranching (46%) were found to slightly outweigh cases in which shifting cultivation was reported to be an activity associated with deforestation (41%). Further, shifting cultivation was shown to concomitantly occur with other, competing agricultural activities and other causes such as wood extraction and expansion of infrastructure, rather than alone.

At the sub-national level, authors have criticised the portrayal of deforestation as a problem, the depiction of shifting cultivation as one of its main drivers and the failure to acknowledge the role of more relevant drivers. Firstly, Fairhead and Leach (1995) and Kull (2000) suggest that African policy discourses depicting a dramatic and widespread forest loss driven by shifting cultivation have misread the region's forest cover history. According to the authors, the policy adoption of forest dominated landscapes as baselines has overlooked evidence indicating that grasslands and savannas represented an important – and in some cases, the main – component of past landscapes. From that alternative point of view, it has been argued that in Madagascar, forest cover reduction was restricted to certain regions rather than country-wide and that in Guinea, forest patches were expanded, rather than reduced.

Secondly, contrary to what is implied by Indonesian government policy about Outer Islands shifting cultivators' role in deforestation, Dove (1983) argues that: (a) only a minority of them are truly nomadic or seminomadic, (b) they commonly take conservation measures to avoid Imperata grassland succession, (c) grasslands are a transitional stage in ecosystemic succession prolonged by farmers, rather than a climatic or edaphic climax or an unwanted product. Evidence presented by the author includes: old village settlement and low ratio of primary to secondary forest clearance; measures which involve avoiding clearance of very young fallows and planting trees or bushes in those areas; and the ability of grasslands to restore soil fertility and, in the absence of burning, spontaneously succeed back to forest, and its susceptibility to hoe or plough systems adopted at medium population-land ratios.

Thirdly, Dressler (2006, p. 416-417) suggests that discourses denigrating shifting cultivation have been used to favour more powerful actors as part of government environmental and development policies in the Philippines. The author presents two contrasting measures taken towards the shifting agriculture practised by the indigenous Tagbanua and the paddy rice cultivation carried out by recent migrants – both of which would be initially engulfed by park boundaries – and discusses the motivations underlying them. According to him, “the Regional Director of Forestry tried to resolve the boundary dispute by ‘zoning around’ the farmers’ plots to maintain the ‘economic contribution’ of paddy rice cultivation”, labelled as “modern and productive”. He adds that “no such allowances were made for Tagbanua”, depicted as “primitive and unproductive”.

Regarding the Brazilian Amazon region in particular, Collins (1986) argues that there is little evidence that small colonists surpassed legal limits of deforestation and that such claims came from large landowners interested in their lands. Various studies indicate that the ultimate driver of deforestation in the Amazon has been pasture formation rather than shifting cultivation in itself (e.g., Browder 1988, p. 251; Fujisaka *et al.* 1996). The first study discusses deforestation at the biome level and attributes 72% of the 1980 deforestation to cattle, whereas 10%, to shifting cultivation. The second study examines household level

mechanisms in two settlements and indicates that conversion to pasture after annual cropping (for cattle raising or land speculation purposes) is more common than allowing fallow regeneration, which inevitably pushes annual cropping to old growth forest¹⁴ areas. While cattle ranching continues to be pointed out as by far the main driver to deforestation in the region, soy plantations have been identified as an also important and more recent driver (e.g., Rivero & Seisdedos 2010, p. 62, 65).

1.2.3 Policy discourses' historical context

Following the examination of how agroforestry and shifting agriculture have been contrastingly portrayed in environmental policy at international and national levels and of alternative perspectives questioning that portrayal, I will now turn to the wider political and economic contexts that contributed to shape policy discourses. Particularly relevant are the adoption of no-take PAs as a conservation model, the momentum reached by the environmental movement and by concerns with deforestation, and the option for cattle ranching in government development strategies for the Amazon.

In this subsection, the approach I take is based on discourse analysis. According to Hajer & Versteeg (2005, p. 175), “discourse analysis sets out to trace a particular linguistic regularity that can be found in discussions or debates”. In discourse analysis, it is assumed that there are multiple, socially constructed realities, meanings and ways in which society makes sense of environmental phenomena. Concepts would be contested in a struggle about their meaning, interpretation and implementation (Hajer & Versteeg 2005, p. 176). According to Hajer (1995, p. 15) “policy making can be analysed as a set of practices that are meant to process fragmented and contradictory statements to be able to create the sort of problems that institutions can handle and for which solutions can be found”. Therefore, in order to illuminate biases in policy

¹⁴ ‘Old growth forests’ are defined, in this study, as those that have experienced little to no recent human disturbance. That is the definition adopted by Gibson *et al.* (2011) for ‘primary forests’. I prefer to use the first term in that context, as the second one frequently implies pristiness or no disturbance at all.

discourses, I will now examine the social context in which problems are defined, what actors contribute to define the problem, and what is included or left undiscussed and why.

The creation of Yellowstone Park in the late XIX century is frequently mentioned as a landmark in the construction of a PA model that has been widely replicated throughout the world (e.g., Adams & Hutton 2007; Kalamandeen & Gillson 2007, p. 167). According to that model, PAs were to be conserved as pristine areas. For that purpose, countless local peoples have been resettled and their local practices, including shifting agriculture, been banned. That model was adopted in Brazil during the military regime, in the context of the Amazon colonisation programs initiated in the 1970s. The idea of a demographic void was widely promoted, which contributed to the invisibility of Amazon local peoples and their practices and justified the strategy combining the expansion of the agricultural frontier towards the region and the implementation of no-take PAs. The implementation of PAs by that regime is seen as a strategy to counterbalance the Amazon Forest destruction driven by settlers' farming activities (Diegues 2000, p. 5). In government discourses, that causal connection between forest destruction and small-scale settlers' shifting cultivation practices was made explicit – the argument was used to justify the shift of government support from small-scale settlers to large-scale ranchers (Hecht 1985, p. 673). Therefore, in the discourses surrounding the Amazon colonisation process, it was implied that shifting cultivation practiced both by local populations and by migrant settlers represented an obstacle to conservation.

The 1980s and 1990s represent important turning points for the narratives on shifting agriculture and agroforestry. The 1980s was a period when many ex-colonies, including Brazil, were initiating democratisation processes after undergoing military dictatorships. Diegues (2000, p. 6) suggests that it was in that context that people living inside PAs have mounted spontaneous and increasingly organised resistance against resettlement. Since that decade, the importance of local peoples' practices to PA conservation has been increasingly recognised in conferences and documents sponsored by International Union for

Conservation of Nature (IUCN), the reference international institution when it comes to PAs conservation (Diegues 1993, p. 19-25). The up to then widespread practice of evicting local populations for the implementation of no-take PAs came to be less and less acceptable, at least in policy documents. It was probably influenced by those undertakings that shifting agriculture practiced by local populations came to be considered benign in some narratives.

The 1990s oversaw the momentum gained by the international environmental movement and, particularly, by concerns towards deforestation in tropical countries. It was in that decade that the United Nations Conference on Environment and Development (UNCED) was held, where several of the most influential international environmental agreements were framed (Newing 2009, p. 175). That was also when migrant settlers at the forest margins, who had been the target of detractive narratives at the national level since at least the 1970s, came to be more explicitly considered an important driver of deforestation also at the international level. In that decade, on the other hand, positive narratives on agroforestry were strengthened and supported its increasing promotion in government initiatives as a tool to recover areas degraded by slash-and-burn practices and as an alternative to those practices in the international and national levels.

The focus on activities such as settlers' shifting agriculture diverts the attention from the argument (e.g., Geist & Lambin 2002, pp. 145-147) that market forces and government policies favouring other activities such as commercial wood extraction and cattle ranching compose the set of actual major drivers of deforestation in many tropical countries¹⁵. At the national level, I would argue that the long history of allegiance between the cattle sector and government policy makers identified by Hecht (1993, p.690) have contributed to a lack of proper acknowledgement of its major role in Amazon deforestation in the past and to ambiguous policies regarding deforestation in present days.

¹⁵ Government policies identified as relevant by those authors also include infrastructure projects, particularly road construction.

From the government's perspective, the maintenance of that allegiance could be explained by the benefits it has been managing to extract from it. In the 1960s and 1970s, federal credit subsidies and tax exemptions offered to ranchers (Hecht 1993, p. 690) were coupled with geopolitical benefits to the military government, related to the occupation and physical control of the territory (Pacheco 2009, p. 496). The government has also extracted economic benefits, particularly in the 2000s and 2010s. The privileged access to credit enjoyed by ranchers (e.g., Amazon Bank/ Banco da Amazônia – BASA 2014, p. 55¹⁶) and the massive acquisition of meat packing companies' shares in the late 2000s and early 2010s by the National Bank of Development (*Banco Nacional de Desenvolvimento* – BNDES 2007, p. 106; 2009, p. 128; 2010, p. 112; 2011, p. 52) was accompanied by generous donations to political campaigns – since the mid-2000s, meat packing companies appear among the top donors (Prazeres 2015).

At least since the 2000s, cattle ranching has been explicitly recognised in national policy as the main driver of Amazon deforestation. However, policies aimed at eliminating the use of fire in agriculture and at recovering lands degraded by fire and pastures with agroforestry serve to mask the fact that the government incentives to cattle ranching continue. Discourses on the role of shifting agriculture manufacture a deforestation problem that can be conveniently addressed with the promotion of alternative activities such as agroforestry, rather than with policies that contribute to make the actual main drivers of deforestation less attractive.

There is clearly a need for a more nuanced examination of the place of different forms of agroforestry in development and conservation. The present thesis will examine agroforestry's potential outcomes in terms of those two interrelated aspects. As outcomes depend on the engagement of potential beneficiaries, this work will also explore the drivers and constraints underlying local peoples'

¹⁶ The livestock sector received the greatest share (18%) of credit resources made available by the Constitutional Fund for the Financing of the North – FNO in 2013.

participation in agroforestry extension projects. The next sections will treat each of these in turn.

1.3 The potential values of agroforestry to conservation

Agroforestry livelihood outcomes are likely to shape local people's decisions concerning its maintenance over time and its place in mixed livelihoods, thus influencing the achievement of conservation aims. Two aspects of agroforestry's potential contribution to conservation can be distinguished:

- a) direct value: positive impacts in terms of in-situ biodiversity conservation and connectivity enhancement between forest fragments, deriving directly from agroforestry's complex structure and high levels of agrobiodiversity.
- b) indirect value: positive impacts in terms of the alleviation of pressure over native biodiversity through the reduction of activities directly responsible for that pressure.

1.3.1 Direct value of agroforestry: agrobiodiversity and connectivity enhancement

Agroforestry systems have the potential to contribute positively to *in-situ* biodiversity conservation and to connectivity enhancement. The extent of those benefits will depend on how closely those systems resemble native ecosystems in terms of species composition, structural complexity and extent of disturbances. PAs could be particularly benefited in cases where agroforestry is practiced within PA zones that allow sustainable uses and along corridors linking distant PAs.

Agroforestry areas can be composed of a combination of exotic and native plant species which have been actively planted or, in the latter case, have grown spontaneously and been spared and managed. That environment can provide suitable habitats for native fauna. Recent reviews have explored the extent to

which that land use resembles biodiversity patterns found in adjacent old growth forest areas. Studies comparing agroforestry areas and neighbouring forest reserves in terms of species composition have found mean similarity¹⁷ values ranging from 25 to 65% across different plant and animal taxa, according to the review conducted by Bhagwat *et al.* (2008, p. 263). In a similar kind of review, Scales and Marsden (2008, p. 165) report that rare and endemic species tend to be among the least represented in those farming systems. Those proportions can be considered limited and be used as arguments in favour of the value of PAs' strictly-protected zones for conservation, particularly for rare and endemic species. Even so, it is argued that agroforestry could still play a complementary role by contributing to conserve native flora and fauna outside PAs (Bhagwat *et al.* 2008), which would also apply to PA's sustainable-use zones¹⁸. The value of agroforestry in that context is highlighted, particularly when compared to monocultures of annual species or other tree-less farming systems.

Those similarity values are also analysed from a wider perspective. At the landscape level, it is said that agroforestry areas may mimic the effect of natural "small-scale high-intensity forest disturbances" (Shankar Raman *et al.* 1998 *apud* Scales and Marsden 2008, p. 164), not causing significant decrease and sometimes even "enhancing biodiversity [...] by creating new habitats" (Kricher and Davis 1992 *apud* Scales and Marsden 2008, p. 164). That would depend, however, on the pattern of disturbance inflicted to forest cover or, in other words, on the size, intensity and spatial distribution of cultivation plots.

Also at the landscape level, it is suggested that agroforestry can enhance gene flow between otherwise isolated populations. The compilation of studies edited by Schroth *et al.* (2004a) and the review conducted by Bhagwat *et al.* (2008) propose that agroforestry areas with high levels of native floral diversity and of

¹⁷ Percentage of the species found in the agroforestry areas that were also found in the neighbouring forest reserve.

¹⁸ I use the term "sustainable-use zone" to refer both to buffer zones, usually defined as areas adjacent to PAs (Martino 2001), and to areas within the PA limits where the use of resources is allowed.

structural complexity can provide suitable habitat for native fauna and act as biological corridors connecting forest fragments and, particularly, PAs. Nevertheless, the former points out that although direct evidence is accumulating, indirect evidence predominates in that respect (Schroth *et al.* 2004b, p. 495). Direct evidence includes works on primate and migratory bird species (Schroth *et al.* 2004b, p. 496; Williams-Guillen *et al.* 2006). Feeding and reproductive behaviour of specific species in agroforestry areas are some of the traits that have been examined (e.g., Williams-Guillen *et al.* 2006; Marsden & Pilgrim 2003).

1.3.2 Indirect value of agroforestry: livelihoods value and the potential to alleviate pressure on wild resources

Agroforestry's direct and indirect conservation outcomes depend on its continued management and local people are unlikely to persist with an activity that does not fulfil their needs. In addition to serving as an incentive for agroforestry being attempted and maintained over the longer term, agroforestry's value for local livelihoods is also related to its indirect value for conservation in a more specific way. In cases where agroforestry is successful in offering an alternative source of forest products and cash income, pressure over wild resources may be alleviated.

1.3.2.1 Potential value of agroforestry for local livelihoods

Agroforestry can potentially contribute to the improvement of local peoples' incomes, to the fulfilment of their various subsistence needs, and to the enhancement of their resiliency. Studies have shown, however, that actual contributions vary across a wide range.

Studies assessing the contribution of agroforestry to local livelihoods have been building up. They have looked at impacts in terms of income generation (Sá *et al.* 1998; Murniati *et al.* 2001; Franke *et al.* 2008; Bisong *et al.* 2009; Feintrenie *et al.* 2010; Jagoret *et al.* 2011; Lehébel-Péron *et al.* 2011; Somboonsuke *et al.* 2011; Hoch *et al.* 2012; Islam *et al.* 2012; Duguma 2013; Tuihedur Rahman *et*

al. 2013) and sometimes also of subsistence use (Essa *et al.* 2011; Rice 2011), assessed the importance of secondary species (Lehébel-Péron *et al.* 2011; Rice 2011) and compared different types of agroforestry (Feintrenie *et al.* 2010; Duguma 2013; Tuihedur Rahman *et al.* 2013) and/or different countries (Rice 2011; Hoch *et al.* 2012). Studies exhibit great variation in their results – agroforestry’s contribution to livelihoods ranges from very limited to very promising. Table 1.1 summarises the main findings of part of those studies regarding agroforestry’s income generation potential. The remainder of those studies (Murniati *et al.* 2001; Essa *et al.* 2011; Somboonsuke *et al.* 2011; Duguma 2013; Tuihedur Rahman *et al.* 2013) explore how agroforestry areas vary in their contribution to income and suggest that climate, agroforestry species composition and diversity, and farming system composition underlie that variation. Those studies have tended to focus on contribution to household overall income; however, few have examined implications in terms of reduction of local inequalities. The present thesis contributes to fill that gap.

Narrowing down to the Brazilian Amazon region, Millikan *et al.* (2002) evaluate the economic outcomes of the Demonstration Projects Subprogram (PDA) of the Pilot Program for the Conservation of Tropical Forests (PPG-7), of which agroforestry systems was a major component (52% of the 195 projects). It is reported that “many projects gave insufficient attention to [...] the insertion of productive activities in the local economy”. Agroforestry projects carried out in the Amazon region are particularly vulnerable to that kind of negligence. Households throughout the region frequently have to cope with distant markets, unpaved roads or no roads at all, lack of an adequate means of transportation and lack of a reliable energy source to power a processing plant. Likewise, Millikan (2002, p. 21) argues that “the most successful projects in PDA have frequently been those that anticipated difficulties in transportation, processing and marketing, and implemented appropriate measures”. Therefore, access to markets should represent a priority concern for agroforestry projects in the region.

Table 1.1 Contribution of agroforestry to household income, according to eight studies.

Study	Country	Agroforestry species	Contribution in terms of income generation ^a
Hoch <i>et al.</i> 2012	Bolivia	Dominated by <i>cupuaçu</i> ^b	Low. Only 15% of the 1,000 participants in an agroforestry project were considered successful regarding commercialisation results by the institution promoting it.
Feintrenie <i>et al.</i> 2010	Indonesia	Dominated by coffee, cocoa, rubber or oil palm	Low. Agroforestry was converted to monoculture plantations in the three study sites. Local perceptions of the limited profitability of the former as one of the main drivers.
Lehébel-Péron <i>et al.</i> 2011	Indonesia	Dominated by rubber	Mixed. Agroforestry is less than half as profitable as rubber monoculture plantations, in terms of net present value at cruising stage. However, while in the latter production lasts only 25 to 30 years, the former produces over more than 50 years.
Bisong <i>et al.</i> 2009	Nigeria	Diversified	Medium. Agroforestry contributed with 28% of the income derived from tree products of 300 households. The remainder income comes from forest lands.
Sá <i>et al.</i> 1998	Brazil	Dominated by <i>cupuaçu</i> ^b ,	High. Agroforestry contributed with 51% of the total income of 50 farms in 2004.
Franke <i>et al.</i> 2008		<i>pupunha</i> ^c , brazil nut & coffee	However, that contribution has declined since 1997, when it corresponded to 74%.
Rice 2011	Cameroon	Dominated by coffee	High. Agroforestry contributed with more than 50% of the total income of 339 farmers. Secondary products correspond to 10% of the income provided by agroforestry.
Jagoret <i>et al.</i> 2011	Guatemala Peru	Dominated by coffee	High. Agroforestry contributed with 75% of the total income of 1,171 farms.
Islam <i>et al.</i> 2012	Bangladesh	Not specified	High. Income from agroforestry was the major contributor to poverty reduction of 99 households participating in an agroforestry project. While 69% of the control group fall below the poverty line, only 36% of the participants do.

^a Relative contributions (low to high) represent estimates, as some results could not be directly compared.

^b *Theobroma grandiflorum*

^c *Bactris gasipaes*

Although studies on agroforestry's importance to local livelihoods have tended to focus on income generation, other facets of that issue have also been explored. A few studies (e.g., Perreault 2005; Freire 2007; Essa *et al.* 2011; Rice 2011) have evaluated the contribution of agroforestry systems with high levels of agrobiodiversity for addressing local people's multiple concerns in terms of nutrition, fuel, cultural identity and social cohesion. Also, there have been some assessments of whether those systems have lived up to expectations and actually enhanced locals' ability to cope with risk, be this risk related to environmental, social or economic factors, be it related to predicted or unpredicted (stochastic) events. Some authors argue that high agrobiodiversity environments often include species or varieties resistant to harsh climate conditions and to pest/disease outbreaks (Altieri & Toledo 2011, pp. 591, 593, 596). Regarding the provision, in those environments, of income alternatives when the main cash crop is off-season or subject to unfavourable price fluctuations, while some have found supporting evidence (Feintrenie *et al.* 2010b, pp. 393-394), others identify the need of long-term studies assessing the matter (Rice 2011, p. 48). The spatial and temporal arrangements of that agrobiodiversity are also examined. Entomological data suggest that mixed plantings with high heterogeneity (rather distinct patches of single species) could pose physical barriers for the spread of pests and diseases and offer the variety of habitats needed for the balance between pests and their predators and parasites (Altieri 1999, p. 202-203). Additionally, it is expected that a system that mimics the natural succession process (by combining fast and slow growing species) could guarantee sources of subsistence and income from the very early stages of the system development. However, even with the inclusion of annual crops, profitability analyses of agroforestry areas in the Amazon indicate that a positive annual net return may be achieved only in the fourth or fifth year, and total investments may be recovered only in the eighth or ninth year (Sá *et al.* 2008^a, Sá *et al.* 2008^b). Those could be considerably anticipated if inputs such as seeds and seedlings are provided cost-free to farmers.

More broadly, farming systems with high agrobiodiversity can potentially be one of the components of "highly diversified rural livelihoods". Rural livelihoods are often based on a diverse portfolio of activities, as "[d]iversification into non-farm

incomes [...] can result in low risk correlation between livelihoods components” (Ellis 2000, p. 14-15, 60-61). Although the concept of livelihood diversification has usually been employed to mean the addition of non-farm income sources, the broader definition proposed by Hussein and Nelson (1998, p. 3), which includes also farm sources such as agroforestry, is adopted here.

The introduction of agroforestry may contribute to livelihood diversification over the longer term if competition with other livelihood activities can be minimised. That would depend on careful consideration of how agroforestry would fit in household’s livelihood portfolio, in terms of potential conflicts in the allocation of limited labour, land and other resources. The analysis of gender roles in mixed livelihoods would be particularly relevant. That is likely to affect how labour investments in agroforestry would be negotiated between men and women and whether potential conflicts could be minimised. Mixed livelihoods, and particularly gender roles, in the agroforestry context are rarely discussed in the literature (e.g., Kiptot & Franzel 2012); the present thesis contributes to strengthen that discussion.

A wider perspective for the analysis of agroforestry’s contribution to rural livelihoods is provided by the literature on forest incomes’ role in that context. According to the review conducted by Angelsen *et al.* (2014, pp. 13-14), that literature has investigated forests’ share within households’ overall income (similar to the studies on agroforestry examined earlier), and suggests a greater dependence on forests among poorer households when compared to wealthier ones. This thesis adds to debates concerning whether this dependence indicates forests’ role as a ‘safety net’ or as a ‘poverty trap’, and whether forests could provide a way out of poverty.

1.3.2.2 Evidence on alleviation of pressure on PAs

Agroforestry can contribute indirectly to conservation by acting as a buffer and reducing pressure on wild resources in general and, more specifically, in PAs’ strictly protected zones. Some works (Murniati *et al.* 2001; Bisong *et al.* 2009; Essa *et al.* 2011) have explored the links between livelihood and environmental

outcomes of agroforestry, and argue that positive impacts on livelihoods can be related to a low dependence of locals on adjacent areas' resources.

It has been pointed out that studies providing concrete evidence of the performance of agroforestry in reducing threats to PAs are scarce (Russel *et al.* 2010, p. 454) – that would also apply to studies on threats to wild resources in general, I would add. Two of those works (Murniati *et al.* 2001; Essa *et al.* 2011) suggest that the extent of agroforestry's impact on the conservation of adjacent areas' resources can be influenced by the composition of farming systems and by the accessibility of those resources. Their main findings are summarised in Table 1.2. Firstly, Murniati *et al.* (2001) argue that agroforestry probably does not provide enough income to buy rice (the local staple food) when this is not planted by the household. This would lead those relying on agroforestry only to be more likely to extract forest resources for income, when compared to those relying on both agroforestry and rice fields. The study highlights the importance of understanding the place of agroforestry in the wider farming system. Secondly, Essa *et al.* (2011) affirm that a higher income provided by agroforestry may contribute to a lower dependence on firewood from natural forests as it increases access to alternatives such as gas and oil. However, their results show that a higher income is not associated with a lower volume of total firewood consumed, but with a greater reliance on agroforestry for that firewood. This indicates that the other factor mentioned by the authors – difficult access to natural stocks of firewood – is a stronger contributor to low pressure on those stocks than higher agroforestry income. Resources that can be easily accessed may require additional measures for their conservation, such as the implementation of economic incentives and the enforcement of restrictions.

The three studies presented in Table 1.2 have focused on the extraction of PAs' plant products such as timber and firewood, and on the agroforestry's ability to provide alternative sources of those materials or of income. The discussion about the potential of agroforestry to substitute other activities such as hunting and deforestation for cattle ranching is even more rare in the literature (e.g., Ruf & Schroth 2004; Franke *et al.* 2008).

Table 1.2 Evidence on indirect value of agroforestry (AF) to conservation through alleviation of pressure on wild resources of adjacent areas, according to three studies.

Study	Country	AF species	AF indirect value to conservation
Bisong <i>et al.</i> 2009	Nigeria	Diversified	Agroforestry provides 28% of the income derived from tree products for 300 households located at a PA buffer zone (the remainder comes from forest lands).
Murniati <i>et al.</i> 2001	Indonesia	Diversified	The presence of agroforestry in farm lands, in combination with rice fields, is related with the reduction the proportion of households that engage in the extraction of PA's timber and firewood from more than 60% (for households that engage in either of the two activities only) to 14% in the sample of 60 households.
Essa <i>et al.</i> 2011	Pakistan	Diversified	Agroforestry provides 18% of the firewood consumed by households at one of the study sites and 99% at the other. Higher income from agroforestry and more difficult access to natural forests are both related with the stronger reliance on agroforestry than on natural forests in the sample of 120 households.

The ability of externally induced agroforestry practices to reduce livelihood activities perceived as threats to biodiversity can be analysed in the context of the broader literature on Integrated Development and Conservation Projects (ICDPs). Those studies “often focus on income-generating initiatives to encourage local people to adopt alternative livelihood strategies so as not to disrupt wildlife and habitats” (Roe and Elliott 2004, p. 90). The ICDP approach rests on the assumption that “biodiversity conservation goals could be achieved through the means of economic development” (Wells & McShane 2004, p. 514). Despite the fact that the reduction of turtle hunting or cattle raising was not among the environmental goals of UFSE agroforestry project, its potential in that context will be explored in this thesis.

1.4 Agroforestry extension, participation and farmers' decision-making

As discussed in earlier sections, agroforestry has been increasingly promoted through extension at PAs due to its potential contributions to local people's well-being and to the conservation of native biodiversity. However, extensionists' expectations about the uptake of technical recommendations are often not met. Studies examining the reasons behind this have also been increasing, but these have rarely attempted to integrate the contribution of different disciplinary perspectives. The present thesis contributes to fill that gap.

This section will review some bodies of literature informing this study's approach: participation in development, farmers' decision-making and, more specifically, adoption of new practices in agriculture and agroforestry. In this section, I provide a brief historical context, examine the main concepts related to those fields and present the conceptual framework used as a basis for the analysis of the multiple factors influencing participation and, more specifically, adoption of recommended practices.

1.4.1 Historical perspective

Agroforestry research and extension were in their initial stages in the 1980s, which coincided with a time of consolidation of participation in development approaches. The 1990s oversaw important turning points in the studies on agroforestry and in those on participation.

Participatory development is conventionally represented as a response to the shortcomings of top-down development approaches, justified in terms of sustainability, relevance and empowerment (Cooke and Kothari 2001, p. 5). Under that rationale, participatory approaches to development would aim to "make 'people' central to development by encouraging beneficiary involvement in interventions that affect them and over which they previously had limited control or influence".

According to Hickey and Mohan (2004, p. 3, 5-6) participation has been a central concern of various approaches to development at least since the 1940s. The authors argue that, since the 1980s, participatory approaches have moved from the margins to the mainstream in development and that in the 1990s, there was already a growing critique against them regarding their promise of empowering marginal peoples. One of the aspects covered by such critique emerges as relevant to the present study: the assessment of (non)participation and motives underlying it, particularly as it takes into account both how (non)participation relates to the approach taken by project managers and also broader temporal and spatial scales than the ones usually explored in the literature on adoption of agricultural innovations (see subsection 1.4.3).

That expansion of participatory approaches can be observed in the specific context of rural extension. In their discussion on paradigm shifts in rural development thinking, Ellis and Biggs (2001) identify the technology transfer paradigm to have risen in the 1960s. According to these authors, this paradigm assumed small farmers as capable to promote agricultural growth and productivity rise in an efficient, rational way – qualities much more pronounced on the large-scale farms, according to the paradigm dominating the previous decade. During the 1980s and 1990s, this top-down approach was overtaken by a participatory, process-oriented, and empowering one. According to Reed (2007, p. 334), within the “Participatory Technology Development” paradigm, scientists and extensionists developed a more facilitatory role, “farmer experimentation must be supported, innovators and their innovations identified, and where necessary it may be possible to work with innovators to optimise their innovations, and disseminate them to other smallholders who may benefit from them (Reij & Waters-Bayer, 2001a)”. In the 2000s, critiques of participation became influential in the rural development context (Ellis & Biggs 2001).

It was in that historical context that agroforestry research and extension arose and evolved. According to Alavalapati and Nair (2001, p. 71), “scientific input into the development of agroforestry as a sustainable approach to land management started (...) a little over two decades ago”, probably in the late 1970’s. Nevertheless, despite the now evident importance of local people’s

decision to adopt an agroforestry practice for the success of the implementation of such a technology and for its environmental benefits to be felt, “adoption and diffusion have lagged behind the scientific and technological advances in agroforestry research” (Mercer 2004, p. 311).

In his review on the theme, Mercer (2004, p. 313-314) argues that studies on agroforestry adoption and diffusion were scarce until the 1990s, since when they would have expanded considerably - representing a broadening of the focus on biophysical aspects to include socioeconomic ones in the analysis of agroforestry performance/success. Pattanayak *et al.* (2003, p. 173) suggest that this may have to do with the growing recognition of the “uneven success rates” of “agroforestry rural development projects in many parts of the world due to inadequate adoption rates and/or abandonment soon after adoption”. However, more than a decade after the initial stages of the expansion identified by Mercer (2004), agroforestry adoption is still viewed as slow and the adoption gap, as largely unexplained, partly due to the underrepresentation of social studies (Jerneck & Olsson 2013, p. 114).

In summary, approaches to participatory development, and more particularly to agroforestry extension, have moved from an optimistic stance to a more critical one, partly as a response to emerging issues related to participation and adoption gaps. In order to address those issues, novel studies that examine underrepresented fields of knowledge and links between different fields are needed. The present thesis aims to make a contribution to that context and the following section presents how relevant factors are conceptualised.

1.4.2 Some definitions – participation, decision-making, adoption, diffusion

In this subsection, I examine two key concepts to the present study: participation (in agroforestry extension) and adoption (of agroforestry practices). I also explore other important related concepts such as decision-making and diffusion.

Despite the pervasiveness of the empowerment discourse among participatory development approaches, Pretty (1995) argues that the term ‘participation’ has been used to justify a wide spectrum of practices, in which local people can take more passive or more active (and potentially more empowering) roles. In the present work, I do explore the various ways local people get involved, influence or control the agroforestry extension process – which involves, for instance, the identification of local needs, the definition of the species and practices to be implemented, and the design of marketing strategies. However, I leave the use of the term ‘participation’ to a much more restricted context (unless otherwise specified); by ‘participants’ in the agroforestry extension project in this study, I shall mean those who have taken part, specifically, by receiving seedlings from the project at least once. I refer to local people as (non)participants rather than (non)adopters; ‘adoption’ is used in this study when referring to specific species and practices (e.g., adoption of the recommended spacing), whereas ‘participation’ refers to the project as a whole.

The adoption of an agricultural practice can be seen as a ‘strategic’ type of decision-making (according to the classification proposed by Bouma 1999 *apud* Janssen and van Ittersum 2007, p. 627). According to those authors, farmer decision-making can be classified as operational, sequential and strategic decision-making, “with an increasing time horizon of the decision at stake (Bouma *et al.* 1999)”, ranging from “day-by-day management decisions” to ones that have “an impact on the structure of the farm over many years”.

According to Mercer (2004), ‘adoption’ can be defined by emphasising the mental process involved in it or by underscoring the degree of use of the technology¹⁹. Nevertheless, ‘full use’ and ‘full information’ – both used by the author to characterise the term – are problematic to be identified in practical situations. Therefore, ‘adoption’ will be analysed here as a process which

¹⁹ “Mental process from first hearing about an innovation to deciding to make full use of the new idea”, citing Rogers and Shoemaker (1971); Rogers (1983); Evans (1988), or “degree of use of a new technology in long-run equilibrium when the farmer has full information about the new technology and its potential”, citing Feder *et al.* (1985).

evolves through time rather than as a final/equilibrium state. In other words, with 'adoption', I imply the use of the recommended species and practices not only in later stages of adaptation and expansion within household's farming system, but also earlier ones of trials and experimentation. As the extension program examined in the present study is so new, the expression is used mainly in the latter context.

In the literature, the definition of 'adoption' is closely related to that of 'innovation'. As the latter term usually implies the idea of something 'new'²⁰, I prefer to avoid it; the present work is concerned not only with the adoption of new management practices or species, but also with the expansion of and small adaptations to practices existing prior to the extension activities. To include both 'new' and 'old', instead of 'adoption of innovations', I refer simply to 'adoption of recommended species and practices'.

Coming back to the study of Mercer (2004, p.312), the author also defines 'diffusion', which would concern "the extent (spatially and temporally) to which the new innovation is put to productive use", or simply, the spread of adoption. As will be examined in the next subsection, diffusion is influenced by how communication channels among local households are structured and used. Those channels allow the flow of information about technical recommendations, as usually explored in the literature of agricultural innovations, and also about the extension project as a whole, particularly regarding its objectives, approach and field staff.

According to Mercer (2004), adoption has been viewed from two perspectives: household/farm level (factors influencing adoption) and macro-level (trends in the diffusion cycle). The present study used mainly the first perspective to examine participation (in its strict sense). Nevertheless, the early stages of

²⁰ Mercer (2004, p. 312) presents two definitions for 'innovation': "an idea, practice, or object that an individual perceives as new" (sociological viewpoint), and "a technological factor of production with perceived and/or objective uncertainties about its impact on production" (economic viewpoint).

diffusion were also looked at, in order to identify possible early participants, and processes of facilitation and constraint within communication channels.

1.4.3 Conceptual framework – factors influencing participation

Local households' participation in an agroforestry extension program can be seen as the result of a complex array of interacting factors. Participation is certainly influenced by factors more directly related to the relationship between each household and the extension program – such as the characteristics of agroforestry, of households and of the communication channels that mediate the relationship between the last two. However, larger temporal and spatial scales should also be considered. Factors operating at the community level, including past experiences with development, are likely to play a critical role in shaping participation.

The conceptual framework adopted here to make sense of the factors influencing participation is part of the present thesis' general framework, presented earlier in Figure 1.1. The former combines contributions of two related, but distinct research fields: adoption of agricultural innovations and participation in development. Particularly relevant to the present study are the typology presented by Degrande (2005) in the former field, and the insights provided by Cleaver (2001) and Vincent (2004) about processes unfolding at the community level in the latter, as will be examined later in this subsection.

Within the literature on adoption of agricultural innovations, different disciplinary perspectives have tended to inform separate lines of research (Mercer 2004, p. 312). In the 1970s, Rural Sociology began to lose its dominance while Economics began to rapidly expand and, since then, the two fields have hardly influenced each other (Mercer 2004, p. 313). Economic studies on adoption have emphasised innovations' profitability and associated investment risks as perceived by individual farmers, whereas sociological analyses have focused on the importance of social networks as sources of information and of other forms of support (Boahene *et al.* 1999, p. 171; Mercer 2004, p. 213; Stone *et al.* 2014, p. 28; Rijn *et al.* 2012, p. 113). The present study's conceptual framework

embraces both perspectives by looking at how local people's decisions are influenced by their concerns related to income generation and by the assets at their disposal at the household level on the one hand, and by the flow of information mediated by social ties on the other²¹.

Among economic studies, Ghadim and Pannel's (1999, pp. 145-146) conceptualisation of adoption²² emphasises the dynamicity of the process, the uncertainty that permeates it and how farmers are affected differently by that uncertainty – it is considered one of the most comprehensive models of adoption (Mercer 2004, p. 314). According to that model, farmers' adoption decisions are affected by the process of learning from their own trials over time, which involves the development of skills and the reduction of uncertainty. This thesis' conceptual framework, however, does not cover that individual learning process, as it focuses on the very initial stage of the adoption decision process – namely, the decision to initiate a trial, marked by the acceptance of seedlings donated by the agroforestry program.

Ghadim and Pannel's model also assumes that the propensity to take risks and the level of risk associated with the innovation vary across farmers. Although the present thesis does not assess risk preferences or risk perceptions directly, it does examine wealth and access to information about the agroforestry program, which can be considered to be related to the first two. Firstly, the wealthy are better able to cope with the risk of losses and, thus, to take risks (Rogers 1983, p. 248). Secondly, access to information can reduce uncertainty and, consequently, risks associated with the innovation (Ghadim and Pannel's 1999, pp. 145-146).

²¹ Psychologists offer another perspective for the investigation of agricultural policy uptake. According to the landmark Theory of Planned Behaviour, action and the intention to perform it are the products of psychological constructs, namely attitudes towards behaviour, perceived social norms and perceived behavioural control (Ajzen 1991; Burton 2004). The influence of other factors would be mediated by those constructs (Ajzen n/d). Although I do consider certain local people's perceptions, psychological constructs are not the focus of the present research.

²² “[M]ulti-stage decision process involving information acquisition and learning by doing by growers who vary in their risk preferences and their perception of the riskiness of the innovation”.

Ghadim and Pannel's model aligns with economic studies assuming that farmers aim at the maximisation of utility²³ or profit. This thesis' framework, on the other hand, is more aligned with the multi criteria decision-making (MCDM) approach (Janssen and van Ittersum 2007) and is based on the assumption that households' decisions are motivated by multiple, often conflicting objectives. The authors add that farmers' decisions are "derived from different dimensions, i.e., economic, environmental, biophysical and social" (McCown 2001; Wallace & Moss 2002; Bergevoet *et al.* 2004)". Therefore, it is assumed in the framework that farmers may encompass multiple objectives and aspirations as diverse as enhancing profit, subsistence use, health, labour conditions, leisure time, soil quality and forest cover, for example.

Sociological analyses have shown that adoption decisions within social networks are sometimes correlated, which has typically been attributed either to social learning or to imitation (Bandiera & Rasul 2006, p. 869; Stone *et al.* 2014, p. 27). Social learning or learning from others would involve the observation of others who are surprisingly successful in the use of a technology, which would induce its adoption and lead to changes in one's own productivity (Foster & Rosenzweig 1995, p. 1177; Conley & Udry 2010, p. 40). The relationship of adoption choices within networks would be ambiguous: having many adopters in the network may favour adoption because of the information they provide, but may also provide incentives to delay of adoption in order to free ride on the information provided by others (Bandiera & Rasul 2006, p. 870). Imitation, on the other hand, has been defined as "conformity that is not obviously adaptive" (Stone *et al.* 2014, p. 27). It has been argued that a farmer may be induced to imitate adopters on the basis of their prestige, social proximity or quantity (rather than of how well the technology is working for them) when the assessment of innovations performance is costly or inaccurate (Stone *et al.* 2014, p. 30). In the present thesis, I discuss the extent to which social learning or imitation may explain adoption decisions patterns regarding the first two years of implementation of an agroforestry extension program.

²³ According to Milner-Gulland and Mace (2008, p. 85), "utility is a vague concept in economics, being the unit of measure of human happiness. A common proxy for utility is money [...]".

Moving on to the specific components of the framework, Figure 1.2 depicts various sets of factors that can influence households' decision to participate or not in an agricultural extension program, and more specifically, to adopt or not adopt the practices that are promoted. One of those sets of factors is related to the extension process. Those include its central objectives, the characteristics of the proposed technology (in this case, agroforestry) and the way the technology is communicated to local households (the last two categories are proposed by Raintree (1983) *apud* Degrande (2005)) (Figure 1.2). It is relevant to consider what emphasis the objectives of the extension program give to social, economic or environmental outcomes, and the extent to which they match households' actual objectives and aspirations. The program's objectives inform the choice and design of the specific technology to be promoted, which would be analysed by local households in terms of the five characteristics²⁴ listed in Figure 1.2, according to the complementary studies of Rogers (1995), Pannel (1999) and Reed (2007). Regarding the communication channels, the flow patterns of information about the technology as well as the approach and method used may have an impact on households' decisions (Figure 1.2). In the first respect, it would matter, for instance, whether the information flows between extension staff and local households or between peer households (see Foster and Rosenzweig (1995), Bandiera and Rasul (2006) and Conley and Udry (2010) for a discussion on how communication network patterns affect diffusion). In the second respect, households' decisions may be affected by whether and the extent to which the method follows a participatory approach or relies on formalised spaces or institutions to interact with the community. As will be examined later in this subsection, social factors can influence households' access to those communication channels and how they view those channels in terms of trust.

²⁴ Two other characteristics are mentioned in the literature: observability and adaptability. However, those do not apply to the present study. As the agroforestry extension project under study was at such an early stage, results of the technology were not yet observable and local households did not yet had the opportunity to adapt the technology to meet dynamic demands.

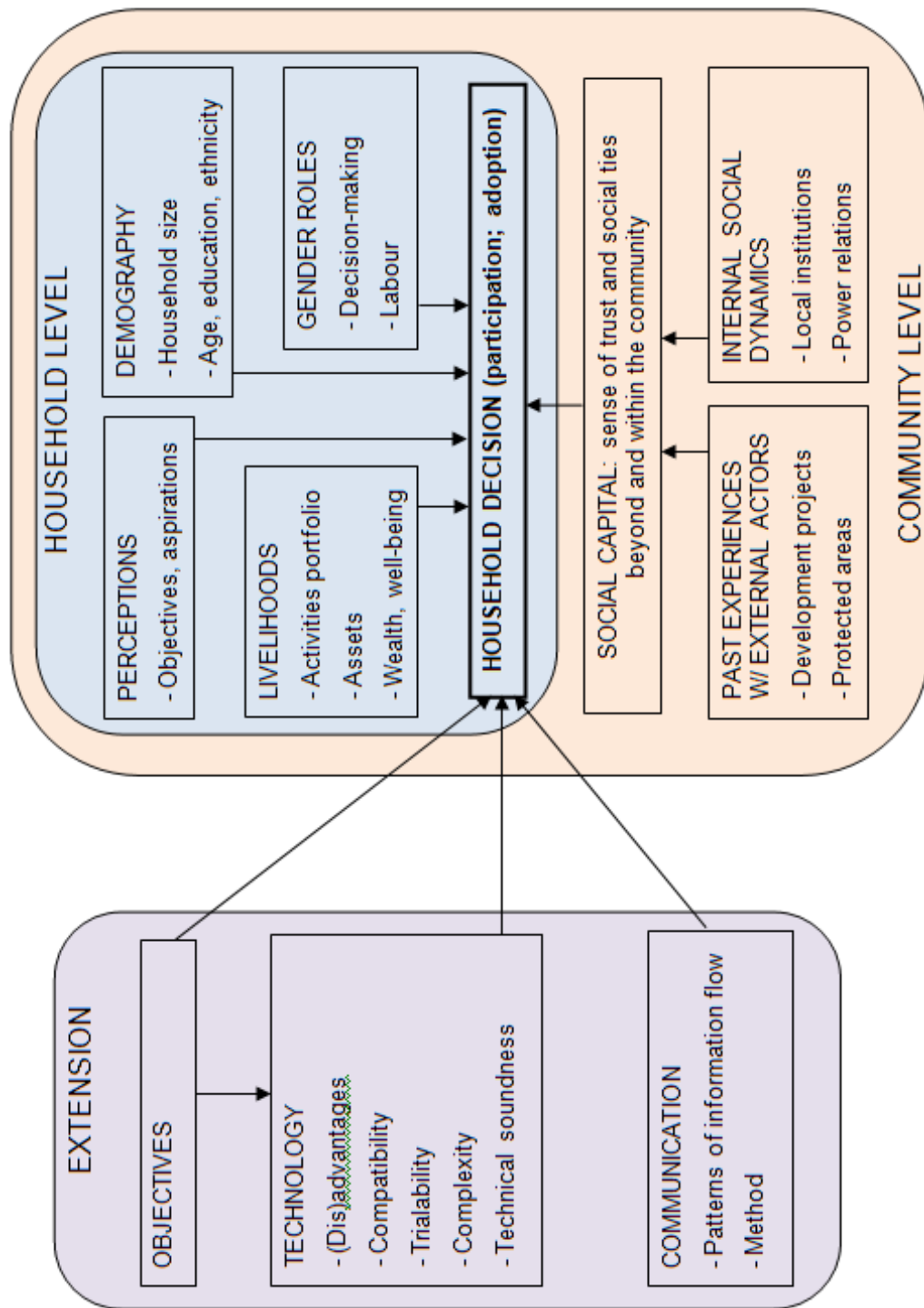


Figure 1.2 Conceptual framework depicting the sets of factors explored in the present study for their potential influence on local households' participation in an extension program and, more specifically, on the adoption of recommended practices.

Based on Raintree (1983), Rogers (1995), Pannel (1999), Cleaver (2001), Vincent (2004), Degrande (2005) and Reed (2007).

At the household level, aspects related to perceptions, demography, gender roles and livelihoods are highlighted in the framework. Regarding the former, households' interrelated objectives (proposed by Reed 2007) and aspirations (Figure 1.2) will frame how they perceive, for instance, the extension program objectives and the (dis)advantages of the technology promoted. I define 'objectives'²⁵ as more specific targets, so I add 'aspirations', with which I imply broader hopes and dreams²⁶. The diagnosis of households' perceptions can inform the design of the extension program objectives and, ultimately, increase participation rates; however, it should be noted that the objectives and aspirations expressed may, instead of reflecting local people's own priorities, mirror what they think that the external institution can offer, as argued by Vincent (2004).

Other sets of factors considered at the household level are demography and gender roles. In the first case, households may be more or less likely to participate according to household size or to household heads' ethnic group, age or education, for example. In the second case, the role played by men and women in terms of decision-making and labour investments in local agricultural practices can be related to the role they would play in agroforestry. Depending on whether men, women or both are likely to get engaged, households' response to extension efforts may vary.

Still at the household level, the factors influencing participation under the 'livelihoods' category include the portfolio of subsistence and income generating activities, the assets households can rely on and their wealth/well-being status (Raintree 1983 *apud* Degrande 2005; Reed 2007) (Figure 1.2). The composition of the activities' portfolio may impose constraints and opportunities in terms of labour and land availability. Also relevant to participation is the assets repertoire, which comprise, for instance, quality of soils (natural capital),

²⁵ The term is not explicitly defined by Reed (2007).

²⁶ Achieving 'objectives' may somehow contribute to reaching 'aspirations' as, for instance, an increased income may contribute to a more secure shelter. The difference between the two is not clear cut; the use of both terms is mainly intended to broaden the scope of analysis.

possession of agricultural tools (physical capital) and labour availability and experience with agriculture (human capital). In the last case, local agricultural practices (and how they compare to introduced ones) may influence how households view the technology promoted in terms of its 'complexity'. Information on livelihood activities and assets can be used to generate indices that aim to reflect households' wealth/well-being status, which can also influence participation.

One particular type of asset – social capital – is documented at the household level and then implications at both household and community levels are discussed. The present study uses the definition of 'social capital' proposed by Coleman (1988, p. 98): "a variety of different entities, with two elements in common: they all consist of some aspect of the social structures, and they facilitate certain actions of actors [...] within the structure", such as the participation in an extension program. According to the aspect of social relations concerned, I distinguish between structural and cognitive social capital. The first includes the extent and intensity of associational links (or "what people do") and the second, perceptions of trust, reciprocity and support (or "what people feel") (Harpham *et al.* 2002, p. 106)²⁷. Additionally, the scale of social relations involved is also used to classify social capital. Relations within, between and beyond communities are associated with bonding, bridging and linking social capital (Woolcock 2001), respectively.

²⁷ Social capital is considered a contested concept (Woolcock 2010, p. 470); among the key authors contributing to its development, Coleman was chosen due to his focus on social capital production and benefits at the individual-level (rather than viewing social capital as a community-level attribute, as in Putnam 1993) and because his definition accommodates both structural and cognitive aspects of social relations (rather than only the first aspect, as in Woolcock 1998, p. 185). Firstly, by examining social capital at the household level, inequalities in the distribution of social capital within the community can be accounted for. Secondly, as studies indicate that structural and cognitive aspects of social relations are deeply interrelated (Fisher 2013, p. 15), both are included in the definition of social capital used in this study. By differentiating between structural and cognitive social capitals, Woolcock's (1998) and Fisher's (2013) concerns about how the two influence each other can be addressed.

Most of the factors presented so far have been proposed in the field of adoption of agricultural innovations. At the community level, the literature on participation in development can provide a complementary contribution – the analysis of social capital proposed in the former field may be enriched by discussions developed in the latter field regarding past experiences with external actors and internal social dynamics. As an attempt to integrate both perspectives, the influence of the last two factors on participation is conceptualised here in terms of their relation to social capital.

Firstly, households' past experiences with external actors, whether positive or negative, can shape their sense of trust towards that type of actors (cognitive linking social capital) and, thus, influence participation. Vincent (2012) argues for the importance of taking an historical perspective and explores how negative past experiences with development projects can contribute to local people's hesitance to participate in subsequent ones. In the present study, considering the significant impact of the creation of the PAs on the study communities, past experiences in that context are also considered in the framework. Secondly, certain institutions and powerful people within the community may have privileged access to the extension program (structural linking social capital) and mediate the access of others, facilitating or hindering access according to the social ties that connects them (bonding social capital). Cleaver (2001) deconstructs the concept of 'community' and highlights processes, related to local institutions and power relations, which can influence who in the community participates. Cleaver (p. 44) argues that participatory approaches to development often fail to consider firstly their communities' heterogeneity in terms of the different and overlapping groups, local institutions and interests within the 'community', and secondly the power relations taking place in terms of "conflict and negotiation, inclusion and exclusion". Therefore, it can be said that a situation which is thought to illustrate a representative example of participation of 'communities' in a project may, in fact, depict the participation of a restricted group – often better-off, more powerful and self-selected.

Factors operating at broader scales, such as the national political and economic climate, are also likely to influence participation. However, those are not

included in this thesis' conceptual framework as they can only be investigated by international comparative analyses.

1.5 Thesis outline

This thesis is organised in seven chapters. In Chapter 2, I introduce the reader to UFSE's agroforestry project, the study site, the study communities, and the methods used in this study. In Chapter 3, I examine UFSE staff's discourses underlying the promotion of agroforestry, particularly regarding its direct value for conservation, trace back their roots and examine implications for reached audiences. In Chapter 4, I shift the focus to local people and explore the drivers and constraints to their participation in UFSE's agroforestry extension project. In Chapter 5, I examine agroforestry's outcomes for local livelihoods potentially arising from that participation, mainly in terms of income generation, taking into account existing portfolios of activities. In Chapter 6, I discuss the potential indirect contribution of agroforestry to conservation, by means of reducing livelihood activities perceived as posing threats to PAs' biodiversity that could result from positive local views on agroforestry's outcomes to livelihoods. In Chapter 7, I present a discussion of all results of the research, summarise conclusions in terms of the wider theoretical issues introduced in this chapter, and offer some recommendations for future extension work in agroforestry.

CHAPTER 2 Field site and methodology

The research that this thesis is based on consisted of a mixed-methods case study at two neighbouring protected areas (PAs) where an agroforestry extension programme had initiated in the previous year.

The case study research design was chosen in order to get an in-depth understanding of that particular on-going experience of agroforestry extension. I opted to conduct a study through which I could offer an outsiders' view, so I searched for and selected one agroforestry extension effort in the same context of my previous experience (involving protected areas and the Brazilian Amazon biome), in which I had no participation as an extensionist. Although agroforestry has been increasingly recommended in PAs' management plans, the site selected is among the few examples of experiences being currently implemented specifically in the PA context in the Brazilian Amazon region. In terms of representativeness, the study site shares characteristics with other Amazon PAs located in remote areas, such as restricted access to markets and well-preserved forest cover. Moreover, similarly with other Amazon PAs, there is a history of conflict among PA staff and local populations and of development projects that failed to deliver some of the expected outcomes. On the other hand, this thesis' findings will find only restricted application in Amazon PAs situated near forest margins, major road networks or large cities.

The choice for a mixed-methods design was informed by the analysis of the strengths and limitations of qualitative and quantitative approaches and of the extent to which each of the two would be suited to explore the different elements of the conceptual framework presented in the previous chapter. While a qualitative approach was followed to get an in-depth understanding of complex themes such as local perceptions of PAs' staff and of natural resources, a quantitative approach was taken to document specific variables such as demographic attributes and to analyse their relationships to participation.

In this chapter, I describe the agroforestry extension project under study, the study site and the study communities, and also examine the methods I relied on for this research and their limitations.

2.1 The agroforestry extension project

UFSE²⁸, a federal university of the southeast region of the country, has been conducting an agroforestry extension project involving *quilombola*²⁹ communities living within or in the buffer zone of two protected areas (PAs). Based on an exploratory research conducted in 2009, extension activities started in the following year. According to project reports, its objectives included the diversification of income sources and of food production with the use of fallow areas. In this section, I provide an historical overview of UFSE's agroforestry project.

The project was financed by UFSE's outreach department. It was being implemented by a group of undergraduate students of the Geography course, coordinated by a permanent researcher from the Geography department.

The extension project was preceded by research on the local practices of food production and dietary habits in five communities, conducted in 2009. That yielded the identification of the main problems faced locally: low incomes particularly in the summer, diets with low diversity, land scarcity and deforestation. Implementing agroforestry activities was how extensionists proposed to tackle those issues.

²⁸ Fictitious name

²⁹ The term '*quilombola*' can be defined, in summary, as 'descendant of escaped slaves'. 'Quilombolas' are the constituents of the 'comunidades remanescentes de quilombos'. The latter expression refers to "the territory where Africans and their descendants came to live during the transition period which culminated in the slavery abolition" in Brazil. 'Quilombo', "which in its bantu etymology means warrior camp in the forest, was popularised in Brazil by the colonial administration [...] to refer to the mutual support units created by the rebels against the slavery system and to their reactions, organisations and struggles for the end of slavery in the country" (Leite 2008, pp. 965, 969).

In 2010, the first areas were planted. An initial group of 13 households from three communities participated. According to the project field coordinator, those were selected based on contacts mediated by 'gatekeepers'. Later in 2010, a group of 35 households from five communities planted additional areas; this second planting event was carried out to cope with the higher than expected demand for seedlings. In 2011, a smaller group of 19 households from four communities participated.

In the first visit of each year, the extensionists would register (*cadastrar*) the interested households, agree with those households the planting location after visiting the areas indicated by them, take note of the species demanded, and ask them to prepare the areas (cut, but not clear or burn, the forest understorey) before the settled date for planting. Soon after that first visit, extension staff returned with the seedlings and planting was carried out.

The seedlings were all donated by the project and were generally planted by individual households; there was quite a diverse range of 31 species, but with a clear focus on one single species, *cupuaçu* (*Theobroma grandiflorum* L.) (Annex 1). That species was chosen based on the fact that it was one of the main species of interest locally according to the 2009 research, and on extension staff evaluation of its marketing potential. Typically, households together with project staff also decided about species arrangement (combination of species, location of seedlings in the plot, spacing between seedlings) and carried out the plantings. In some cases, in addition to the owner of the area, other households stepped in to help. After the planting was done, extensionists would leave the field and then return once more in the same year to monitor seedlings' growth parameters and general development.

Some technical advice was given during the planting with each household. Those included not cutting the forest upperstorey or burning before planting, leaving cut understorey as soil cover and maintaining appropriate distance between seedlings. Apart from that, communal meetings with households for

technical assistance were rare, but they did include training for seedling production and presenting the local school as a marketing option.

As a university outreach project led by undergraduate students, it might be expected that there would be a high turnover rate in the field staff. In fact, part of the team, including the field coordinator, graduated and left the project in 2012. However, their plans were to continue working with the local communities in the region, and indeed they were actually getting involved in new projects. That said, UFSE's agroforestry extension project has continued, under new field coordination, basically with the same objectives, field activities and focus on *cupuaçu*; the target communities for 2014 were still the same five communities that participated in the project in 2010 and 2011.

2.2 The study site

The agroforestry extension activities investigated in the present research involved communities living either within or nearby two contiguous PAs: Saracá-Taquera National Forest and Rio Trombetas Biological Reserve. This section briefly characterises both PAs in terms of their location, use restrictions and demography.

The two PAs lie on the north-central portion of the Brazilian Amazon Forest, in Pará state (Figure 2.1), along opposite margins of Trombetas River (a tributary of the northern bank of the Amazon River) (Figure 2.2). They are fairly isolated from major road networks (e.g., Transamazon, Manaus-Porto Velho, Porto Velho-Cuiabá, Cuiabá-Santarém and Belém-Brasília highways) and from other of the most human impacted areas of the biome (closer to its southern and eastern limits).

One of the nearest urban areas to the two PAs is Oriximiná city, which resident households typically resort to for basic services and trade. The urban area of Oriximiná lies roughly 30 km away from the PAs' limits and had approximately 40,000 inhabitants in 2010, from a total of nearly 60,000 if rural areas are

included (IBGE 2010). It can be considered poor – it is the 3,631th city (out of a total of 5,565) in Brazil in terms of the Human Development Index – HDI (United Nations Development Program – *Programa das Nações Unidas para o Desenvolvimento* – PNUD 2010). The industry and service sectors form the base of Oriximiná’s economy, corresponding to 56 and 36% of the city’s gross domestic product (GDP), respectively (IBGE 2011). Mining, and secondarily timber and brazil nut processing, constitute some of the main activities in that context. In the farm sector, the main products include cattle and manioc, followed by banana, corn, rice and beans (IBGE 2011).

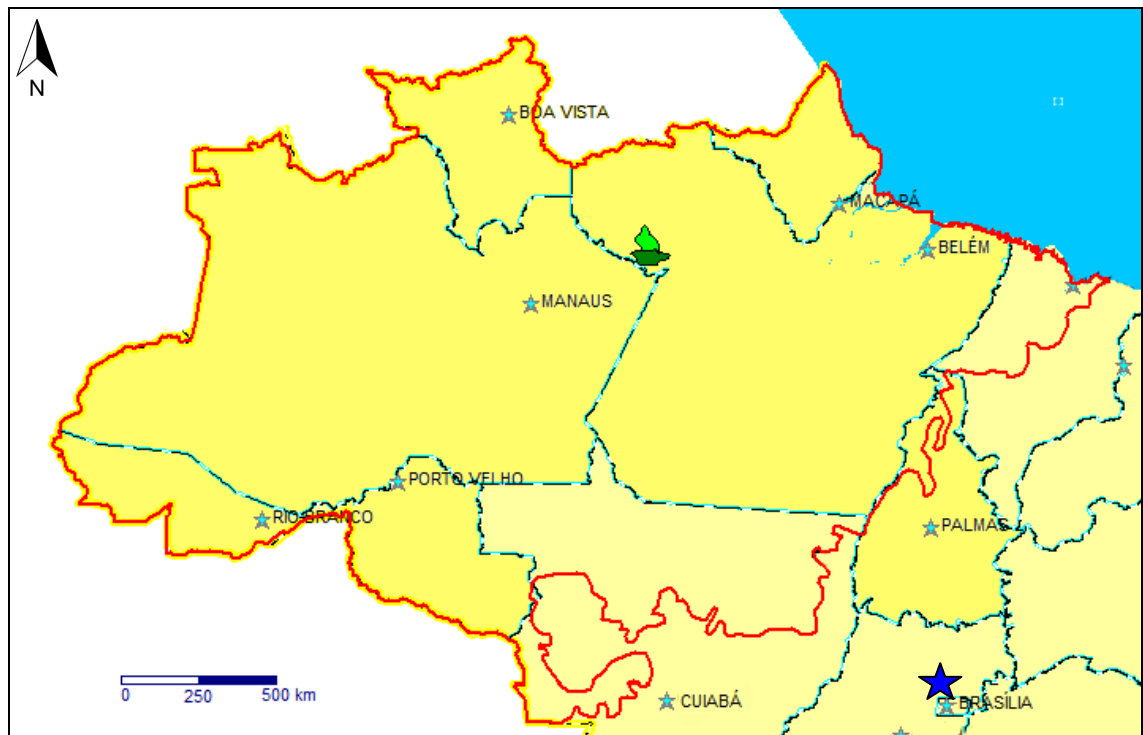


Figure 2.1 Location of Rio Trombetas Biological Reserve (light green) and Saracá-Taquera National Forest (dark green), in the North region (seven states in darker yellow) of Brazil.

Red line – limits of the Brazilian Amazon Forest biome; dashed blue lines – states’ boundaries; light blue stars – states’ capitals; dark blue star – country’s capital.

Sources: Brazilian Institute of Environment and Renewable Natural Resources (*Instituto Brasileiro do Meio Ambiente e dos Recursos Naturais Renováveis* – IBAMA)/ Remote Sensing Centre (*Centro de Sensoriamento Remoto* – CSR) n/d (protected areas’ shape files); Ministry of Environment (*Ministério do Meio Ambiente* – MMA) & Brazilian Institute of Geography and Statistics (*Instituto Brasileiro de Geografia e Estatística* – IBGE) n/d (biome shape file); IBGE n/d (basemap)

Rio Trombetas Biological Reserve and Saracá-Taquera National Forest were created in 1979 and 1989, and cover approximate areas of 410,000 and 440,000 ha, respectively. The conservation of the South American river turtle (*Podocnemis expansa*) and its main nesting site in the Amazon region at the time was one of the main drivers for the creation of the former. Upland forests are the predominant protected vegetation, covering more than 90% of the PAs' combined area; small areas of floodplain forests and non-forest vegetation (*campinarana*) are also found (IBAMA 2001; IBAMA 2004).



Figure 2.2 Location of Rio Trombetas Biological Reserve (light green) and Saracá-Taquera National Forest (dark green), highlighting Porto Trombetas company town (blue dot), the main city nearby (Oriximiná, red dot) and rivers (Trombetas River, flowing southwards towards the Amazon River).

Sources: IBAMA/CSR n/d (shape files) and IBGE n/d (basemap)

Both are federal protected areas, managed by Chico Mendes Institute for Biodiversity Conservation (*Instituto Chico Mendes de Conservação da*

Biodiversidade – ICMBio), a federal institution directly linked to the Brazilian Ministry of Environment. The biological reserve belongs to a more restrictive category of PA ('strictly protected' or *proteção integral*) in which only indirect use (research, in the case of biological reserves, and also tourism, in case of other PA types) of the natural resources is allowed. The national forest, on the other hand, belongs to the other of the two PA categories adopted in Brazil ('sustainable use' or *uso sustentável*), which allows the direct use (e.g., resource extraction, land clearing) of the natural resources, both by traditional peoples using them prior to the creation of the PA, and by companies licensed by the government (mining and timber extraction in the case of Saracá-Taquera). Figure 2.3 shows the two study PAs and the mosaic of federal and state PAs they are part of.

According to its management plan, an estimated 1,500 residents live in the 14 communities found in the national forest (IBAMA 2001). They consisted of rural people dominated by *quilombolas* (57%) and *ribeirinhos*³⁰ (28%). Despite allowing only indirect uses, the biological reserve is also inhabited by roughly 1,000 people (56% *quilombolas* and 44% *ribeirinhos*) distributed in 12 communities, according to IBAMA (2004). The biological reserve's natural resources are used by its inhabitants and also by those from the neighbouring national forest, generating conflicts with ICMBio. In 2011, there were four members of that institution responsible for the management of the two PAs. In addition to that, there was a support staff of 20 people, some of whom were local residents. ICMBio staff members were based at Porto Trombetas

³⁰ The term '*ribeirinho*' can be defined, in summary, as nontribal, non-settler, lower-class rural people of the Brazilian Amazon. *Ribeirinhos* are mixed-blood, resulting from the intermarriage of Amerindians with early Portuguese settlers and later, in the XVIII and XIX centuries, with Northeasterns of African descent – African influence was, however, restricted to specific regions. The definition draws on the classical work of Chibnik (1991), who examined the various terms used to refer to Amazon residents who neither self-identified as Indians nor colonists.

Although the author points out that the terms '*ribeirão*' and '*caboclo*' have been used in the literature to refer to groups of different portions of the Amazon – Peruvian and Brazilian, respectively – both terms are commonly used in the Brazilian Amazon as a self-identifier. Therefore, I consider that the author's definition of '*caboclo*' applies to the populations referred to as *ribeirinhos* by the PAs' management plans (IBAMA 2001; 2004).

company town (*vila operária*) (see Figure 2.2), while support staff members stayed in one of the four field bases located within the PAs' boundaries.

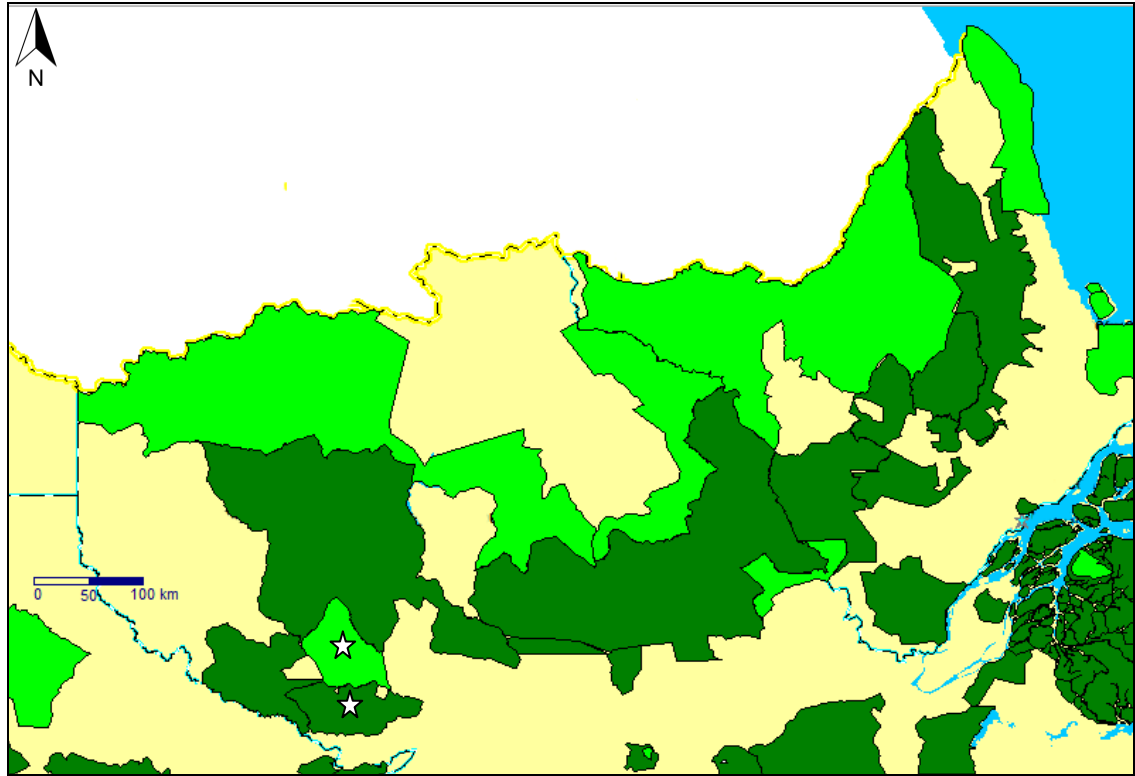


Figure 2.3 Mosaic of federal and state PAs comprising Rio Trombetas Biological Reserve and Saracá-Taquera National Forest (marked with a star).

Strictly protected PAs in dark green; sustainable use PAs in light green.

Source: IBAMA/CSR n/d (shape files) and IBGE n/d (basemap)

2.3 The study communities

The study population encompassed four of the five communities³¹ that participated in the extension activities conducted by UFSE in 2010 (Table 2.1 and Figure 2.4). The four communities are reasonably representative of the whole group of participants in terms of ethnicity and main livelihood activities. People in those four communities generally recognise themselves as *quilombolas* or, in other words, descendants of escaped slaves.

³¹ I was not able to include one of the communities due to restrictions in time.

Table 2.1 Location and land tenure status of the four study communities.

	Sagrado Coração	Tapagem	Paraná do Abuí	Abuí
Location	Inside PA	Inside PA	Outside PAs	Outside PAs
Land tenure	Untitled	Untitled	Titled	Titled



Figure 2.4 Location of the study communities marked in red diamonds (from south to north: Sagrado Coração, Tapagem, Paraná do Abuí and Abuí.

Limits of Saracá-Taquera National Forest in dark green and of Rio Trombetas Biological Reserve in light green. Source: IBAMA/CSR n/d (shape files) and IBGE n/d (basemap)

The study communities were selected so that equal numbers were located inside and outside the PAs, for comparative purposes. From the three communities participating in the extension activities and lying within the boundaries of the national forest, two were selected: one, Sagrado Coração, for

its uniqueness in terms of low participation rates and the other, Tapagem, because it was more easily accessible during the rainy season. The other two study communities, Paraná do Abuí and Abuí, lie in an area adjacent to the two PAs, officially recognised (titled) as a *quilombola* territory (*território*) since 2003 (Table 2.1 and Figure 2.4). The overlap of the area occupied by the first two with the national forest has contributed to a delay in its official recognition.

This section presents the history of livelihoods and particularly of income generating activities in the communities and generally describes the current situation in relation to livelihoods and access to basic services.

2.3.1 History of income generating activities

Historically, households in all four study communities have lived by a mixture of trade and subsistence involving both gathering of wild natural resources and small-scale farming.

According to Andrade (1995, p. 95), historical records indicate that the occupation of the study communities' territory dates back to XIX century; it was sparsely settled at that time but grew with in-migration from more isolated and protected locations upstream after abolition in 1888. According to local accounts, Tapagem is the oldest of the four study communities or, in other words, where human occupation built up first. The other three study communities – Sagrado Coração, Paraná do Abuí and Abuí – were formed mainly due to the expansion of Tapagem.

In XIX century, brazil nut collection was already an important source of income in the region, together with *salsaparrilha*³² (*Smilax* sp.) extraction and tobacco (*Nicotiana* sp.) planting (Acevedo & Castro 1998, p. 109-110). According to local accounts, other non-timber forest products (NTFPs) have provided income

³² Medicinal plant

since XIX century, such as *cipó-titica*³³ (*Heteropsis* sp.) and various types of tree resins (*copaíba* – *Copaifera* sp., *breu* – *Protium* sp., *jutaicica* – *Hymenaea* sp.) and latex (*seringa* – *Hevea* sp., *balata* – *Manilkara* sp., *coquirana* – *Chrysophyllum* sp.). Historical data regarding *pirarucu* fish (*Arapaimas gigas*) and turtle (*Podocnemis expansa*) industries presented by Acevedo and Castro (1998, p. 183-185) suggest that the reliance on those income sources also dates back from that century. Those products were traded – covertly, before the slavery abolition in 1888 – with *regatões*³⁴ and traders in the city. Particularly in the case of brazil nut, extraction was severely controlled from the 1920s to the 1970s – some of the traders from the city, who already monopolised the nut trade, came to actually own extensive areas of brazil nut stands at the study region in the 1920s and 1930s (Acevedo & Castro 1998, pp.136, 139, 141).

Elderly local informants report to have witnessed two other common income generating activities during the 1960s and 1970s – extraction of timber and hunting for skin. They state that the previous generation also carried out those activities, but it is not clear from their accounts when these activities date back to. Timber was extracted from May to July, the few months between the end of the brazil nut season and Oriximiná religious festivity in August. Unmanufactured timber was taken tied up as rafts (*jangadas*) to the city and sold to sawmills. Various species are mentioned as sources of skin, such as jaguar (*Panthera onca*), margay (*Leopardus wiedii*), giant otter (*Pteronura brasiliensis*), deer (*Mazama* sp.), peccaries (*Tayassu tajacu* and *T. pecari*), caiman (*Melanosuchus niger*) and snakes (anaconda – *Eunectes* sp., boa – *Boa constrictor*). Skins supplied the international market, which according to the National Network of Fight against Wildlife Traffic (*Rede Nacional de Combate ao Tráfico de Animais Silvestres* – Renctas 2001, p. 42, 46) was at its peak demand for tropical carnivores and crocodylians during the 1950s and 1960s.

³³ Hemi-epiphyte plant (grows upon another plant, spending part of its life cycle rooted in the ground). Its long roots growing towards the ground are used in crafts (e.g., to make baskets and brooms) and in construction (e.g., to tie house and fence structures).

³⁴ Intermediaries travelling on boats who sold industrialised products and purchased extractive and agricultural products.

In the late 1970s, the Rio Trombetas Biological Reserve was created by the Brazilian Institute for Forestry Development, IBDF (now Chico Mendes Institute for Biodiversity Conservation, ICMBio), resulting in the compensation of the private proprietors within its limits in exchange for their lands (Carrilho 2006, p. 51-52). It encompassed one of the main brazil nut areas used by the four communities, as well as fundamental fishing, hunting and other NTFPs extractive areas. Local people and PA staff report that, despite the prohibition of any direct use of natural resources, common in all protected areas of that category, NTFPs extraction (mainly brazil nut) and turtle hunting continued, generating conflicts. According to them, prohibitions or limitations targeting specifically other important income sources – such as *pirarucu* fish, unmanufactured timber and skins – were also put in place or intensified, contributing to the abandonment of the last two.

The 1970s was also when the local population first had access to regular monthly sources of income. In that decade, Andrade Gutierrez and Rio do Norte Mining (MRN) companies started operating respectively at Cachoeira Porteira community and Porto Trombetas company town (Wanderley n/d, pp. 1, 7), within a few hours distance from the four communities, opening wage labour opportunities. The former's planned activities involved, at first, road construction and, later on, a hydroelectric power dam development, whereas the latter's, bauxite extraction (Wanderley n/d, pp. 1, 7). Local accounts indicate that other resulting outcomes include, firstly, the immigration to the companies' areas leading to an increasing market for agricultural products and, secondly, the ban regarding the transportation of timber tied up as rafts, incompatible with MRN's bauxite uploading port at Porto Trombetas company town (Figure 2.2) and frequent transit of international ships.

In the 1980s and 1990s, respectively, job opportunities and markets for agricultural products declined. In the late 1980s, Andrade Gutierrez left Cachoeira Porteira, as pressures from the ecological movement and other groups had led to the withdrawal of plans for the hydroelectric power plant construction (Wanderley n/d, p. 8); and so by the late 1990s, approximately, there was an oversupply of agricultural products at Porto Trombetas according

to local accounts – both those markets became less attractive for those products.

On the other hand, in that same period, social organisation was strengthened, which contributed to the alleviation of brazil nut extraction rules. Local narratives reconstruct a social re-organisation process that was triggered by the creation of the biological reserve and facilitated by a priest. In the late 1980s, that process culminated in the creation of ARQMO (Association of the Slave Descendants of Oriximiná city - *Associação dos Remanescentes Quilombolas do Município de Oriximiná*), enhancing communities' political power and opening a new channel for negotiations with ICMBio. A practical outcome, mentioned by local people and PA staff, was the settlement of a new agreement in 2003 regarding the brazil nut extraction. Local people would, from then on, be allowed to enter the area of the biological reserve from January to May, which encompasses most of the brazil nut collection season. Another relevant outcome was the implementation of livelihood-related projects in the communities – the two most cited ones among locals aimed to enhance the income generated through brazil nut collection.

In the early 1990s, women subsistence farmers' rights to important social service payments were secured through legislation. Since then, the right to state pension has been extended to all household members – before that, only the breadwinner (usually male) was recognised as a beneficiary (Berwanger 2011, pp. 5, 10). Local narratives suggest that state pension has been effectively accessed by both men and women in the study communities at least since that decade. From the early 1990s, women subsistence farmers were also recognised to be entitled to a maternity leave with remuneration (*salário-maternidade*), just as urban and wage rural workers previously were³⁵. According to local accounts, the latter has been actually accessed since the late 1990s.

³⁵ *Lei Federal Complementar*, 25 May 1971 – *Institui o Programa de Assistência ao Trabalhador Rural*; *Lei Federal* 8213, 24 July 1991 – *Dispõe sobre os Planos de Benefícios da Previdência Social*.

The 1990-2009 period was the time when local jobs became more widely available to the communities – before that, the only available local jobs were as teachers, and there were very few of those. Since then, according to locals, the municipal government has been hiring *serventes/merendeiras* (they both clean the building and make the meals), boat drivers and more teachers to work in the two local schools and community health agents, while ICMBio has been employing people in some of their field bases as support staff. In addition to the impact on the livelihoods of those individual households, local accounts suggest that the latter has contributed considerably to improve the relationship between ICMBio and the communities. Before that period, only people from outside were hired for that duty, who are said to have been much more truculent in their relationship with the communities and to have motivated a sense of animosity and lack of trust.

In the 2000s, several new income sources arose or old ones improved according to local accounts. Cattle raising was the alternative found by some families to make a living, in the face of prohibitions imposed by ICMBio against other livelihood activities. Previous attempts to raise cattle in those communities were said to precede the creation of the biological reserve. Also in the early 2000s, a number of federal social service payments aimed at improving nutrition and education of poor families were implemented nationwide and accessed by the study communities, and then combined to compose the *bolsa família* program³⁶.

In summary, historically the communities made a living principally from the use of various types of wild products together with farming. The creation of the protected area in the 1970s appears to have had a significant impact on livelihoods by reducing access to natural resources for both market and subsistence use. On the other hand, since the 1970s, people have also had increasing access to social service payments and wage labour, and since the late 1980s with the creation of ARQMO there has been a succession of

³⁶ *Lei Federal 10836, 9 January 2004 – Cria o Programa Bolsa Família.*

livelihoods-related projects. It was in this context that UFSE's agroforestry project began in 2010.

2.3.2 Socioeconomic overview – present day

The difficulty of reaching Oriximiná city was one of the main issues faced by the study communities – there was limited means of transportation available for the long 12-hour journey. In the city, households can access markets, social service payments, and important complements to the restricted education and health services available in the communities. In their monthly trip to the city, households' expenses are mainly for industrialised foodstuffs and hygiene products. In terms of durable goods, the ones more widely owned include: wooden canoes, small engines for the canoes, agricultural steel tools and gas stoves; the most typical housing have wooden walls and are roofed with corrugated fibre cement (*fibrocimento*) sheets.

The four communities' access to education and health care was restricted. School education had not been accessed at all by 20% of the heads of households (men and women); 49% had completed only one to four years of education. The two local schools that served the four communities offered only primary education – a secondary school was being built in 2012. Hypertension and diabetes were considered the main health problems in the communities by a local health agent; malaria and diarrhoea had been problems in the recent past and malnourishment was not considered an issue. There was no public hospital or the like in the communities; some exams and medical treatments were provided by visiting doctors only once a month for two days, through a project financed by MRN.

As an alternative, households resorted to the nearest urban area of Oriximiná. It was accessible exclusively by river – the trip, in community boats or commercial lines, could take as long as 12 hours. In general, households went to the city once a month – in overcrowded boats – to sell some agricultural and extractive products, receive government social service payments, buy manufactured products and get medical treatment. Some sent their offspring to live and study

in the city to complete their education. However, the possibilities offered by Oriximiná, a small and poor city, were also limited (see section 2.2). Moreover, adequate means of transportation were restricted to the few households (12%) that owned a covered boat and a relatively powerful engine. Boats purchased by the municipal government were under the responsibility of each of the communities and were used to make up to two trips per month, but those could take only about 20 people and had insufficient place to also take extractive and agricultural products. Also, one free trip per month, subsidised by the municipal government, was available to the communities in a commercial line; that boat was larger but still not big enough to take all four communities, much less their produce (Annex 2).

Access to clean water and electricity was also an issue. Virtually all households got their drinking water directly from the river; they generally did not boil it and there seemed to be a misuse of the water purifier (sodium hypochlorite) that was distributed to them. Electricity from the regional network was not available. Therefore, households could not benefit from the free allowance of electricity they would be entitled to as recognised *quilombolas*³⁷. Power generators were the alternative for about half of the households, who either could afford to purchase their own (most cases) or live close enough to the community centre to benefit from the community one.

Regarding the possession of other durable goods, the vast majority (more than 90%) owned items essential for their subsistence activities such as a wooden canoe and steel agricultural tools: hoe, machete and axe (*enxada*, *terçado* and *machado*). Most but fewer households also possessed a gas stove (85%) at home and a small engine (*rabeta*) adaptable to their canoes (73%), which was frequently also used for the otherwise highly labour demanding task of grating (*sevar*) the manioc roots to make ‘flour’ (*farinha*). The most common housing had walls made of wooden planks (74%) and was roofed with corrugated *fibrocimento* sheets or clay tiles (69%). A smaller proportion relied on palm thatch in the walls (16%) and roof (27%) (Annex 2).

³⁷ According to legislation on “electric power social fee” - *tarifa social de energia elétrica*.

The monthly expenses went mainly to industrialised foodstuff and hygiene products – essentially powdered coffee, refined cane sugar, soy cooking oil and soap; some could also afford to buy varying quantities of rice, beans, powdered milk and biscuits. Those expenses also comprised transportation to the city, usually once a month and, for the better-off, gasoline for the power generator and instalments of home electrical appliances. Clothing was considered expensive in the city and thus, bought much less often – more so for the worse-off. According to legislation, the national minimum wage (*salário mínimo*) is supposed to be enough to provide for those kinds of basic needs (apart from electrical appliances)³⁸. Key informants reported that local households spent monthly from 30 to 50% of the equivalent of the minimum wage on those needs (excluding clothing and electrical appliances) (2013 data), varying according to household wealth.

2.4 Methods

The present study combined the strengths of both quantitative and qualitative approaches to data collection and analysis. It relied primarily on data collected through interviews, participant observation and informal conversations in the four of the communities that participated in UFSE's agroforestry extension project. This was complemented by interviews with PA and extension staff and archival searches in order to place them in a broader context, and to gain an overview of the history of the interaction between the PAs and local communities and of the thinking behind the agroforestry extension activities. In this section, I explore the general approach and specific methods used in the process of data collection. The methods used for data analysis are then briefly described. Following that, I examine the methods used to analyse wealth differentials and factors influencing participation. I conclude by discussing the main limitations of the study methods.

In the specific context of local people' decision-making process, the studies of Mercer (2004) and Gladwin *et al.* (2002) have presented different sets of

³⁸ *Lei Federal 185*, 14 January 1936. *Institui as comissões de salário mínimo*.

methods possible to be used. The main point to be made here is that it would be possible to take either a quantitative or a qualitative approach – or a combination of both, as in the present work. In the review conducted by Mercer (2004, p. 324) on the adoption of agroforestry innovations, it is suggested that not only in data analysis, but also in data collection, quantitative approaches have been predominant. Gladwin *et al.* (2002) are explicit in defending the need for combining **qualitative** and **quantitative** methods in the investigation of farmers' decision-making. The authors recognise that **qualitative** participatory approaches play a fundamental role in facilitating the development of answers (innovations) for the 'right questions' (farmers' needs, constraints). They additionally emphasise the complementary value of **quantitative** methods for **data analysis**, arguing that, although statistics and precise measurements would not be able to replace the complex information gathered through ethnographies, "hypothesis-testing sequence is the basis of science. Without it, researchers have no way to give themselves a reality check. Without a reality check, researchers have no way of sifting through all their ideas and ethnographic observations to cull the ones that are wrong; and unfortunately, untested ethnographic observations can give the researcher just as false a sense of security as do (...) numbers (...)" (Gladwin *et al.* 2002, p. 526).

The claims of Gladwin *et al.* (2002) on the indispensability of quantitative methods of data analysis are based on assumptions about what counts as science and valid knowledge, and what can best inform policy makers. However, as Newing *et al.* (2011) comprehensively argue, quantitative as well as qualitative approaches in data analysis have their merits and limitations regarding both aspects. According to that author, the test of statistical significance, held so dear and essential to attain a valid scientific knowledge from a quantitative perspective, implies the reduction of complex phenomena to simple numbers and the production of knowledge not valid or useful from a qualitative one. Those opposing views, instead of leading to unfruitful discussions, can each be useful in different contexts as Newing *et al.* (2011, p. 9) conclude: "quantitative research is good at addressing very focused questions concerning correlations or cause-effect relationships between different variables", whereas "qualitative research is good at providing an

overview of an issue or situation, disentangling its complexities, and providing an in-depth understanding of different perspectives”, both of which, as exemplified by Gladwin *et al.* (2002), can be combined - but not necessarily.

Another difference between both types of research, discussed by Newing *et al.* (2011, p.51), is the different types of research validity related to each of them. Quantitative approaches with a consistent hypothesis-testing research design tend to exhibit high ‘internal validity’, as it allows us to “rule out ‘confounding variables’ (...), test for causes and effects with a high degree of confidence” and “draw conclusions with a high level of theoretical rigour”. On the other hand, in qualitative approaches, such as the ones using participant observation, ‘context validity’ tends to be high, as the situation under which the research is carried out tends to be more representative of ‘real life’ or, in other words, less artificial than when using pre-arranged interviews or questionnaires, which are more likely to induce people to behave differently from the way they behave in ‘real life’.

That contrast affects what kind of information each approach can provide policy makers with. Qualitative approaches can produce a bigger picture, consisting of the various criteria and limitations affecting decision-making, as well as of the complex interaction among them. Quantitative approaches can inform about a more specific set of factors and present a measure of the relevance of those particular factors on decision-making. The examination of factors in their context and the quantification of their relevance are trade-offs; it is possible to prioritise one of them and the kind of validity associated with it.

The present study relied mainly on a qualitative approach for data collection and analysis, in order to get an in-depth understanding of farmers’ decision-making process (objectives a, b, c³⁹) and also of: discourses on agroforestry’s direct

³⁹ In this subsection, I relate each method with the research objective(s) it is supposed to address. In the case of objective c, I also relate the method in question with the relevant component(s) of the conceptual framework on participation. This thesis’ objectives and the

value for conservation (objectives b, e), agroforestry's potential contribution to livelihoods in terms of income generation (objective a, d), and agroforestry's potential to substitute activities perceived as threats to PA natural resources (objective b, e). This was complemented by a quantitative approach for the collection of data concerning a specific set of factors related to local livelihoods, demography and gender roles and in the analysis of their influence on participation (objective c). In contrast with the study of Gladwin *et al.* (2002), the findings derived from participant observation and interviews in the present study were not necessarily used to generate models or submitted to statistical analysis. It is assumed here that systematised and useful results can also be generated through qualitative data analysis and support policy makers in their decisions about priorities and allocation of resources.

The methods used for data collection in this research are listed in Table 2.2, along with information on the period when it was predominantly used, sample sizes, data gathered and thesis' objectives addressed. Secondary sources consulted consisted mainly of projects submitted by extension staff for fundraising and reports for donors, of policy documents and also of wildlife and forest cover monitoring data. The information extracted from the first two sources included the description of the extension process and related projects and programmes, as well as the discourses on agroforestry made explicit in the justification for and evaluation of the activities developed (objectives a and b). Discourses on agroforestry were also extracted from policy documents. The monitoring data, on the other hand, was used in the identification of trends in the abundance of PAs natural resources, which supported the analysis of agroforestry's potential to attenuate declines in those resources (objective e). I explored those issues in the interviews with the different actors and investigated how they confirmed, contradicted, complemented and/or explained that information.

conceptual framework were presented in subsection 1.1.1 and in Figure 1.2 of the previous chapter, respectively.

Table 2.2 Data collection methods used in different periods, with respective sample size, data gathered and thesis' objective addressed.

Period	Method	Sample size	Data collected	Objective
2010-2015	Survey of secondary sources	-	- Description of extension process - Discourses on agroforestry - Trends in PAs natural resources	a b, e e
May / 2011	Unstructured interviews – local people	14 key informants	- Historical trends in: - Livelihood activities - Local institutions - Relationship to PAs and PAs' resources - Relationship to development projects - Perceptions of agroforestry extension	a, e a, b, c b, c, e b, c b, c
Jun-Jul / 2011	Participant observation – local people	-	- Livelihood activities - Social dynamics	a, d a, c
Aug; Oct / 2011	Structured interviews – local people	116 households	- Demographic attributes, gender roles, livelihoods (activities portfolio, assets), agroforestry extension	a, c
Nov / 2011-Jan / 2012; Jun-Jul / 2012; Jun / 2013	Semi-structured interviews – local people	23 participant and 23 non-participant households	- Perceptions of PAs and agroforestry extension; relationship with local institutions and powerful people; objectives and aspirations; - Perceptions of development projects - Perceptions of livelihood activities (particularly in terms of environmental outcomes); perceptions of PAs' natural resources	b, c b, c, d b, c, e
2011-2013	Semi-structured interviews – PA staff	3 staff members	- Perceptions of PAs' natural resources	b, e
2011-2013	Semi-structured interviews – UFSE extension staff	3 staff members	- Description of extension process - Discourses on agroforestry	a b, e
2014-2015	Semi-structured interviews– academia & state extension	3 staff members	- Discourses on agroforestry	b, e

I spent a total of 11 months in the field, divided in three periods: the first and main one lasted from May/2011 to January/2012 (briefly interrupted by a one-month break); the other two complementary ones comprised the months of June and July/2012 and of June/2013. Language was not an issue, as my native language Portuguese was the one spoken locally. Interviews with PA and extension staff were irregularly distributed during field research and will also be described later in this section.

For the first six months of field research, I lived with my husband in a house shared with other researchers in a PA field base – I typically stayed from early morning to late afternoon in the communities and returned to the field base to sleep. I preferred to spend some time letting people know me and what I was doing before I asked for shelter. That was important, as people were frequently hesitant to engage with outsiders due to negative past experiences. For the next five months, I took turns staying with five local host families. During that period, I would alternate nights between the PA base and one of the host families.

To reach the communities and the individual houses, I relied on an aluminium boat borrowed from PA staff, powered by a small engine (*rabeta*) similar to the ones used locally in wooden canoes. That was also important as, in addition to that engine being far more economical than the more powerful ones used for surveillance purposes by PA staff, that also contributed to local people apparently not associating me with the PA staff; thus they talked to me quite freely about their negative and positive perceptions of the PAs. In fact, with the added factor that I myself drove the boat, the *rabeta* served me well in establishing rapport and close ties to local residents. I had to rely on locals and their experience as I was learning to find my way around the area, how to solve little problems with the *rabeta*, and how to interpret the changing weather. In an extreme example, I was able to share and – almost – laugh with them about my story of being caught in a storm and having the boat almost turned upside down by the wind and waves.

To conduct the unstructured, semi-structured and structured interviews with local people, I generally met them either at their homes or elsewhere during their routine activities. Those meetings were held with one household at a time, and usually agreed a few days in advance (except for the questionnaires/structured interviews), when I would explain my work and ask for their consent. I also had time during the day for more informal conversations – for example, at the end of the day when households would sometimes gather to talk, and at other social events.

Taking into consideration the apparent disappointment caused by past development projects, I emphasised that I was not bringing any kind of ‘project’; I tried to explain that, instead, I hoped that locals could benefit indirectly from my research, as one of its objectives was to inform current and future projects on how to better engage with the study communities. Local reactions to my own research – verbalised or not – helped me to get an understanding about social networks and how locals related to outsiders in general. Both the general willingness and openness to talk to me, and the few exceptions of reluctance or hesitation to talk, were informative. After some time in the field, some people would openly tell me why they had come to like me or trust me, what had been said about me and by whom to whom, or why they did not want to talk to me anymore.

I began field research by attempting to get an overview on what seemed to be the most important issues affecting local communities and, consequently, agroforestry extension. My study population consisted of four of the communities involved in UFSE’s agroforestry project in 2010 and 2011⁴⁰. Based on previous talks with PA and extension staff and on the two frameworks presented in Figure 1.1 and in Figure 1.2 of chapter 1 (the general one and the one specifically on participation), I chose to focus on four broad key themes in the first month of unstructured interviews with local people: 1) activities

⁴⁰ I was not able to include one of the communities involved in the agroforestry project in 2010 due to restrictions in time. In 2011, when most of my fieldwork was carried out, other *quilombola* and indian communities joined the project, but these were not considered for the present study.

composing local livelihood portfolios (objective a); II) local institutions and decision-making processes (objectives a and b); III) relationship to the PAs and PA natural resources, and with PA staff (objective b); and IV) perceptions of development projects (objective b). The last two themes emerged recurrently and spontaneously as people talked about how life had changed in the communities in the past decades. In search of an historical perspective, I talked mainly with elderly key informants and also with people occupying leadership positions in local institutions in all four study communities. Local perceptions of historical trends on livelihood activities and on PA natural resources were particularly useful in the analysis of the extent to which local activities are responsible for declines on those resources and should be substituted by alternatives such as agroforestry (objective e). On the other hand, experiences with local institutions and with external actors such as PA and development project staffs fall under the community-level component of the conceptual framework on participation (targeted by objective c). Key informants were initially indicated and introduced to me by extension staff, and later on by the local households themselves. At my request, extension staff made clear that we were not working together, which I tried to emphasise during field research.

Recording oral histories was the main approach used in that initial phase. Oral histories generally covering the period from the 1950s to the time of research were recorded for a total of eight households, whereas those going back until the 1980s were recorded from two. Less structured variations of methods such as timeline and seasonal calendar construction and wealth ranking were also used (the last one is described in more detail in subsection 2.4.1). I would come to interview sessions prepared to use the visual aids usually recommended for those methods, but talking flowed so naturally, that the visual aids seemed an unnecessary intervention. Preliminary timelines and seasonal calendars were constructed based on data extracted from oral histories and improved based on later interviews with individual households. Later interviews specifically aimed at identifying and attributing dates (i.e., the approximate year) to key events were carried out with seven households and also tended to cover the 1950s-2010s period, while those aimed at identifying when (months) the main livelihood activities' typically occurred were conducted with three households. Additionally,

I also interviewed seven participant and five non-participant⁴¹ key informants in search of perceptions about UFSE's project. In order to get an initial sense of the range of those perceptions and of their influence on participation, I talked to households falling on both extremes in terms of their acceptance or resistance towards the project (objectives b and c).

In the next two months, while continuing with the interviews with key informants, I focused on observing and many times also participating in routine daily activities. Those included, for instance: fishing, house chores (cooking, washing, cleaning), the various steps in manioc processing (harvesting, peeling, grating, roasting) and canoe making (from the fallen tree to the final piece), small *mutirões*⁴² to weed the community centre (*centro comunitário*⁴³), the weekly church service and the annual religious festivity. I did not accompany locals in activities that required long expeditions – mainly brazil nut and *copaíba*⁴⁴ extraction – due to limitations in my schedule, but talked at length and in detail about them. I was able to get a deep sense of the various activities, especially in terms of labour constraints and underlying social dynamics (objective a). The first aided the analysis of how agroforestry would fit in with other livelihood activities and how this would influence livelihood outcomes (objective d). The second supported the understanding of how participation would be shaped by the social capital component of this thesis' conceptual framework (objective c). I also accompanied households in visits to the agroforestry areas implemented under the scope of UFSE's project, located mostly either in the homegardens, fallows or agricultural fields.

⁴¹ By 'participant' households I shall mean, from now on, the ones who have received the donated seedlings at least once. In specified contexts, I may imply other forms of engagement with UFSE's project or broader forms of exercising agency with the use of the expression 'participation' and its variants.

⁴² Groups of people that gather to perform a particular task collectively.

⁴³ Community space where important social events – such as church service, school classes, football match, meetings and festivities – take place.

⁴⁴ Resin produced by the tree trunk.

In the next two months, I piloted and then applied a questionnaire (Annex 3) with 116 households (approximately 90% of the study population; the remainder could not be reached after three attempts). It was drafted before field research and finalised during its first months based on my initial findings. The heads of households (men and women) were interviewed jointly whenever possible. The survey comprised variables on UFSE's agroforestry extension project and on themes under the 'demography', 'livelihood' and 'gender roles' components of the conceptual framework on participation (variables are detailed in Chapter 4) (objectives a and c).

In the next six months, I conducted semi-structured interviews with a sample of 23 participants (cases) and 23 non-participants (controls) in UFSE's project – two to three interview sessions were carried out with each of those households. During this period, I also continued observing and participating in the local routine activities. The 23 cases were selected from a total of 32⁴⁵ participant households of the study population using quota sampling. The sampling was stratified so that all four communities would be represented and disproportionate, as I aimed to include all participant households from the two communities with fewer participants (one of those households ended up being left out). Convenience sampling was used in the two other communities until the predefined quota was reached. The control households selected were the best individual matches⁴⁶ for each of the 23 cases in terms of community of residence, main income sources and age – at the time, evidence suggested that those might act as important confounding variables. Randomisation of samples was not crucial as the analysis would be mostly of qualitative nature. The

⁴⁵ Other two participants had moved to the city at the time of my fieldwork, coming to the field site only sporadically, which made it unfeasible to talk to them. My aim was to focus on the enrichment of the tree and shrub component of local farming systems, so I did not consider as participants the seven households who reported to only have received herbaceous species seeds, which were planted mostly in homegarden *jiraus* (elevated small container, such as an old canoe or a wooden box, used to grow medicinals, spices and vegetables).

⁴⁶ In case-control studies, controls can either be individually or frequency matched. In the first case, cases and controls are matched in a one-to-one basis, according to set attributes. In the second case, case and control groups are matched in terms of the frequency of set attribute states in each group.

interview guide used was elaborated in the previous months and covered themes that needed more in-depth investigation (objective b). Most of the components of the conceptual framework on participation were explored: factors concerning the household-level (objectives, aspirations) and community-level (relationship with local institutions and with people locally perceived as more powerful due to their wealth or leadership position, perceptions of PAs and past development projects), and factors related to the extension program (perceptions of extension objectives and general approach, and of agroforestry). Interviews also focused on perceptions of livelihood activities, particularly in terms of environmental outcomes. The data gathered provided the basis for the analysis of factors influencing participation, of agroforestry's potential in terms of income generation, and of the contribution of local activities to declines in PA's natural resources (objectives c, d and e).

In terms of the data collected with the collaboration of PA staff and UFSE extension staff, initial informal conversations held in 2010 were complemented by unstructured and semi-structured interviews conducted at the beginning of field research. Interviews with PA staff looked at the PAs management activities and at trends concerning its natural resources, in order to inform the analysis of agroforestry's potential to reduce perceived declines (objectives b and e). Oral histories were recorded and timelines were constructed, following a similar approach to the one adopted with local households in terms of the complementarity of both methods and of the lack of visual aids. Both methods were employed with two members of PA staff and covered the 1970s-2010s period in one case, and the 1980s-2010s period in the other. A total of 10 follow-up semi-structured interviews sessions were conducted on those issues with PA staff (two with one of the members and four with each of the other two members). Informal conversations about day-to-day activities and threats to PAs were also carried out, mainly during my stay in the PA field base.

With UFSE extension staff, oral histories were recorded to explore their historical perspective of the extension process, including unpredicted events, redefinition of aims and strategies, and lessons learned along the way (objective a). Oral histories were recorded for three of the five members of

UFSE extension staff. At the start of field research, I also accompanied some of the planting events carried out by UFSE staff. From 2011 to 2013, a total of seven follow-up semi-structured interview sessions on the extension process were conducted (five with one of the staff members and one with each of the two others). Their narratives (and their sources, e.g.: literature, peers, empirical) on agroforestry's role in farmers' livelihoods, biodiversity conservation and PA management and about factors influencing participation were documented, which informed the analysis of agroforestry's potential contribution to conservation (objectives b and e). Their motivations, implementation strategies and evaluation of the extension process were also explored.

I also conducted semi-structured interviews with those who appeared to be among the main sources of UFSE extensionists' views on agroforestry. Two of them worked for federal research institutions (UFSE and National Research Institute of the Amazon – INPA) and the other one, for the state extension service (EMATER/PA). Their narratives on agroforestry's role in conservation were recorded (objective b) so that they could be compared to those of UFSE extensionists, in order to assess how the former may have influenced the latter (objective e). I conducted a total of six interview sessions (three with EMATER/PA staff member, two with INPA staff member, and one with UFSE staff member).

The analysis of the interview and participant observation materials and secondary data was mostly of a qualitative nature. Those were searched for recurrent and contrasting perceptions, factual accounts, events and quantitative measures concerning UFSE's agroforestry extension in terms of drivers and constraints to local participation, and of potential outcomes for local livelihoods and biodiversity conservation. That search was supported by the coding of all the interview material – subjects covered under those broad themes included: agroforestry; the extension process; past development projects; local livelihood activities, particularly those perceived as threats to the PAs; the PAs and its natural resources, particularly in terms of perceived trends; and household assets. Regarding survey data, logistic regression was used to assess the

influence of the various explanatory variables on the dependent variable of 'participation' (see subsection 2.4.2 for a detailed description).

I have withheld the names of most people referred to in this thesis and sometimes used fictitious names for the institutions they worked for. I have identified people in the few cases they explicitly stated that preference after seeing the relevant sections of this thesis' final version. Occasionally, it was difficult to ensure anonymity, particularly when talking about influential local people. When appropriate and possible, I omitted details that would reveal a person's identity.

2.4.1 Wealth ranking

In this subsection, I explore the measurement of wealth differentials among households (which was seen as a key variable potentially affecting participation), focusing on how livelihood portfolios and aspired material goods were used as criteria to contrast the worse and better-off households.

I was interested to find out whether local people perceived marked differences in wealth within the communities. To guide me in the choice of the method to be used, I considered two aspects: the level of detail I required and the feasibility to collect the necessary data. My ultimate aim was to explore whether agroforestry was likely to benefit the worse-off, so categorising households into wealth groups, rather than ranking every single household in relation to each other, would suffice. Moreover, income surveys are associated with the opportunity to secure social service payments, making questions about monthly or annual cash income very likely to yield unreliable responses.

Guttman scaling was one of the methodologies used. In a perfect Guttman scale ($CR = 1.0$ and $CS = 1.0$ ⁴⁷), a unit of analysis (e.g., a person, a household) accumulates or manifests certain traits in a certain order (e.g., from less to more

⁴⁷ CR – coefficient of reproducibility; CS – coefficient of scalability

valuable in scales of material goods), so if that unit of analysis exhibits one trait, then it also must have all other ones lower in the order. In other words, when a list of items conforms closely enough to a perfect Guttman scale ($CR > 0.90$ and $CS > 0.60$, as proposed by Guest 2000), we can affirm with an acceptable level of confidence that households with the same score manifest the same traits. That allows households to be ranked meaningfully according to their score – and specifically to their wealth when using indicators of wealth as traits.

Several households mentioned certain material goods – some of which are particularly expensive – when talking about aspirations for the future, while others reported to have actually purchased those very goods when they managed to gather enough money. Based on those observations, I argue that those goods could be reliable indicators of wealth, although few households explicitly made that association. I included questions about the possession of those items on the household survey and apparently found no resistance towards them from respondents. The survey results for six of those material goods presented an acceptable level of conformity ($CR = 0.934$ and $CS = 0.713$) to a perfect Guttman scale. My list of material goods produced the following scale:

1. gas stove
2. house roofed with corrugated *fibrocemento* sheets or clay tiles
3. television
4. fridge or freezer
5. large boat and respective engine
6. house walled with bricks and cement

For instance, a household owning three items would probably own a gas stove, a house roofed with corrugated sheets or clay tiles and a television (the higher the values for CR and CS, the higher the probability). As households generally did not explicitly associate those items to either worse or better-off, I had to

establish the cut-off value arbitrarily. Households were divided in three groups: worse-off (owning one of the items – probably item 1 – or none), in-between (owning two or three items – probably items 1 and 2 or 1, 2 and 3) and better-off (owning four items – probably items 1, 2, 3 and 4 – or more).

While this classification focused on material wealth, local accounts suggest that state pension, formal employment and cattle are locally associated with a “better condition” not only as sources of material wealth, but also as they provide a reliable income and require less strenuous labour. Therefore, a better-off group defined as such by the reliance on those income sources would imply that broader connotation. That difference is reflected on the fact that the better and worse-off groups resulting from the two classifications agree only in part – at the extremes of the Guttman scale ranking. The households that possess either five or six items of the scale on one side (8%) and the ones that possess no items on the other side (7%) correspond exactly to households that, respectively, do and do not have either state pension, formal employment or cattle raising as a component of their portfolio of income generating activities. On the other hand, among the households that own one to four items of the scale, both livelihood portfolios are observed in similar proportions.

Both criteria – ownership of material goods and composition of livelihood portfolio – will be used, as both produce a meaningful identification of the worse-off. The two will be used separately as both focus on different aspects of wealth – I will discuss how participation is likely to impact the worse-off, as identified by these two distinct methods.

2.4.2 Group-lasso regularised logistic regression

In this subsection, I describe the group-lasso regularised logistic regression method, used in the analysis of the drivers and constraints to participation.

Logistic regression is a type of regression analysis specifically appropriate when the outcome variable in question is dichotomous – in this study, to have

participated or not in the agroforestry extension project. The analysis models the probability of participation for given values of the explanatory variables – if linear regression was used instead, some values would fall outside the 0-1 range (James *et al.* 2013, pp. 130-131).

As the number of predictors (41) was high relative to the number of cases (116 households), other routines needed to be run in combination with logistic regression. Routines that conduct feature selection were preferred over ones that do not, such as ridge regression. Feature selection involves excluding some of the predictors from the model, reducing its complexity and enhancing its interpretability.

Lasso was chosen as a feature selection method, as it is recommended when the number of cases is not much larger than the number of predictors. In such case, least squares coefficient estimates have particularly high variance – in other words, small changes in the sample would tend to result in large changes in estimated coefficients. Lasso shrinks/penalises/regularises the least squares coefficient estimates towards zero (coefficient estimates that reach zero are excluded from the model), which results in a considerably lower variance at a cost of a negligible increase in bias (James *et al.* 2013, pp. 34-36, 218). Under that reasoning, lasso would be more advisable than methods based on unregularised least squares estimates, such as stepwise methods. Group-lasso (a specific application of lasso) was used, as it ensures that the different categories of a particular nominal variable are treated as a group and are all included or excluded from the model (Hastie *et al.* 2008, p. 90).

Logistic regression modelling involves estimating coefficient β for each of those variables. Coefficients were estimated for a range of penalty parameter (λ) values. λ controls the strength of the penalty and its optimal value (one that minimises error considering the bias-variance trade-off) was obtained by conducting 10-fold cross validation. That consisted in randomly dividing the sample into 10 folds (groups), estimating coefficients for a range of λ values 10 times (each time with each of the folds omitted), testing the models in the

omitted folds, and calculating the average errors over the folds. Cross validation was repeated 100 times in order to reduce randomness and to average the error curves. The predictors with β coefficients estimated as nonzero for the optimal λ were included in the model. Positive coefficient values indicate that the increase in the predictor (in the case of continuous ones) or the presence of a state (in the case of categorical ones) is associated with an increase in the probability to participate, and negative values, with a decrease in that probability.

Testing the significance of predictors that enter the lasso model is a work in progress and still a matter of disagreement (e.g., Lockhart *et al.* 2014 and related discussion by several other works in the same journal issue). For instance, the use of bootstrapping (repeating the statistical analysis of interest with multiple random samples with replacement of the original dataset) as a technique to estimate standard deviations of lasso model coefficients has been criticised (Kyung *et al.* 2010). Therefore, bootstrapping is used here in a more general way, in order to assess the volatility of the predictors set that entered the original lasso model and, thus, get a sense of the extent to which the model could be extended to other similar samples. This was carried out by comparing the composition of the original predictor set with the sets included in the lasso models generated for 100 bootstrap samples with the same size as the original dataset.

Finally, the overall ability of the method employed here to find the 'true' variables (the ones that would be included in the model, if the whole population is considered), was estimated through the Monte Carlo simulation method (Johansen & Evers 2007, pp. 5-7). The actual 'true' variables are not directly accessible for comparison with the variables included in the original lasso model. As a way to address that, the latter were taken to represent the 'true' ones and are compared to the ones generated in the simulated samples. 1000 new outcome sets (participation versus non-participation) were simulated for the original dataset of predictors based on the original model added by an error factor. The error factor consisted in generating random values between 0 and 1

and assuming that participation is the predicted outcome when its probability is higher than those values, instead of the usual 0.5 cut-off value.

2.4.3 Limitations of the study methods

The main limitations of the study methods concern the applicability of results, and the detail and precision levels of the data generated.

Firstly, the case study design allowed for an in-depth understanding of a particular experience of agroforestry extension but yielded results that find restricted application in certain sites, as discussed earlier in this chapter.

Secondly, the mixed-methods design combines the strengths of quantitative and qualitative approaches to data collection and analysis, but some limitations are still imposed by the methods used. On the one hand, household surveys helped me, for instance, to address specific questions related to the composition of livelihood activities portfolios, whereas participant observation and qualitative interviews allowed me to get an in-depth understanding of how households manage labour demands from different activities daily and across seasons, and how and why portfolios have changed across decades. Additionally, the use of both secondary sources survey and qualitative interviews to collect data on wildlife and forest cover trends allowed for triangulation.

On the other hand, certain methods associated with different disciplinary perspectives could contribute with more detailed or more precise data. For example, the data collected through participant observation and qualitative interviews did allow me to explore how social ties may have influenced information flows and participation. However, for a more detailed analysis of communication structures, additional tools such as social network analysis (e.g., Isaac *et al.* 2007) should be used. Also, I was interested in exploring local perceptions of agroforestry when compared to local livelihood activities and the potential of agroforestry to fit into existing livelihood portfolios. It was beyond the

scope of this study to compare agroforestry and local activities in terms of external measures of profitability; for that matter, methods such as net present value and cost-benefit analyses (e.g., Oliveira *et al.* 2010) could be applied. Moreover, available analyses of forest cover trends were sometimes incomplete or unreliable. More precise deforestation rates could be provided by direct analysis of satellite imagery, but estimations yielded by secondary sources in combination with those obtained from local people were enough for the purposes of this study.

2.5 Conclusion

In summary, my mixed-methods case study focused on the agroforestry extension project conducted by UFSE among *quilombola* communities in two neighbouring PAs. The project consisted of planting donated seedlings (mainly of *cupuaçu*) in individual households' areas for forest conservation and income generation purposes. The remoteness of the study site is likely to favour the former and constrain the latter significantly.

The two PAs have a well-conserved forest cover and are home to important nesting sites of the giant river turtle. Their creation appears to have significantly reduced access to wild resources that were historically used by the study communities. On the other hand, since then, people have also had increasing access to social service payments and wage labour, and there has been a succession of livelihoods-related projects.

Data was collected primarily through qualitative and quantitative interviews, participant observation and informal conversations in the study communities during an 11-month-period. This was complemented by interviews with PA and extension staff and archival searches.

The next chapter will focus on an important aspect of the analysis of agroforestry's potential role in PA conservation. It will examine the extent to

which extension staff's narratives on agroforestry's contribution to forest cover conservation are evidence-based or merely reproduce received discourses.

CHAPTER 3 Discourses on agroforestry's role in deforestation reduction at Saracá-Taquera National Forest – where do they come from and who are they aimed at?

3.1 Introduction

At least since the 1990s, agroforestry has been recommended for the recovery of deforested areas and the reduction of deforestation in environmental policy documents at the international level (e.g., United Nations Division for Sustainable Development 1992). From the 2000s on, a similar path was followed at the national level (e.g., Interministerial Permanent Working Group/ *Grupo Permanente de Trabalho Interministerial* 2004; Dias 2006). Narratives have historically implied an opposition between agroforestry and shifting agriculture – the latter has been portrayed as an important driver of the deforestation ‘problem’ that agroforestry would be supposed to address. However, as explored in Chapter 1, those narratives have tended to overlook evidence indicating an overlap between the two land uses, a distinction between the shifting cultivation practiced at forest margins and in isolated areas, and the role of more powerful drivers of deforestation. Although some of those are acknowledged in current funding guidelines (e.g., Eringhaus 2012), a certain ambiguity still persists about the role of shifting agriculture in deforestation. Moreover, the ways in which contrasting policy portrayals of shifting cultivation and agroforestry are reflected in conservation practice have rarely been examined (e.g., Pollini 2009).

The present research is concerned with the first two years of implementation of an agroforestry extension project conducted by Federal University of the Southeast (UFSE)⁴⁸ at Saracá-Taquera National Forest. The objectives of this chapter are:

⁴⁸ Fictitious name.

- to trace back the roots of project staff (herein extensionists) discourses about agroforestry's potential role in the context of deforestation;
- to analyse the extent to which those narratives reflect an analysis of literature and empirical evidence, or the mere reproduction of received discourses;
- to examine the role extensionists' discourses may have played, considering the audiences they have reached.

Although this chapter will look at perceptions of agroforestry both in terms of its direct and indirect contribution for conservation, it will focus on the former, particularly when compared to shifting cultivation practices. The latter, involving the substitution of livelihood activities perceived as threats, is discussed in more detail in Chapter 6.

The present chapter relied on the collection of secondary data – public policy documents, funding proposals, project reports, publications – and of primary data through semi-structured interviews with extensionists and with actors identified as the main sources of their narratives on agroforestry. Empirical evidence in support of discourse analysis was collected through participant observation and qualitative interviews and through structured interviews with a sample of 116 households (approximately 90% of the study population).

Discourse analysis is used as a methodological approach. The narratives of extensionists and their sources are viewed as illustrating “socially constructed realities” and analysed in terms of the “meaning given to social and physical phenomena” (Hajer & Versteeg 2005, pp. 175-176). Hajer and Versteeg assert that studies on environmental policy discourse have identified biases in the conceptualisation of ‘problems’ and ‘solutions’. In Chapter 1, I have discussed how problems can be constructed to fit a solution that one can or is willing to offer. The conceptualisation of problems are considered here as part of a process of developing ‘crisis narratives’, in the sense discussed by Roe (1995, p. 1066) and by Bravo (2009 p. 262). According to them, “by generating [...]

crisis narratives, technical experts [...] assert rights as 'stakeholders' in the land and resources they say are under crisis", claiming that "not only are insiders, specifically local residents, not stewarding their resources, but those who really know how to sustain those resources are outsiders" and defining "communities 'at risk' in order to justify expert interventions".

In section 3.2, I examine UFSE extensionists' discourses concerning the role of agroforestry and shifting cultivation in the context of deforestation. In section 3.3, I explore the roots of UFSE extensionists' discourses. I examine the discourses in the literature and public policy context and those of key university and state extension service staff members. In section 3.4, I analyse how they contribute to shape UFSE extensionists' discourses and the role of the latter considering the audiences it has reached. In section 3.5, I discuss the chapters' main findings.

3.2 UFSE extensionists' discourses on agroforestry – the place of deforestation and shifting cultivation

The contribution of agroforestry to conservation permeates – in both explicit and implicit terms – the accounts of UFSE extensionists. However, arguments about the deforestation problem that agroforestry would address and the role of local practices are not always internally consistent. The comparison of those arguments with empirical evidence obtained in the present study reveals the extent to which UFSE extensionists' narratives reflects a critical analysis of available evidence.

This section is based on the examination of project documents such as funding proposals and reports and of semi-structured interviews with three of the four staff members involved in project field work in 2011.

Project documents develop the justification for the promotion of agroforestry along two main lines: its potential contribution to livelihoods on the one hand and to the environment on the other. The second rests on a crisis narrative

stressing that local agricultural practices, described as relying on “the clearance of small fallow areas to plant almost exclusively manioc”, generate impacts, such as: “soil depletion”, “impacts on local fauna and flora” and “great environmental impacts which have been reproduced for decades”. Higher level impacts in terms of climate change also compose that narrative: “changes in rainfall and in river levels and record temperatures in the summer which destroy entire agricultural fields corroborate the need of channelling our attention to agricultural practices in the forest”. It is implied in that narrative that the forest clearance for shifting cultivation would underlie those impacts.

In a clear contrast to the impacts attributed to local practices, agroforestry is portrayed as a “diversified planting where species are intercropped with native vegetation”, part of a process of “soil maintenance”, “fallow enrichment” and of “reforestation of stagnated areas, which contributes to the decrease of the high deforestation rates in the Amazon driven by smallholders”. That storyline conveys the idea that the soil, biodiversity and forest cover impacted by shifting cultivation demands a recovery intervention and that the introduction of agroforestry can play that role.

Some of the extensionists' accounts obtained through interviews tell quite a different story when compared to project documents regarding the diversity of crops in shifting cultivation and the role of that land use in deforestation.

Firstly, the latter emphasises that “fields are planted almost exclusively with manioc” and that “the most cultivated species are manioc and banana”, although they also mention a few other species (sweet potato – *Ipomoea batatas* and *cará* – *Dioscorea* sp.) as being planted by most of the households. Interview accounts diverge on that matter. The accounts of one of the staff members align with project documents, adding that diversified agricultural production was characteristic of past generations and something agroforestry would come to revive. On the other hand, another staff member emphasises the polycultural nature of current local agricultural practices; he affirmed that agroforestry was present in local practices in the sense that the dominant

manioc is frequently combined with other species, including perennial ones (not cited in the two project documents). According to that staff member, that interpretation dates back to 2009 and even favoured the choice towards agroforestry for the 2010-2011 extension activities – agroforestry would come to build upon already existing practices. In the interviews, he also suggested that homegardens and the practice of leaving some forest species when clearing the field (the two were not mentioned in the two project documents either) can be seen as composing the set of local agroforestry practices. The last staff member combines the perspectives of the other two members: he agrees with the first when referring to manioc fields and to the second, when talking about homegardens:

Long ago, they [local people at the study communities] used to plant much more than they do today. Nowadays, they have almost a manioc monoculture. [...] So agroforestry was a way to revive their traditional culture. [...]

I find agroforestry much like local practices. [...]. Sometimes, they already used the techniques we taught, for example, plant one species that will grow very tall next to another. They already did it around their houses. These fruit trees are common there.

(UFSE extensionist)

The results obtained in the present study are more aligned with the UFSE extensionists' accounts emphasising polyculture. The results indicate that, in four of the five communities UFSE's staff worked with, households grow an average of 10 annual cultivars in their agricultural fields and nine annual or perennial cultivars in their homegardens (see Chapter 5 and Annex 4). Moreover, several households (66 and 44%, respectively) affirm that they often either spare a few forest trees when clearing the field or actively plant a few perennial species among the annual ones (typically one to three species are mentioned per household as examples, in each of the two cases).

Secondly, by mentioning that the project involved “allying the rotation of [agricultural] areas to the management of fallows”, project documents suggest that the perennial agroforestry practices recommended were to coexist with the local itinerant agriculture. However, one of the documents mentions, as benefits of the proposed practices, the fact that they contributed to maintain the soil biomass and, consequently, did not depend on the rotation of areas – it is implied that they would be preferable to the local practices of burning and of rotation, associated in another document with soil depletion. Two explanations can be extracted from project documents. The first and more prominent one is that agroforestry, as a perennial land use, could be implemented in fallows located by river margins near homes rather than in old growth⁴⁹ forest areas, portrayed as scarce there. Thus, it is related to local land scarcity and its social implications⁵⁰, rather than to the environmental aspects of deforestation at the landscape level. In contrast, the second explanation is based on environmental concerns: firstly that the introduction of an itinerant land use would contribute further to deforestation and secondly, that fallows have been deforested by local shifting cultivation and need to be recovered. It is implied by the latter that agroforestry could play that role.

According to the interview accounts of one of the UFSE extensionists, with the 2009 survey and later with the analysis of satellite imagery, that staff member came to realise that local people would “scratch a little fraction of the forest, of its margin”. Another member seconds that view; he suggests that deforestation in the study communities would be negligible in comparison to the one in Rio do Norte Mining company (*Mineração Rio do Norte* – MRN) extraction sites.

⁴⁹ ‘Old growth forests’ are defined, in this study, as those that have experienced little to no recent human disturbance. That is the definition adopted by Gibson et al. (2011) for ‘primary forests’. I prefer to use the first term in that context, as the second one frequently implies pristiness or no disturbance at all.

⁵⁰ Local land scarcity is perceived as more intense in one of the participant communities. Social implications include the pressure to establish new itinerant fields in areas that are more difficult to access.

According to those accounts, deforestation would not be a problem in the study communities. However, the opposite is implied in other interview extracts of the two extensionists, which reinforce the link between shifting cultivation practices and deforestation verified in project documents. They contrast agroforestry and shifting agriculture in terms of the extent of deforested areas and of the use of fire: “agroforestry does not require so much forest clearance as slash-and-burn agriculture”; “agroforestry was going to enrich the soil again, to bring the fauna back, important things to restore the ecosystem which was many times destroyed with too much burning”. In the context of the second account, agroforestry is portrayed as a tool for the recovery of degraded fallow areas. In the context of the first, it is explained that agroforestry would coexist with, rather than replace shifting agriculture.

UFSE extensionists' interview accounts on low deforestation rates were the ones corroborated by the analysis of deforestation based on secondary monitoring data and local households' accounts conducted in the present study. The area deforested at the study communities in the 2000s has been identified through satellite imagery analysis by Andrade (2011, p. 25). As will be discussed in Chapter 6, it corresponds to cattle pastures and may also include adjacent shifting agricultural fields in earlier stages of regeneration. The total deforested area of 89 ha can be considered very small – 0.04% of the *quilombola*⁵¹ territory (titled and non-titled areas) and 0.01% of the national forest (interior and buffer zone)⁵². Focusing only on shifting agriculture and including areas that are unlikely to have been detected by satellite imagery analysis, the total area under cultivation in a given year around the time of this study can be estimated as falling within a 74-89 ha range⁵³ – similarly, very small (for simplicity, I will use the average value of 81 ha from here on). If the

⁵¹ Descendant of escaped slaves.

⁵² In contrast, the non-titled area occupies as much as 9% of the national forest proper and the titled area is equivalent to 8% of its buffer zone (see Chapter 6 for details).

⁵³ The area usually cleared for agriculture in a given year by each household was obtained through structured interviews. Minimum and maximum values reported were each summed up, so as to estimate the total area under cultivation in a given year.

area occupied by young fallows is added⁵⁴, the total deforested area concerning shifting cultivation can be obtained. From the available data⁵⁵, it could be rather safely argued that, at the time of this study, that total area would fall below 0.8% of the *quilombola* territory area and 0.2% of the national forest area.

From that snapshot, the rate of forest clearance can be estimated⁵⁶. Firstly, it is widespread practice to 'replant' (*replantar*), or to cultivate the same field with manioc twice. Secondly, although it is common that, in each of those two times, a field that is harvested as needed can supply a household for approximately one year, it is not rare that such period is extended to up to two years. Therefore, it can be argued that an area of 81 ha was definitely not cleared annually, but only every two to three years.

That does not mean, however, that the area deforested by shifting agriculture was expanding at that rate. Although part of that area corresponds to old growth forest, the other part of it refers to fallows. According to local households, the type of area predominantly chosen over the past years depended mainly on: a) whether they had recently moved to a new site where old growth forest dominates (due to reasons unrelated to the agricultural activity, or – from the most to least cited – to poor accessibility, conflict with livestock, ant attacks, soil problems including 'tired' soils or rotting manioc roots in the previous site); b) what time of the year the household was available to clear the field (old growth forests and old fallows need to be cleared earlier) and c) whether households preferences favour old growth forests (due to the lighter work involved in

⁵⁴ After a certain age of regrowth, it would be questionable to consider fallows as deforested.

⁵⁵ According to structured interviews, households have cultivated an average of two different sites up to the time of this study. However, households were rarely able to estimate the number of fields they had cultivated in each of those sites. According to anecdotal evidence, the number of fields cultivated in a given site would not exceed 20 and would frequently be less than five. A hypothetical average of 10 fields per site (possibly an overestimation) would yield an average total of 20 fields per household. Even if old fallows are not subtracted, this would correspond to only 0.8% of the *quilombola* territory area and 0.2% of the national forest area.

⁵⁶ The following estimate does not take into account population growth. The annual rate between 2000 and 2010 for Oriximiná was 2.65%.

weeding, or to the greater manioc productivity per area) or fallows (due to lighter work involved in forest clearance, or to the earlier manioc maturing and harvesting). Households were divergent about that matter – both options of areas featured prominently across households' accounts.

Moreover, even if only the fraction of the 81 ha area that represents old growth forest clearance is accounted for as deforestation expansion, that would still represent an overestimation. At the same time shifting cultivation is expanding to old growth forest areas, fallows are reaching advanced stages of regrowth.

In summary, extensionists' claims implying that shifting cultivation fields are composed of few cultivars and that shifting agriculture constitutes a relevant driver of a deforestation problem at the study communities are not supported by empirical evidence. Received discourses to be explored in the next section may have contributed to shape those claims.

3.3 The roots of UFSE extensionists' discourses

Agroforestry has historically been portrayed as a solution for a deforestation problem driven by shifting agriculture. That storyline has been reproduced, despite literature and empirical evidence indicating its weaknesses. In this section, I trace the roots of extensionists' discourses on agroforestry. I firstly examine literature and public policy narratives. Then, in the context of those narratives, I analyse the discourses of university and state extension service staff members who contributed to shape extensionists' discourses.

3.3.1 Literature and public policy

As examined in Chapter 1, policy narratives at the international and national levels have historically implied an opposition between shifting agriculture and agroforestry regarding their role in deforestation. In this subsection, I contrast two Brazilian biomes in particular – the Atlantic and the Amazon Forests – as it is in that context that UFSE extensionists' and their sources' discourses take shape. I examine the two biomes in terms of deforestation history, discourses

about deforestation in the literature and public policy, and implications for narratives on shifting cultivation. The public policy recommendations of agroforestry for the two biomes run along similar lines, so will not be dealt with here (see Chapter 1 for a discussion of policy at the Amazon Forest biome level and at the national level and MMA (1998, p. 20), for a sample of the Atlantic Forest policy).

Deforestation history

Deforestation in the Atlantic Forest dates back to the colonial period – the biome is located along the country's Atlantic coast and, thus, was the first to be occupied by colonisers. Sugar cane and coffee monoculture farming, gold mining and cattle ranching have taken turns as protagonists in successive economic cycles and, consequently, as major drivers of deforestation since XVII century (Câmara 2005, pp. 37-38; Joly *et al.* 2014, p. 462). In XX century, deforestation is said to have accelerated – in its early decades, several states still retained most of their original forest cover⁵⁷ (Câmara 2005, p. 37). That acceleration has been attributed to coffee farms expansion, wood extraction (Câmara 2005, p. 37; Victor *et al.* 2005, pp. 24, 31; Gubert-Filho 2010, pp. 16-18) and, from the 1970s on, to sugar cane plantings for alcohol production in the context of the petroleum crisis; to eucalyptus monocultures for the paper industry (Câmara 2005, pp. 37-38; Joly *et al.* 2014, p. 462); and to new settlements integrating the national agrarian reform program (Tabarelli *et al.* 2005, p. 696).

Deforestation in the Amazon Forest is much a more recent phenomenon – by 1975, less than 1% of the biome had been cleared (Browder 1988, p. 252). The process of agriculture modernisation in the south of the country intensified with

⁵⁷ For instance, approximately 58% and 60% in the southeastern states of São Paulo and Espírito Santo and 80% in the southern state of Paraná (SOS Atlantic Forest Foundation/ Fundação SOS Mata Atlântica & National Institute for Spatial Research/ Instituto Nacional de Pesquisas Espaciais – INPE 2007 *apud* Atlantic Forest Biosphere Reserve's National Council/ Conselho Nacional da Reserva da Biosfera da Mata Atlântica n/d; Victor *et al.* 2005, p. 15; Gubert-Filho 2010, p. 15).

the onset of the military dictatorship in the 1960s, which led to land consolidation and to an excess of rural labour force in that region (Browder 1994, p. 48-49). This, coupled with demographic pressure in the drought-and-poverty-stricken northeast of the country, are part of the context in which government programs – designed to serve as safety valves by supporting migration towards the Amazon region – were implemented in the 1970s and 1980s (Smith 1981, p. 755; Browder 1994, p. 49).

Those government colonisation programs comprised road construction and pavement, tax and credit subsidies, as well as extension services (Smith 1981; Browder 1994). They represented the expansion of economic incentives and extension that had been supporting the process of agriculture modernisation in the south. However, program components were accessed by a limited proportion of migrants and, moreover, were shown to be inappropriate both in social and environmental terms (Smith 1981, p. 213-215; Browder 1994, p. 53-55, 57). That was many times followed by crop failure and indebtedness among the poorer farmers and, ultimately, by conversion of agricultural areas to pastures. The latter can be seen as the result of poor people's strategy to speculate, with low labour investments, in the face of rising land prices (especially for partially 'improved' – i.e. deforested – land), and also of land consolidation and pasture expansion carried out by the wealthier (Collins 1986, p. 3; Browder 1994, p. 56). It is in that sense that peak deforestation rates detected in the Brazilian Amazon in the 1970s and 1980s have been attributed to government colonisation and development programs involving pasture planting (as in Browder 1988, p. 251).

In the 1970s, the process of deforestation intensification in the two biomes was coupled with the acceleration in the creation of protected areas (PAs) following the Yellowstone model (Diegues 1993, p. 30; Câmara 2005, p. 38).

Discourses on deforestation

Similarly to the Amazon Forest biome (see Chapter 1), discourses on Atlantic Forest deforestation and its solution matured in the context of the momentum

gained by the international environmental movement in the 1990s. In the former, there is lack of clarity concerning which land use should be prioritised by efforts aimed at deforestation reduction (see Chapter 1), whereas in the latter, there is contention regarding the urge to preserve remaining forests as pristine areas.

At the international level, discourses on the Atlantic Forest are deeply related with the rise of the 'hot spot' concept. That biome has been listed among the world hot spots since Myers (1988) introduced the concept, based on criteria that considered the species endemism of a given area and the level of threat it was under. Regarding the latter, the area would need to have lost more than 70% of its primary vegetation to qualify as a hot spot.

Conservation International (CI) was one of the first non-governmental organisations (NGOs) to incorporate the hot spot concept into conservation practice at both international and national levels. Since 1989, just one year after Myers' seminal work, CI has used the concept (CI 2014) and the associated crisis narrative as part of a discourse justifying its conservation priorities. Policy level impacts include the development of priority areas and actions for conservation in the Atlantic Forest by CI and collaborating Brazilian institutions, as part of the National Program for Biological Diversity (CI-Brasil *et al.* 2000).

Since then, the Atlantic Forest has been depicted in the literature as one of the top-five leading hotspots (Myers *et al.* 2000) and even as the "hottest of the hotspots" (Laurance 2009). In support of those headlines, the authors develop crisis narratives emphasising how little of the forest is left.

Earlier narratives sourced deforestation data from the pioneer national level assessments that the Brazilian NGO SOS Atlantic Forest Foundation (*Fundação SOS Mata Atlântica*) had been coordinating in partnership with the National Institute for Spatial Research (*Instituto Nacional de Pesquisas Espaciais* – INPE) since 1990 (which referred to the 1986-1990 period)

(Fundação SOS Mata Atlântica & INPE 1990; 1993; 1998; 2001; 2008; 2009; 2011; 2013; 2014). More recently, other institutions have conducted assessments with similar aims, such as Institute for Socio-environmental Studies of South of Bahia (2007), Ribeiro *et al.* (2009) and Ministry of Environment/ *Ministério do Meio Ambiente* – MMA and Brazilian Institute for the Environment/ *Instituto Brasileiro do Meio Ambiente* – IBAMA (2010; 2012). The estimates of remaining vegetation coverage for the 2001-2005 period vary widely among studies: from as low as 11% to as high as 27 and 29%. That variation is said to reflect, in addition to actual changes in vegetation cover across time and technical issues (e.g., images' resolution and cloud coverage) (Fundação SOS Mata Atlântica & INPE 2008; MMA & IBAMA 2012), the different definitions adopted for 'remaining vegetation' – lower figures are attributed to the exclusion of forests in earlier stages of regeneration (Ribeiro 2009)⁵⁸. The crisis narratives mentioned earlier have made use of figures falling on the lower end of the range of estimates of remaining forest, benefiting from the greater sense of urgency they create.

Implications for discourses on shifting cultivation

The Yellowstone model assumes that PA conservation and local peoples' practices – among them, shifting cultivation – would be irreconcilable (see Chapter 1). From the late 1980s on, the crisis narratives in the national policy and in the scientific literature appear to have provided further justification for the application of that model in the Atlantic Forest.

It is also in the context of those crisis narratives that deforestation in that biome came to be strongly restricted outside PAs as well. According to 1993

⁵⁸ It has been suggested that, in the Amazon Forest biome, secondary forests are also sometimes overlooked by analyses of remaining forests (e.g., Hecht 2010). However, I focus my analysis on the Atlantic Forest biome as, I would argue, the emphases on 'how little forest is left' or 'how big the forest loss is' are more crucial for policy narratives concerning that biome, than for those concerning the Amazon Forest. I suggest that policy narratives are mainly legitimised in the former biome by assessments of deforestation extent; while in the latter, by the identification of deforestation drivers.

legislation⁵⁹, forest clearance could be authorised only in areas in early stages of regeneration, rather than areas in intermediate or advanced stages or primary areas⁶⁰. The specific case of fallow clearance for shifting cultivation is not mentioned. In practice, law enforcement has compelled farmers to reduce fallow periods (e.g., Ferreira 2004). That legislation was amended in 2006⁶¹ to explicitly admit the existence of shifting cultivation, and to regulate the authorisation of 10 year fallow cycles and the clearance of forests in intermediate stages of regeneration. Although legislation became more tolerant towards shifting cultivation, it is still based on the assumption that primary forests and secondary forests in more advanced stages of regeneration should all be conserved as pristine areas. That assumption, and the surrounding crisis narratives, overlook evidence on the compatibility of shifting cultivation practices with the persistence of large patches of Atlantic Forest with high conservation status (e.g., Gamberini 2013).

In the Amazon, non-fragmented and conserved forest areas are much more abundant; nevertheless, evidence of their coexistence with shifting cultivation practices is not fully acknowledged either. While international policy has distinguished the shifting agriculture of more isolated areas from that of forest margins, national policy is not so clear about that matter. The latter does identify forest margins as the site where deforestation is concentrated and cattle ranching as the main driver of deforestation. On the other hand, it implies that efforts to reduce deforestation should aim to reduce the use of fire in agriculture in general, regardless of location or of whether it is used for large-scale pasture expansion or for cyclic manioc cultivation in smallholdings. I have suggested, in Chapter 1, that such ambiguity and previous policies favouring cattle ranching

⁵⁹ *Decreto Federal 750*, 10 February 1993. *Dispõe sobre o corte, a exploração e a supressão de vegetação primária ou nos estágios avançado e médio de regeneração da Mata Atlântica.*

⁶⁰ That piece of legislation considers 'primary vegetation' as the one "in its fullest expression, with great biological diversity, where effects of human actions are minimal, so as not to affect significantly its original characteristics regarding structure and species".

⁶¹ *Decreto Federal 6600*, 21 November 2006. *Regulamenta utilização e proteção da vegetação nativa do Bioma Mata Atlântica.*

may represent a reflection of a long-term allegiance between the government and the cattle ranching sector.

The above national policies promoting the preservation of specific areas in the Atlantic Forest and the restriction of a specific practice in the Amazon provide the justification to restrain a range of land uses, shifting agriculture included. Acknowledging cases in which shifting agriculture may be compatible with forest conservation may not be of interest within the context of policy making (e.g., Dove 1983). That acknowledgement would require that crisis narratives strategically crafted to create a sense of urgency for the Atlantic Forest are softened, and that the attention is turned to the actual main drivers of deforestation in the Amazon, which other policies happen to contradictorily support.

3.3.2 Academia and state extension service members

Both the academia and the state extension service (*Empresa de Assistência Técnica e Extensão Rural do Pará – EMATER/PA*) acted as important links between literature and public policy narratives and those of UFSE extensionists. Events connected to two actors were shown to be particularly relevant: extension projects and modules run by a teacher from UFSE and an agroforestry project carried out by an extension worker from EMATER/PA. An earlier agroforestry project developed by a teacher from the Federal Research Institute of the Amazon (INPA) may also have influenced UFSE extensionists' discourses, indirectly. In this subsection, I examine as background how those actors are linked to the UFSE agroforestry extension project and the educational and professional experience underlying those actors' discourses. Then, I analyse those actors' discourses on deforestation and how those may have influenced their portrayal of agroforestry. I conclude by discussing the extent to which literature and public policy narratives (examined in the previous subsection) contribute to shape those actors' discourses.

Members of UFSE's extension project are unanimous in identifying their previous participation in MÃE (*Mutirão de Agroecologia* 'Agroecology

*mutirão*⁶²) as a landmark in shaping their common interest in agroforestry. MÃE was an extension project run by undergraduate students and a teacher of UFSE's Geography course. It involved the implementation of an agroforestry area on campus and the organisation of an annual series of talks on agroecology. The modules offered by that teacher earlier in the course are mentioned by students as one of the main sources of their knowledge about agroecology and agroforestry.

The UFSE Geography teacher's educational background in Biology and Ecology at the undergraduate and MSc levels was coupled with an involvement with folk culture, both in UFSE's state. The teacher identifies her desire to integrate ecological and social aspects as being at the roots of her interest in the Agroecology field. She says that such interest dates back to the mid-1990s, a period she links with the strengthening of the Movement of the Landless Rural Workers (*Movimento dos Trabalhadores Rurais Sem-Terra/ MST*) in the state. In the second half of the 1990s, she started to coordinate an extension project in which undergraduate students experienced the everyday lives in MST settlements, and also to offer the 'Ecosystems, Biodiversity and Culture' postgraduate module. The two events culminated in the 'Agroecology' undergraduate module and in the 'MÃE' extension project, initiated in the late 1990s and in the mid 2000s, respectively. UFSE extensionists took part in both.

According to the UFSE teacher, the 'Agroecology' module built upon the extension project at MST settlements and relied strongly on fieldwork at various locations in the state. It included visits to farmers in areas of the Atlantic Forest biome⁶³ with different levels of fragmentation and also to research institutions. At the onset of MÃE extension project, one of the farmers visited in that module was invited to participate in the planning of an agroforestry area for the UFSE campus by sharing his experiences with students. While the extension project at MST settlements is seen to "have a strong social component, as it was related to the agrarian reform issue", MÃE is viewed as based on an "ecological

⁶² Group of people that gather to perform a particular task collectively.

⁶³ The biome covers the whole state.

perspective”; the teacher recalls that the students had an urge for a hands-on experience.

Around the time an exploratory survey was being concluded by UFSE students at my study site, in 2009, they came into contact with EMATER/PA's staff at the Oriximiná office. EMATER/PA staff had been implementing an agroforestry project in four communities relatively close to the city and shared their experience and documents on the project with the students. EMATER/PA's strategy of donating seedlings, planting in fallows and targeting the school meals was also adopted by UFSE.

One EMATER/PA staff member is recalled by students as being particularly helpful. He undertook a technical course in Agriculture in UFSE's state, during which he was introduced to agroforestry in the context of reforestation. Following that, he graduated in Biology back in his native state of Pará. The choice, as a professional, to focus on agroforestry is attributed by him to that educational background and to a categorisation of that land use under a “sustainability” umbrella. He started working with agroforestry in Oriximiná city, as an employee for IBAMA. For a few years, he has collected information on local demands in terms of species that could be used to enrich local properties as part of the preliminary stage of an agroforestry project. He left before the implementation phase to join the EMATER/PA office in the same city and started working with agroforestry there in the subsequent year, in 2007.

EMATER/PA agroforestry project's objectives comprised the recovery of altered areas, making fallows productive and income generation, according to project documents. Its target was to support 100 families, approximately, with the implementation of a 1 ha agroforestry plot per family consisting of a combination of annual, semi-perennial and perennial crops. It started with two communities in 2007 and was expanded to include another two in 2009, with funding from MRN. Monthly visits were paid to participant farmers for technical advice on themes that included weeding and soil fertility management based on mulch, cattle manure and, when necessary, chemical fertilisers.

One of EMATER/PA's project documents attributes great importance to a previous agroforestry extension experience, carried out by INPA since the early 1990s, and uses an extract from a paper authored by one of its leaders as an argument for the projects' environmental relevance.

That INPA staff member, MSc Johannes van Leeuwen, is native to Europe, where he graduated in Tropical Silviculture and concluded MSc studies in that same field and also in the fields of Plant Breeding and Rural Sociology. According to him, his interest in the first field was focused on eucalyptus monocultures at first and came to shift towards agroforestry "by chance". In the late 1970s, he started researching local farming systems in Mozambique which, as he came to realise, were based on the combination of cashew trees with annual species such as manioc, maize, beans and peanuts. After ten years there, he moved to Brazil and, since then, has been part of INPA's academic staff and concentrated his research efforts on agroforestry. INPA teacher's approach to agroforestry research and extension takes shape in the context of his concern with small farmers. He argues that the latter would not benefit from green revolution technologies or those developed at experimental stations.

During the 1990s and 2000s, he coordinated a research project involving the implementation and evaluation of pilot agroforestry plantings in areas of 90 families distributed among 10 cities of Amazonas and Rondônia states, both located in the Amazon Forest biome (van Leeuwen 2002, pp. 90-91). Among the project's objectives, was the "development of agroforestry proposals that are suitable for the reality of farmers", with "as much diversity as possible and acceptable" (van Leeuwen *et al.* 1999, p. 253; van Leeuwen 2002, p. 89). The project reflects INPA teacher's concern, recurrently expressed in interviews, with agroforestry's adoptability.

Discourses on deforestation – main drivers and potential solution

The deforestation problem features in the crisis narratives developed by all of the three main sources of UFSE extensionists' discourses. However, the manner in which that problem is framed and the role attributed to shifting

cultivation by each of them is apparently influenced by their contrasting research and extension experiences. The crisis narratives set the background for the examination of how agroforestry would be likely to contribute to a solution.

The UFSE teacher refers to the deforestation in the Atlantic Forest of her state, specifically in MST settlements. That process is located in the past and attributed to the former owner of those areas – large cattle, sugar cane or rice monoculture farms – rather than to current smallholder settlers:

Ranchers and companies view the environment as a commodity. [...] That land was all covered with pasture, and the environmental agency was never able to recover it [restore the deforested land]. It was the [small] farmer who managed to recover it, by following a different model.

The absence of shifting agriculture from UFSE teacher's crisis narrative can be explained by her attention to the historical causes of deforestation and by a clearly positive evaluation of that land use from a conservation perspective. According to her explanation, that land use is not as widespread among the smallholders in the southeast of the country as among those in the north. On the one hand, that narrative attributes certain disadvantages to the use of fire, but on the other, it stresses the small scale of shifting agriculture and depicts fallows as resembling forest areas, rather than as degraded areas:

They [farmers of a specific city of her state] use the practice of fallowing, which is interesting; they take the forest as a model, but they burn. But it never is on a large scale. [...] You will never burn that area uninterruptedly; it will sometime be left to fallow. In that region, fallowing is allowed by the state law; it was a victory of the farmers. It was a traditional practice, but the environmental agency would always fine them because they were managing a forest area. Without fallows, they ended up cutting much more forest. After a certain stage [age of regrowth], they

were not allowed to cut the forest [so they cut it before that stage was reached].

Regarding agroforestry, the UFSE teacher emphasises its ability to “regenerate” or recover; in the context of her crisis narrative, the “regeneration” would be carried out by smallholders in lands deforested by former (capitalist) owners. She describes the process from an ecological perspective:

One very interesting thing, among many, is agroforestry's ability of regenerating in a short period of time. [...] You can regenerate and allow the use, regenerate and pick a fruit [...], so you shift the paradigm that says that agriculture is one thing and forest is another. [...]

In studies on basic Ecology, you deal much more with competition than with cooperation. But nature is much more cooperative than competitive. You understand this very quickly in an agroforestry system when you combine the species, watch the animals arriving and the soil changing. [...]

José Ferreira's area has a biodiversity conservation status that is similar to that of a primary forest. He recovered a good part of it. As there is much natural forest surrounding his land, things also have a synergy with it.

Agroforestry and natural forests are portrayed as very similar; in line with that, biodiversity is mentioned as a necessary characteristic of her concept of the former.

In contrast with UFSE teacher's positive evaluation of shifting agriculture, INPA teacher's accounts are ambiguous about it. The latter talks about deforestation in the context of the Amazon region, and is emphatic in situating it at forest margin settlements, rather than at more isolated, sparsely populated areas. In accounts obtained through interviews, shifting cultivation is portrayed as one of its drivers, but the main role is clearly attributed to cattle ranching:

The agroforestry issue was born as a reaction to, as a concern with, the environmental degradation in Africa, at the margins of Sahara, at the colonisation areas of the Amazon. But I believe that, at that time, no one thought about the quilombolas [referring to my study site], because the population density is very low. [...]

Every year one has to clear a new manioc field and with manioc, you have to advance over the forest. [...]

70% of the deforestation is for cattle ranching.

Differently from interviews, however, shifting cultivation and cattle ranching are not clearly distinguished in terms of their relative contribution to soil degradation and, implicitly, to deforestation in a publication cited in an EMATER/PA project document:

“The agriculture that is practiced in the Amazon replaces the forest for annual crops, which are abandoned after two to three years (Kitamura 1994). In the case of pastures, the period of use is larger: 10 to 12 years (Kitamura 1994), but the resulting soil degradation is also greater. The problem is that the Amazon soils do not provide a suitable environment to either annual crops or pastures, due to its low levels of biomass per area” (van Leeuwen et al. 1999, p. 251).

From another publication's extract, one may even be lead to deduce that shifting cultivation is considered as a major driver of deforestation. Based on fallow periods needed for soil fertility recovery cited from the literature, the INPA teacher concludes that “shifting cultivation requires large areas of forest. The fundamental question is how to reduce the smallholder's need for new land, or, in other words, how to decrease his dependence on annual crops” (van Leeuwen 1992).

As in UFSE teacher's accounts on agroforestry, the INPA teacher also praises agroforestry's ability to recover or, in other words, to restore deforested lands.

However, in contrast with its quite romantic depiction as being based on natural processes of “cooperation” and “synergy” by the previous narrative, a context of stricter law enforcement is mentioned by the INPA teacher as a driver underlying agroforestry-led recovery. That recovery is examined in the context of Amazon Forest margins, where deforestation would be concentrated according to his crisis narrative. Moreover, enforcement is portrayed not as a standalone driver, but one that should be combined with measures that ensure the system’s profitability and, consequently, acceptability. Those measures would include attenuating restrictions motivated by romantic ecological concerns and allowing reforestation with agroforestry systems composed of fewer species.

With the [new] forest code, [...] there will be a great reforestation component. [...] [But] will that be limited to fulfil law requirements or are we capable of making it productive? [...] If it is not productive, you will always need a lot of surveillance. But there [Rondônia state, forest frontier], and this is for the biologists, [...] you should not so dogmatically look for combinations of many species. The planting has to have one main species; it has to have an economic justification. No one plants motivated by environmental concerns, if you have environmental concerns, fence it and leave it, nature recovers it.

In addition to that narrative on the recovery of already deforested areas, the INPA teacher also develops a storyline in which agroforestry would contribute to prevent future deforestation. Aligned with the ambiguity of his crisis narratives regarding the main driver of deforestation, both cattle ranchers and farmers practicing shifting cultivation are part of that storyline. Regarding the former, he proposes that trees could be integrated into pastures as part of a soil fertility management in order to reduce the need to abandon pastureland and to advance into the forest. Concerning the latter, he argues that agroforestry could replace part of the area under shifting cultivation. The reasoning would be that agroforestry, as a perennial land use, would depend less heavily on the clearance of forestland.

EMATER/PA extensionist's ambiguous discourses on shifting cultivation may have been influenced by the ambiguity expressed by the INPA teacher. The former voices his concerns with deforestation in a specific rural area near Oriximiná city. Shifting cultivation practiced by small farmers is depicted as the main driver and cattle ranching, as a minor one:

Here in the Amazon you can clear up to 80% [of the property], but most have already cleared nearly half [of the property] and sometimes even all of it. [...] There are not many ranchers, most are farmers. Each farmer clears 0.5, 1ha, if you sum it all up, he is the great villain.

That crisis narrative takes a side by implying that fallows are to be considered as deforested areas, rather than areas in a regeneration process. That takes place in the midst of an ambiguous account on shifting cultivation – the EMATER/PA extensionist depicts fallows as passing through an efficient recovery process but, at the same time, as being unproductive and in need of an intervention that speeds up the process:

They live at the margins of the lake and keep on advancing. There are agricultural fields far from the houses. The area close to the house is already unproductive, very worn out. [...] That area used to be a forest area, they cut it, plant, then it is left to fallow, it recovers. It needs six, eight, 15 years so that he can return. [...] Some plant pasture, but most let it recover. [...] That area stays abandoned. [...] He could plant some species to recover it.

The EMATER/PA extensionist adds that shifting cultivation would rely on a single product, as it would involve “only harvesting manioc”. Concerning agroforestry, his narrative bears resemblance with certain aspects of both UFSE and INPA teachers' ones. According to the EMATER/PA extensionist, agroforestry would help to diversify the manioc-based shifting agriculture, as an adaptation to local homegardens. Similarly to the UFSE teacher, he depicts

agroforestry as an “imitation” of natural forests, with some adaptations so as to favour its use:

The forest has species which are interesting for nature, but for the farmer, a species that does not bear fruits is not interesting. With agroforestry, he will imitate nature, but in a way that he has the species that he wants in that area.

He relates that analogy with agroforestry's ability to enhance and maintain soil quality, which would allow the farmer to stay in the same area rather than force him to move onward.

According to the EMATER/PA extensionist, in order to find out whether the introduction of agroforestry actually contributed to a reduction of deforestation at his field site, further research would be needed. On the other side, he builds upon his crisis narrative depicting shifting agriculture as a major driver of deforestation there. He contrasts the perennial agroforestry with the itinerant local practices, implying that the former would occupy less forestland. Like the INPA teacher, he suggests that the former could, potentially, prevent future deforestation by replacing part of the area under the latter:

They have an income in their property from agroforestry. It is an income which they did not have before, which they come to have annually, at different times of the year. So that surely will reduce [deforestation]. He [the farmer] says: 'I have a regular income, so I will work less to produce my farinha [manioc "flour"]'.

One of the differences in the accounts of the three actors concerns the driving forces to which they attribute the deforestation problem. At the biome level, the historically uneven roles played by small-scale shifting cultivation and by large-scale land uses such as cattle ranching in deforestation expansion are clearly acknowledged by UFSE teacher's narratives. That may reflect her positive

stance towards local knowledge and practices, apparent in her early engagement with social issues. The INPA teacher, on the other hand, is not as clear on whether shifting cultivation should be considered an important driver, together with cattle ranching. Both actors align with certain aspects of public policy narratives of their respective biomes: with the greater tolerance of shifting cultivation practices in recent Atlantic Forest legislation and with the ambiguity of Amazon Forest policy which acknowledges cattle ranching as a major driver but fails to prioritise it in the context of deforestation reduction efforts. EMATER/PA extensionist's narratives refer to a specific site of a city, rather than to the biome as a whole. Although, as the INPA teacher, the EMATER/PA extensionist also expresses some ambiguity regarding shifting agriculture, the latter takes a side by clearly identifying that land use as the main driver of deforestation.

That difference among the three actors' discourses on the place of shifting cultivation among the drivers of deforestation would explain their contrasting narratives on agroforestry. Firstly, although all three mention agroforestry's ability to recover deforested areas, for each of them the areas in need of recovery corresponds to the land uses identified as important drivers of deforestation: large land owners', both pastures and shifting cultivation fields, and shifting cultivation fields, according to UFSE teacher, INPA teacher and EMATER/PA extensionist, respectively. Secondly, agroforestry's potential contribution to deforestation reduction through the substitution of shifting cultivation appears in the narratives of the INPA teacher and of the EMATER/PA extensionist, but not in the ones of the UFSE teacher. Therefore, although both the Atlantic Forest and the Amazon Forest policies recommend agroforestry as an "alternative" to deforestation and also as a tool to "recover" deforested areas (e.g., Eringhaus 2012, p. 90; MMA 1998, p. 20), only the two actors working within the second context mention those two aspects.

Another difference among the three actors is apparent in the portrayal of agroforestry. UFSE teacher's analogy of agroforestry with forests and emphasis on the ecological processes involved in agroforestry-based regeneration may have been shaped by their educational background in the Biological Sciences.

The EMATER/PA staff member is also a Biologist and makes a similar analogy. On the other hand, in INPA teachers' accounts, pragmatic concerns with agroforestry acceptability among farmers takes precedence over ecological concerns, which may have been influenced by his educational background in the more applied science of Silviculture.

3.4 UFSE extensionists' discourses on agroforestry – influence of received discourses and implications for reached audiences

Literature and public policy narratives, as well as those of actors closely related to the UFSE extension program are likely to have contributed to shape UFSE extensionists' discourses on agroforestry. In this section, I will analyse the aspects of UFSE extensionists' discourses which were not supported by empirical evidence (as examined in section 3.2) in terms of the extent to which they may represent a reproduction of received narratives (analysed in the previous section). I will also discuss the role which reproduced narratives may have played, considering the audiences they have reached – directly, or indirectly through the extension interventions they support.

Reproduction of received discourses?

Regarding the type of problem agroforestry would address, there are similarities among the narratives of UFSE extensionists, of environmental policy, and of actors closely related to the UFSE extension program. All of them depict deforestation as a relevant problem, in terms of its extension. In comparison to UFSE extensionists, however, Atlantic Forest policy and the UFSE teacher refer to an entirely different biome; and Amazon Forest policy, the INPA teacher, and the EMATER/PA extensionist, to specific areas of the same biome which do not include the study communities. Interpretations have lost relevance as they were taken out of their original context.

Concerning the deforestation problem's driver with which agroforestry is contrasted, UFSE extension staff narratives are closer to the ones of the EMATER/PA extensionist, who clearly refers exclusively to shifting agriculture in

that context⁶⁴. In the Atlantic Forest's primary areas and those in more advanced stage of regrowth, policy also implies that shifting cultivation is a relevant driver of deforestation, although not the only one, by failing to distinguish the role of that land use from that of large-scale uses. Similarly, although the INPA teacher refers to shifting cultivation in that setting, he also refers to cattle ranching and, additionally, is not clear whether the first should be considered a relevant driver, reflecting the ambiguity of Amazon Forest policy. UFSE extensionists partially reproduce policy narratives that, in their original context, served the purpose of maintaining a sense of urgency to conserve, and of diverting the attention from the actual main drivers of deforestation.

In terms of how agroforestry would contribute to solve the deforestation problem, the recovery of deforested areas mentioned by UFSE extensionists is also mentioned by the UFSE teacher, the INPA teacher and the EMATER/PA extensionist. However, only for the last one those deforested areas would have been cleared mainly by shifting cultivation. Differently from the last two actors, for the UFSE extensionists agroforestry would coexist with, rather than replace that land use. Therefore, only one of the two potential contributions of agroforestry that are mentioned in Atlantic and Amazon Forests policy are reflected in UFSE extensionists' narratives.

In summary, UFSE extensionists combine elements of multiple narratives in order to compose their own discourse, without a clear predominance of a particular actor or biome policy. The greater emphasis, in project documents and in some of the interview accounts, on the predominance of a few species in local agriculture helps to compose a crisis narrative in support of agroforestry's contribution in terms of "fallow enrichment" and "reforestation". The link between shifting cultivation and deforestation also contributes to a crisis narrative that justifies the introduction of agroforestry with the purpose of recovering allegedly degraded areas.

⁶⁴ Regarding the narratives of the EMATER/PA extensionist, it was beyond the scope of this study to examine whether the identification of shifting agriculture as the main driver of deforestation at his working site is supported by empirical evidence.

Discourses' role for outside and inside audiences

UFSE extensionists' environmental discourses on agroforestry are directed outwards, to an audience of potential funding agencies, and inwards, to potential participants. To the former, the project is presented as one that contributes to solve a relevant environmental problem and, thus, is worth funding (through documents such as proposals and reports, as examined in section 3.2). UFSE extensionists managed to get their funding, which covered up to one year of project activities, renewed twice during the present study.

Although it was also directed inwards, extensionists' discourses probably had limited impact in terms of promoting participation. While local households do mention the reforestation of fallows as they describe how the project was presented to them by extension staff, conservation aspects were hardly pointed out as one of their motivations to participate. Households' accounts suggest that the scale of the forest areas cleared for shifting agriculture or cattle raising in the national forest by the time of my fieldwork were generally perceived as small and not seen as a problem. On the other hand, income generation through the marketing of tree products was typically mentioned as a motivation to join in.

UFSE extensionists' discourses on agroforestry could also impact local households indirectly, by shaping extension interventions. From those discourses, it could be expected that the extension program would focus on the recovery of young fallows with native perennial species. Although that expectation has been partially fulfilled, agroforestry plantings were also carried out in other areas such as homegardens, old fallows and even old growth forest, and planted species also included non-native species.

Regarding the selection of the area(s) where agroforestry would be implemented, local households' preferences were determinant according to themselves and extensionists. Those included manioc fields still under cultivation and young fallows, but also other areas – labour demand was one of the factors considered. For instance, some households privileged homegardens for species aimed at home consumption or “fire fallows” (*capoeiras de fogo*),

where the understorey, which would require partial cutting to make way for the seedlings, had recently been bunt by fire escaped from an adjacent field.

Concerning the choice of which species would compose the agroforestry plantings, factors such as species marketing potential, availability at donor institutions and abundance at the study communities had a relevant influence. Firstly, *cupuaçu* (*Theobroma grandiflorum*) was elected by extensionists and local households as the predominant species based on their perception that a particularly favourable market existed for that species. The species is native to the Amazon region, but does not occur in old growth forests at the study communities, according to households⁶⁵. Secondly, due to limited availability of other species, many of the species donated in the second planting event were already abundant locally as natural stands (e.g., *açaí* – *Euterpe* sp., *bacaba* – *Oenocarpus bacaba*, *paricá* – *Schizolobium amazonicum*). That perception of local abundance was one of the reasons given by locals to having dropped out of the extension project. In the face of local households' complaints, extension staff avoided donating those species in the subsequent planting event.

3.5 Discussion

Public policy crisis narratives presenting shifting cultivation as an important driver of a deforestation problem are reproduced by UFSE extensionists' narratives and used to legitimise the promotion of agroforestry. Crisis narratives are reproduced despite the awareness of opposing empirical evidence, as an attempt, I would argue, to add value to the project before the eyes of funding agencies and local households.

UFSE extensionists' discourses have roots both in the Atlantic Forest and the Amazon Forest settings. Public policy crisis narratives concerning both biomes

⁶⁵ Another species of the same genus (*cupuí* – *Theobroma subincanum*) is identified by locals as common there. The information provided by locals about the two species aligns with Martini and Tavares' (2005) analysis of the natural distribution of different species of the *Theobroma* genus across the Brazilian Amazon.

have historically suggested that shifting agriculture constitutes an important driver of deforestation. I have applied the discourse analysis approach in an attempt to clarify “assumptions, judgements and contentions on which each discourse rests” and “tactical or strategic goals” that can lie beneath “dogma[ti]c” experts’ conceptualisations, as discussed by Hajer and Versteeg (2005, pp. 179, 181). The fact that public policy on deforestation in the Atlantic Forest relies on authoritative experts’ analyses of satellite imagery may be concealing the strategy of presenting only the lowest of the available estimates of remaining forest in order to justify the preservation of certain areas as pristine areas. In the Amazon, public policy narratives have acknowledged that cattle ranching represents the main driver of deforestation, but at the same time have favoured that land use by failing to clearly prioritise it in the context of deforestation reduction efforts.

Three actors contributed to shape how public policy discourses were assimilated into UFSE extensionists’ narratives. Similarly to public policy concerning Amazon Forest deforestation, the INPA teacher and the EMATER/PA extensionist are ambiguous in their portrayal of shifting cultivation. The former presents cattle ranching as the main driver of deforestation in the Amazon, but also argues that agroforestry could contribute to reduce deforestation by reducing shifting cultivation areas. The latter implies that fallows are to be considered as areas under a regeneration process efficiently managed by farmers, but also in need of an intervention that speeds up the process. On the other hand, the UFSE teacher questions certain aspects of public policy on Atlantic Forest deforestation and depicts shifting cultivation as compatible with forest cover conservation.

Certain elements of those three actors’ discourses are reflected in UFSE extensionists’ narratives, which have at times reproduced and at times challenged public policy discourses. Project documents aimed at funding agencies tend to reproduce crisis narratives by presenting a deforestation problem in which forests are cleared and replaced by manioc monoculture and then by fallows degraded by the use of fire. Although some of the interview accounts align with project documents, other interview accounts demonstrate

that UFSE extension staff do not ignore empirical evidence indicating that shifting agriculture and agroforestry overlap in terms of species composition and that deforestation rates in the study communities are far from alarming. I align my analysis of environmental discourses with Mosse's (2004, p. 657) conceptualisation of the links between development policy and practice by arguing that UFSE extensionists' crisis narratives are oriented outwards to wider policy goals, so as to legitimise the promotion of agroforestry and secure reputation and funding. However, as Hajer and Versteeg suggest (2005, p. 181), I do not mean to reduce extensionists' discourses to strategic behaviour, as "there are discursive categories that are inaccessible to subjects". Instead, I see the pursuing of strategic goals as one of possibly multiple factors that contribute to shape those discourses.

Although UFSE extensionists' environmental discourses were also aimed at local households, they had limited impact among the latter in terms of shaping participation either directly, or indirectly by shaping extension interventions. Households' concerns related to livelihood outcomes were apparently more important, in the second case.

In this chapter, I examined the extent to which extensionists' claims about agroforestry's potential to contribute to conservation were supported by evidence. This chapter also introduced the issue of participation, by examining its link with extensionists' discourses. Participation is another crucial element in the analysis of agroforestry's role as a tool for PA conservation and will be the focus of the next chapter.

CHAPTER 4 Why do(n't) they participate? – factors influencing participation in UFSE's agroforestry extension project

4.1 Introduction

Local people's decision-making processes are one of the fundamental aspects to be considered in the design of an agroforestry extension project. Such an endeavour would probably have little prospects to engage households in the achievement of its final aims – be they social, economic or environmental – if those households' aspirations and views were overlooked. Nevertheless, as mentioned in Chapter 1, although scientific input to technological advances in agroforestry dates back at least to the 1970s, it was only from the 1990s that studies on the drivers of and constraints to agroforestry adoption and diffusion expanded significantly (Alavalapati & Nair 2001, p. 71; Mercer 2004, pp. 313-314). Pattanayak *et al.* (2003) and Mercer (2004) present relevant reviews on the theme; the latter points out that “[a]pproaches to analyzing agroforestry adoption tend to follow the vast literature on adoption of agricultural production technologies”.

It may be relevant, however, to take a broader view. Taking part in an extension process might be as closely related to the technology promoted and to the extension process themselves as to wider contexts in which the extension project takes place. The literature on participation in development has much to contribute to the understanding of the factors affecting the uptake of agroforestry practices as it explores, for instance, social dynamics within communities (e.g., power relations as discussed by Cleaver 2001) and community's relationship with external actors (e.g., past experiences with development, as illustrated by Vincent 2004). The way in which those factors interact and influence the participation in agroforestry extension is examined in subsection 1.4.3 of Chapter 1.

The central aim of this chapter is to identify and analyse the main drivers and constraints to local people's participation in the agroforestry extension project carried out by Federal University of the Southeast (UFSE)⁶⁶.

In section 4.2, I present the methods used, particularly for quantitative data analysis. In section 4.3, I briefly present how participation rates varied among planting events and among communities. In sections 4.4 and 4.5, I focus on particular sets of factors and their bearing on participation. In section 4.4, I analyse factors relevant at community level, focusing on those concerning relationships with external actors and internal social dynamics, and examining implications in terms of communication channels and social capital. In section 4.5, I examine household-level factors regarding objectives and aspirations, and also those related to demography, gender roles and livelihoods. In section 4.6, I discuss the chapter's main findings.

4.2 Methods

A mixed methods approach was followed for data collection on the factors influencing participation depicted in Figure 1.2 of Chapter 1. As detailed in Chapter 2, participant observation and qualitative interviews were used to explore community-level factors regarding the relationship with external actors and to internal social dynamics, household-level ones concerning aspirations and kinship ties, and implications in terms of extension-related ones regarding communication channels and perceptions of agroforestry. A timeline was created in order to gather historical trends on the changing relationships with outsiders and also on internal social changes. Quantitative interviews (questionnaires) targeted the remaining household-level factors, related to demography, gender roles and livelihoods (Table 4.1).

During its first two years of implementation (2010-2011), 32 households of the four study communities (28% of the sample) participated in the agroforestry project. By 'participant' households I shall mean, from now on, the ones who

⁶⁶ Fictitious name.

have received the donated seedlings at least once. They were all included in the quantitative interviews carried out with a sample of 116 households (approximately 90% of the study population). I additionally conducted qualitative interviews with key informants and with a subsample of 23 participant and 23 non-participant households, aiming to look into some issues in more depth.

The indicators composing each set of factors, listed in Table 4.1, were developed based on the literature on adoption of agricultural innovations and on participation in development. Some of them take into account certain specificities of the study site: the 'activities portfolio' includes all the main income sources; 'social capital' comprised participation in the main social events, local institutions and past development project; under 'human capital', experiences with the tree component and with species diversity in agriculture were considered as examples of experiences with aspects of the technology that was promoted; for 'natural capital', soil type was used as proxy – soils containing dark earth (*terra preta*) are considered the most fertile by local people; the 'wealth and well-being' indices were based on local perceptions of livelihood activities and material goods associated with the worse and better-off (see Chapter 2). The categories of the variables considered in the statistical analyses are detailed in Annex 5.

Group-lasso regularised logistic regression was conducted in order to assess the influence, on participation, of the variables documented through quantitative methods and of one of the variables investigated through qualitative methods ('close kinship ties with supportive gatekeeper') (for a more detailed description of the method, see Chapter 2). Chi-square, on the other hand, was used in specific bivariate analyses⁶⁷ to test the independence between variables. When expected cell counts fell below five, Fisher's exact test was applied instead.

⁶⁷ Bivariate analyses were conducted between explanatory variables, and between the outcome variable and specific explanatory variables with the purpose of undertaking comparisons across communities.

Table 4.1 Methods used to collect data on the explanatory variables

Factors	Data collection method
COMMUNITY-LEVEL	
Past experiences with external actors Development projects Protected areas	Qualitative interviews (incl. timeline)
Internal social dynamics Local institutions Power relations	Participant observation and qualitative interviews
Place of residence Relative to the protected area Community	Questionnaire
HOUSEHOLD-LEVEL	
Perceptions Objectives and aspirations	Qualitative interviews
Demography Age of adult male (years) Age of adult female (years) Formal education of adult male Formal education of adult female Household size – total Household size – 14-60 years	Questionnaire
Gender roles Choice/planting of homegarden trees by adult male Choice/planting of homegarden trees by adult female Weeding of homegarden by adult male Weeding of homegarden by adult female	Questionnaire
Livelihoods – activities portfolio Brazil nut extraction as income source <i>Copaíba</i> ^a or <i>breu</i> ^b extraction as income source Wood extraction as income source Agriculture as income source Cattle as income source State pension as income source Medium to long-term job as income source	Questionnaire
Livelihoods - assets - social capital ^c Close kinship ties with supportive gatekeeper Participation in the brazil nut project Use of <i>mutirão</i> ^d for own <i>roça</i> ^e Participation in <i>mutirão</i>	Qualitative interviews Questionnaire Questionnaire Questionnaire

Factors	Data collection method
Participation in football match	Questionnaire
Participation in church service	Questionnaire
Participation in other meetings	Questionnaire
Participation as community coordinator	Questionnaire
Membership in local association	Questionnaire
Membership in umbrella association	Questionnaire
Livelihoods - assets - human capital	Questionnaire
Household labour used in <i>roça</i>	
Experience of adult male with <i>roça</i>	
Experience of adult female with <i>roça</i>	
Tree planting in <i>roça</i>	
Tree tending in <i>roça</i>	
Species diversity in <i>roça</i>	
Species diversity in homegardens	
Livelihoods - assets - natural capital	Questionnaire
Type of soil in <i>roça</i> – <i>terra preta</i> ^f or <i>areia preta</i> ^g	
Type of soil in <i>roça</i> – <i>areia</i> ^h or <i>areia</i> with <i>barro</i> ⁱ	
Type of soil in <i>roça</i> – <i>barro</i>	
Livelihoods - wealth and well-being	Questionnaire
Index based on livelihood portfolio	
Index based on possession of key durable goods	

^a *Copaifera* sp. ^b *Protium* sp.

^c Certain aspects of social capital were also analysed at the community level

^d Group of people that gather to perform a particular task collectively.

^e Agricultural field ^f dark earth ^g black sand ^h sand ⁱ clay

The predictors with β coefficients estimated as nonzero were included in the logistic regression model and will be presented in the next sections. Positive coefficient values indicate that the increase in the predictor (in the case of continuous ones) or the presence of a state (in the case of categorical ones) is associated with an increase in the probability to participate, and negative values, with a decrease in that probability.

Testing the significance of predictors that enters the lasso model is a work in progress; therefore, bootstrapping and Mont Carlo simulation were applied with

a broader purpose. Bootstrapping was used in order to assess the volatility of the predictors set that entered the original lasso model and, thus, get a sense of the extent to which the model could be extended to other similar samples. Monte Carlo simulation was employed to estimate the overall ability of the method employed here to find the 'true' variables (the ones that would be included in the model, if the whole population is considered).

4.3 Preliminary results

Participation varied both across time and space. Firstly, extensionists had carried out three seedling donation events by the time I initiated my fieldwork – two in 2010 and one in 2011. New households joined the extension project mainly in the second planting event; some of the households joining the project in the first two events accepted more seedlings in subsequent events. (Figure 4.1). Secondly, participation rates differed among the four study communities (Table 4.2).

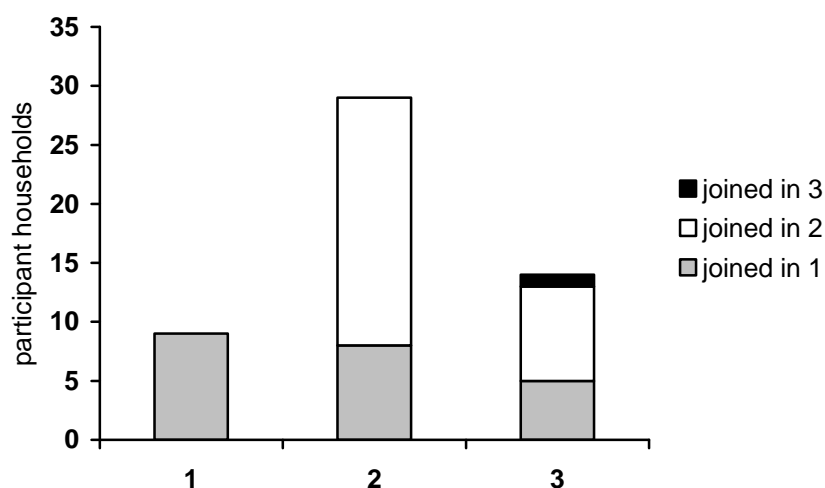


Figure 4.1 Number of households participating in each of the three plantings of UFSE's agroforestry project.

Grey – households that joined the project in the first planting; **white** – households that joined the project in the second planting; **black** – households that joined the project in the third planting.

Table 4.2 Number and proportion of households, in each of the four study communities, that participated in the agroforestry project (n=116).

	Sagrado (n=17)	Tapagem (n=37)	Paraná (n=17)	Abuí (n=45)
Participant households (number)	2	10	7	13
(%)	12	27	41	29

The 41 predictors analysed quantitatively are described in Annex 5 in terms of mean values or frequencies. Nine of them were included in the lasso model predicting participation in the original sample (Table 4.3). The results generated through bootstrapping suggest that most of those predictors (7 out of 9) would also tend to be included in new models generated for similar samples. Although the new models tended to include more predictors than the original one (17 against 9), only six of them were included in more than 75% of the new models. All of those six entered the original model. Those findings indicate that the original model can be extended to similar samples to a considerable measure.

A modest proportion of predictors composing the 'true' set match the ones that entered the models generated in the Monte Carlo simulation (4 out of 9, on average), and vice-versa (4 out of 9, on average). That indicates that part of the 'true' set tend to be included in the model generated by the method employed here and that part of the predictors in that model tend to correspond to the 'true' predictors. The more frequently the variable was included in the models generated for the bootstrap samples (see Table 4.3), the more likely it is that the variable composes the 'true' set.

In summary, the results suggest that participation tended to be greater among those closely related to the community gatekeeper; those who participated in the brazil nut project, those who take part in *mutirão*⁶⁸ or in church service less frequently, those who sell agricultural produce, *copaíba/breu* (*Copaiba*

⁶⁸ Group of people that gather to perform a particular task collectively.

sp./*Protium* sp.) or cattle more frequently; those who plant a higher diversity of species in their farm plots and those who use a higher number of family members as labour in those areas. Those factors are analysed in greater detail in the next sections, together with factors explored through qualitative methods.

Table 4.3 Predictors included in the lasso model, the change in the probability of participation with the increase in the predictor (in the case of continuous ones) or with the presence of a state (in the case of categorical ones), and the proportion (%) of the models generated for the bootstrap samples that included each variable.

	Increase (+) or decrease (-) in the probability of participation	Proportion (%) of bootstrap models including the variable
Livelihoods – activities portfolio		
<i>Copaíba</i> or <i>breu</i> extraction as income source	+	99
Cattle as income source	+	58
Agriculture as income source	+	54
Livelihoods – assets – social capital		
Close kinship ties with supportive gatekeeper	+	97
Participation in the brazil nut project	+	86
Participation in <i>mutirão</i>	-	92
Participation in church service	-	89
Livelihoods – assets – human capital		
Species diversity in <i>roça</i>	+	77
Household labour used in <i>roça</i>	+	46

4.4 Drivers and constraints to participation – community level

4.4.1 Past experiences with external actors: protected areas and development projects

The historical relationship of local people to protected areas (PAs) and development projects has shaped their views on external actors and on externally induced projects. Relevant events in that context include the creation of the Rio Trombetas Biological Reserve and the implementation of a project aimed at improving the commercialisation of brazil nuts. Since the first event,

the threat of forced resettlement has been a matter of deep concern to local households. To the second event, locals attribute a long list of shortcomings which include delayed and unfair financial returns, and mismanagement of project funds.

In this subsection, I take an historical perspective in the analysis of participation, following the approach taken by Vincent (2012). That author produces a detailed account, based on a long term study in a Peruvian community, about how people's experience of past projects informs their reactions to subsequent ones. That study analyses the multiple development projects carried out in that community over a 25-year-period; one of its findings was that the perceived shortcomings of a past rural development project contributed to make people hesitant to depend on collective commercial production. To the present study, the history of their relationship to PAs and the implications in terms of land tenure are also particularly relevant.

In search of perceptions of key historical events affecting local livelihoods, I asked key informants whether and how life in the community had changed from what it was like in the past and following that, what they could tell me about past projects. The Brazilian Institute for Forestry Development (IBDF) (later Brazilian Institute of the Environment and Renewable Natural Resources – IBAMA and now Chico Mendes Institute for Biodiversity Conservation – ICMBio) and the Association of the Slave Descendants of Oriximiná City (ARQMO) played major roles in their narratives – the former is associated with the forced resettlement of families occurring in the early 1980s and the latter, with an ambitious development project initiated in the early 2000s – the 'brazil nut project'. I will now briefly explore how forced resettlement contributed to the creation of ARQMO, and then trace how it culminated in the collective land tenure for part of the area claimed by the communities and in the 'brazil nut project'. The unfolding of key events is summarised in Figure 4.2.

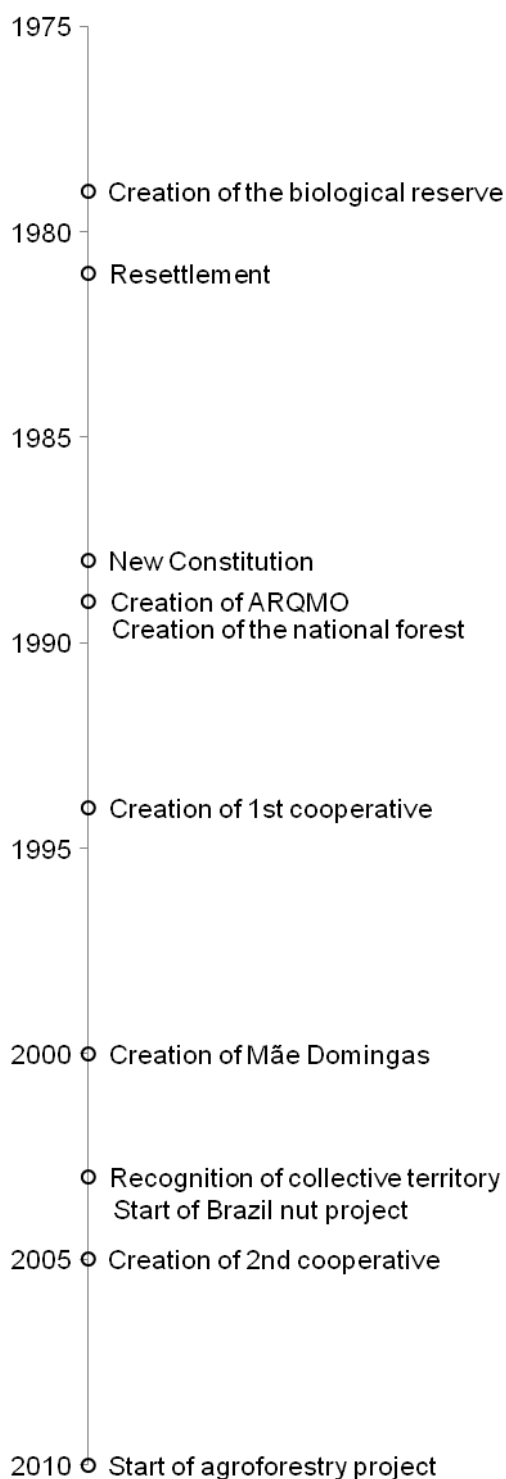


Figure 4.2 Timeline of key events.

In 1979, the Rio Trombetas Biological Reserve was created, encompassing an area adjacent to the study communities. Its creation can be seen as part of a wider movement proposed by Medeiros *et al.* (2004, pp. 86, 90). Those authors

argue that the creation of protected areas during the military dictatorship regime (1964-1984) composes the Brazilian state's strategy regarding the expansion, integration and control of the territory. With the creation of the biological reserve, all private proprietors within its limits had the right for compensation in exchange for their lands. Among them was Rio Xingu S/A company, owner of extensive areas used for nut extraction by the study communities at Lago do Jacaré. According to a member of PA staff, the company's access to compensation was conditional on the resettlement of the local population living in the area.

Local accounts reveal a traumatic experience. According to them, all the 25 families living at Lago do Jacaré left their houses as well as their planted fields and homegardens at short notice, for little or no financial compensation – families were legally entitled to compensation for their *benfeitorias*⁶⁹ (houses and plantings). This would have occurred following an episode in which they were compelled to sign a document (probably agreeing with the resettlement and its terms) of which many claim they were not aware of the meaning. Several moved to one of the four study communities, others are said to have moved to other communities downstream or to the city. At the time of this study, one household in each study community was composed of former residents of Jacaré – an exception was Paraná do Abuí, with five households. That signature episode is mentioned to justify a present lack of trust towards people seeking their cooperation.

When this reserve was created, they said that there were no residents inside it. The first lie. [...] They threw [the people] from Jacaré because they acted cowardly, they made [the people] sign minutes. [...] Today in meetings they get signatures, make minutes.

(Elderly man from Tapagem)

⁶⁹ Work done in a property to improve it.

The lack of fair compensation is also suggested by the accounts of the historian Vicente Salles (according to Acevedo & Castro 1998, p. 137) and the press media (according to Salles 2013, p. 18), which mention the “expulsion” of the households living at Jacaré. Official records on that compensation are missing from the local ICMBio office, according to PA staff; a 2005 survey of land tenure issues in the biological reserve area gathered documents relative to compensations paid or owed by IBDF/IBAMA/ICMBio directly to the land owners rather than those paid or owed by those owners to the families living on their lands (Carrilho 2006, pp. 51-52).

Narratives from the four study communities reveal that a feeling that the resettlement event could repeat itself in those very communities was nurtured in response to pressure and threats put forward by PA staff and by the alleged owner of the land they stood on. Sagrado Coração community, however, can be considered to have come closest to that fate in a land conflict episode of its early history, in the year of 1985. According to accounts of local households' and of a member of PA staff, an outsider actually cleared a patch of forest land and planted pasture, in an attempt to legitimise his claim to the land. The families got together and built a church just next to it, aiming to halt the pasture's expansion. The outsider left, eventually, and the site was turned into a new community centre. Some households, previously part of Tapagem, came to join the newly formed Sagrado Coração community from that event on. As an elderly community member summarises: “he [the outsider] wanted to take our land little by little. We knew about it and would not let him stay”.

In addition to the conflict regarding land, Sagrado Coração also staged one of the most dramatic moments of the conflict concerning PA's environmental regulations. The period following the creation of the biological reserve was generally recalled among local people as one of intense truculence in dealing with law offenders or suspects thereof. The occasion in which a child ended up dead – unparalleled in the history of the study communities – was recurrently

used to illustrate how far the patrolling interventions went, as exemplified below⁷⁰. A PA staff member confirmed the turn of events.

Here in this place of mine, they came; it was the time that a child of my compadre [father of own godson or godfather of own son] died. [...] They did not bring any good, they only brought disturbance.

(Elderly man from Sagrado Coração)

People were fishing turtles. So they brought [police] backup. [...] They took people in handcuffs. So despairing. It came to such an extreme that they killed a child.

(Woman from Paraná do Abuí)

They had the power in their hands, beat people. [...] They threw the boat over a poor child, killed it. This will never be forgotten by our race.

(Elderly man from Tapagem)

In the face of the situation of the resettled households and of the intense conflicts following the resettlement, a priest began to facilitate the strengthening of social organisation by stimulating the membership in the local rural labour union and the participation in meetings with other *quilombola*⁷¹ communities of Oriximiná city and of other cities of Pará state. This culminated in the creation of ARQMO (an umbrella association of municipal scale) in 1989. The Saracá-Taquera National Forest, encompassing two of the four study communities (Sagrado Coração and Tapagem), was created in that very same year – despite the recognition of the rights of slave descendants to territory by the 1988 Constitution. That protected area category, as opposed to the biological reserve, is compatible with the permanence of traditional peoples within its limits. However, as in most categories of protected areas in Brazil, the state

⁷⁰ “They” was used to refer to those in charge of the patrolling, which included PA staff and police officials.

⁷¹ Descendant of escaped slaves.

retained the ownership of land. Backed up by the new Constitution, several claims for territory were facilitated by ARQMO. In 2000, the local association Mãe Domingas (involving the four study communities and a neighbouring one) was created and a claim for territory was formalised on its behalf. The existence of such an institution, representative of the claimant communities, was a prerequisite for the bureaucratic process; while ARQMO represented *quilombola* communities of all Oriximiná city, local associations such as Mãe Domingas represented smaller groups of communities claiming rights to a particular territory. Three years later, part of the claimed area was recognised as a *quilombola* territory (*território*) and is now collectively owned; the area which overlaps with the national forest and the biological reserve is still under dispute⁷². Regarding rights of access and use, members of those five communities have common access to resources such as non-timber forest products (NTFPs), game and fisheries in the recognised territory and in the claimed area overlapping with the national forest; farming products, on the other hand, are owned by households individually. In the area overlapping with the biological reserve, brazil nut and fisheries (for subsistence during the brazil nut season) are also commonly accessed, but are the only resources allowed to be directly used, according to legislation and PA regulations. In terms of decision-making, all five communities have to be consulted about issues affecting the resources of those commonly accessed areas, as exemplified below in the case of commercial logging.

Despite that considerable advance in the local land tenure status, a feeling of insecurity in that matter was still expressed. The actual validity of the land document (*título da terra*) people hear about is questioned. That is reflected in the perceptions expressed about commercial loggers (*madeireiros*), who were said to have held community meetings, since the late 2000s, in search of support for timber extraction in the recognised territory – agreement of all five communities would be a prerequisite. The lack of support for logging was

⁷² The area recognised as a slave descendant territory and now collectively owned encompasses Sagrado Coração and Tapagem communities in their totality, whereas the area under dispute, Paraná do Abuí and Abuí, also in their totality. For that reason, land tenure is considered a community-level factor, rather than a household-level one.

extremely widespread in all study communities. Among other explanations, households mentioned cases of illegal loggers murdering or displacing local people, known to them from meetings and recent news in the mass media:

Nobody thought it [loggers' proposal] was good. People who have already been to trainings outside saw what they [loggers] are doing, they are even killing people. After they are established, they want to be the owner of the land. [...] I am not going to die because of money.

(Elderly man from Abuí)

In addition to the conflicts related to land and environmental regulations following PA creation, local people's perceptions of the agroforestry extension project are coloured by experience of previous development projects. One such project started in the 1990s, when an autonomous development effort involving the creation of a cooperative was carried out. One of the leaders of this effort was a member of Tapagem community who had migrated back after spending several years employed and having witnessed the unfolding of a cooperative experience elsewhere. That community member gained support from a politician, who helped him to deal with bureaucratic requirements, to arrange training, and with donations in kind. The creation and management of the local cooperative involved the formation of new institutional structures (board of directors, collective marketing practices) rather than the formalisation of existing ones. The cooperative managed a small market and the collective commercialisation of brazil nut. Foodstuff and other products were taken by community members and paid for with a fraction of their nut production. According to cooperative documents, 31 households from the four study communities have joined in, 14 of which were still living there at the time of the present study – six at Tapagem, four at Sagrado Coração, three at Paraná do Abuí and two at Abuí. However, the cooperative was functional only for a few years. Mismanagement of the cooperative funds by board members in favour of personal benefit and non-payment for the products taken from the small market by participants are some of reasons given for the project's decline. That negative experience is mentioned to justify the resistance to participate in a very similar project to be carried out on a larger scale by ARQMO:

The cooperative started selling products. [...] She [my wife] used to buy foodstuff for us to eat, we were going to pay for it afterwards. After some time, they came here, they were receiving payments. They wanted brazil nuts. I was in a difficult situation. [...] Then, things got a little better, I paid everything I owed. [...] Many others did not pay. Then, you know what? To rush into something as soon as it arrives? No!

(Man from Tapagem)

In the 2000s, ARQMO began to implement development projects after a period concentrating on securing land tenure. A project locally referred to as the 'brazil nut project', conducted by ARQMO and a non-governmental organisation (NGO) from São Paulo state, aimed (in its first 2000-2005 phase) to "organise the extractors and implement infrastructure to allow the collective extraction and marketing directly with the processing company" (according to the 2002 report from that NGO). The project expanded from eight communities in 2001 to 32 communities by 2005 (according to 2002 and 2005 reports). The project reached all four communities taking part in the present study; however, only half of those households reported that they participated by selling at least part of its nut production under its scope. Those participants are distributed unevenly among the study communities ($p < 0.05$, chi-square test) – Sagrado Coração stands out as the one with the lowest participation rate.

Table 4.4 Number and proportion of households, in each of the study communities, that participated in the brazil nut project (n=116).

	Sagrado (n=17)	Tapagem (n=37)	Paraná (n=17)	Abuí (n=45)
Participant households (number)	3	22	9	25
(%)	18	59	53	56

With the financial support received from the European Commission and the Interchurch Organization for Development Cooperation (ICCO), facilities to allow the collected nuts to dry naturally and to store them were built in some of the communities involved and equipped with radio communication. Also, boats powered by small engines (*rabetas*) were purchased to bring the nuts to these facilities. Among the four communities involved in the present study, the two largest ones (one inside and one outside the national forest) received such infrastructure. The narratives about the most active phase of the brazil nut project refer to the period between 2000 and 2006. In the beginning of the brazil nut season, households would receive an amount of foodstuff to support them until the payment for their production. In the projects' first year that foodstuff was purchased with external funds; in subsequent years, the purchase would depend on payments made by extractors in the year before, as part of a strategy aiming for economic self-sufficiency. The extractor was required to undertake the new practice of washing and selecting the brazil nuts before handing them in, when he would receive a receipt which was redeemed once the brazil nut was sold - usually in Óbidos, taken in bulk in the local association boat. A percentage was discounted to cover administration costs (payment to two community members working at each storage facility, transportation). One would expect that from a better quality product, the elimination of one of the intermediaries (*regatão*) from the market chain and the collective marketing, better prices and improved incomes would no doubt result. Indeed, positive views about the project's beginnings were evident in local accounts.

However, shortcomings were foreseen right from the start and, over the years, the production sold under the scope of the project declined. In 2005, a new cooperative was created to manage the collective commercialisation in a process facilitated by the São Paulo NGO, also targeting self-sufficiency. The association of the project's decline with the creation of that cooperative was suggested among locals. Firstly, the membership in the cooperative was, as usual, conditional on a fee, perceived as inaccessible. Although membership was not a prerequisite to sell the nuts for the cooperative, members enjoyed advantages such as better prices. Secondly, around the time of the creation of the cooperative, the provision of foodstuff previously received at the beginning

of the season was phased out – due to lack of payment by extractors, according to cooperative directors and to staff from the partner São Paulo NGO, as was observed in the previous cooperative. This aggravated a disadvantage repeatedly attributed to the project by local households: the delay in the payment for their product. Their reference for comparison was the trading with the *regatão*, who used to pay immediately either in cash or with much needed foodstuff and other products.

Another set of factors related to the decision of dropping out of the project or of not participating at all were particularly prominent in local accounts. There was the argument that the project paid a price similar to the one paid by the *regatão*, when it was judged as only fair that households were paid more for their additional labour of washing and selecting the nuts. Investigating the matter further, a coherent explanation was given for such a situation by cooperative directors: in fact, at some point, the *regatões* raised the price paid for the nuts and were able to do so as they were backed up by the very same processing companies that were buying the nuts from the project. Their argument was that it was of interest to the companies to avoid the strengthening of the involved communities and they would thus be willing to pay the *regatões* a price similar to the one paid to the project, despite the worst quality product offered by the former. A staff member from the partner São Paulo NGO confirmed that the *regatões* did raise their prices and that those intermediaries work in partnership with the owners of processing companies, but was not aware of the exact agreements involved.

Moreover, there was the claim that payments were not made in full, and the accusation directed to project staff (composed of members of the communities involved in the project) of mismanagement of the project funds for their own benefit – very similar to what was reported for the previous autonomous effort. That, on the other hand, was partially challenged by the São Paulo NGO staff, based on its experience in accompanying the project in the field and on information provided by external auditing. Although the possibility of non-optimal management of project funds is not discarded, the NGO staff member affirmed it was not aware of irregularities in the payments to the extractors or of project

funds misappropriation by project staff. NGO staff recognised that project staff's livelihoods may have improved and that this may have been viewed locally as evidence of funds misappropriation; however, NGO staff attributed that improvement to the remuneration of one minimum wage received for their work in the project. Regardless of the contrasting perceptions of underlying factors, there is some consensus that community members were unevenly benefitted, and that this generated resentment.

By the start of my field research in 2011, the project infrastructure showed signs of abandonment – the radio and the boat engine were not in working condition and the storage facility walls had deteriorated. After some years of no purchase, the cooperative partially resumed its activities in the 2012 brazil nut season.

The history of experiences with external actors affected local views on UFSE's project, particularly in the case of community coordinators. That will be explored in the next two subsections.

4.4.2 Internal social dynamics: the role of community coordinators and other institutions

Coordinators (*coordenadores*) play a key role in the relationship between the community and outsiders – in UFSE's project, they acted as the main gatekeepers. The contrasting perceptions of the project held by coordinators influenced the kind of support they offered to extension staff and, consequently, the participation rates in each of the study communities

Each of the four communities involved in the present study elect, among its members, a coordinator every two to three years. That person is seen as the representative of the community for that period and acts as a bridge between outsiders and the community. For instance, the coordinator is expected to take community demands to the city mayor, and is usually the person sought out by anyone wishing to send a message to or undertake some project within the community. The coordinator position dates back to the early communities'

history, when church service began to be regularly held in each of the four communities at the “community centre” (*centro comunitário*). As the original settlement expanded outwards from the first community centre, the other three have been formed. Most houses are located apart from the community centres in each community. Much of the local social networking takes place in the community centre before, during and after the weekly church service and football matches, periodical collective weeding sessions, the annual religious festivities and other meetings. The coordinator in each community is expected to take a leading role in organising those different events.

The community coordinators were the first to be contacted by UFSE extension staff and briefed about their project in each of the four communities. Their first impressions of the project varied tremendously, defining whether and to what extent they collaborated with it by introducing the staff in the community and by making logistics feasible.

While the coordinators of the two communities located outside the PAs and within the officially recognised (or titled) *quilombola* territory – Abuí and Paraná do Abuí – have been extremely supportive of UFSE’s project, the coordinators of the other two – Tapagem and Sagrado Coração – did not significantly collaborate with it (Table 4.5). The coordinators of the first two communities indicated to UFSE staff people that could be contacted, actually accompanied extensionists in their first visits to local households and spread the word themselves; they also offered them accommodation and means of transportation. The other two communities are located inside the national forest, within the claimed but not officially recognised (or untitled) *quilombola* territory. The narratives of their coordinators suggest that the land tenure status of those two communities was among the factors that underpinned their lack of support to UFSE’s project.

The initial indications about which communities to contact and who to look for once there came from ARQMO staff in Oriximiná urban centre. The coordinator of one of the titled communities was himself part of ARQMO staff at the time,

and was the very first of the four coordinators to be contacted; his community was the first to take part in the diagnostic phase in 2009. He had been in close contact with extension staff since those early stages and contributed to the conception of the extension strategy, suggesting for example that the plantings should be carried out in individual areas rather than in a collective one. For the first planting, in 2010, he in turn suggested the coordinator of the other titled community as a first contact there. Those two communities – Abuí and Paraná do Abuí – were the only of the four communities to participate in that planting event. In the view of both coordinators, households' interests were taken into consideration both in the choice of agroforestry and of aspects of the extension strategy:

They [extension staff] asked a question like this: if some way to earn some money comes up, apart from copaíba or brazil nut, if they [local families] would accept. [...] They asked what they thought would produce a better earning, faster. There were people that cited plants.

It [a past agroforestry project carried out under the scope of ARQMO with other communities] was a work that we had begun before. [...] We noticed that the collective way did not work. I told this to him [UFSE's project field coordinator]. We agreed. Afterwards, there was a meeting with the community; it was proposed to work with each family. The families also thought this way would be better. [...] It was a work well talked through, well accepted by the community.

The two untitled communities – Tapagem and Sagrado Coração – joined the project in the second planting event, later in 2010. As an example of the issues discussed in subsection 4.4.1, the coordinator of one of them demonstrates his lack of assurance about UFSE's project aims and makes explicit reference to the feeling of insecurity related to the community land tenure status (collective ownership not officially recognised) to justify his resistance in collaborating with the project. His views are illustrated below.

They supported [the extension staff] at Abuí because it [the land] is titled there. I thought: why do they [extension staff] come to make this planting? Aren't they going to take the land?

Although the coordinator of the second one was not so explicit, a similar situation was suggested by his narrative. Those narratives suggest this coordinator acts cautiously when it comes to projects in general, due to concerns in the community that the resettlement episode may repeat itself. An excerpt of that coordinator's thoughts is shown below.

Long ago, people lived where IBAMA is now, there lived many people. There was a project there, IBAMA, and finally they threw people from there. People are scared of those things. [...]

Q: Would you be interested in planting fruits to eat or to sell?

It depends on the project. It depends on the talking. We have to see to know, to decide if we accept or not. [...]

Q: How to know if a project is willing to do something good?

We have to get good clarification; mainly from the community. [...] Only we, coordinators, to decide in a situation like this...

The views of the first coordinator may have been influenced by the perception that his first contacts with extensionists were not mediated by a trusted person or institution, in contrast with the case of the coordinators of the titled communities. His accounts suggest that ARQMO's advice about coming projects used to be trusted and is missed – with the decline of the Brazil nut project, ARQMO also declined and the community meetings it used to hold to discuss that kind of subject became rarer. In the case of the second coordinator, however, the mediation of the first contact with extension staff by a trusted person did not seem to contribute to a better acceptance of that staff. The relationship between participation and trust in who mediates the contact with extension staff is also examined in terms of community members' trust in the gatekeeper in subsection 4.4.3.

In Tapagem, in contrast with Sagrado Coração, extension staff had considerable alternative support with contacting other households and logistics from another community member (Table 4.5). This other member expressed positive impressions about a previous experience in supporting an UFSE's researcher (unrelated to the agroforestry extension staff) and was reportedly interested in *cupuaçu* (*Theobroma grandiflorum*) planting even before the arrival of UFSE's extension staff. In Sagrado Coração, the coordinator's hesitance towards UFSE's project despite the trusted mediator and the lack of an alternative source of support to the project could be related to the community's particularly conflictual history, described in the previous subsection.

Table 4.5 Presence or absence of 'gatekeeper' supportive of UFSE's project in each of the study communities.

	Sagrado	Tapagem	Paraná	Abuí
Supportive coordinator	No	No	Yes	Yes
Alternative support	No	Yes	NA	NA

In Sagrado Coração, in addition to the role of its coordinator, I also examined the role of another of its residents, who was also the president of the local association Mãe Domingas at the time of my work and UFSE's. When I learned from him about his strongly negative views about UFSE's project early in my fieldwork, I became interested in investigating whether that could also have influenced in some way a decision not to take part in UFSE's project. The association's creation, in 2000, is related and closely precedes the recognition of the collective ownership of part of the territory claimed by the four communities. The association was generally seen, at the time of my field research, to be weak and indebted. However, from the first remarks I heard about its president, he seemed a quite influential person. People would talk about his intelligence, honesty and how well he could discern projects that may be beneficial or not for the communities. I heard about how people would ask for and trust his opinion on that matter. To my surprise, however, although the

positive comments about him were evident in the accounts of the interviewed participants and non-participants, awareness of his criticisms towards the agroforestry project were restricted to a very few, quite close kin. Although his judgment is shared by only two of the seven interviewed relatives, I reproduce an account of one of them below as an alternative view to the ones of the supportive coordinators. It criticises the extension project's top-down approach that fails to consider households' interests:

He [UFSE's project field coordinator] invited the community to make a project, took a document to ARQMO [umbrella association] to sign. People from ARQMO did not sign, as it was in the Mãe Domingas [local association] area, we did not let them sign. Every project, to do it in this area, it has to pass through our recognition, to see if we accept or not, how much we are going to gain from this project. We have to make a project together.

This tension between ARQMO and Mãe Domingas was apparent only in the narratives of Mãe Domingas' president and those of his kin. They argued that projects should address Mãe Domingas rather than ARQMO, as the first is the "owner of the land". Also, they attribute the interest of ARQMO directors in projects to an interest in the money that comes with them, rather than in actual benefits to the communities. Those accounts suggest the perception of Mãe Domingas as a legitimate representative of the communities and that it should act autonomously, independently from ARQMO.

As opposed to the coordinators of Tapagem community and of Mãe Domingas association, most households did not attribute any actual or potential role to either ARQMO or Mãe Domingas in the implementation UFSE's project. Both institutions were widely considered as weak among locals at the time of field research. However, whereas the success in negotiations with ICMBio and the glorious days of the brazil nut project are attributed to ARQMO, Mãe Domingas is rarely talked about with enthusiasm. People in general do not oppose the resumption of ARQMO's work, as long as the directors blamed for some of the

shortcomings of the Brazil nut project are replaced. Nevertheless, ARQMO's involvement in UFSE's project was apparently not deemed as fundamental. Therefore, the perception that neither ARQMO nor Mãe Domingas were involved in UFSE's project probably did not influence participation significantly.

The analysis presented in this and in the previous subsection suggests that a particularly conflictual history connected with the creation of the biological reserve may underlie the absence, at Sagrado Coração, of someone mediating contact between community members and extension staff. However, having a supportive gatekeeper within one's community, by itself, was probably not among the main drivers of participation in UFSE's project. The difference between the relatively low participation rate observed in the only community where extension staff did not encounter relevant support from gatekeepers and the rates ranging from medium to high in the other three ones (Table 4.2) are not statistically significant – 'community of residence' was not among the variables included in the model generated to predict participation ($\beta=0$, group-lasso regularised logistic regression). On the other hand, being closely connected to those gatekeepers is likely to have facilitated participation in a relevant way. In the next subsection, I discuss the place of kinship ties in the relationship between gatekeepers' support and participation rates within communities.

4.4.3 Implications in terms of social capital and communication channels

The two community-level factors explored earlier in this section contributed to shape participation through their links with social capital and with communication channels. Coordinators played a relevant role in the flow of information about the project. Their place in kinship networks influenced households' access to and views about that information.

Evidence indicates that bonding social capital (within the community) plays a relevant role in participation as it affects communication channels about the extension project. It has been examined earlier in this section how gatekeepers'

support to the project was particularly affected by the conflicts following PA creation and how supportive gatekeepers favoured participation in their communities by facilitating access to information about the project and to project staff. Additional evidence suggests that in two of the four study communities, the participation of close kin⁷³ to those gatekeepers tended to be particularly favoured. That could be explained by a more privileged access to the project and a greater trust in the positive information received.

It was beyond the scope of this work to examine more extensively internal social networks other than those among close kin, such as those among neighbours, friends, *compadres*⁷⁴, *mutirão* members and others. Although there is some overlap among groups of close kin, neighbours and *mutirão*, my analysis focuses on kinship ties based on the qualitative evidence supporting its relevance on participation. When I was living in the communities, I could observe that visits were particularly prominent between parents and their children and between siblings, and that those visits enabled cooperation and exchange of information. Those visits were frequently paid with the purpose of helping with house chores or agricultural activities, or of spending some leisure time talking. That favoured and was favoured by the frequent decision to settle and build one's house right next to their parents'. Clusters composed of a household surrounded by the houses of sons and daughters could be seen in all communities: at least five at Sagrado Coração, eight at Tapagem, three at Paraná do Abuí and five at Abuí.

In Tapagem, kinship ties either to the supportive or unsupportive gatekeeper may have contributed to shape trust towards extension staff. Narratives about how households got to know about or to come into direct contact with the project staff attributed an important role to the supportive gatekeeper, regardless of how close they were to gatekeepers in terms of kinship ties. Some

⁷³ By households 'closely related' to or that are 'close kin' of supportive gatekeepers, I mean those households with at least one member who is an immediate kin (father, mother, brother, sister, son or daughter) of that gatekeeper or an immediate kin of an immediate kin of him.

⁷⁴ What a person's father and godfather are to each other.

households had their first meetings with extension staff at that gatekeeper's home; in other cases, gatekeepers accompanied extension staff in visits to households; others households, in turn, got to know about the project from talks directly with the gatekeeper. On the other hand, non-participation associated with lack of trust towards extension staff was observed predominantly among those not closely related to that gatekeeper. Thus, although access to extension staff was apparently not restricted, kinship ties to the supportive gatekeeper may have influenced trust in the information received about the project either from the gatekeeper himself or from extension staff when accompanied by the gatekeeper. Moreover, kinship ties to the unsupportive coordinator seemed to have hindered participation:

He [UFSE's project field coordinator] did not go to the community centre. He used to go to G.'s [supportive gatekeeper] house; that was not right. At that time, when my brother was coordinator, my brother even told them: - You are wrong, [...] you come here, come to G.'s house, they are not coordinator. Why don't you come and talk to us, for you to tell us what your work is?

(Non-participant elderly woman from Tapagem, sister of community coordinator)

Similarly, in Paraná, contacts were also said to have been mediated by the supportive gatekeeper. However, close kin to that gatekeeper seems to have played a more relevant role in that respect. Most of the participants among those close kin are siblings and live next to each other. That may have made easier that extension staff was positively evaluated due to greater access to positive trusted information from their kin and that extension staff themselves were more easily accessed. In addition to the flow of information from extension staff to local households, the latter also were able to transmit information to the former regarding their interest in plantings – in both cases it is likely that close kin played an important role:

At Paraná, he [UFSE's project field coordinator] came only with my brother-in-law [who was also the coordinator's father-in-law], walked around with him and that was it. They started contacting people to make that planting. [...] At that time, my nephew started accompanying them. My nephew came to talk to me about the project. Then they brought these seedlings.

(Woman from Paraná do Abuí, one of the participant siblings)

They [extension staff] asked me if I was interested [in the plantings]. They got to know about my planting, that it was beautiful. [...] I observe. If you do something you don't know what it is, you don't know what will come out of it. I want to do something that doesn't bring problems to people, and I also don't want to have problems. [...] My sister told me, they come from the southeast, bought seedlings, helped to weed and to plant if needed. You could see they were interested in doing something useful.

(Man from Paraná do Abuí, one of the participant siblings)

In Abuí, the supportive gatekeeper had few close kin. When the second most important person in terms of contact mediation is considered, the relationship between kinship ties and participation seems weaker than in the other two communities. In fact, kinship ties in general (not only to those two key persons) had limited influence on participation. Participants were distributed throughout several families. However, three clusters in particular, each composed of a household and the households of sons and daughters, had no participants among its ten households. Among those households, there were actually cases in which interest to participate was manifested to the community coordinator, with no result. Their lack of access to information about UFSE's project and to extension staff themselves is viewed with some resentment, as part of a wider context of exclusion; there was the perception that it was deliberate, based on wealth-related criteria (the relationship between wealth and participation is further examined in subsection 4.5.2):

Husband: *Those who go to represent us, it is only the chosen ones. Those people have a better condition. Parties, mutirões, meetings, the chosen ones are who usually go. [...] The mayor helps the community, but in a certain way, only the chosen ones. Some work in the school, in the school boat. Only those who are already better get better. [...]*

Wife: *It was the coordinator who made note of the names [of those interested in the plantings], so I went to him. He told me he included the name of some people. He included only the name of the chosen ones; he did not put our names there. [...]*

Husband: *When we got to know about it [UFSE's project], they [extension staff] were already working around here.*

Wife's father: *It is not informed at all when benefits come; when we get to know, it is already going on.*

Husband: *It is like it is not a community.*

(Members of two households composing a non-participant cluster from Abuí)

Qualitative evidence was corroborated by quantitative data. Kinship ties to supportive gatekeepers was among the predictors that entered the lasso model ($\beta > 0$, group-lasso regularised logistic regression), indicating that it may be an important factor in explaining participation, and was associated with an increase in the probability of participation. Results presented in Table 4.6 suggest that in Tapagem and Paraná communities that would be particularly prominent (Fishers' exact test, $p < 0.05$): in Tapagem, all close kin of the supportive gatekeeper and only 16% of non related households participated, whereas in Paraná, 58% of close kin of the gatekeeper participated and none of the non-kin participated at all. That suggests that the gatekeeper had much less influence in the community as a whole than among their close kin.

Variation concerning communication channels may underlie the difference between UFSE's agroforestry project and the brazil nut project (examined in subsection 4.4.1) in terms of community participation rates. On the one hand,

households which had participated in the brazil nut project were more likely to participate in the agroforestry project than those who had not⁷⁵. On the other hand, that positive relationship was less prominent in the three communities with relatively high participation rates in the first event (Table 4.2 and Table 4.4); in the second event, they exhibited lower participation rates and were not significantly more likely to participate than the fourth one ($\beta=0$, group-lasso regularised logistic regression).

Table 4.6 Number and proportion of participating and non-participating households, according to their kinship ties with supportive gatekeepers, in three of the study communities*.

	Tapagem **		Paraná **		Abuí			
	Kin	n-kin	kin	n-kin	Gatekeeper		2nd contact	
					kin	n-kin	kin	n-kin
Participants (number)	5	5	7	0	1	12	5	8
(%)	100	16	58	0	50	28	31	28
Non-participants (number)	0	27	5	5	1	31	11	21
(%)	0	84	42	100	50	72	69	72

* Kinship ties to second most important contact in Abuí is also shown. Sagrado Coração community is omitted, due to the absence of a supportive gatekeeper or other important contact (kin – close kin to supportive gatekeeper or other important contact; n-kin – not close kin to supportive gatekeeper or other important contact)

** $p < 0.05$ (Fisher's exact test)

As a first explanation for the community-level pattern, the brazil nut project may have relied on the support of other gatekeepers (in addition to or instead of those in the agroforestry project) who were able to reach wider social networks. Alternatively, the snapshots taken from the brazil nut and the agroforestry projects may each correspond to different stages of a project life cycle. The

⁷⁵ This will be examined further in section 4.5, where I focus on household-level factors.

former may have relied, at a certain point, on communication through similar social networks as those found to be important in the latter, but in later stages, the former may have reached a wider network through complementary communication channels. Or else, the two projects may have shared the same gatekeepers and the snapshots taken from them may correspond to similar stages, but both those closely related and those not closely related to a supportive gatekeeper may have participated in the brazil nut project. That project's shortcomings might have contributed to the importance of close kin's mediation for the establishment of relationships with external actors in subsequent projects. Future work could explore those hypotheses by studying the communication channels on which the brazil nut project relied.

4.5 Drivers and constraints to participation – household level

4.5.1 Households' objectives and aspirations and implications in terms of perceptions of agroforestry

One of the household-level set of factors influencing participation comprises local households' objectives and aspirations. The extension project's focus on income generation was aligned with households' plans and dreams for the future. However, its specific focus on agroforestry met mixed local interests regarding the livelihood activities households would be willing to attempt.

Considering the complexities of households' objectives and aspirations and related perceptions of agroforestry, those factors were examined only qualitatively, through in-depth interviews, rather than quantitatively.

The identification of local problems related to income generation by extension staff was confirmed in the present study. The historical events that led to a scarcity of income sources, particularly in the summer, include the creation of PAs and the stricter enforcement of restrictions and are examined in more detail in Chapter 1.

That scarcity of income sources tended to constrain some of local households' hopes for the future. In order to gather information on their priority aspirations, they were asked to talk about their plans and dreams for the future, about what they wished their lives to be like in a few years time. Some priorities were repeatedly mentioned both among participants and non-participants such as: build a better house (wooden, if you have one made of palm thatch, and made of bricks if you have a wooden one), buy a larger covered powered boat (and not to depend on the small and irregular transportation available), and buy a power generator and electric household appliances (like freezer and television). I was actually shown – by apparently proud owners – those items as the result of their investments. Those are made in times when they manage to gather a high amount of money – from a job, cattle or a good brazil nut harvest, for example. Community level aspects were also mentioned as aspirations, such as: the strengthening of the local cooperative; and also improvements in health assistance, school education and means of communication. While higher incomes could aid local people in meeting their hopes for the future related to the acquisition of material goods, community level aspects would require complementary measures.

Households' objectives in participating in the agroforestry project were consistent with their life aspirations and with projects' objectives. The selling of tree products was typically mentioned among those who joined the project as one of their objectives. In line with that, income generation was perceived as one of the project's objectives and was viewed positively. Also, one of the most prominent views expressed about UFSE's work – both among participants and non-participants – was that it was quite likely that it would be successful in achieving that objective.

In part as a means to achieve the better life they aspired, the great majority within both participant and non-participant groups have experimented with adding new activities to their livelihood portfolios in the past and were willing to do so in the future. I asked about local perceptions of those new activities – especially about jobs and cattle raising, as those are locally regarded as sources of material wealth (wealth differentials are discussed in Chapter 2).

Other activities locals wished to attempt include fish farming, selling agricultural products with a fixed contract and in their own boats, trade, and, more generally, an activity less labour demanding than *farinha* (manioc “flour”) making and brazil nut extraction. Agroforestry – in other words, planting fruit trees on a larger scale – was also among the activities mentioned.

As households contrasted the activities attempted in the past or wished for the future with agriculture in general or with agroforestry in particular, differences could be observed between participant and non-participant groups. Participants tended to be more favourable towards agroforestry than non-participants, when comparing it with cattle raising or with agriculture as locally practiced. On the other hand, both groups expressed similar views as they compared agriculture with jobs. Through those comparisons, households revealed their perceptions of agroforestry regarding its (dis)advantages and the extent to which that activity would fit in with, or be preferable to, the alternatives.

Concerning jobs, there were mixed responses both among participants and non-participants. The activity was widely praised as it provides an income that is regular (monthly), and requires less strenuous labour. Some would be willing to take a job locally (at the local school or at ICMBio) so that they could be near their families and continue with their subsistence activities. On the other hand, only a small minority seemed to be willing to migrate definitely to the city and look for a job, as “everything needs to be bought” (*tudo se compra*) there, and it is perceived as less safe to raise their children. It was also argued that in a job you work for the benefit of others; that if you do not watch (e.g., do not keep your subsistence agriculture) when you are dismissed from the job you are left with nothing; and also that you cannot work at your own pace. Despite the contrasts in some aspects of their views, households tended to agree about the importance of not abandoning agricultural activities when arranging a job, which would be made easier in the case of local jobs. The choices of combining the two activities and of undertaking the first alone were both justified by the argument that subsistence agriculture would compose a safety net, considering the perceived instability of job positions. Although it could be expected that those views were more widespread among participants, they were expressed

both among participants and non-participants. Most referred to agriculture in general, while some, specifically to tree planting:

In a job, you earn your salary every month. But if you are not trying to build anything here, when you return from there, it gets worse. It is not like planting. Planting orange and avocado seedlings, that will be yours, you will harvest them for a long time.

(Man from Sagrado Coração)

On the other hand, both groups diverged as they compared agroforestry with cattle raising or with agriculture as locally practiced. Regarding cattle raising, the activity was widely praised for the high income provided. Perceptions were divergent in terms of the necessary labour and cash investments. While participants tended to point out relevant advantages regarding both cattle and agroforestry, non-participants tended to be more favourable towards cattle than agroforestry (divergent opinions and underlying factors are dealt with in more detail in chapter 6):

Cattle give you more money. Planting gives you money too, but it has to be a very large planting, more than 2000 fruits. Cattle are hard work, but only when you start raising them, when you are still not prepared. You can fence the field later on. We have a fence.

(Non-participant man from Paraná do Abuí)

Planting is easier work. With cattle, you work more: cutting the forest, planting, fitting fence posts. Cattle give you more money. But it depends, if you have a good planting, it gives you good money. One is not very different from the other.

(Participant man from Abuí)

Demands on labour were also considered, as households compared agroforestry as promoted by extensionists with agriculture as locally practiced.

Narratives emphasising that agroforestry was less labour demanding were more prominent among participants than non-participants. The argument used was that, in the case of *cupuaçu* harvesting, the work needed is restricted to picking the fallen fruits from the ground and carrying them away; whereas manioc has to be processed, which takes as much as three days and involves several steps: pulling the roots out of the ground, carrying them on the back, peeling, grating, and finally mixing the heavy grated pulp (*massa*) in a large stove for a whole morning or even a whole day. On the other hand, accounts stressing that species grown in local agriculture start producing much sooner after they are planted and that the labour demanded was either not an issue or compensated by returns were more widespread among non-participants:

Roça [agricultural field] is more advantageous. You plant manioc and already in the next year you harvest it, cará [Dioscorea sp.] and sweet potato [Ipomoea batatas] as well... If a person has to wait a cupuaçu or a coconut tree to bear fruit for him to satisfy his necessity, he will not resist.
(Non-participant man from Paraná do Abuí)

Planting is more advantageous. Roça is advantageous, but it takes twice as much work. To pull the manioc from the ground and carry on the back, it is not easy. Planting is lighter work.
(Participant man from Sagrado Coração)

While species usually grown locally take from a few months to one year to start producing, the main species promoted by extensionists, *cupuaçu*, takes as much as five to six years to reach a mature production (Ribeiro *et al.* 2005; Fraife-Filho). The differing perceptions illustrated above may have influenced the decision whether or not to participate in UFSE's project.

Participants and non-participants also differed when it came specifically to agroforestry and its place in their previous experiences and in their aspirations. The interest to plant fruit trees on a larger scale than is usually found in

homegardens was widely reported among participants to precede UFSE's project – whereas such previous interest was generally denied among non-participants. There were actually attempts among participants to plant mainly *cupuaçu* (cocoa, coffee and orange are also mentioned) but trees were lost, which is attributed mainly to accidental fire, improper soil and drought. Therefore, a concrete demand for the technology promoted by the UFSE project, despite the losses faced in previous experiences with it, may have been among the drivers of participation.

Perceptions of agroforestry's (dis)advantages as compared to other livelihood activities were apparently more relevant in shaping participation than perceptions of specific technical recommendations or seedlings' biological performance in terms of trialability, complexity and technical soundness. Firstly, non-participants' accounts generally implied that they had little knowledge about extensionists' technical recommendations. Secondly, diverging perceptions of seedling's development were expressed both among participants and non-participants. They were either enthusiastic with the seedlings' growth rate and were expecting the start of production soon, or pointed out the loss of part of the plants, or viewed their development as unsatisfactory. Only a small proportion of households (less than one fourth of the participants interviewed) mentioned one of those negative perceptions as one of the reasons for having dropped out of the project or not wishing to receive seedlings in the future. Other households, despite that kind of negative perception, persisted in the project or wished to receive seedlings in the future.

4.5.2 Demography, gender roles and livelihoods

Demography, gender roles and livelihoods compose three of the sets of factors that may influence participation at the household level. For a sample of 116 households (approx. 90%) of the study communities, I documented household size, age and education as demographic attributes, gender roles in terms of decision-making and labour in agriculture, and activities portfolio, assets and wealth/well-being status as livelihood indicators. Group-lasso regularised

logistic regression was used to assess the influence of those various aspects on participation in the agroforestry extension project.

Regarding household livelihood activities portfolios, the diversity found in the four communities in general is, in a way, reflected in the group of participant households. All the main sources of income are represented among the participants: extraction of NTFPs brazil nut, *copaíba* and *breu*, extraction of timber, state pension, medium to long-term job and cattle raising. The frequency of three of those activities – agriculture, extraction of *copaíba* or *breu* and cattle raising – were included in the lasso model; a greater frequency was positively associated with participation ($\beta > 0$, group-lasso regularised logistic regression). The results may indicate that issues such as competition for labour are not hindering participation and, in the case of the three activities included in the model, other factors such as willingness to complement or replace the livelihood activity in question are favouring participation.

In terms of assets, one of the investigated proxies of social capital was the participation in the brazil nut project. The expectation that experiencing brazil nut project's shortcomings would undermine households' trust towards external actors (linking social capital) and, thus, be associated with greater resistance to participate in subsequent projects was not corroborated at the household level. In fact, participation in the brazil nut project composed the set of variables included in the lasso model and was associated with an increase in the probability to participate in the agroforestry project ($\beta > 0$, group-lasso regularised logistic regression). Also, the various criticisms regarding the brazil nut project were expressed both among participants and non-participants. This may indicate not only that a negative previous experience is not preventing participation in the agroforestry project, but also that the drivers for participation in the two are similar at the household level.

In addition to linking social capital, I also looked into aspects of bonding social capital and of bridging social capital. I documented, as proxies: the frequency of attendance to the most common social events within the community (football

match, *mutirão* to clean the community centre, church service and other community meetings), experience as community coordinator, and membership in associations encompassing several communities (*Mãe Domingas* and ARQMO). As discussed with kinship ties (see subsection 4.4.3), social events could also be relied on to share positive and negative perceptions about the project or grant access to information about the project and to extension staff. Moreover, experiences in social organisation and leadership could affect households' critical evaluation of the project or be related to a tendency to participate in events such as the agroforestry extension project. Two of those aspects were included in the lasso model ($\beta < 0$, group-lasso regularised logistic regression): attendance to *mutirão* and to church service. Those were negatively related to participation, which can indicate that the two events are being used to share negative perceptions.

Certain aspects of human and natural capital were also examined. Both overall experience with the shifting cultivation and with specific practices (diversity of grown species, tree growing) were assessed. Experience with shifting cultivation could favour participation in the agroforestry project, as both have aspects in common. Other assets related to agriculture that could favour participation – such as available labour and soil type – were also examined. The analysis suggests that two of those factors may be relevant in increasing the probability to participate: high levels of household labour used in shifting cultivation fields and high species diversity in those fields ($\beta > 0$, group-lasso regularised logistic regression). The former can be considered a proxy for available labour and its relevance could be explained by the fact that labour constituted one of the main investments required for the implementation of the practices recommended by extensionists. The latter could be related to a favourable attitude towards species diversification, of which agroforestry would be a particular case.

Other proxies for available labour were also documented: 'total household size' and 'number of household members between 14 and 60 years old'. In addition to those, demographic variables also comprised age and formal education of the heads of the household. Among the demographic variables, none of them

were included in the lasso model ($\beta=0$, group-lasso regularised logistic regression).

Concerning gender roles, a more important part played by men or women in local agricultural practices could be related to the part they would play in agroforestry. That, in turn, might affect household's likelihood to participate. However, that is apparently not the case at the study site, since none of the gender roles indicators were included in the lasso model ($\beta=0$, group-lasso regularised logistic regression).

Finally, in terms of wealth and well-being, none of the two examined measures entered the lasso model ($\beta=0$, group-lasso regularised logistic regression), indicating that neither worse nor better-off households are more likely to participate. That contrasts with the local perception that wealth-related criteria was used to deliberately exclude some households in one of the study communities (see subsection 4.4.3).

4.6 Discussion

Evidence collected for this study indicates that local people's participation in the agroforestry project was influenced by both community and household-level factors. Those included collective experiences with the PAs, the social role of coordinators within communities, households' aspirations for the future and composition of the portfolio of livelihood activities. Those elements shaped participation partly through implications in terms of factors related to the extension project such as the flow of information about the project through communication channels and local perceptions of technology promoted.

At the community level, I argue that one of the factors with a relevant contribution to participation is the history of relationship between the communities and the PAs – the communities with the most conflictual history tended to be the hardest to get involved. Vincent (2012) is among the few studies that have examined how past experiences with external actors shape

participation. The resettlement episode and the related perception of insecure land tenure had important places in local narratives about that relationship. The influence of those two themes on participation was particularly relevant as they featured in the accounts of coordinators as justifications for lack of support. One of the communities has a particularly conflictual history, marked by extreme events concerning land tenure and PA regulations enforcement. Only in that community, extension staff could not rely on anyone for support. While land tenure status has been included in most of the 32 agroforestry adoption studies reviewed by Pattanayak *et al.* (2003), the broader history of conflicts does not appear at all among the explanatory variables considered by those studies.

Social capital, particularly kinship ties, is likely to be a relevant contributor to participation. Close kinship ties with supportive gatekeepers (coordinators or other community members) tended to favour participation by facilitating access to trusted positive information about the project and to extension staff themselves. Gatekeepers had important roles in communication channels firstly accompanying extension staff in their talks to local households, secondly by acting as direct sources of information about the project, and finally by letting extension staff know about local households' interest to join the project. They can be viewed as 'brokers', as they composed the chain of translations linking extensionists and local beneficiaries. That concept has been extensively discussed in the development literature (e.g., Bierschenk *et al.* 2002, p. 17; Mosse & Lewis 2006, p. 13); however, the role of brokers has rarely been investigated in the context of agroforestry extension (e.g., Kiptot *et al.* 2006; Isaac *et al.* 2014). Moreover, this chapter contributes to the evolving literature on the relation between adoption of agricultural innovations and social capital, which has recently been portrayed as being "fraught with issues of the measurement of social capital beyond membership of farmers in groups" (Njuki *et al.* 2008). The issue of 'social ties' was explored, not only quantitatively as in most studies (e.g., Bandiera & Rasul 2006; Njuki *et al.* 2008; and Rijn *et al.* 2012), but also qualitatively.

Moving on to household-level factors, participation may also have been facilitated by positive perceptions of agroforestry, when compared to livelihood

activities that are frequently attempted locally as a means to pursue some of households' aspirations. Participants tended to be more favourable towards agroforestry than non-participants, when comparing it to activities such as cattle raising and manioc-based agriculture. Rather than asking about specific agroforestry features in absolute terms, and following a quantitative approach as in Neupane's (2002) study, I opted to stimulate the comparison with familiar livelihood activities and to let households express their perceptions about agroforestry more freely. Perceptions of agroforestry's cash returns and demands on labour, for instance, varied according to the activity it was contrasted to, as suggested by Reed (2007, p. 337). Moreover, the fact that different households emphasised different aspects of the promoted technology was assumed to reflect the importance given to those particular aspects; this information would be lost in a quantitative approach.

Still at the household level, of the various examined aspects of local livelihoods, demography and gender roles the composition of local livelihood portfolios and human capital in terms of experience with related practices and of labour availability were suggested as important contributors to participation, according to the logistic regression analysis. The results of the present study align only partially with the pattern observed by Pattanayak *et al.* (2003). According to the review of 32 studies conducted by those authors, age, education and labour availability tend not to influence agroforestry adoption significantly, whereas experience with related practices, soil type and assets such as houses of different types and other durables do tend to influence.

The identification of drivers and constraints to participation in the early stages of agroforestry extension can guide extensionists in the analysis of whether and how participation should/can be enhanced. The analysis of participation is crucial in the context of the present thesis, as two other key elements in the analysis of agroforestry's role in PA conservation – agroforestry's outcomes for livelihoods and conservation, examined in the next two chapters – depend heavily on it.

CHAPTER 5 The income generation potential of agroforestry in the context of mixed livelihoods

5.1 Introduction

Development agencies and research institutions have targeted agroforestry at least since the 1970s, as an option potentially beneficial to livelihoods and the environment. Since the 2000s, the extent to which agroforestry has lived up to the optimistic expectations regarding its livelihoods outcomes has been increasingly assessed. As examined in Chapter 1, assessments have tended to focus on contributions in terms of cash income (e.g., Murniati *et al.* 2001; Franke *et al.* 2008; Bisong *et al.* 2009; Feintrenie *et al.* 2010; Jagoret *et al.* 2011; Hoch *et al.* 2012; Tuihedur Rahman *et al.* 2013).

While some of those assessments have concentrated on agronomic factors, others have explored broader issues, exogenous to the farming unit. Some case studies have compared agroforestry areas with different species composition and arrangements in terms of the income generated and of how it fluctuates during the year. They usually come up with recommendations regarding which systems should be prioritised. Other case studies have portrayed good access to credit and to technical assistance as important conditions for favourable financial returns and difficulties in transportation and low prices as relevant constraints.

Increased access to markets does not necessarily lead to specialisation in the activity or product yielding the highest returns as once was argued (Cramb 2009, p. 327; Morsello 2014, pp. 140-141). Under that reasoning, an improved market access for agroforestry crops may induce a livelihood strategy that privileges either diversification or specialisation – in other words, agroforestry may add to the existing activities or replace a number of them. Diversification has been extensively praised in terms of its contribution to coping with risk and to the fulfilment of multiple needs (Morsello 2014, p. 140). The ability to employ

that strategy has been shown to be influenced by the assets at disposal, particularly labour and land (Hoeffler 2011, p. 17-19; Guèye 2014, pp. 8-11).

In contrast with contributions to income, potential impacts in terms of the composition of activities portfolio remain underexplored in the literature on agroforestry's livelihood outcomes. That absence in the agroforestry literature can be considered part of larger gaps. Firstly, the introduction of agroforestry in mixed livelihoods can potentially contribute both to agricultural intensification and to livelihood diversification⁷⁶ and the links between the two strategies have been considered in need of further research (e.g., Hussein & Nelson 1998, p. 5). Secondly, studies examining households' diversification strategies have focused on diversification at the activities level (off-farm versus on-farm) or, less commonly, at the crop level (Morsello et al. 2014, p. 141), rather than on integrating the two by investigating, for instance, how the addition of new (agroforestry) crops influence the mix of livelihood activities.

In line with the approach that has historically guided agroforestry programs, one of the original objectives of the agroforestry project at the study site was to provide an additional source of income to local people, in a way that would not encourage deforestation. The project was initiated by Federal University of the

⁷⁶ Agricultural intensification, in addition to livelihood diversification (examined in Chapter 1), is pictured in the livelihoods literature as commonly employed by rural people in the construction of their livelihoods (Hussein & Nelson 1998, pp. 4-5). Agricultural intensification would involve an "increased average inputs of labour or capital [...] for the purpose of increasing the value of output per hectare" (Tiffen *et al.* 1994 *apud* Carswell 1997, p. 3). Agroforestry has been conceptualised as an example of sustainable agricultural intensification as its promotion frequently consists in enriching the tree component of farming systems aiming, for example, the enhancement of soil fertility and the diversification of income (Pretty *et al.* 2011, p. 9; Carsan *et al.* 2014, p. 36). Sustainable agricultural intensification, rather than depending on external inputs associated with the Green Revolution and generating negative environmental impacts, would be based on the support of ecosystem processes and the reduction of those impacts (Pretty *et al.* 2011, p. 9; Carsan *et al.* 2014., p. 36).

Southeast (UFSE)⁷⁷ in 2010, at first with five communities, with a view to expanding it to additional communities in the future.

Because the project is so new, it would be unrealistic to look for concrete effects on local people's livelihoods at this stage; rather, this chapter examines the potential impacts on local incomes and on mixed livelihood portfolios. It focuses on contributions to income rather than to diets – although both were targeted by extensionists, the first may be considered a more pressing demand. While no seasonal food shortages could be identified, seasonal gaps in income generation emerged as a recurrent theme in the narratives of local households.

The main objectives of this chapter are:

- to explore whether and the extent to which agroforestry may contribute to local incomes;
- to describe the main activities that compose households' livelihoods;
- to analyse the ways in which different livelihood activities come together in mixed livelihood portfolios; and
- to explore whether and how agroforestry might fit into existing livelihood portfolios.

Four of the total five communities participating in UFSE's extension project in 2010 took part in the present study. As detailed in Chapter 2, a mixed methods approach was used. The composition of individual households' livelihood portfolios was documented through quantitative interviews (questionnaires) with a sample of 116 households (approximately 90% of the study communities). The quantitative interviews also yielded data on the possession of durable goods, which allowed households to be ranked according to wealth as was examined in Chapters 2 and 4. On the other hand, the investigation of mixed portfolios in terms of labour and land constraints and cash income relied mainly

⁷⁷ Fictitious name.

on participant observation and qualitative interviews, and particularly on a seasonal calendar.

In section 5.2, I discuss how agroforestry is likely to impact the livelihoods of participant farmers in terms of cash income. Section 5.3 examines the context of existing portfolios of livelihood activities. Subsection 5.3.1 describes each of the individual livelihoods activities in turn. I leave a deeper investigation of two activities – cattle raising and turtle hunting – for the next chapter. In subsection 5.3.2, I discuss how households combine those various livelihood activities. I analyse how that is shaped by labour demand and income availability at different times of the year and by land availability. In subsection 5.3.3, I examine local livelihood portfolios and how agroforestry would fit in, considering potential conflicts and synergies. Finally, section 5.4 discusses the chapters' main findings.

5.2 The income generation potential of agroforestry

The composition of plantings and the quality of market access are fundamental in shaping agroforestry's potential to contribute to local incomes. The dominance of *cupuaçu* (*Theobroma grandiflorum*) can lead, for instance, to phytosanitary issues as well as to considerable delays in the income generated. Moreover, the local markets targeted by the agroforestry project have restricted capacity to absorb production. If those constraints can be managed, as other projects recently undertaken in the region suggest, agroforestry can potentially provide a significant raise in households' annual income.

Households' motivations towards the market are in accordance with extensionists' objectives for the agroforestry project. As discussed in Chapter 2, low income, especially in the summer, is among the 'problems' agroforestry was supposed to address.

Regarding the composition of the agroforestry systems implemented, the main promoted species, *cupuaçu*, was planted by all participants (with one exception)

on scales varying from five to approximately 100 units (29 units on average). All other species were generally planted on a smaller scale. The fact that plantings were dominated by *cupuaçu* could undermine the development of that species and the ability of the system as a whole to provide income from its early stages. Firstly, that environment is said to favour the spread of one of the main pests *cupuaçu* is susceptible to – *broca-do-fruto* (*Conotrachelus humeropictus*). That pest has caused losses of up to 100% of the fruit production among families cultivating *cupuaçu* in agroforestry systems (Silva & Alfaia 2004, pp. 7, 14-15).

Secondly, *cupuaçu* produces at increasing scales until stabilisation, which occurs only five to six years after it is planted (Ribeiro *et al.* 2005; Fraife-Filho n/d). Therefore, positive annual net returns may be reached only in the fourth year and total investments may be recovered only in the ninth year in *cupuaçu*-based agroforestry, according to profitability analyses (Hoch *et al.* 2012, p. 370⁷⁸). The addition of annual crops and other fast growing species to the system could anticipate returns considerably. In fact, beans were promoted in the very beginning of UFSE's project, but were abandoned by extension staff in subsequent years. Most households could not get any bean production, reportedly due to the improper period of the year chosen for the plantings. Other annual species such as spring onion, coriander and bell pepper were distributed, but only at subsistence scale.

Extensionists argue that *cupuaçu* yields various marketable products (edible pulp, chocolate from the seeds and soap from the shell) and that some of them reached good prices in the city, but did not carry out, at the start of the project, any comprehensive survey on the markets those could be sold to, prices, demand or necessary infra-structure regarding fruit processing and transportation. Some authors (Parente 2003; Sá *et al.* 2008^a; Oliveira *et al.* 2010) have assessed the economic feasibility of *cupuaçu* growing experiences in and proposals for the Brazilian Amazon and presented positive findings. However, those findings have limited application to relatively isolated areas as

⁷⁸ In the agroforestry project analysed by that author, external inputs were all provided cost-free to farmers but only a small fraction of labour costs were covered, similarly to the UFSE project.

research has tended to focus on areas with easy access to roads. The constraints faced by the study communities include, in addition to the relative isolation from main road networks, the restricted access to electricity, limited demand for the agroforestry products in the study communities themselves and in the nearest city, and insufficient means of transportation to the city (more details in Chapter 2). Some of the extensionists' accounts suggest that, relying on the fact that the trees would still take a few years to start producing, market surveys were not deemed as a priority in the beginning of the project:

There is a market for cupuaçu. The problem will be to transform this into a high quality product. Commercialisation is a difficult issue. But as it is a medium to long term thing, we will begin by donating tons of cupuaçu seedlings, later on we will be a little better on this.

(Member of extension staff)

Concerning local markets, the municipal schools were one of the main selling points advertised by extension staff, not only for agroforestry products but also for agricultural ones in general. When I left the field, agreements for selling agricultural products to supply the school meals (*merenda escolar*) were being made, but it was not clear when this would start operating and to what extent households would be benefitted. Since 2008, government schools are required by law⁷⁹ to spend a minimum of 30% of the funds allocated for school meals with products purchased directly from small farmers. UFSE extensionists have been in contact with the nutritionist and teachers working for the municipal government since 2010 and discussing how schools could come to comply with that requirement. Since then, community workshops were carried out by the non-governmental organisation (NGO) Imaflora in partnership with UFSE and other institutions in 2011, and staff from the Technical Assistance and Rural Extension Company of Pará – EMATER/PA (state institution in charge of agricultural technical assistance) visited households from the study site individually to register (*cadastrar*) the interested ones in 2012, according to one of the workshop coordinators, Leo Ferreira/Imaflora, and to UFSE staff.

⁷⁹ *Lei Federal 11947, 16 June 2009. Dispõe sobre o atendimento da alimentação escolar.*

Most households agree on the advantages of local products for school children. They argue that the locally planted fruits and vegetables are fresher (in contrast to the usual canned and sometimes expired products) and that children are more used to them. On the other hand, households diverge on the potential benefits in terms of income. Some expressed optimism about the potential of selling to schools and see this opportunity as an incentive to cultivate, in larger scale, species currently planted for subsistence. However, two main opposing concerns were raised by the more sceptical households. The first one was that local supply would not be able to meet the schools demand, either due to the limited number of households interested to join in or due to the insufficient supply of individual farmers. Accounts suggest they based that judgment on the fact that, at that time, agriculture was practiced mainly for subsistence, and on the belief that few would be interested to produce on a larger scale. On the other hand, according to the second concern, if and once most of the households join in, the schools' demand would not be enough to absorb the production.

Some say it [selling products for the school meals] will be good, some say it will not work. I think that we won't be able to maintain the school meals with products from here if we do not work. The ones that find it difficult do not like to work. To maintain those things, one has to have a large planting, not only one or two trees.

(Woman from Paraná do Abuí)

Here, the school is small. If everyone engages in this [selling products for the school meals], the school will not be able to buy it all. If ten [households] do it, there will be leftovers.

(Man from Abuí)

A survey of traditional recipes and of agricultural products that could potentially be sold for school meals was conducted in the community workshops, which

involved the study communities and other *quilombola*⁸⁰ communities in the region. Items suggested by households include fruits and vegetables and also manufactured products such as *farinha* (manioc 'flour'), fruit pulp for juice and jams (Imaflora 2011). Based on local estimates of market prices⁸¹, current expenditure of schools per household with the purchase of local produce⁸² would pay, for example, for approximately 180L of *farinha*, 18 banana bunches or 360 *cupuaçu* units⁸³ (2012 data). Each of those values is compatible with the reported production capacity of one household – households could choose either to specialise in a few products or to diversify. However, taking as reference the funds available for municipal school meals in Oriximiná (*Controladoria-Geral da União* 2012), the 30% minimum quota⁸⁴ to be destined

⁸⁰ Descendant of escaped slaves.

⁸¹ The local estimates are equivalent to the lower end of the price ranges obtained by the market surveys conducted by the Supply Centre of Pará State (*Centrais de Abastecimento do Estado do Pará* – CEASA-PA 2013) during 2013 in the state. Market prices are the reference used to establish the amount to be paid to farmers by the municipal government.

⁸² Those estimates takes as reference the amount paid per household at the time of this study. In 2012, 58 households (not belonging to the study communities) were supplying the school meals and receiving approximately 60% of the national minimum wage for their agricultural products, according to estimates from a member of the municipal government.

The minimum wage is adopted as reference in this study because, in addition to its relevance at the national level, it approximates one of the poverty lines adopted by The World Bank (n/d a) (US\$2.00/day). The 2012 minimum wage was R\$622.00/month, which corresponds to US\$363.74/month (based on the purchasing power parity rate, private consumption – see The World Bank n/d b) or US\$12.12/day. For the average household at the study site (with 5.6 members), this would be equivalent to US\$2.16/day/member.

⁸³ The first two are the main agricultural products marketed by local households and the last is the main component of agroforestry plots implemented by UFSE project.

⁸⁴ Estimates based on the market prices (made available by the National Supply Company – *Companhia Nacional de Abastecimento* – CONAB 2012) for three of the main fruits and vegetables cultivated in the study communities (banana, pumpkin and *cupuaçu* pulp) and on the number of students enrolled in the municipal schools of Oriximiná in 2012 (according to the Brazilian Institute of Geography and Statistics – *Instituto Brasileiro de Geografia e Estatística* – IBGE 2012) indicate that this quota would exceed the funds necessary to cover the minimum consumption of 200g of fruits and vegetables per student per week required by law (*Resolução do Conselho Deliberativo do Fundo Nacional de Desenvolvimento da Educação* 38, 16 July 2009. *Dispõe sobre o atendimento da alimentação escolar*).

directly to small farmers as required by law would be enough to provide merely 123 families, based on current expenditure per household. Considering Oriximiná's rural population of nearly 5,000 households (IBGE 2010), the limitations of the schools' impact on income become evident. Schools meals may only be able to absorb an initial *cupuaçu* production while plantings are in their experimental scale. It is a very different scenario from the one in which rural families sell to schools in larger cities.

In terms of marketing alternatives and the necessary logistics, communities had negative previous experiences. In a project implemented by Association of the Slave Descendants of Oriximiná City (ARQMO), crafts made from the brazil nut fruit (*ouricho*) were sent as far as São Paulo; in another one (the 'brazil nut project' – see previous chapter), brazil nuts were taken to the less distant city of Óbidos, neighbour to Oriximiná. One of the perceived problems was that the payment was not received immediately, but only after the product reached the client. The high costs of sending items by mail to São Paulo or of taking nuts in the cooperative boat to Óbidos are also mentioned as challenges. In 2012, a project on *copaíba* (*Copaifera* sp.) was in its early stages of planning. According to a *copaíba* extractor, people were discussing about how to avoid those past problems by strengthening the local cooperative, having a purchase contract with a company and paying the extractor immediately. The last two had been achieved by 2013, according to one of the cooperative directors, as the result of a negotiation process between the cooperative and a São Paulo company that was facilitated by the partner NGO Imaflora. The director suggested, however, that the first issue still represented a challenge. Similarly to what happened in the brazil nut project (see previous chapter), intermediaries were able to match the better prices offered for *copaíba* by the local cooperative and some households preferred to sell to the former.

Nevertheless, most fruits pose differing challenges, in comparison to brazil nut and *copaíba*. The implementation and operation of a processing plant that can extend fruits' shelf life in compliance with legal hygienic requirements – and, thus, allow the access to more distant and robust markets and higher prices – can involve high costs and specialised training.

In summary, I would argue that the commercialisation of agroforestry products would only be feasible if they are able to access a robust market, to overcome challenges regarding storage and transportation, and to cover the associated costs. Lessons learned from past projects and experimented with the on-going project on *copaíba* can be highly instructive. Moreover, if the *merenda escolar* project develops well and people can sell for that local and guaranteed market, then that can act as a minor complement to some local livelihoods.

Considering the best-case scenario in which all those constraints are overcome, the potential impact on local households' incomes was estimated. In fact, two scenarios were considered: in the first, areas planted with *cupuaçu* would be equivalent to the largest plantings implemented (approximately 100 trees) and in the second, to plantings expanded to approximately 550 trees or 2ha. The estimation applies to those (possibly few) households that are able to maintain the areas until they reach mature production despite delays in returns. Additionally, the estimation was based on the following specific assumptions⁸⁵:

- a) agroforestry adds to rather than replaces activities composing existing mixed livelihood portfolios;
- b) the average spacing between *cupuaçu* trees is 6x6 m, which is somewhat lower than the one recommended in the literature (7x7 m) in order to avoid competition between trees and the spread of pests;
- c) technical recommendations available in the literature concerning fertiliser application and pest/disease management are adopted on a very limited basis or not adopted at all due to cash and labour constraints;
- d) the local cooperative is able to gather financial support and build a fruit processing facility;
- e) the local cooperative is able to settle purchase contracts;

⁸⁵ The different implications of assumption a) for men and women are discussed in section 5.4.

Assumptions c) to f) mirror the occurrences of previous projects involving brazil nut and *copaíba*. Regarding assumption c), however, the processing of *cupuaçu*'s fleshy pulp would require a more complex and more costly facility than the one built for brazil nuts.

- f) part of the local *cupuaçu* production is sold to the local cooperative, who extract and commercialise the fruit pulp;
- g) the other part of the production is sold to intermediaries.

The values used in the estimation of fruit productivity, pulp productivity and price at the farm gate correspond to 1,700kg/ha, 634kg/ha⁸⁶ and R\$1.05/kg (of fruit)⁸⁷, respectively. In the first scenario, the *cupuaçu*-based agroforestry system would provide the household with an extra annual income of approximately R\$708.00 and in the second, of R\$3,894.00, assuming the systems reached mature production between 2010 and 2012⁸⁸. The second amount would be equivalent to 52% of the 2012 minimum wage. If the worse-off came to be preferentially targeted by UFSE's project in a later phase, the expanded plantings could make an important contribution to reduce the gap

⁸⁶ The productivity values used were extracted from the study conducted by Said (2011) in Manacapuru city (Amazonas state). They were based on data gathered from 20 properties with an average area planted with *cupuaçu* trees of 2.68 ha, with an average spacing between trees of 6x6 m, and with an average tree density of 277 trees/ha, in which no fertilizer application or pest/disease management is conducted.

⁸⁷ Up-to-date information on prices at the farm gate for *cupuaçu* in the Amazon region, in contrast to prices to the consumer, is scarce. The value used in the present research represent the average of the values presented by two studies immersed in contrasting contexts. It should be noted that in both, producers have easy access to roads and lie close to capital cities and therefore, income values will be overestimated – studies focusing on isolated producers could not be found. The first is Said (2011), which was conducted in Presidente Figueiredo city (Amazonas state), located approximately 100km by road from Manaus (state capital). It involves producers who extract the fruit pulp manually and sell it predominantly to intermediaries and also to a cooperative and a processing company, and refers to prices paid in 2010. The second is Bayle (2014), which refers to an experience conducted in Tomé-açu city (Pará state), lying approximately 200km by road from Belém (state capital). It involved producers organised in a cooperative which owns a processing facility and sells the frozen pulp to supermarkets in state capital and exports it to other countries, and refers to prices paid in 2012.

⁸⁸ Ideally, *cupuaçu* prices and total annual income from *cupuaçu* should be projected for 2017, when *cupuaçu* would reach mature production in the study communities. However, available data on tendency and cyclic fluctuations of *cupuaçu* prices across years is still incomplete. Nogueira & Santana (2009), for instance, analyses *cupuaçu* market prices in the period from 2000 to 2007, in which one cycle is only partially distinguishable.

between that group and the better-off (that gap is estimated in the next section). As discussed in the previous chapter, none of the three wealth groups were significantly more represented among participant households at the time of this research.

5.3 The potential place of agroforestry in current mixed livelihood portfolios

In this section, I examine current mixed livelihoods in terms of their individual components and factors involved in their implementation, in order to better contextualise the analysis of agroforestry's impacts on them.

5.3.1 Current livelihood activities

Current livelihoods are composed of a combination of subsistence and market activities. In terms of subsistence activities, traditional agriculture, fishing and hunting provide the basis of the local diet and nourishment – manioc *farinha* and animal protein. Non-timber forest products (NTFPs) are also collected for food and a variety of other uses. Subsistence agriculture, fishing, hunting and gathering are practiced by the vast majority; a few others count on gifts of food from kin or opt to buy *farinha* from neighbours or in the city instead. Some raise chickens, to which they resort when they cannot go out to fish or hunt. Households also count on cash income as some of the household needs are not fulfilled by those subsistence activities. Sources of cash income include trade in farm products and in wild resources, wage labour and social service payments. The main subsistence and income generating activities are listed in Table 5.1; some of them are illustrated in Annex 4, Annex 6 and Annex 7. This subsection describes each of the principal livelihoods activities in turn.

Table 5.1 Proportion of households (%) that benefit from⁸⁹ the main subsistence and income sources (n =116).

Livelihood activities	Households (%)
Subsistence	
Fishing	96
NTFP extraction	89
Agriculture – fields	86
Agriculture – homegardens	80
Hunting	70
Livestock – chicken	26
Cash income	
<i>Irregular</i>	
NTFP extraction – brazil nut	78
Agriculture – fields	33
NTFP extraction – <i>copaiba</i> ^a	29
NTFP extraction – <i>breu</i> ^b	28
Timber extraction	22
Livestock – cattle	9
<i>Regular (monthly)</i>	
Social service payment – <i>bolsa família</i> ^c	47
Medium to long-term employment	25
Social service payment – state pension	25

^a *Copaifera* sp. ^b *Protium* sp.

^c Payment aimed at improving nutrition and education of poor families

⁸⁹ In the present study, households are said 'to benefit from' an irregular source (farming and extraction of wild resources) when that source was rated as yielding food or cash inflows 'some' or 'many' times during the year (rather than 'never' or 'few' times). An exception is cattle raising, as cattle are typically sold a few times during the year when a particularly high amount of cash is needed. 'To benefit from' cattle raising or a regular source means simply that the source is part of the household's livelihood portfolio.

5.3.1.1 Agriculture

Agriculture is practiced in fields under shifting cultivation and in homegardens. The fields are dominated by manioc (*Manihot esculenta*), a root crop from which “flour” (*farinha*) is manufactured for consumption and, sometimes, for the market. Homegardens are used almost entirely to grow produce that can be picked as needed for use in the home.

Manioc *farinha* together with fish and game form the basis of the local day to day meals. Only a few households (14%) do not benefit from their own manioc fields for subsistence and therefore buy *farinha* during most part of the year, or count on gifts of food from kin in the case of older ones. The marketing of agricultural products – mainly manioc *farinha* and banana – benefits 33% of the households.

Agricultural fields are typically between 0.75 and 1.0 ha in size and also contain other annual and perennial cultivars typically grown for home consumption, of which the most frequent are the root crops *cará* (*Dioscorea* sp.), *macaxeira* (sweet varieties of *Manihot esculenta*), and sweet potato (*Ipomoea batatas*), banana (*Musa* sp.), pumpkin (*Cucurbita* sp.), watermelon (*Citrullus lanatus*), pineapple (*Ananas comosus*), sugar cane (*Saccharum* sp.) and *maxixe* (*Cucumis anguria*). Homegardens are much smaller cultivated areas immediately adjacent to each house. The most common plants in homegardens are cashew (*Anacardium occidentale*), mango (*Mangifera indica*), orange (*Citrus* sp.), *cupuaçu* (*Theobroma grandiflorum*), coconut (*Cocos nucifera*), guava (*Psidium guajava*), lemon (*Citrus* sp.), *ingá* (*Inga* spp.) and *azeitona* (*Syzygium cumini*). Fruit tree species are sometimes also planted around the *casa de farinha*⁹⁰ by the agricultural field.

⁹⁰ A roofed and unwallled construction containing a stove and other equipments needed to make *farinha*.

5.3.1.2 Domestic livestock

Chicken and cattle are the main types of livestock observed in the four communities. The first is mostly raised for home consumption, while the second is typically raised for the sale of meat.

Some households (26%) benefit from chicken raising for consumption in a small area adjacent to the house, with an average of ten chickens per household. Cattle are raised by 20 households (17%), but only 11 (9%) claim to benefit from it as an income source – the others were either beginning the activity or abandoning it. The animals are raised along the river margin, with an average of 13 animals/household and 1.6 animals/ha. Pasture is frequently established in upland agricultural areas following manioc harvest, but also in old growth forest areas. Pasture is planted in floodplain areas by some households to be consumed by cattle during the dry season; the animals are moved to upland areas (their own or that of kin) during the rainy season.

5.3.1.3 Extraction of wild resources

Extraction of wild resources comprises fishing, hunting, and NTFP and timber extraction. All of those are practiced both for cash income – especially the last two activities – and subsistence.

Fishing and hunting are households' main sources of animal protein. The great majority of households fish and hunt; exceptions are those with only older, retired members, who can count on gifts of food from kin. Among the consumed fish species are *pacu* (various Serrasalminae species), *tucunaré* (*Cichla* sp.), *apapá* (*Pellona* sp.), *aracu* (various Anostomidae species), *piranha* (various Serrasalminae species), *pescada* (*Plagioscion* sp.), *acari* (various Loricariidae species), and *pirarucu* (*Arapaima gigas*). Some of the consumed game species are monkey (*guariba* – *Alouatta* sp.), *paca* (*Cuniculus paca*), agouti (*Dasyprocta* sp.), deer (*Mazama* sp.), peccary (*Tayassu tajacu*), tapir (*Tapirus terrestris*), river turtles (*tracajá* – *Podocnemis unifilis*, South American river turtle – *Podocnemis expansa*) and tortoise (*jabuti* – *Chelonoidis* sp.). The aquatic fauna

is caught with the aid of fishing nets, *espinhe*⁹¹, types of spear, wooden fishing rods or simply a line ending in one or two hooks. Terrestrial game is hunted with shotguns and can be carried out in the forest with dogs or *na espera*⁹², or along the river margin from a canoe.

Commercial fishing by the study communities is targeted mainly at *tucunaré* and *pirarucu*, and commercial hunting, at the South American river turtle; both were said to be carried out by very few households at the time of my fieldwork. In the recent past, however, it had been one of the main sources of conflict between the communities and ICMBio.

NTFPs also contribute to local diets, especially brazil nuts (*Bertholletia excelsa*), *açaí* (*Euterpe oleracea* and *Euterpe precatoria*), *bacaba* (*Oenocarpus* spp.) *uxi* (*Endopleura uchi*), *tucumã* (*Astrocaryum* sp.), *inajá* (*Maximiliana maripa*) and *pequiá* (*Caryocar villosum*). Of those, only brazil nuts are significantly sold for cash.

Brazil nut extraction for the market benefits 78% of the households – it is by far the most widespread natural resource-based activity generating income in the four communities. Some of those households use stands near their homes, whereas others use farther ones and make week-long expeditions. The activity involves gathering the fallen fruits (*ouriços*) from the ground and carrying them in a woven basket (*paneiro*) on one's back. The basket is also used to carry the extracted nuts after breaking the fruits with a machete.

Copaíba (*Copaifera* sp.) and *breu* (*Protium* sp.) are resins produced by the tree trunk and their extraction is, after brazil nut collection and agriculture, the next most common among natural resource-based activities generating income – they respectively benefit 29 and 28% of the households. Both are typically

⁹¹ Hunting apparatus consisting in hooks tied to a line, at regular intervals from each other.

⁹² In this hunting technique, the hunter waits for and ambushes the game from a spot among tree branches, elevated from the ground.

collected by the same households, in far stands located one to three days of canoe trip from home, generally in expeditions lasting from 10 to 15 days. Trees are not impaired by the extraction of either of the two. For the extraction of *copaíba*, a manual drilling tool (*trado*) is used to make a hole in the tree trunk, from which the resin drains. After the extraction, the hole is closed and can be reopened some months later for a new extraction. *Breu* is expelled naturally by the tree trunk and then solidifies; it is collected from the ground, or from the trunk with a machete.

Timber is extracted mainly for house construction and canoe making; its local sale benefits 22% of the households. Among the main timber species used are *itaúba* (*Mezilaurus* sp.), *tento* (*Ormosia* sp.), *aroeira* (*Hymenolobium* sp. and/or *Pithecolobium* sp.), *louro* (various Lauraceae species) *acari* (*Minquartia guianensis*), *cupiúba* (*Goupia glabra*) and *mandioqueira* (*Qualea* sp.)⁹³. The present generation of carpenters was the first to make use of chainsaws, which apparently became more widespread in the 2000s. At the time of field research, carpenters who did not own one would generally hire someone to do part of the job. In the case of canoe making, steel axes and other carpenter's tools (such as *enxó* and hand plane) are used to complete the job.

5.3.1.4 Wage labour

Among the four communities, wage labour refers mainly to medium to long-term employment – short-term jobs⁹⁴ were undertaken by fewer households. The former is part of the livelihood portfolio of 25% of the households. Local jobs are

⁹³ Scientific names were obtained from the national forest management plan (IBAMA 2001), which presents the results of a forest inventory conducted in the PA.

⁹⁴ 'Short-term employment' refers, in this study, to work that usually terminates in less than two months, with the completion of an assignment, and is arranged as part either of the formal or informal economy. 'Medium to long-term employment' refers to work that is arranged as part of the formal economy, for which either there is no objective criterion for the termination of the job or the termination of the job is agreed for more than six months after its start. In the case of formal employment, the employee has the right to receive a minimum wage per month for six months after he is dismissed. The longer-term and greater income stability implied in the second case, motivated the categorisation adopted in this study.

much more frequent than jobs away from the local communities – they account for 24 and 6% of the households, respectively. Wages vary from the level specified as the minimum wage to approximately twice that amount.

There is quite a limited range of jobs available in the local communities themselves. The municipal government is one of the employers – in 2011, 17% of the households relied on jobs either in the two local public schools or in the health care system. Those jobs include the ones as school directors or teachers (7% of the households), as *serventes/merendeiras* – they both clean the building and make the meals (3%), and as boat drivers (8%). There were only two “community health agents” (*agentes comunitários de saúde*) (2%) attending the four communities. As there is no hospital or the like provided by the municipal government, the agents’ work is the only public health service that communities have access to locally. They undertake tasks such as: weighing the children and checking if their vaccinations are up to date, collecting blood to be tested for malaria, measuring blood pressure and ensuring that medicines are taken properly.

ICMBio, the other local employer, had local people from 5% of households among their staff at the time of my fieldwork, at three of the four of its field bases in the two PAs. Those local people support other ICMBio staff members in monitoring activities, which intensify during the turtle breeding season.

Local jobs are said to be preferable to ones in the city or in the Rio do Norte Mining (MRN) company town (*vila operária*), as employees can see their families more often and, in some cases, continue with their subsistence activities (perceived as a safety net in case of a job loss, as will be examined in subsection 5.3.2). Commonly attempted jobs in those places include those in construction works. Remittances sent by household members in medium to long-term employment outside their own – or neighbour – communities compose the livelihood portfolio of 6% of the households.

5.3.1.5 Social service payments

Social service payments include state pension, *bolsa família* and *salário-maternidade*, described in turn below.

State pension is received by 25% of the households. 60 and 55 are the ages from which rural men and women, respectively, can request that payment. Illness and death are also cases in which pension can be – and have been, at the study site – claimed by the beneficiaries and their dependants. Monthly inflow from pension corresponds to one minimum wage.

Social service payments also include *bolsa família*, received by 47% of the households. The *bolsa família* program is aimed at poor households and conditional on attendance at school and up to date vaccination of children. Payments depend on the number of eligible children and varied greatly among households at the study site; in 2012, they generally received between 15 and 50% of the minimum wage per month under that program.

Salário-maternidade is the remuneration that women receive during a four-month-leave after they give birth – a right of women employed in the formal economy, extended to women farmers. Women farmers receive four times the minimum wage all at once, which can be enough (and has actually been used) to build a new wooden house or partly build one made of bricks. Whether or not this has made having a child more tempting I shall not discuss here; the fact is that it has allowed worse-off households to make investments that they would not otherwise be able to.

5.3.2 Mixed livelihood portfolios and wealth differentials

It is clear from the above that some of the activities households make a living from are aimed at income generation, others at providing directly for subsistence needs, and others are a combination of the two. Most households make a living from a mixture of those different activities. Among those who have paid jobs or receive social services payments, most continue to farm, and

farming – whether agriculture or cattle raising – is usually mixed with the extraction of wild products. However, the mix of livelihoods activities that are combined in the portfolio of a single household is shaped by and has implications in terms of wealth. Different compositions of livelihood portfolios are also influenced by patterns of labour demand and income generation at different times of year and to a lesser extent by land availability. This subsection describes how the different activities are combined in mixed livelihoods, so that the following subsection can analyse the extent to which agroforestry is likely to fit into existing livelihood portfolios.

Labour demand from some activities – such as farming and extraction of wild resources – is irregular or concentrated at certain times of the year, whereas labour demand from others – such as medium to long-term jobs – is regular or spread evenly throughout all months of the year. That distribution pattern during the year is relevant in the analysis of income availability and is influenced by the two seasons identified by local households: the winter (*inverno*), rainy season, comprising the period from January to June, and the summer (*verão*), dryer and hotter season, from July to December.

The composition of income sources portfolios is constrained by and also has implications in terms of wealth. The difference among the three wealth groups⁹⁵ was found to be significant (chi-square and Fisher's exact⁹⁶ tests, $p < 0.10$) for one regular and one irregular sources: medium to long-term employment and cattle raising (Table 5.2⁹⁷). Both are associated with a higher wealth status. Regarding the other four irregular sources, the difference was shown to be insignificant (chi-square test, $p > 0.10$) (Table 5.2). Concerning state pension,

⁹⁵ In the present analysis, the ownership of durable goods was the criterion used to classify households in wealth groups (see details in Chapter 2).

⁹⁶ Fisher's exact test was applied as an alternative to the chi-square test when there were expected cell counts falling below five.

⁹⁷ Although chi-square and Fisher's exact tests were applied on absolute values rather than on proportions, the latter is presented in order to allow for easier comparison between wealth groups.

available evidence is not conclusive: although the difference between wealth groups was also statistically insignificant ($p > 0.10$), local households' qualitative accounts associate that income source with a wealthier status. In another words, there is a tendency among the wealthier households of combining the first two sources (and possibly pensions) with other irregular sources, rather than specialising in any of the former. Figure 5.1⁹⁸ suggests that although a wealthier status could be explained both by a greater reliance on portfolios mixing either job or cattle with other irregular activities, and on portfolios specialising on either of the first two sources, only the first scenario is associated both with the gap between the worse-off and in-between groups and with the one between the in-between and the better-off. The same analysis applies if pensions are added to the set including jobs and cattle.

Table 5.2 Proportion of households (%) in different wealth groups benefiting from each of the main income sources (n=116).

Income sources	Wealth groups				
	Overall	Worse-off (n=33)	In-between (n=54)	Better-off (n=29)	
Irregular					
NTFP extraction – brazil nut	76	88	74	72	
Agriculture – fields	33	36	33	28	
NTFP extraction – <i>copaíba</i>	29	39	26	24	
Timber extraction	22	24	24	14	
Livestock – cattle	9	3	7	21	**
Regular					
Social service payment – <i>bolsa família</i>	47	42	50	47	
Medium to long-term employment	25	9	28	38	*
Social service payment – state pension	25	15	24	38	

* $p < 0.05$ (chi-square test)

** $p < 0.10$ (Fisher's exact test)

⁹⁸ *Idem.*

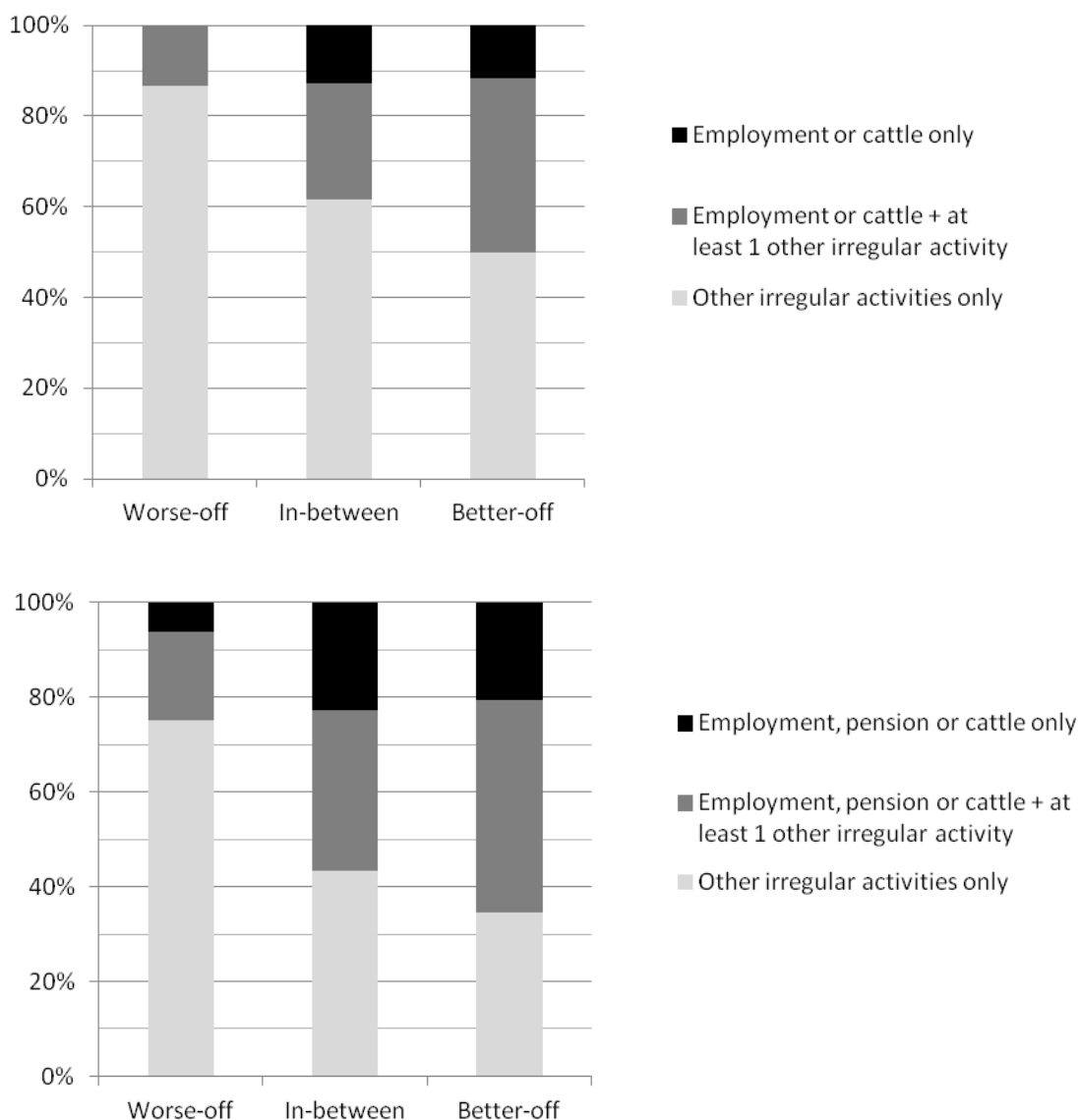


Figure 5.1 Proportion of households (%) in different wealth groups benefiting from different portfolio of activities (n=114). (p<0.05, chi-square test)

Why might that be the case? Firstly, certain jobs require relatively high levels of human or physical capital. In the local schools, for instance, teachers are among the ones who were able to study in the city usually with the financial support of their parents, and the boat drivers, among the few ones who owned that means of transportation. Secondly, the strategy of including regular sources in the form of wages or of pensions in a livelihood portfolio, while not abandoning irregular sources, could be expected to underlie a wealthier status.

Bolsa-familia payments also come monthly, but are much lower – less than 1/3, on average. Local households say that the extra cash provided by jobs and state pensions has allowed investments in cattle, an important asset in many societies, which would explain their co-occurrence in many of the wealthier households. Earnings from other irregular activities have sometimes also allowed those investments, according to them.

Labour and income related concerns also underlie the decision to either combine regular income sources that are associated more often with the better-off with irregular sources (other than cattle) or specialise in one of the two sets. Importance attributed to a sense of autonomy or of “being in charge”, whether the regular income is perceived as insufficient or not, available time outside job hours, physical condition, the appreciation for the irregular activity (despite the demand for intensive labour), and the extent to which the irregular income is perceived as a safety net in case of a job loss, all play relevant roles in that choice. Similar factors also underlie the decision to continue with subsistence activities – subsistence agriculture benefits the great majority (79%) of the households that have regular sources in their income portfolio, while the others buy *farinha* from neighbours or rely on gifts of food from kin during most of the year. There are mixed accounts regarding that, for example:

We don't have manioc anymore, we stopped planting it. Now we have this pension, an opportunity. It is money that we have to facilitate, to allow us to stop working. We are almost incapable, we have worked too much. Now we buy farinha. We are only two here at home, one sack of farinha we bring from town lasts one whole month.

(Elderly man from Abuí)

My husband wanted to plant manioc, but it is bad when it is only me here, he works away. He spends 15 days at home every month now; it was only five days sometime ago. Now we can even plant manioc because we can go to the field every now and then.

(Woman from Tapagem)

A job helps but, in fact, a planting is safer. The company can suddenly dismiss you; you are not even expecting that.

(Man from Sagrado Coração)

On the one hand, some only have weekends free from their job (teachers and those working in the city), or mention, even among the younger, that they are either too old or have some physical impairment to work in a job as hard as making *farinha*. On the other hand, some argue that the monthly salary is not enough to buy *farinha*; some claim to have half of the week (school *serventes*) or half of the month (those employed by ICMBio) as free time, which would allow for the practice of subsistence agriculture if they wished; some prefer, in the case of the older and retired ones, to pay someone to help them prepare the field so that they themselves can then plant and harvest, rather than abandon agriculture completely; some emphasise that they really like planting and could not live without their fields (*roças*); some argue that if you do not watch out (e.g., do not keep your subsistence agriculture), when you are dismissed from a job you are left with nothing.

A variety of irregular income sources are also frequently combined in livelihood portfolios. Winter is the season when “even children make money” (*até criança faz dinheiro*) with the collection of brazil nut, the most widespread cash income source. In years of peak production, the brazil nut trees shed their fruits mostly during the winter, from January to June. During that season, brazil nut collection is usually prioritised over other natural resource-based income generating activities, apart from cattle raising – pasture maintenance is carried out by household members not involved in the nut collection or else the two activities are undertaken alternately (Figure 5.2 and Figure 5.3).

Some households opt to interrupt even subsistence manioc harvesting in the winter, as they see as unprofitable to lose even a few days of nut collection to make *farinha*. It is commonly unfeasible for the woman alone, who generally stays in the house while the man collects the nuts, to make *farinha* – an exception is when their children are able to help. During that period, they

purchase it from intermediaries or from neighbours who do not hold the same view and manage to take advantage of that opportunity.

On the other hand, fishing and hunting are part of households' daily routine during the whole year. They spend a considerable part of each day involved in either of those activities – frequently the whole afternoon, night or morning, and sometimes even longer. In terms of gender issues, although women never hunt, most do fish. In the cases they do not, due to lack of knowledge or available time, it can be problematic for the man to leave the house for extended periods as is demanded by *copaíba* extraction and certain jobs. In such situations, some resort to consuming animals they have raised.

Elderly community members say that, in the past, it was common practice to stock up with basic products (such as powder coffee, refined sugar and soap) using the brazil nut earnings, which would last for the summer. Today, stock piling is uncommon. The main reasons for that are not clear, but a decrease in the productivity of brazil nut stands and a decrease in the purchase power of brazil nut earnings are some of the explanations offered. Therefore, one of the issues is the irregular production as, in addition to the fact that nut production is concentrated in winter, productivity fluctuates across years and is not commercially viable every three to four years. Since the creation of the biological reserve, livelihood options for the summer and for the transition between the two seasons – such as taking unmanufactured logs tied up as rafts (*jangadas*) to the city for timber, hunting for animal skins, *pirarucu* fishing and turtle hunting – have narrowed due to prohibitions and restrictions being more regularly enforced. Few options remain, in the perception of households.

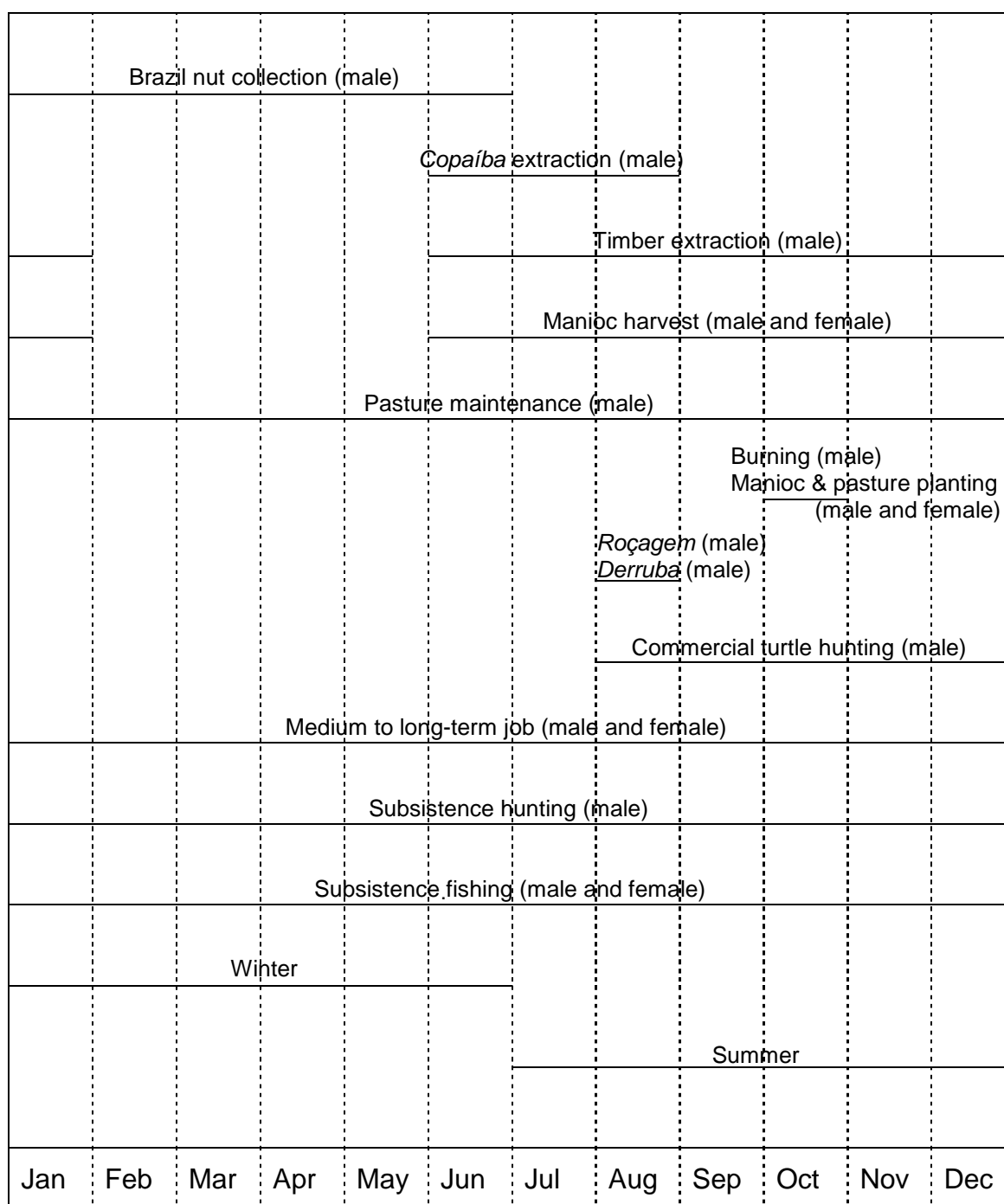


Figure 5.2 Calendar of labour demand from the main subsistence and income generating activities and how it is typically shared between men and women.

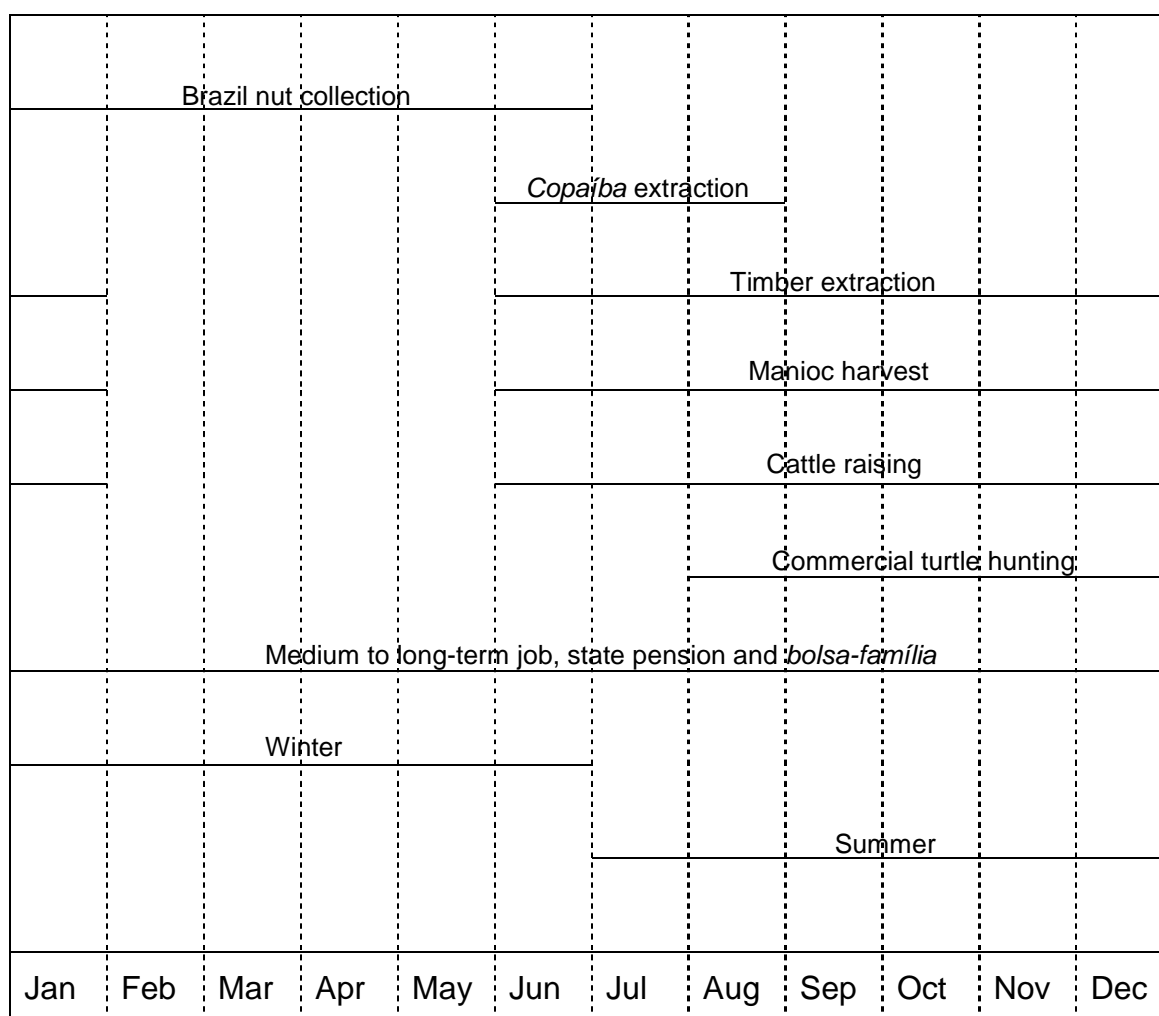


Figure 5.3 Calendar of cash inflow from the main income sources.

During the winter of unproductive years for brazil nut and the summer, households benefit from three main natural resource-based activities as income sources: the extraction of *copaíba*⁹⁹ and timber, and *farinha* making. While timber extraction and *farinha* making can be carried out during the whole summer, *copaíba* is usually extracted during its first two months – before the river is too low and, consequently, the trees are perceived as too far from the river margin.

⁹⁹ Although *breu* and *copaíba* were collected by a similar proportion of the households, the first was usually collected less often during the year. Therefore, just *copaíba* will be analysed here.

Income and labour related concerns influence not only households' decision of whether or not to combine regular and irregular income sources, but also the composition of the mix of irregular sources. Among the three irregular activities typically carried out when brazil nut is out of season, *copaíba* extraction can be considered the most labour demanding one, as it requires large periods away from home from the adult male. As a way to manage competition for labour, during the *copaíba* 'season' the other two activities are alternated with *copaíba* extraction expeditions in response to demand and price fluctuations or, more rarely, undertaken by the other members of the household (in the case of *farinha* making). While timber extraction is also a male activity, the workload involved in *farinha* making is typically shared between husband and wife.

Some households do not have either state pensions or medium to long-term jobs in their portfolio of income sources. Due to restrictions such as those regarding specialised knowledge, labour availability or physical condition, a small part of those households benefit almost entirely from brazil nut extraction among the irregular income options – they engage in other NTFPs or timber extraction or in farming only occasionally, or not at all. In most of those cases (10), the role of other social service payments in the summer turns out to be particularly important.

Fewer households benefit from cattle raising as an income source. Income from that source is also concentrated in the summer, when cattle are sold to get better prices. Nearly all of those households (10 out of 11) also benefit from brazil nut extraction, while a smaller proportion (three out of 11) benefit from *copaíba*, timber or agriculture. Five of the cattle ranchers also benefit from regular income sources (state pension or medium to long-term employment). The decision to invest in cattle is shaped by perceptions of the activity's demands on labour and profitability; positive perceptions are apparently related to the availability of certain assets, as will be explored in more detail in the next chapter.

Also typical of the summer months, field preparation for manioc and pasture planting is perceived as a long, heavy labour-demanding process. It usually starts in August with the slashing of the understory (*roçagem*) and the clear cutting (*derrubada*) of the forest (Figure 5.2). After about one month of work, the cut vegetation is left to dry. In October, the field is burned and planting is carried out. In that way, in November, when the rain starts, the field is already planted. This process allows for some flexibility. The month when the household is available to start field preparation can vary from year to year and this will determine the kind of fallow that can be used. The older the fallow to be used, the longer the time necessary to clear cut the forest and for it to dry enough to burn properly and, consequently, the sooner the household has to begin the field preparation, to be able to burn before the November rain. If household labour is available only later in the year, a younger fallow must be chosen.

To help in certain parts of field preparation for manioc planting – *roçagem*, *derrubada* and/or planting – most households organise a *mutirão*, which is a work group of people that perform a particular task collectively. The use of *mutirão* was not mentioned for cattle raising. Some ranchers report to occasionally pay other households for help in field preparation and pasture maintenance.

At the time of my field research, commercial turtle hunting was being carried out by very few households. Hunting is said to be very labour demanding as it can involve several weeks of unfruitful daily hunting attempts until an animal is caught. The hunting season conflicts with that of manioc planting and hunters are said not even to plant manioc for consumption, suggesting their specialisation takes priority.

In addition to constraints in terms of wealth and demands on labour, households are also faced, to a lesser extent, with issues of land availability within the

territory claimed by the study communities¹⁰⁰. There has been some competition for land between cattle raising and agriculture – the first has been pushing the second to less accessible areas in two ways. Pastures are sometimes established on land previously used for agriculture by the cattle owner, and some households (the rancher himself or his neighbours) have reported to have been compelled to move their agricultural fields further away to avoid conflict arising from cattle eating or trampling manioc plants.

As mentioned earlier, the composition of livelihood portfolios has implications in terms of wealth. I will now turn to an attempt to estimate the gap between the worse and better-off groups.

The mix of income sources typically adopted by the wealthier yields higher incomes, as the extra that the wealthier earn by having more regular sources in their portfolio than the poorer compensates for the reduction in earnings from irregular sources¹⁰¹. The income generated per activity per household was not quantified in the present research¹⁰²; however, the number of household members benefiting from regular sources and the frequency households engaged in the different irregular activities were obtained from household surveys (Table 5.3 and Table 5.4) and the ranges of income provided by different sources, from interviews with key informants.

¹⁰⁰ As examined in Chapter 4, land ownership has been claimed by the study communities collectively. Part of the claimed area was recognised as a slave descendant territory (*território quilombola*) and is now collectively owned; the area which overlaps with the national forest and the biological reserve is still under dispute.

¹⁰¹ *Bolsa família* and cattle are excluded from the present analysis. The earnings from the first are relatively low and differences between wealth groups regarding that source would tend to be negligible. The earnings from the second are extremely variable across years; moreover, for the purpose of this specific analysis, it can be considered an asset or a form of saving, rather than an income source.

¹⁰² The association of income surveys with the opportunity to secure social service payments would contribute to unreliable responses concerning household income.

The following evidence and assumptions backed up the estimation of income differentials:

- a) a state pension typically provides an income of one minimum wage per person, whereas the income from medium to long-term jobs ranges from 100 to 200% of that value (according to qualitative interviews). Based on that and on the finding that each of the two sources benefit similar proportions of the population aged 18 or above (14 and 12%, respectively), the average income provided by the two sources was estimated as 125% of the minimum wage. By multiplying that value (125%) by the difference between the worse and better-off in terms of the average number of members per household benefitting from either pension or jobs (0.9) (Table 5.3), the value of 113% is obtained;
- b) the four main irregular income sources are typically alternated during the year, rather than undertaken simultaneously (as examined earlier in this subsection);
- c) two of the main irregular sources (agriculture and copaíba extraction) yield, approximately, up to 120% of the minimum wage in a single month per household and one of them (timber extraction) up to 160%, each during a maximum of six months per year (according to qualitative interviews). Based on that and on the finding that different proportions of households benefit from each of those three sources (33, 29 and 22%, respectively), the weighted average maximum in a single month was estimated as 130% of the minimum wage. Therefore, the annual income from each of those sources would not surpass 65% of the minimum wage. As the difference between the worse and better-off as displayed in Table 5.4 (1.7) is below 3 (the maximum frequency of a single irregular activity), it can be estimated that it would correspond to less than 65% of the minimum wage.

In summary, it can be estimated that the extra income mentioned earlier corresponds to roughly 113% of the annual minimum wage on average, whereas the income reduction, to less than 65% of that value. Thus, it can be

safely argued that the average difference between the wealthier and the poorer households in terms of their annual income falls between 48% and 113% of the annual minimum wage¹⁰³.

Table 5.3 Benefits from pension or jobs.

	Wealth groups			
	Overall	Worse-off	In-between	Better-off
Pension of jobs (average no. of persons/ household)	0.7	0.3	0.8	1.2

Table 5.4 Frequency of cash inflows from the four main irregular activities

	Wealth groups			
	Overall	Worse-off	In-between	Better-off
Main irregular income sources (average frequency index*)	4.9	5.7	4.6	4.0

*The indices for individual households were obtained by summing up the frequency scores for each of the four activities. The frequency scores ranged from 0 (never) to 3 (many times in the year).

That income gap has implications in terms of food availability, and of acquisition of locally aspired valuables. Regarding the former, in general, the poorer do not lack the essential tools or land for subsistence activities, and they do fish, hunt and plant manioc. Also, *bolsa família* has improved the inflow of groceries, particularly among the worse-off. However, the wealthier are able to complement their subsistence production with a greater amount of purchased foodstuff and, consequently, it is rarer for them to skip a meal. Regarding the

¹⁰³ The three wealth groups are comparable at the household level, as the average household size is very similar among them: it ranges from 5.5 and 5.7 members.

implications in terms of the latter, the extra income earned by the better-off allows them to invest in home appliances and more durable housing materials. Some in that wealth group invest in cattle, which has been used as a buffer against shocks and as savings which are then turned into the above mentioned valuables when desired.

5.3.3 The potential place of agroforestry in mixed livelihoods portfolios

In terms of how agroforestry fits with other livelihood activities, there is potential for some conflict regarding labour and land, and for the income generated to be concentrated in certain times of the year. As the labour requirements for maintaining and harvesting from agroforestry plots over the winter and the summer are compared to those for existing activities (depicted in Figure 5.2), the distinction in gender roles stands out. Conflicts involving land use are less frequent and mainly related to cases in which agroforestry plantings are established close to cattle.

The main activities involved in agroforestry are weeding, pruning and fruit harvesting: weeding is to be carried out preferentially in the winter, according to extension staff and local perceptions; pruning was not among extensionists' recommendations, but is recommended for *cupuaçu* in the literature (Silva & Alfaia 2004, pp. 15-17) and can be carried out as needed during the whole year; and the harvesting season varies among the different planted species.

The fruiting season of several of the planted species (including *cupuaçu*, the main species), the weeding season and the part of the pruning interventions coincide with the brazil nut season (winter) and with the time of the year most suitable for *copaíba* extraction (transition between winter and summer), which usually require expeditions of one to two weeks away from home. However, those are predominantly male activities. Women do not take part in *copaíba* extraction and participate in brazil nut collection for only a small period (one month or so) until the school year starts and they have to go back home with their children. On the other hand, labour investments on agricultural activities

are typically shared between men and women. Most of the participant households (27 out of the 32) can count on the labour of the adult women – in some cases (4 out of 32) they are actually the leading household member in terms of participation in the agroforestry project. Therefore, the involvement of women in weeding, pruning and in the collection of the agroforestry fruits during the winter would emerge as a way to manage competition between agroforestry and other income generating activities. However, in that case, there is potential for conflict with daily chores of washing clothes in the river, cooking the food (sometimes after going fishing themselves), cleaning the house and garden, and also with jobs (in the case of teachers and *serventes/merendeiras* at the local schools). The number of small children and of older ones able to help, as well as the distance of the planting from the house, can make this task more or less challenging, allowing for more or less frequent weeding and fruit collection.

Also, women could potentially step in when it is a job that requires that men spend extended periods away from home. On the other hand, certain jobs leave free time that could be enough for engagement with agroforestry. Similarly, timber extraction is said to also leave enough free time for agroforestry.

During the summer, a potential source of conflict with agroforestry, in terms of labour, is subsistence agriculture. Nevertheless, the fact that several of the plantings were undertaken very close to their current agricultural fields could attenuate the conflict. In those cases, households would be able to save some time by pruning and collecting the agroforestry fruits planted at subsistence scale in the same trip they make to harvest manioc or to clear and plant a new field.

Concerning competition for land, there is apparently no conflict between agroforestry and agriculture, even in cases where the plantings are made in fields and fallows still suitable for the latter. The largest planting, at the time of my fieldwork, consisted of approximately 100 *cupuaçu* seedlings (complemented with few individuals of other species). This takes an area of about 20-35% of 1ha, the average agricultural field size. In order to estimate the

expansion potential of *cupuaçu* plantings, an analogy with banana can be made. In the 1970s, when markets for agricultural products were most favourable (as described in Chapter 2), banana was the main fruit crop sold and plantings were said to have reached up to 600 trees. If the largest *cupuaçu* plots were expanded up to that amount, they would account for only about one to two agricultural fields¹⁰⁴. Households usually have several fallows around their current agricultural fields and can afford to dispose of an area of such size.

Agroforestry and cattle do not exactly compete for the same land, but having them near each other can cause conflict. To prevent cattle from eating the seedlings, participant households have either planted them far from the animals or relied on an existent fence.

In terms of the potential contribution of agroforestry to local livelihood portfolios, *cupuaçu* bears fruits during the winter and could be a relevant source of income especially in the years when brazil nut is unproductive. However, it would need freezing, to be dried or to be transformed into jams or the like to be able to generate income during the summer, which is considered the most difficult period of the year by local people.

5.4 Discussion

This chapter has examined the main components of local livelihood portfolios and how they are combined in order to contextualise the analysis of whether and how local livelihoods are likely to be impacted by the *cupuaçu*-based agroforestry promoted by extensionists.

¹⁰⁴ It is assumed that labour demand was the main factor limiting the size of banana plantings and that labour demand is similar for the same amount of banana and *cupuaçu* trees.

The study communities live either in a national forest or in a collective territory. Immigration is severely restricted in those places and, thus, would not represent a relevant source of labour.

Firstly, for agroforestry to make a contribution to incomes at the study site, complex arrangements would be required such as: strengthening social organisation, establishing infrastructure for production processing, securing more appropriate means of transportation and accessing robust markets. The few commercial agroforestry experiences in the Amazon portrayed as successful (e.g., Franke *et al.* 2008) offer some insights on how those issues can be tackled. However, as those experiences are usually located at road margins, their findings have limited application to the more isolated study site.

Secondly, agroforestry's potential impact on the composition of activity portfolios was investigated by examining how mixed livelihoods are constructed. Local livelihoods are composed of a combination of subsistence and market activities. While manioc-based agriculture, fishing and hunting provide the basis of local diets, the main sources of cash income include trade in wild and farm products, wage labour and social service payments. Demands on male/female labour and availability of income from each activity at different times of the year influence which activities are combined. Regular income sources such as wages and state pensions have commonly allowed the accumulation of wealth and the investment of cash surpluses in cattle. The better-off have only to a small extent tended to substitute other irregular activities for those regular sources, keeping a diversified livelihood portfolio.

The extent to which the introduction of agroforestry would fit into a similar strategy – which privileges diversification rather than substitution – would depend on the level of involvement of both men and women. However, there are constraints for a fair distribution of burdens and benefits within the household. Certain areas are not conventionally considered the domain of each of them – for instance fruit processing in the case of men and wholesale trade in the case of women. Kiptot and Franzel (2012)'s study on gender roles within the agroforestry context suggests that women tend to be responsible for the retail trade of fruit crops, for which markets are not well established, whereas men, for the wholesale trade of major cash crops. According to Benson (2010, p. 66), due to the perception that traditional women's roles are restricted to activities

such as seed storage and crop processing, women often do not get the advice they need.

Moreover, agroforestry's potential to enhance income reliability of livelihood portfolios and total household income is likely to be restricted by the planting composition. The dominance of *cupuaçu*, a winter tree crop, has key consequences for how portfolios comprising agroforestry compare to ones in which regular monthly income sources (such as state pension and medium to long-term jobs) play an important role, as in the case of the better-off households. Those to whom jobs are either not accessible or not attractive could be particularly benefited by an agroforestry production more spread out through the year.

Agroforestry's contribution to local livelihoods is likely to influence the decision of whether or not to continue participating in the extension project (see previous chapter for an analysis of participation) and also agroforestry's indirect conservation outcomes, as will be examined in the next chapter.

CHAPTER 6 Declines in biodiversity and the potential of agroforestry

6.1 Introduction

The potential direct value of agroforestry to biodiversity conservation has been examined in Chapter 1, which focused on beneficial outcomes that may result from the complex structure and high levels of native biodiversity frequently exhibited by that land use system. Additionally, a positive contribution of agroforestry to livelihoods, discussed in Chapter 5, can potentially favour indirect conservation outcomes such as the alleviation of pressure on natural resources. That would be of particular relevance to a strategy aiming to reduce threats to protected areas' (PAs) resources.

The few studies exploring agroforestry's indirect value for conservation show contrasting results. For instance, while Murniati *et al.* (2001) detected a reduction in PA's timber extraction associated with the practice of combining agroforestry with rice fields in Indonesia, Franke *et al.* (2008) found an increase in deforestation for pasture formation in Brazilian smallholdings despite increases in agroforestry's financial returns.

Among the activities perceived by PA staff as the main threats to Saracá-Taquera National Forest and Rio Trombetas Biological Reserve are mining and timber extraction conducted by large companies, but also hunting of chelonian species and fishing carried out by local populations. Cattle raising and timber extraction undertaken by those populations are perceived by staff as minor threats. However, there is no consensus among PA staff, local people and researchers on the relative contribution of each of those activities to wildlife population decline and deforestation. The assessment of those contributions could indicate which activities should be prioritised by efforts aimed at relieving pressure over PAs' biodiversity and whether local livelihood activities should be targeted at all.

In this chapter, I investigate turtle hunting and cattle raising as cases indicative of a wider range of threats perceived to be posed by local people. The biological reserve was created mainly for the conservation of the South American river turtle (*Podocnemis expansa*). Moreover, I focus on that species rather than on *tracajá* (*P. unifilis*) – the two are by far the main chelonian species caught by hunters in the PAs – due to the fact that the second is not significantly captured for markets in the study communities.

The objectives of this chapter are:

- to analyse the role of turtle hunting and cattle raising in perceived biodiversity declines;
- to assess whether agroforestry may contribute to lower the impact of those two activities.

Section 6.2 focuses on turtle hunting. I examine the extent of turtle fluctuations over time in the PAs, as well as the possible drivers underlying them and the place of turtle hunting among those drivers. Section 6.3 turns, then, to cattle raising. I explore the extent of deforestation expansion in the PAs and the relevance of cattle raising in that context. I end the two sections by examining local people's perceptions of the activity in question and agroforestry, in terms of advantages, shortcomings and preferences. I assess the extent to which the former is motivated by income generating concerns and the potential of agroforestry to decrease its scale in that context. Finally, section 6.4 discusses the chapters' main findings.

6.2 Turtle hunting

The four study communities live in the buffer zone of Rio Trombetas Biological Reserve. The South American river turtle has historically been hunted for consumption by local people and, more recently, for markets in a more intensive way. In this section, I will present the legislation pertinent to turtle hunting as background, examine local trends on turtle population and discuss the contribution of that activity to those trends based on secondary sources and

local households' accounts. I conclude by assessing the extent to which turtle hunting is motivated by livelihood issues such as income generating concerns, and ask whether a livelihoods approach promoting alternative income sources is appropriate. For the cases where it is deemed appropriate, I discuss the potential of agroforestry to decrease the impact of turtle hunting.

Since at least the 1930s¹⁰⁵, capturing South American river turtles (*Podocnemis expansa*) has been subject to legal restrictions in Brazil – catching them during the breeding season and taking immature specimens has been prohibited. Since the late 1960s, hunting of wild fauna for commercial purposes has been completely banned; however, legislation was ambiguous as to whether hunting or fishing regulations should apply to aquatic species¹⁰⁶. In practice, according to a member of PA staff, river turtle catching has been considered a form of hunting at the study site since at least the mid-1970s.

Following a survey of turtle nesting sites in the Brazilian Amazon basin carried out in the 1970s by Alfinito (1978), an increasing number of the identified areas have been monitored and protected. Since that decade, concerns about the conservation status of the South American river turtle have reached the international level, which contrasts with its absence on national lists of threatened species.

Podocnemis expansa has been listed in the annex II of CITES (Convention on International Trade in Endangered Species of Wild Fauna and Flora) since 1975 – the convention was ratified by the Brazilian government in that same year¹⁰⁷.

¹⁰⁵ *Decreto Federal 23672*, 2 January 1934. *Aprova o Código de Caça e Pesca*.

¹⁰⁶ *Lei Federal 5197*, 3 January 1967 – *Dispõe sobre a proteção à fauna*; *Decreto-Lei Federal 221*, 28 February 1967 – *Dispõe sobre a proteção e estímulos à pesca*. While the former regulated hunting and applied to “animals of all species [...] living naturally outside captivity”, the latter regulated fishing and applied to “animals and plants that have in the water their normal or more frequent living”.

¹⁰⁷ Annex II includes “species which although not necessarily now threatened with extinction may become so unless trade [...] is subject to strict regulation [...]”. The export of annex II

The species also features in the IUCN (International Union for Conservation of Nature) Red List of Threatened species. It has been categorised as 'endangered' in 1986, 1988, 1990 and 1994 Red Lists and, although since 1996 it has been listed as of 'least concern', "a recent Red List reevaluation of this species suggests that it will be listed as 'Critically Endangered' following completion of the formal review process" (Tortoise & Freshwater Turtle Specialist Group 1996; IUCN Species Survival Commission – SSC 2011). However, none of the official lists of threatened Brazilian wild fauna species mentions the South American river turtle¹⁰⁸, despite specialists' recommendations for inclusion in the 1973 and 1989 lists (Machado *et al.* 2008, p.98; Schneider 2011, p. 150). Crime against animal species mentioned in CITES annex II or in national lists of threatened species has been penalised with fines seven or ten times higher, respectively, when compared to non-listed species since the late 1990s¹⁰⁹ (both 20 times higher, since the late 2000s¹¹⁰).

In the late 1990s¹¹¹, the contentious status of river turtles was addressed: catching turtles came to be generally treated as a form of hunting rather than fishing, as the definition of the latter in national legislation was narrowed to apply only to fish, crustacean, mollusc and algae species instead of aquatic species in general. That was also the time when hunting for consumption was first mentioned in national legislation, which states that "killing an animal is not a crime when practised in a state of necessity, to satiate the hunger of the agent

species are dependent on an export permit, which is only granted if the specimen was legally obtained and if the export will not be detrimental to the survival of the species.

¹⁰⁸ National official lists were firstly published in 1968 and subsequently updated in 1973, 1989 and 2003/2004 (*Portaria* 303 IBDF, 29 May 1968; *Portaria* 3481-DN IBDF, 31 May 1973; *Portaria* 1522 IBAMA, 22 December 1989; *Instrução Normativa* 03 MMA, 27 May 2003 and *Instrução Normativa* 05 MMA, 21 May 2004). The two most recent ones used IUCN categories.

¹⁰⁹ *Decreto Federal* 3179, 21 September 1999. *Dispõe sobre a especificação das sanções aplicáveis às condutas e atividades lesivas ao meio ambiente.*

¹¹⁰ *Decreto Federal* 6514, 22 July 2008. *Dispõe sobre as infrações e sanções administrativas ao meio ambiente.*

¹¹¹ *Lei Federal* 9605, 12 February 1998. *Dispõe sobre as sanções penais e administrativas derivadas de condutas e atividades lesivas ao meio ambiente.*

or that of his family”. Biological need rather than cultural concern is the focus of the legislation. According to the interpretation of that regulation proposed by Bechara (2003 *apud* Abdalla 2007, p. 74), hunting for consumption would only be justifiable when no other option of animal foodstuff is available. I argue that this is an extreme interpretation, according to which hunting for consumption should not be allowed in a situation of food insecurity when, for instance, domestic animals or fisheries are scarce but not completely unavailable. In addition to the criterion proposed by Bechara, a hunter’s poverty and dependence on natural resources and the extremely small scale of the activity have been used to justify court decisions for the non-application of sanctions (*Ministério Público Federal* 2013).

At the study site, turtle nesting beaches are located on the banks of the Trombetas River. Those beaches lie within the limits of Rio Trombetas Biological Reserve, created in 1979. Subsistence hunting or any direct use of natural resources except for research has been forbidden in that category of protected area since at least the late 1960s¹¹². However, since the early 2000s¹¹³, new legislation specifies that populations depending on PA resources prior to its creation – which applies to the study communities – should have their subsistence secured until they are compensated. In that case, the legislation on hunting for consumption would apply. In practice, the staff members of that PA diverged in how extremely they interpreted and enforced the legislation on hunting for consumption. However, when it came specifically to turtles, a PA staff member asserted that all staff enforced a complete ban allowing no exception, and used the critical population level at the time of this study to justify such measures.

6.2.1 Turtle ecology and turtle population fluctuations

Systematic monitoring carried out since the creation of the biological reserve in the late 1970s reveals a drastic decline in turtle population during the 1990s.

¹¹² *Lei Federal* 5197, 3 January 1967. *Dispõe sobre a proteção à fauna.*

¹¹³ *Lei Federal* 9985, 18 July 2000. *Institui o Sistema Nacional de Unidades de Conservação da Natureza.*

Nesting sites within the PA have been surveyed during the breeding season, generating estimates of the number of reproducing females and of hatchlings produced per season. This subsection starts by describing key aspects of turtle reproductive ecology in order to contextualise the secondary data, and is followed by local households' accounts of the decline of the turtle population.

Unexpectedly large and high sand banks (*tabuleiros*) are revealed with the seasonal ebb of the water level in the Trombetas River (Annex 8), which delineates the southern boundary of the biological reserve. During July and August, *tabuleiros*' higher areas are uncovered and turtles migrate to those areas from lakes located nearby and downstream. In late September, turtles start the pre-nesting basking behaviour (*assoalhamento*) – gathering on *tabuleiros* during the day to benefit from the sun's heat. From late October to November, they make use of those areas at night to lay their eggs. Adult animals stay nearby the *tabuleiros* until hatchlings leave the nests, mostly during December (Annex 8).

The four study communities are the ones located closest to the two main *tabuleiros* used by turtles. Group behaviour and the choice of predictable and exposed areas for reproduction make that species particularly vulnerable to hunting during migration, oviposition and gathering around *tabuleiros*. The two main nesting sites are patrolled by PA staff on a 24/7 schedule from August to January.

Some authors propose that turtles tend to come back to the same *tabuleiro* every breeding season and that they are very sensitive to disturbances in the nesting site, compared to other chelonian species (Nascimento 2002, p. 204; Brazilian Institute of Environment and Renewable Natural Resources – *Instituto Brasileiro do Meio Ambiente e dos Recursos Naturais Renováveis* – IBAMA 2004). Studies carried out in the 1970s and 1980s observed an average number of eggs per nest varying from 75 to 92 and hatching success, from 0.75 to 0.89 at the study site (Vanzolini 2003, p. 417, 420). Egg position and parent turtle urine are considered important factors in hatching success in the literature

(Bonach *et al.* 2003, p. 712). Local households' accounts also attribute importance to the latter.

The literature on females nesting annually on the main sites of Trombetas River before the creation of the biological reserve in 1979 is incomplete. For the period from 1965 to 1978, available data on reproducing females indicate a decline to at least one fourth of the approximately 5,400 of these individuals observed in 1966, followed by an almost complete recovery (Vale *et al.* 1973 and Alho *et al.* 1979 *apud* IBAMA 2004). After the fairly stable number of reproducing females and production of hatchlings observed annually in the 1980s, an even more drastic decline was detected in the 1990s: from nearly 400,000 hatchlings in 1990 to just 40,000 in 1999 (Figure 6.1). After reaching only 8,000 hatchlings in 2003, annual production has increased and, in the past few years, stabilised at 500 to 600 reproducing females and 30,000 to 40,000 hatchlings. Local households' accounts corroborate some of those findings; they are emphatic in arguing that, in the past, the turtle population was much larger than today: "the beach used to turn black [reference to the colour of turtle carapace], today it is not like that" (elderly man from Abuí), "one [turtle] dug out [the eggs] of the others" (man from Abuí), "one used to hit the oar on turtles, not today" (elderly man from Abuí). Local views on when the decline became more drastic are related to the perceived driving factor underlying the decline. According to the two main narratives, turtle population decreased either after PA staff came and implemented new regulations and management practices (PA staff arrived in the area in 1976 and started enforcing regulations and introducing management practices in 1979 with the creation of the biological reserve, according to a staff member), or after the introduction of fishing nets (*malhadeiras*) to the repertoire of turtle hunting apparatus used in the region (in the period between the late 1980s and early 1990, according to local households).

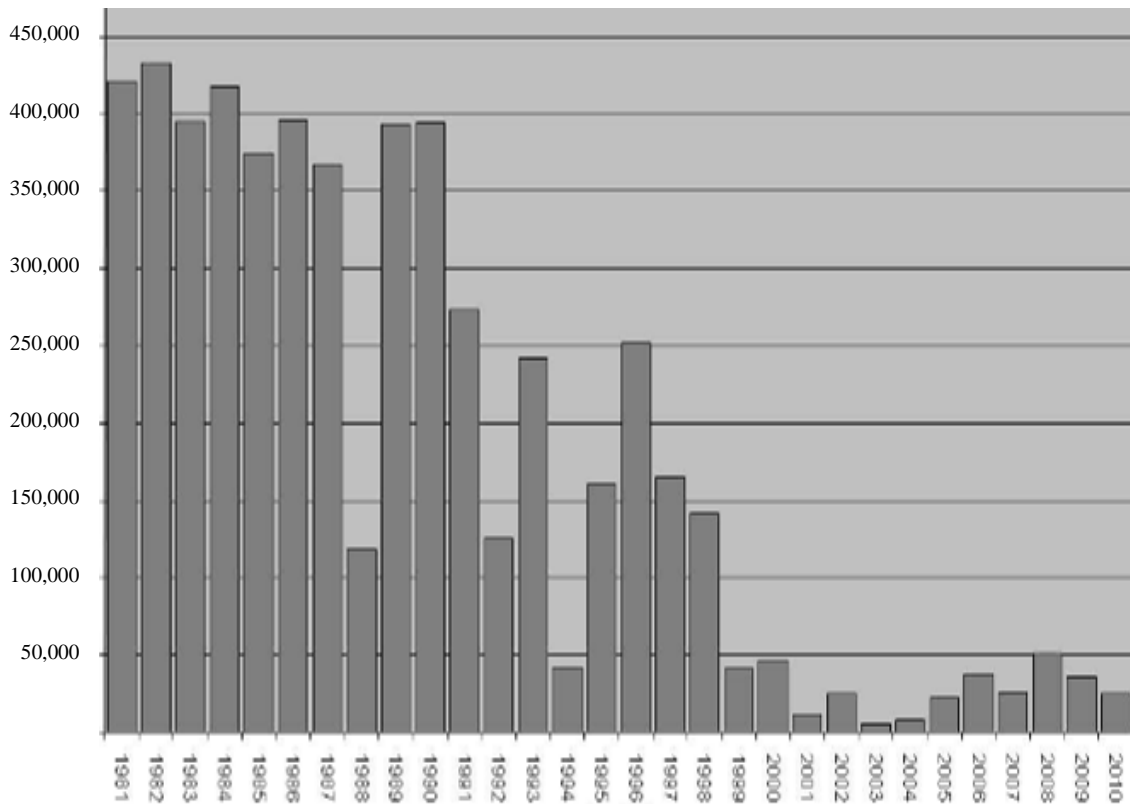


Figure 6.1 Number of hatchlings observed annually from 1981 to 2010 at Rio Trombetas Biological Reserve.

Source: Chico Mendes Institute for Biodiversity Conservation (*Instituto Chico Mendes de Conservação da Biodiversidade – ICMBio 2011*)

6.2.2 Factors associated with turtle population decline and the place of turtle hunting

There is strong consensus among locals and PA staff regarding the severe decline in the turtle population, but its drivers are contested. The perceived drivers most prominent in locals' narratives were hunting and PA managers (mal)practices. PA staff also emphasise the role of the former and add the possible impact of the Rio do Norte Mining (MRN) company port. After examining each of the perceived drivers in turn, I take an historical perspective in the analysis of those drivers' relative scale of impact.

Turtle hunting

Commercial turtle hunting targets mainly the adult females, which are kept alive until they reach the final consumer. The smaller males and the soft-shelled eggs are predominantly consumed locally. The importance of turtle hunting to local livelihoods goes beyond income generation or the satisfaction of biological needs; for instance, according to various accounts from local people, turtle being part of the menu makes the *mutirão*¹¹⁴ much more attractive – a *mutirão* with turtle means a more crowded, and more lively, *mutirão*.

There is disagreement both among local people and among PA staff about the influence of local hunting on turtle population decline. The flourishing turtle population despite the hunting that was carried out before the creation of the biological reserve was highlighted among locals:

It used to be easy to catch turtles, there were a lot of them. And today, with this surveillance all the time, we do not see them. When you see 100 turtles on the beach, you can think that it is a lot, but it is not. [...] We used to catch more turtles than now.

(Man from Paraná do Abuí)

They tell that families used to be allowed by authorities to catch the animals outside the breeding season and outside breeding areas during the breeding season. Moreover, authorities would supply each household with a few animals (usually two to three) per year to feed the *mutirão* gathered for the annual preparation of agricultural fields and the annual cleaning of the local cemetery. Before the creation of the biological reserve, turtle used to be the traditional dish for those occasions. A member of PA staff adds that turtle capture by hunters has not increased since the creation of the biological reserve, as a result of the intensification of patrolling carried on by PA staff.

¹¹⁴ A group of people who gather to perform a particular task collectively.

On the other hand, the adoption of new hunting technologies and the consequent increase of hunting efficiency was also mentioned among locals and PA staff and regarded as one of the drivers of the species population decline. The scale of more recently used hunting apparatus – 100 to 300 hooks *espinhel*¹¹⁵ and 50 to 100 m long fishing nets – contrasts with the scale of older ones such as one line ending in two hooks and types of spear (*haste de tapuá*, *zagaia*). Some locals suggest that the increased access to Manaus' (capital of the neighbouring state of Amazonas) markets – through intermediaries (*regatões*) that came by boat all the way from Manaus to the study communities – could have motivated the intensification of hunting.

Another aspect about local hunting practices with potential impact on turtle populations is the avoidance of the “Enchanted Lake” (*Lago Encantado*), where turtles would migrate to after the breeding season, according to local people. Underlying that practice was the local belief that there was only one man who knew the way to the lake and that death or madness could come to those who try to find it with the intention to exploit it. On the other hand, local households' accounts also suggest that people could hunt freely in another lake – *Lago do Farias* – which would also be used by turtles after the reproductive season. That illustrates that there were traditional mechanisms managing turtle hunting still in place, through both spatial zoning and seasonal restrictions. While it is not known how extensive or effective those were, one has to note the maintenance of such high numbers of hatchlings (~400,000) year after year prior to the 1990s.

PA staff practices

Households differ also about the influence of PA managers' practices on turtle population. While some point out the negative impacts of specific practices, others argue for the importance of patrolling, without which turtles would have vanished as a consequence of hunting. PA staff practices criticised by locals are mainly related to species management.

¹¹⁵ Hunting apparatus consisting in hooks tied to a line, at regular intervals from each other.

Relocation of nests was one of the criticised management practices. Eggs are removed from unmonitored beaches to monitored ones, as it is feasible for staff to continuously survey only the two main beaches out of the four locally used by turtles to nest. Moreover, eggs are transferred to higher areas whenever the risk of death by flooding is perceived as high by PA staff – sudden short-term rises in the river level (*repiquetes*) are a common occurrence. Species management also comprises collecting some of the hatchlings to raise in nurseries. That practice aims to decrease predation rates by releasing hatchlings after partial absorption of the egg yolk and hardening of the carapace and also allows hatchlings to be marked for monitoring purposes; in the past, the focus was on research that could inform commercial nurseries. Local people argued that death rates caused by both management practices – nest relocation and raising hatchlings in nurseries – were significant.

They [PA staff] take the eggs from one beach to another, only so that people do not take them to eat. They prefer to spoil it. Not all of the eggs they take hatch. [...] The eggs used to hatch, they [hatchlings] would go straight to the river and there they would grow up. But with their [PA staff's] silliness, spoiling all the eggs, the turtles are decreasing.

(Woman from Paraná do Abuí)

Some added that in the process of relocation, the parent turtle urine, fundamental in the hatching success, was lost. PA staff recognised the lower hatching success of relocated nests when compared to natural ones, but suggests that the avoidance, in relocated nests, of complete mortality due to flood or human predation would pay off. Staff added that nests are marked and the river level is monitored on a daily basis, allowing nests to be moved as late as possible, avoiding unnecessary relocations (Silva *et al.* 2011a). Staff explained that the lower hatching success in relocated nests may be affected by trepidation during eggs transportation and by change in eggs position, despite attempts to avoid those; the benefits of substances eliminated by the parent turtle are actually recognised and motivate the use of sand from the original nests in the new ones. One PA staff member also admits that, for a short period, mortality in the nurseries was increased. That staff member affirmed that

today hatchlings are kept in nurseries for a shorter time than in the past (two weeks instead of one month) in order to avoid that problem and to prevent behaviour modifications that could decrease survival rates after release.

The current existence of turtle nurseries in the city was presented among households as evidence of the PA staff practice of taking hatchlings away. The practice would be supported by law, if the area had not been protected as a biological reserve since 1979. A 1967 piece of legislation determining government support for commercial nurseries also determines that catching wild fauna specimens in biological reserves is prohibited. There were narratives of local people – questioned by other locals – who had witnessed members of PA staff boxing hatchlings, and taking them to the city. This practice is mostly located in the past – locals state that, as a result of the participation of communities in the release of hatchlings and of specific community members in the surveillance of nesting beaches, they feel more well informed about current management practices and conclude that hatchlings are no longer taken away. Members of PA staff affirmed that they were aware of those narratives, but had no additional evidence supporting them. One staff member argued that there was only one single occasion in which adult animals, rather than hatchlings, had been sent away in an attempt to repopulate a breeding area located downstream. Staff members stated that nurseries' requests for hatchlings had been turned down due to the designation of the area as a biological reserve and the critical status of the turtle population.

Transit of boats

The threats to turtles perceived by PA staff and local people to be related to the transit of boats involve boats used by communities, PA staff *voadeiras*¹¹⁶ and ships loaded with bauxite at MRN port.

¹¹⁶ Aluminium boats propelled by an outboard motor. Its engine is much more powerful than that of other local boats.

According to PA regulations, local people are not allowed to transit past the *tabuleiros* in any kind of powered boat at night – PA managers argue that the underwater noise may disturb turtles' nesting behaviour. Community members argue back, questioning the use of *voadeiras* by PA staff for the surveillance of the *tabuleiros* during the night. There is no consensus among locals about the significance of underwater noise impact on turtles. Both explicit agreement with PA staff about noise impacts and emphatic opposition to the existence of transit restrictions were expressed among locals. They express dissatisfaction about being forced to interrupt their journey home until the next morning when arriving from the city at night. PA staff claim that they try to minimise the impact resulting from the use of *voadeiras*. One member affirmed that staff know where turtles gather and avoid transiting through those areas at those times.

The MRN port at Porto Trombetas company town (see Chapter 2, Figure 2.2) was the other factor mentioned related to underwater disturbance. There is a continuous flux of international ships at MRN port to be loaded with bauxite. The port capacity is of one ship at a time; one new ship with capacity of up to 60,000 tons arrives every day, in average (according to PA staff and to Opinião 2006). PA staff and a few community members mentioned that the noise and turbulence caused by the ships may prevent turtles migrating upstream, passing through the MRN port towards the nesting sites.

Turtles are very sensitive to noise from boat engines. So with all this noise at MRN, no turtle that is upstream goes down and no one that is downstream goes up. These ones laying eggs here are from Trombetas River, not from anywhere else.

(Elderly man from Sagrado Coração)

PA staff also argue that port works may have contributed to altered river flow patterns and to the lowering of Leonardo beach. Turtles have moved their main nesting site from that *tabuleiro* to two other ones nearby.

Research

Research about the South American river turtle at the study site has relied on methods such as capturing them with fishing nets, taking measurements, marking by cutting the edge of the carapace, inducing regurgitation to check feeding patterns and installing tracking devices. It is suggested among locals that such research practices can scare turtles away:

Turtles are suspicious of others. They [researchers] put this device on its shell, it flees. The male turtle, no one sees it anymore, no one catches it.
(Elderly man from Tapagem)

One member of PA staff recognised that capture methods can disturb nesting behaviour such as the use of fishing nets where turtles are gathered and the capture of animals at beaches before they lay their eggs. That member argued that there were instances where research authorisation was conditional on adaptations to the originally proposed capture techniques. According to that member's perception, the use of fishing nets for research does not necessarily scare turtles away as several marked individuals have been recaptured.

Perceived drivers of turtle decline – history and relative scale

My historical analysis (Figure 6.2) of the timing and scale of possible drivers on turtle population decline suggests hunting and ship traffic may have contributed significantly to that decline. Although PA efforts have focused on relieving hunting pressure, further investigation is needed to elucidate the actual relevance of that pressure.

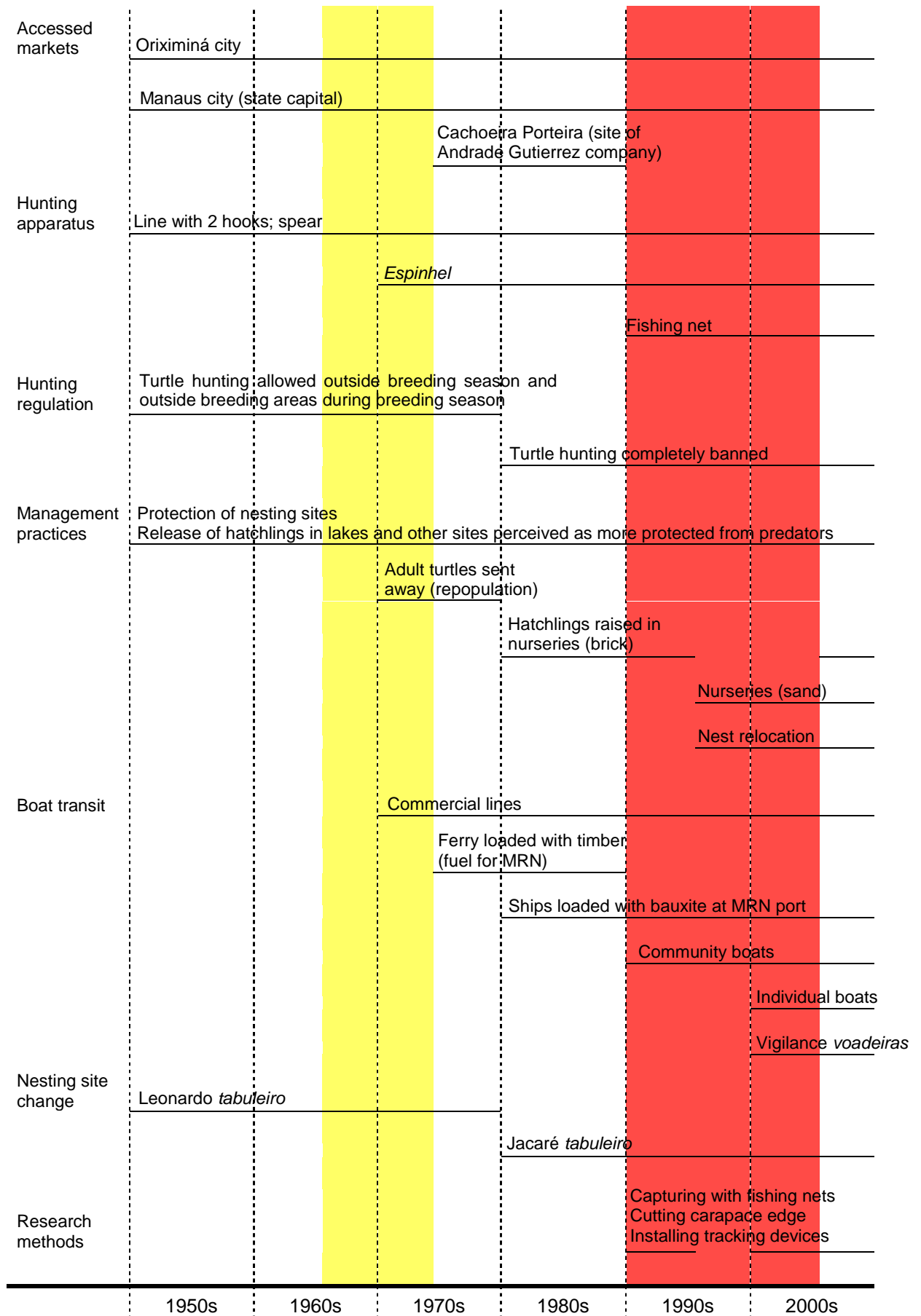


Figure 6.2 Approximate occurrence periods of possible drivers of turtle decline.
 Periods of decline in yellow (less steep, followed by recovery) and red (more steep).

From the two most significant periods of turtle population decline since 1965, I will concentrate my analysis on the one lasting from 1990 to 2003, for which data on reproducing females and hatchling production is more complete. It is relevant to differentiate negative impacts that could have directly affected hatchlings from those that could have affected reproducing females – it could be expected that the latter resulted in a more immediate decline in hatchling production than the former. It appears that hatchlings may have been directly impacted by new turtle management practices, while females are likely to have been impacted by the increased transit of boats through turtles' migration route and past *tabuleiros*, as well as the adoption of more efficient hunting methods for commercial purposes (Figure 6.2).

Evidence presented by IBAMA (2004) suggests the possibility of turtle migration from the study site to other river basins. According to that study, turtle hatchling production is estimated to have increased in two other Amazonian nesting sites at similar rates to their decline at the study site. However, baseline data, from direct records of migrations previous to the 1990-2003 decline period, is lacking. The author recommends that genetic studies are carried out to test that hypothesis by evaluating how those populations are related. IBAMA (2004) proposes that migration could have been induced by the MRN port. Migration to distant regions is also an argument used among locals to explain turtle population decline, but in that case migration is attributed to the disturbance caused by fishing nets, used both by hunters and researchers.

Research on turtle migration and hatchling growth patterns at the study site has intensified since the late 1980s, when staff from the National Research Institute of the Amazon (INPA) started their activities. According to one of the staff members, Dr. Richard Vogt, at different moments during the two periods when the institute have worked there (late 1980s to mid-1990s and early 2000s until the time of the present study), researchers have captured turtles – in the river with fishing nets or at *tabuleiros* – and attached VHF and satellite transmitters onto their carapace (see Guilhon *et al.* 2011 for a detailed description of those tracking devices) to track their movements. There is evidence – although limited in scale – that neither the capture methods nor the tracking devices used induce

significant emigration of animals to other river basins. In one instance (Vogt 2006), researchers tracked eight animals equipped with the two types of transmitters and concluded that, for six months, they had not left the Trombetas River basin. In another (Souza 2012), the data gathered over several months indicated that the use area of most of the studied animals (nine out of 14) lies within the Trombetas River basin. The remaining five animals could be located for only a few days; although this could imply that they have moved out of range (as only VHF transmitters with limited range were used in this study), their disappearance could also be due to transmitter failure or to human predation.

On the other hand, some of the local accounts suggest that the introduction of fishing nets in the study communities has contributed significantly to turtle population decline. The date estimated by key informants for that introduction – the period between the late 1980s and the early 1990s – coincides with the start of the 1990-2003 decline period. Manaus' markets have been accessed since the 1950s¹¹⁷ and hunting has intensified since then, but the uptake of fishing nets was possibly a turning point in that intensification. There was consensus among locals about the higher efficiency of fishing nets when compared to *espinhel*, used since the 1970s, but quantitative estimates of efficiency given by informants are challenging to compare as they usually could not specify what time period those estimates would apply to. An exception was one local informant (very close to an ex-hunter) according to whom hunting efficiency would have approximately doubled with the adoption of fishing nets – one was able to capture 10 to 15 per day with an *espinhel*, while fishing nets increased that to 25 to 30 animals per day (similar figures were mentioned by other locals). The impact of the uptake of *espinhel* in the 1970s cannot be estimated, as data on the efficiency of previously used apparatus (such as spears) is unavailable.

There is no information on when the traditional management practice of avoiding hunting in certain areas dates back to. Therefore, that factor was not included in the present analysis.

¹¹⁷ Historical data on the sale of turtles in the markets of Manaus is unavailable.

The protection of nesting sites by different institutions dates back at least to the 1950s and has limited considerably the collection of eggs by hunters, according to local and PA staff accounts. On the other hand, management practices undertaken by those institutions were mentioned by local people as one of the drivers of turtle population decline. However, those claims are not supported by quantitative estimates provided by PA staff. Firstly, according to a staff member, the only event in which animals were sent away – for repopulation purposes – involved around 150 adult animals and occurred in the 1970s. The scale of the interference may not be negligible (between 3 and 12%, considering the fluctuating total of approximately 1,250 to 5,000 reproducing females estimated for that decade) but at least a decade separates it from the 1990-2003 decline, indicating that it is not the sole nor the main driver of that decline. Secondly, the practice of nest relocation started only in the mid-1990s, according to PA staff members. Moreover, although the proportion of relocated nests annually can exceed 25% of total nests, hatching success of relocated nests is typically only 6-23% lower than natural ones (with one exception of 69%) (2005-2010 data), according to monitoring carried out by PA staff (Silva *et al.* 2011b)¹¹⁸. Finally, although hatchlings have been retained in nurseries regularly during the decade prior to the 1990-2003 decline period and data on survival rates of hatchlings after release (compared to non-retained ones) are not available, PA staff estimated that a negligible sum of 500 to 1000 hatchlings (or less than 0.1% of total observed) were kept in nurseries in the 1980s and that less than 1% of those died before they were released. According to a staff member, relevant mortality rates in the nurseries would have occurred only for a couple of years in the 2000s, additionally indicating that it is unlikely that effects on turtle population of raising hatchlings in nurseries were significant. The effect of changing from brick to sand nurseries and of reducing the period hatchlings are kept in nurseries from four to two weeks in the mid-1990s would not be relevant for the 1990-2003 decline and is unknown.

¹¹⁸ It should be noted, however, that Jaffé *et al.* (2008, pp. 215-216) found an association between the practice of nest relocation and increased first-year mortality rates in the Orinoco river, Venezuela. Therefore, longer term studies should be carried out in order to better understand the impact of that practice on turtle populations at the study site.

Evidence gathered in this study suggests that the ships that are loaded with bauxite at MRN port may be one of the relevant contributors to the 1990-2003 decline. Firstly, those ships are by far the largest in size, when compared with the other motorised means of river transportation that have historically crossed turtle migration routes at the study site. Based on descriptions provided by a PA staff member, it can be estimated that the carrying capacity of the second largest ship on the river – a ferry that carried timber to be used as fuel by MRN – corresponds to less than 5% of the one of the mining ships. Secondly, if it were the case that noise generated by ships disturbed reproducing females and prevented oviposition, an immediate impact on hatchling production would have been expected. Yet, the MRN port started operating as much as a decade before the 1990-2003 decline period. However, a PA staff member affirms that the traffic intensity has gradually increased from approximately one ship per week to approximately one per day. The increase in traffic intensity is corroborated by a member of the MRN staff; according to him, the increase would have been from approximately 14 ships per month from 1979 to 2003 to 29 ships per month from 2003 to 2006 (Opinião 2006). Other sources of underwater disturbance have been introduced during or near the decline period as well: PA surveillance *voadeiras*, community-owned boats, and individual households' boats. Unlike the ships loaded with bauxite and the ferry loaded with timber, these boats pass not only through migration routes but also near turtle nesting sites during the oviposition season and therefore their increased traffic could have had an impact on oviposition (see Annex 2 and Annex 9 for illustrations of local means of transportation and a bauxite carrier ship).

According to a member of PA staff, average river levels have not changed significantly since the 1970s (available monitoring data is incomplete). Contrastingly, that member adds that changes in *tabuleiros*' height are common. The change in the preferred nesting site (from Leonardo to Jacaré beach) has been induced by the lowering of the original beach, according to PA staff members and certain local people. The former attribute that to the MRN port works – but that occurred in 1982, quite long before the decline period.

In conclusion, the relative importance of potential drivers of turtle population decline remains unclear. Increased boat traffic of all kinds, with an accompanying increase in underwater noise, seems to be a significant factor. Intensification of turtle hunting due to the introduction of more efficient hunting equipment may have also had a contributing role but this is hard to demonstrate categorically. There may be additional contributing factors, as yet unknown. Finally, there is always the possibility that at a larger scale, there has been no overall decline in the turtle population, the increased disturbances here having caused a migration to other parts of the Amazon basin, for which the IBAMA (2004) data are suggestive. The role of boat transit and of commercial hunting could be better understood by monitoring their intensity and its effects on turtle population levels, and conducting the genetic studies proposed by IBAMA (2004).

6.2.3 Motivations to turtle hunting and the potential of agroforestry as an alternative

As discussed earlier in this section, commercial hunting is banned in Brazil and its intensification may have contributed significantly to the 1990-2003 turtle population decline at the Trombetas basin. Both locals and PA staff members agree that today only a small fraction of local people hunt turtles for markets. This subsection analyses the cultural and economic aspects of motivations underlying turtle hunting, the widespread negative locals' views on that activity when compared to agroforestry, and whether hunters are likely to incorporate agroforestry into their portfolio of income sources, and lower hunting intensity.

PA staff and community members report that, until the 1990s, the market demand for turtles hunted at the study site used to come mainly from Manaus, the capital of the neighbouring Amazonas state. From Oriximiná, where some of the animals were consumed, most of them used to be sent to Manaus by boat. Today, with the depleted turtle population, hunting and exports to Manaus have diminished considerably. According to local accounts, the earnings obtained from the sale of only one to two of those animals are enough to supply the

household's monthly basic needs. However, hunters are perceived by locals to be among the worse-off economically speaking.

Only three households were mentioned by PA staff and locals to be substantially involved with commercial turtle hunting in 2011. I chose not to talk directly to them; I felt unsafe after hearing reports of their hostility towards PA staff, and there was the possibility that I would be mistakenly viewed as one of them. I also pondered about the reliability of their narratives on such a delicate matter to a stranger. My way around those issues was to get the opinion of non-hunters on turtle hunting – including households involved in that activity in the past – and secondary accounts on those hunters' views.

Negative views on turtle hunting as a livelihood option were manifested by most households. Those views were mainly related to a lack of positive livelihood outcomes in terms of wealth or well being, and the risk of being caught by PA staff surveillance, as will be detailed later in this subsection. Considering those perceived downsides of turtle hunting, why do a few still engage in that activity? Turtle hunting was labelled as an “addiction” among locals, suggesting that cultural as well as economic concerns motivated those hunters; they added that turtle hunters did not prefer other activities they attempted, such as formal jobs. Local householders' accounts indicate that hunting turtles is intertwined with other aspects of their livelihoods. According to them, hunters would have mirrored their fathers in terms of their tendency to specialise in the activity and not to accumulate locally aspired durable goods (better housing, electrical appliances); the latter would have been, in the past, connected with a nomadic livelihood. Some of those features are illustrated in the following account:

They [hunters] are stubborn. They learned it long ago. Those buying the turtles encourage them by saying: if you have it, I'll buy it again. So he [hunter] doesn't plant manioc anymore, he's a blind man. They [hunters] didn't have a manioc field or a house. They bought some farinha [manioc “flour”], a piece of clothing, when there was some money left.

(Elderly man from Tapagem)

Locals also reported that turtle hunters perceived hunting as highly lucrative, if they managed to catch the animals and not get caught by ICMBio, but predominantly for the hunters themselves – their high earnings were typically spent on women and alcohol, and not on their families. Although fewer animals were caught at the time than in the past, the high returns per animal still allowed hunters to get more than twice the equivalent of the monthly average household expenditure in a productive week. Moreover, the labour invested in turtle hunting can be considered much lighter when compared, for instance, to brazil nut extraction, manioc agriculture or wood extraction. The following quote depicts how hunting contrasts with the other three activities, which frequently involve several hours a day of carrying more than 60kg of nuts or manioc roots on one's back and working with a steel axe to clear cut a forest area or manufacture a canoe.

It [turtle hunting] is light work. One feels sleepy, but they [hunters] would at this time be sleeping on the river margin, waiting for the fishing net. We hear them [hunters]; they bet they will catch this much, some take alcoholic drinks. If it [turtle hunting] were heavy [work], they [hunters] would not do it.

(Woman from Paraná do Abuí)

Thus, although cultural issues seem to play a crucial role, income generating concerns are apparently also among the main motivations for turtle hunting, indicating that a livelihoods approach could be appropriate to lower the scale of that activity.

When asked to compare turtle hunting and agroforestry, local people stressed the disadvantages of the former. They repeatedly argued that “with life you don't make a living” (*com vida não se faz vida*). According to them, people who had dedicated part of their lives to turtle hunting could not translate it into a better life, making reference either to their own past experience or to neighbours'. They argued that they did not see nor have any possessions resulting from hunting, as they did from brazil nut collection, for example. Some suggested

that it was money easily earned, and then easily spent, explaining that the man would typically go by himself to the city – hiding from the guards – to sell the turtles, and then spend the money on women and alcohol. Alternatively, he might have to spend it on a new – expensive – means of transportation, because of the confiscation of his previous one. A new canoe could cost the equivalent of the amount earned from four animals. Others point out that it was currently harder, compared to the past, to catch the animals: one would pass weeks and even months without capturing a single animal at the time of field research; a productive week would yield as few as five turtles. Locals reported that, in the past, it had been usual that a hunter caught 10 to 15 animals in one single day with his *espinhel* and even more with a fishing net.

Some added that it was not worth taking the risk of being caught and that it was not good to live always hiding from the PA guards. The use of violence by PA staff was reported not to be an issue at the time of my field research, as it had been in the past. However, the confiscation of fishing nets and canoes continues to be enforced, causing considerable financial loss.

Contrastingly, local households emphasised that earnings from agroforestry were more secure, as there was no risk that the products would be confiscated. It was also mentioned that by working with agroforestry, one would work with freedom, without the need to hide, and that income from that activity was more likely to be translated into material wealth. As exemplified below:

If they [turtle hunters] planted rather than hunting turtles, they would have more result. With a planting, you would not have to risk yourself by taking your product clandestinely. Besides losing the product, you lose your means of transportation, a great loss.

(Woman from Paraná do Abuí)

If he [turtle hunter] had a planting that guaranteed his future, it would be much better. Because it is only in that moment that he is seeing the

money he got from turtles; when he leaves, it is like a smoke. With a planting, if he uses his brains, he will invest in something, an engine, a stove, a bed, a canoe, something he can see. But with life [referring to animals'], I think it is unlikely.

(Elderly man from Abuí)

Those accounts of local householders suggest that most people did not regard turtle hunting as an advantageous livelihood option and/or discarded that activity as a reflection of the hard surveillance in the past and present. In other words, it seems that most people were already not inclined to hunt turtles to sell. Still, alternatives such as agroforestry could serve social purposes. For most households, rather than inhibit commercial hunting, alternatives to that activity could come to improve livelihoods already impacted by ICMBio prohibitions – concerning not only turtle hunting but also other activities.

Regarding the potential for agroforestry being attempted by the few current hunters and substituting hunting, mixed views were expressed. Both cultural and economic aspects were mentioned. One of the locals' arguments was that commercial hunters would not be interested in carrying out agroforestry, as they do not even plant manioc, the basis of local meals. According to them, hunters would specialise in that activity to the extreme, spending the whole day looking for the animals and not allocating time for agriculture. It was also mentioned that the more immediate returns of turtle hunting – even considering the unproductive periods – would be more attractive to hunters than those from agroforestry, which would take a few years after the first plantings to start producing in the case of UFSE's project. On the other hand, other locals and members of PA staff affirmed that, if given the opportunity, people would abandon or lower the scale of turtle hunting for agroforestry or for other options. For those people, hunters kept their main activity due to necessity and lack of other choices. However, that argument contradicts local householders' assertions that alternative job opportunities were presented to current hunters and turned down. Therefore, I argue that the view that agroforestry would be unlikely to replace turtle hunting finds more support in the available evidence.

6.3 Cattle raising

Cattle raising by local residents is among the activities perceived by PA staff as a threat to the forests of Rio Trombetas Biological Reserve and Saracá-Taquera National Forest. Similarly to the approach taken with turtle hunting, I first present the environmental regulations relevant to cattle raising, then examine local trends of deforestation and discuss the contribution of cattle raising to those trends, based on secondary sources and local householders' accounts. Finally, I assess the extent to which cattle raising is motivated by income generating concerns and thus, whether an approach promoting alternative income sources is appropriate. For the cases where it seems appropriate, I discuss the potential of agroforestry to decrease the impact of the activity.

In Brazil, converting forest to other uses is usually conditional on formal authorisation by government environmental bodies, as a way to ensure that areas protected by legislation are preserved. The definition of those areas have been modified significantly through time, with the “forest codes” (*códigos florestais*) of 1934, 1965 and 2012¹¹⁹ and their amendments. Small scale agriculture has benefitted from simplified procedures for requesting permits for deforestation at least since 1985¹²⁰. In protected areas (*unidades de conservação*), forest clearance should be restricted to specific zones and follow specific rules, specified in its management plan.

Two of the main current legal restrictions to deforestation refer to the requirement to set aside areas of “legal reserve” (*reserva legal*) and of “permanent preservation” (*área de preservação permanente*), where forest clearance is forbidden (with a few exceptions) due to ecosystem services and biodiversity related concerns. “Permanent preservation” areas includes river margins, slopes and tops of mountains. “Legal Reserves”, in the case of forest

¹¹⁹ *Decreto Federal 23793*, 23 January 1934. *Aprova o Código Florestal*.

Lei Federal 4771, 15 September 1965. *Institui o novo Código Florestal*.

Lei Federal 12651, 25 May 2012. *Dispõe sobre a proteção da vegetação nativa*.

¹²⁰ *Portaria Normativa 122 IBDF*, 19 March 1985.

areas located in the “Legal Amazon”¹²¹ (*Amazônia Legal*) region, corresponds to 20 to 80% of the land area¹²². This applies to collective properties such as the area inhabited by two of the study communities, recognised as a *quilombola* territory. Although made simpler for small farmers, bureaucratic requirements for forest clearance can still be impractical, especially for isolated communities with restricted access to information or to government authorities.

Deforestation carried out in protected areas is subject to specific limitations, in addition to the ones regarding the “permanent preservation areas”. On the one hand, households are exempt from the need to get permits for subsistence forest clearing and the associated bureaucratic requirements¹²³. On the other hand, in PAs belonging to the “sustainable use” category (as is the case of national forests) deforestation by resident populations is to be restricted to certain zones. The PA management plan should establish zones with a range of allowed use intensities. One of them is the population zone (*zona populacional*), which includes “the spaces and land uses necessary to the reproduction of the way of life” of resident traditional peoples; its general objective is to “reconcile the conservation of natural resources with the needs of those populations” (ICMBio 2009, p. 35-36). Limits regarding the scale of forest clearance related to farming activities can be specified in the PA management plan and in agreements¹²⁴ settled between ICMBio¹²⁵ and the communities. In Saracá-Taquera National Forest, the population zone is restricted to a strip along its northern limits (Figure 6.3) and includes two of the study communities; the only official restriction to farming activities in that zone is the prohibition to expand current pasture areas (IBAMA 2001). According to PA staff, areas

¹²¹ *Amazônia Legal* comprises the states of the North region of Brazil (Tocantins is included only in part) and its neighbour states of Mato Grosso, Goiás and Maranhão (the last two are included only in part).

¹²² *Lei Federal* 12651, 25 May 2012. *Dispõe sobre a proteção da vegetação nativa*.

¹²³ *Lei Federal* 9605, 12 February 1998. *Dispõe sobre as sanções penais e administrativas derivadas de condutas e atividades lesivas ao meio ambiente*.

¹²⁴ One example is the *acordo de gestão*.

¹²⁵ This institution is in charge of federal PAs management.

occupied by populations in the northeast, southeast and southern portions of the PA since prior to the creation of the PA will also be included in the population zone in the upcoming version of the PA management plan.

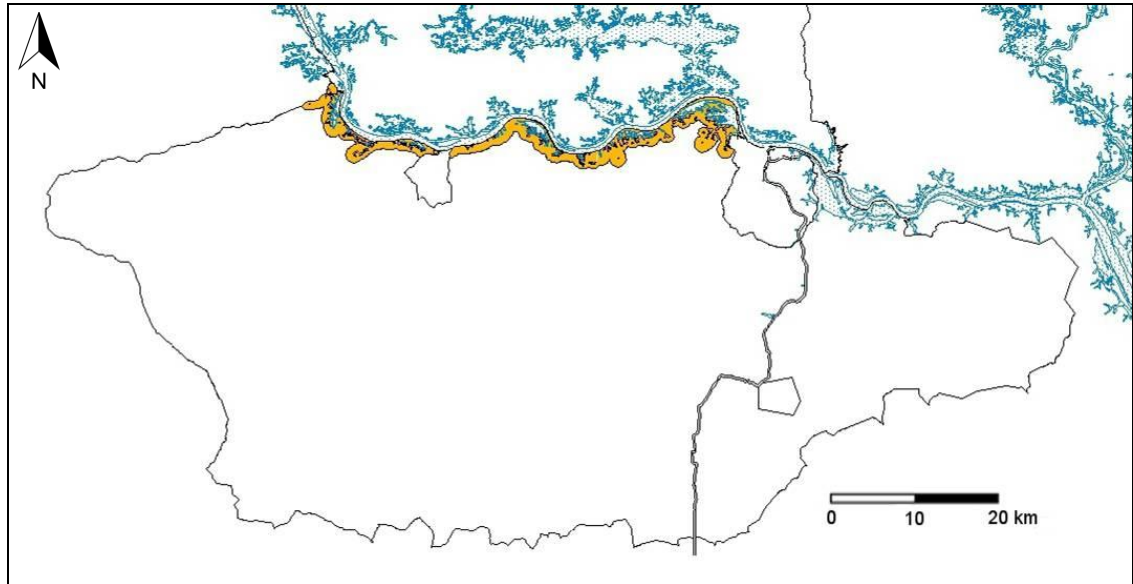


Figure 6.3 Population zone (orange) within Saracá-Taquera National Forest.

Source: IBAMA (2001)

6.3.1 Deforestation expansion and relevance of cattle raising

Based on the interpretation of satellite imagery data, the studies from IBAMA (2001), Andrade (2011) and the National Institute for Space Research (*Instituto Nacional de Pesquisas Espaciais* – INPE 2013) provide deforestation estimates for the national forest area, its surrounding buffer zone and the study communities' territory. This subsection analyses deforestation based on the findings of those studies and on estimates provided by local households, in terms of its extent and spatial distribution in the national forest, sources and trends.

The deforested area detected by IBAMA (2001) within the limits of the national forest and in its buffer zone corresponded to less than 7% of those areas.

Nevertheless, the former have nearly doubled since that study (INPE 2013). Deforestation in the national forest is mainly attributed by IBAMA (2001) to mining and farming (agriculture and cattle raising) activities. The latter was identified mainly in the southern region of the national forest; the study communities, located in the north-western region (Figure 6.4), would be responsible for only a minor fraction. In the 2000s, however, an increasing trend was suggested in two of them by local estimates of pasture size and by deforestation rates identified by Andrade (2011).

Until 1997, only 1.9% of the national forest area had been deforested, according to satellite imagery analysis (INPE 2013). By 2012, or in 15 years time, the deforested area detected by that study nearly doubled, reaching 3.7%. The forest clearance identified in the national forest buffer zone (the 10km-wide strip surrounding its limits) by the most recent national forest management plan (IBAMA 2001) was quite a lot higher than within the PA limits: 6.4% against 1.9% (Table 6.1).

Based on the interpretation of satellite imagery and on field surveys, IBAMA (2001) identifies mining and farming activities as the main drivers of deforestation within the national forest, attributing similar weights to each. In its buffer zone, on the other hand, deforestation is attributed by that study almost exclusively to farming activities (Table 6.1).

Mining activities are carried out by MRN, which started operating in 1979. Forest areas already cleared by MRN after approximately 20 years of activities correspond to less than 10% of the total area to be explored (Figure 6.5). Areas authorised by federal government for mineral exploration total 10.6% of the national forest area (IBAMA 2001). Their exhaustion was projected by MRN for approximately 2042, according to PA staff. By the time of the 2001 management plan, the company had reforested around half of the cleared areas (IBAMA 2001). However, the development of some of these reforested areas is considered unsatisfactory by PA staff analyses based on satellite imagery and field visits.



Figure 6.4 Limits of Saracá-Taquera National Forest (orange), of its buffer zone (light blue), of the territory claimed by the study communities and officially recognised (red, solid line), and of the territory claimed but not yet recognised (red, dotted line). Deforested areas in pink. Study communities as yellow dots (from north to south: Abuí, Paraná do Abuí, Tapagem and Sagrado Coração). Source: Adapted from Andrade (2011)

Table 6.1 Land uses within the limits of Saracá-Taquera National Forest and in its buffer zone.

	Interior		Buffer zone	
	Area (ha)	Area (%)	Area (ha)	Area (%)
Forest	416,144	94.2	290,841	78.7
Deforestation	8,406	1.9	23,740	6.4
Mining activities and infrastructure	4,457	1.0	816	0.2
Farming activities	3,949	0.9	22,924	6.2
Non-forest vegetation (<i>campinarana</i>)	946	0.2	15,897	4.3
River basin	4,104	0.9	39,158	10.6
TOTAL	429,600	100.0	369,636	100.0

Source: IBAMA (2001)

* The national forest total area has been recently recalculated to 441,760ha.

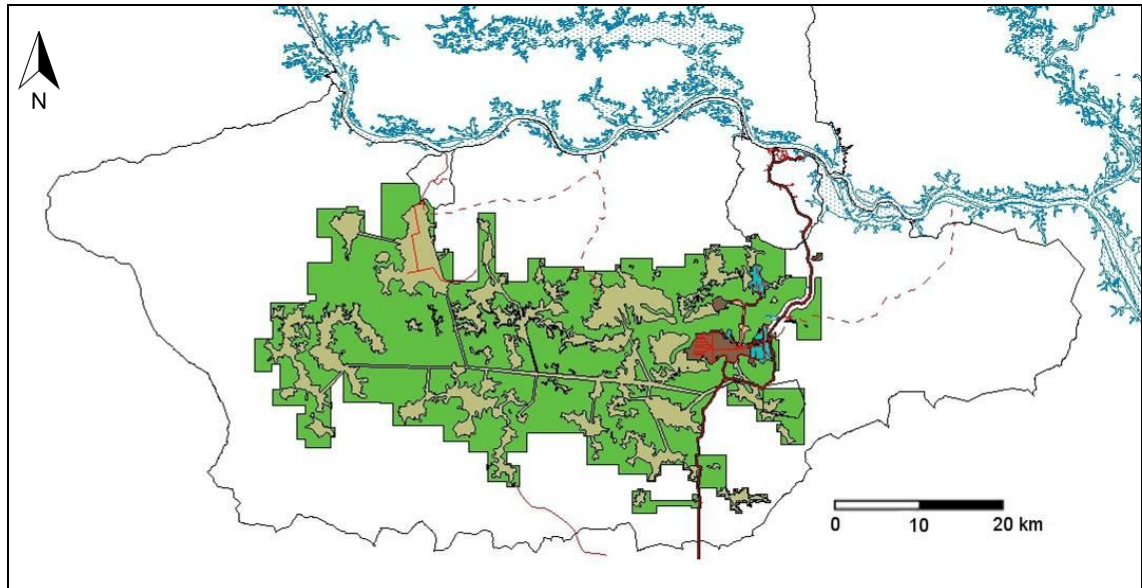


Figure 6.5 Mining zone within Saracá-Taquera National Forest. Brown – areas under exploration at the time of the 2001 management plan.

Grey – areas of future exploration. Blue – reforested areas.

Source: IBAMA (2001)

Some methodological constraints are involved in the analysis of deforestation induced by cattle raising. From the satellite monitoring system's limit of detection¹²⁶, it could be inferred that both the national forest deforestation attributed to farming activities by IBAMA (2001) and the deforestation identified by Andrade (2011) in the *quilombola* territory occupied by the four study communities refer specifically to cattle pastures. However, some studies show that sometimes not only clear-cut forest, but also fallows are also counted as deforestation (Corazza *et al.* 2011). In that case, adjacent agricultural fields, in different stages of natural regeneration could be counted as deforested. The reliability of local householders' accounts, recorded by the present study, on estimates of pastures' size is also questionable. Some households view self-reports as overestimations – attempts to look better and appear hard working.

¹²⁶ The monitoring system in which the measurements were based has a lower limit of detection of 6.25ha, much higher than the average area of 1ha of clear cut forest per year per household for shifting cultivation (which rarely exceeds 2ha) – the areas clear cut in previous years naturally regenerate to form fallows and theoretically are not detected.

On the other hand, some were hesitant in specifying size of pastures, which may be related to uncertainty or to concerns with possible consequences regarding ICMBio's limitations to this activity – in that case, it is possible that they are underestimating the actual values. Whenever possible, data from satellite imagery and local householders' accounts will be compared.

Local householders' accounts suggest that nearly all of the areas deforested for cattle pastures before 2000 are located outside the territory claimed by the study communities (Figure 6.4 and Figure 6.6). According to those accounts, recent attempts to raise cattle in those communities have mostly occurred since 2000; before that, only one attempt¹²⁷ was said to precede the creation of the biological reserve in 1979. That is partially corroborated by IBAMA (2001), who suggests that at least 75% of the farming related deforestation within the PA limits prior to that study occurred outside the population zone (Figure 6.6) where two of the study communities¹²⁸ and other *quilombola* communities are located. Local householders' accounts also indicate that the study communities have not been responsible for those deforested areas outside their territory.

According to perceptions of local people, pasture areas established between 2000 and 2011 in the four study communities were still small, compared to ones near Oriximiná urban area (which could reach 3,000ha), and families expanded them 'only' (as they said) by one or two hectares per year. However, expansion of pasture areas can potentially be accelerated with the input of wealthy ranchers from outside, who frequently support local people in their cattle raising enterprise by 'lending' them some animals and then dividing the production, according to PA staff and locals. The deforestation identified by Andrade (2011), through the analysis of satellite imagery, in the *quilombola* territory occupied by the four study communities for the period from 2000 to 2009 was

¹²⁷ A household who owned up to 20 animals.

¹²⁸ The other two communities live outside the PA.

not supported by local households' accounts on pastures' size¹²⁹; on the other hand, both sources agreed on decreasing trends in two of those communities and increasing trends in the two others.

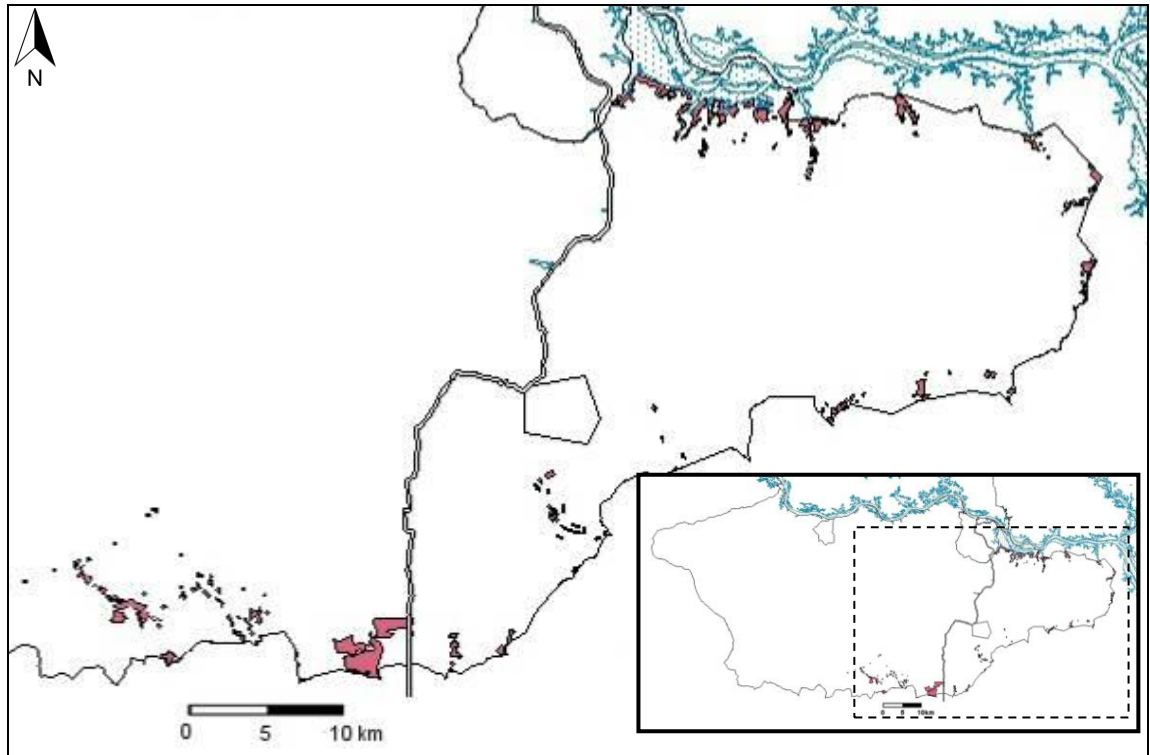


Figure 6.6 Areas deforested by farming activities outside the population zone (pink), located in the eastern portion of Saracá-Taquera National Forest.

Source: IBAMA (2001)

Some of those supposed pasture areas were attributed to the territory claimed by the study communities but not yet recognised, where two of the study communities live. Assuming that those supposed pastures identified by Andrade (2011) are concentrated in that part of the territory which is inhabited and overlaps with the national forest (Figure 6.4), they correspond to only 0.3% of the deforestation identified by INPE (2013) in the total area of the PA (while the

¹²⁹ Deforestation identified by Andrade (2011) diverges from local households' accounts on pastures' size. The former is more than two times higher than the latter for pastures inside the national forest and approximately 20% lower outside.

overlapping area occupies 9% of the PA). According to Andrade (2011), the deforested area in that territory has not increased during the second half of the 2000s. Local householders' accounts are in consonance with that finding – in 2011, the three main pasture owners¹³⁰ in the two communities had either abandoned their activity some years before or had not increased their herd for some years. Their accounts suggest that critical shortcomings with cattle raising in those areas – disease, predation of animals, and conflict with neighbours – motivated that stagnation, rather than the prohibition against expansion of current pasture areas within the national forest, formalised in its 2001 management plan. Despite that, one of those three households and other community members expressed the aspiration to raise cattle in the future.

The recognised portion of the claimed *quilombola* territory, inhabited by the two other study communities, lies outside the national forest (Figure 6.4) – part of it in its buffer zone. Even taking into consideration the whole recognised territory, the 51 ha deforestation detected in it (by Andrade 2011, for the period from 2001 to 2009) corresponds to a negligible fraction (0.2%, while the whole recognised territory would occupy an area equivalent to 8%) of the total deforestation identified in the buffer zone (by IBAMA 2001 – more recent data is not available). The identified deforestation is also small when compared to the total area of the recognised *quilombola* territory. While legislation imposes the limit of 20%, only 0.08% had been cleared by 2009. Although still minor, evidence indicates a trend of increasing forest clearance – the deforestation rate identified for the second half of the 2000s is double that of the first half. Moreover, two of the three main cattle raisers intend to keep expanding their pasture areas.

As illustrated in Figure 6.6, deforestation in the national forest proper is concentrated in areas very close to its south, southeast and northeast limits. This suggests pressure originating from outside the PA, which is confirmed by the deforestation pattern observed in the buffer zone (Figure 6.4). According to PA staff members, that was caused mainly by cattle raising, which was

¹³⁰ They were the only ones with pastures above the monitoring system limit of detection.

concentrated in that area of Oriximiná. National survey data indicate that Oriximiná's rural area had a herd of approximately 148,000 heads of cattle and ranked 37th among the 144 cities of Pará state in 2012 (IBGE 2013). The herd has grown 42% in eight years – the 25th largest rate in the state.

The studies examined in this subsection indicate that deforestation still represents a minor threat to the national forest, primarily due to expected expansion of mining areas in the PA proper, and continuing expansion of agricultural activities in the buffer zone and along its edges. They also suggest that cattle raising is an important driver of deforestation in the southern area of the PA's buffer zone – outside the study communities areas. However, deforestation does appear to be increasing in some of the study communities in the buffer zone, and though tiny in comparison, they should not be overlooked. That increasing trend can potentially be accelerated with an increase in the input of wealthy ranchers from outside, which in turn could be favoured by Oriximiná's high rates of cattle herd expansion.

6.3.2 Motivations to cattle raising and the potential of agroforestry as an alternative

A gap of a couple decades separates past attempts to raise cattle and more recent ones carried out since the early 2000s in the study region. Evidence examined earlier in this section indicates that deforestation for pastures in the national forest still represents a minor threat, but also suggests an increasing trend in some of the communities. That trend should not be overlooked as it can potentially be accelerated with the input of wealthy ranchers from outside. This subsection examines opposing views expressed by worse and better-off households when comparing agroforestry and cattle raising in terms of the necessary investments and outcomes, and whether agroforestry is likely to substitute for cattle raising practices or aspirations.

Cattle raised at the study site are taken by boat to be sold in the urban area of Oriximiná, and so supplies the local demand for meat, according to local people. The boat used can be the rancher's own one in the case of the better-

off, or a neighbour's one for a fee. The animals are sold to meet the household's need for a particularly high amount of cash – mentioned examples are shocks, such as the illness of a member of the family, and planned investments in electrical appliances, a new boat, or the refurbishment of a house or a boat.

Cattle raising before the creation of the biological reserve in 1979 failed in the region mainly due to predation by bats, according to locals. Since that time, cattle raising has only recently been attempted again, in 2000, approximately. The activity was described by some families as an alternative to make a living in the face of the prohibitions imposed by the environmental agency with the creation of that PA. In 2012, there were four main families (who were at that time being followed by the families of their grown-up sons) raising cattle on a larger scale of 40 to 50 animals (an example can be seen in Annex 7), but several other households were beginning to raise cattle, had tried it in the past or aimed to attempt it in the future. While 11 households reported relying on cattle raising as an income source, nine were not getting any earnings out of that activity – they were either in the process of beginning the activity or of abandoning it. It is seen as a very advantageous activity that has led people to prosper in their lives. Among the motivations households mention for having tried to raise cattle are: viewing it as an immediately available source of cash in case of need and watching the example of other cattle raisers being able to buy the goods they require. Drivers also include finding the animals “beautiful” (*bonito*) and having had the aspiration of raising cattle since childhood.

As with turtle hunting, income generating concerns are among the main motivations for cattle raising, indicating that a livelihoods approach could be appropriate. In order to investigate the potential role of agroforestry as an alternative to cattle raising, households were asked to compare both activities. Additional reported advantages of cattle over agroforestry are related to financial returns and labour demand, including: higher cash returns, which would compensate for higher labour inputs; not requiring too much work; and shorter time span between the beginning of the activity and first returns. The first is illustrated below:

You can make more money from cattle. You can make money from a planting too, but you would need a large quantity [of trees]. You cannot make much from a hundred fruits, only from two thousand onwards.

(Man from Paraná do Abuí)

With cattle you have to spend, it is true, you get wood to make fences, buy wire, but once you get on your feet with your cattle, you are all set. Then you can sell four or five animals, and you will have what you invested back.

(Man from Abuí)

According to prices reported by locals for 2012, one animal would be worth approximately the equivalent of 600-1200 units of *cupuaçu* (*Theobroma grandiflorum*) – this is the average production of 40 to 80 trees in one season (Gondim *et al.* 2001). Also, cattle have been sold by locals as soon as two years after the start of the activity, while *cupuaçu* trees takes five to six years to reach mature production after the seedlings are planted.

The main disagreement among households concerned the perception of labour inputs. Those who were more inclined towards cattle than to agroforestry expressed views such as: “cattle raising needs a little work when planting the pasture; “once the pasture is ready, it is done” (elderly man from Paraná do Abuí); “with all fenced, it doesn't need a lot of work” (man from Abuí); and “everything that makes money needs work” (man from Paraná do Abuí). Contrastingly, those who were more inclined towards agroforestry argued that cattle involve too much work, such as: retrieving wandering cattle, fixing broken fences, making and setting fence-posts, and establishing and maintaining a big enough pasture. According to them, maintaining a well-cleared pasture area requires work on a daily basis, whereas the frequency of weeding necessary in an agroforestry area would be limited to a few times in a year.

Others mentioned disadvantages of cattle raising, which include the high expenses (mainly with fences – the cost of barbed wire and posts needed to fence 1 ha is equivalent to the sale price of one animal – but also with vaccines, medication and salt), and the conflict with neighbours resulting from the inability to cope with those expenses and with the demand of intensive labour:

To have cattle, you need to have a good pasture land, to keep it fenced. If you have a neighbour close by and are not able to maintain the animals, you will always be disturbed, they will invade your neighbours' field, there will be conflict, you will have to pay for his lost work. Better not to work with cattle.

(Man from Tapagem)

Contrastingly, investments required by agroforestry would encompass basically labour – to plant, weed, prune and harvest – rather than cash. Insufficient pasture area coupled with nonexistent or weak fences frequently lead cattle to invade neighbours' homegardens and agricultural fields, many times causing losses to both sides – damaged plants and dead animals. The cattle owner has to spend considerable time retrieving his animals. The lack of fodder also results in cattle of worse quality, which forces the ranchers to sell animals below the market price.

Additional aspects are related to previous experiences: the perception of agroforestry as closer to their own agricultural practices and the feeling of fear of the animals were both expressed. The fact that the majority are personally more used to agriculture than to cattle raising can favour agroforestry; on the other hand, the positive perceptions of the local cattle raisers suggest that the results from this activity are more quickly realised than the ones from fruit tree planting on a large scale, which can act in favour of cattle.

Environmental issues – such as cattle raising causing greater impacts on forests than agroforestry and resulting conflicts with ICMBio – were rarely

mentioned in local householders' accounts as a downside of cattle raising as practiced at that time. Negative views about large-scale deforestation were expressed – as it would result in hotter temperatures and increased distances to needed resources such as brazil nut, timber and game – but are usually associated with pasture areas much larger than those found in the study communities.

Local householders' accounts suggest that those opposing perceptions of cattle raising, when compared to agroforestry, are greatly influenced by the assets households can rely on. Cash and labour investments seem higher in the initial phases, which involve planting pasture, setting up fences and purchasing the first animals. As households in general start with very few animals (one or two), it can take several years until they have enough animals with enough weight to be able to dispose of some, so that they can have a return to their initial investment. Moreover, there is the need to pay for transportation of the animals to the city if and while you do not have your own boat. Those high costs make the activity more disadvantageous – or even out of reach – to the worse-off.

According to the narratives from three of the four main cattle raising households, to overcome those challenges they had to rely on various kinds of assets as they got started with the activity, which suggests they were among the better-off households. Firstly, able-bodiedness of adults was essential, in all three cases (and of sons in two cases), for the labour demanding tasks of planting pasture and setting up and maintaining wooden fences. Among those cattle raisers, wooden fences are said to be weaker but avoid the financial costs of wire. Then, for the purchase of their first animals and first covered boats, income from other livelihood activities (such as brazil nut extraction and agriculture or a wage employment) was fundamental for the three ranchers. Accounts indicate that all three managed to acquire a covered boat prior to or in the initial stages of cattle raising. This allowed them to avoid, from a very early stage, the extra costs of relying on someone else's means of transportation to bring new animals in and to take mature animals to be sold in the city. Moreover, two of the ranchers were backed up by strong social capital in the form of very good relations with the city mayor. Accounts indicate that the

mayor helped them to further reduce transportation costs and offered additional sources of income, through the purchase of animals for the local religious festivities and through jobs involving the transportation of students to the local school. A few of the interviewees say with some resentment that some things are only for the “chosen ones” (*escolhidos*).

Most of the householders who perceived agroforestry as more advantageous than cattle raising did not aspire to attempt the latter in the future. In other words, if agroforestry was actually to be incorporated into the livelihoods of those people, it would not be substituting cattle, as that was not being considered as an option anyway. Moreover, agroforestry seems unlikely to lower the scale of cattle raising among those with the intention to continue raising cattle in the future or with the aspiration to attempt it as a new activity. Those householders mentioned also to be willing to try other income generating activities, such as raising other animals (fish, turtle, chicken) and agriculture, suggesting they do not intend to specialise in cattle raising. In line with that, a willingness to combine agroforestry and cattle raising was reported among the households participating in the agroforestry project – participant households that intend to raise cattle in the future tend to attribute advantages to both activities. Agroforestry and other aspired activities are seen as compatible with plans of maintaining or expanding current pasture areas.

6.4 Discussion

From the two case studies analysed in this chapter, it can be argued that the turtle population has been through a dramatic decline, while deforestation has been minor and restricted to certain areas. On the other hand, the turtle population has apparently stabilised, whereas deforestation patterns reveal an increasing trend.

In that context, the threat posed by turtle hunting and cattle raising is challenging to evaluate. Local people and PA staff accounts, as well as secondary monitoring data indicate that mining and local people’s livelihood activities may have significant shares in the observed and projected impact to

turtle population and to forests. The introduction of fishing nets in the study communities increased hunting efficiency considerably and coincides with the period of major decline in turtle population. However, further studies are needed to evaluate additional factors possibly involved, such as boat transit at the MRN's port. Cattle raising was partially motivated by PA regulations and the abandonment of previous activities such as turtle hunting, but is likewise perceived by PA staff as a potential threat. Uncertainties in estimates provided by local households and in the interpretation of satellite imagery hinder the precise quantification of deforestation for pastures and evaluation of the relevance of that threat when compared to mining. On the other hand, areas of concentration of deforestation and deforestation trends are more consensual among different sources. By prioritising the area near the national forest southern limits, where deforestation for pastures is more concentrated, agroforestry extension or other projects could more efficiently relieve pressure over PA's forest cover. However, increasing trends in the study communities should not be overlooked.

Evidence examined in this chapter suggests agroforestry has very limited potential to reduce pressure over PAs' biodiversity. Firstly, although turtle hunting and cattle raising may represent significant threats to turtle population and forest cover, they are only two among several threats. Some of those are related to activities not carried out by locals – such as mining – and will not be addressed by agroforestry.

Secondly, income generation corresponds to only part of the motivations to turtle hunting and cattle raising, suggesting that a livelihood approach proposing alternative income sources may not be appropriate in some cases. Income generating concerns are coupled with non-economic motivations, especially in the case of turtle hunting, where a strong cultural component seems to be in place. Gibson and Marks (1995, pp. 944, 950) and Kaltenborn *et al.* (2005, pp. 215, 218, 221) argue that cultural incentives to hunt tend to be underestimated.

Thirdly, in the case that marketing constraints discussed in the previous chapter are worked out, agroforestry may benefit those who are neither engaged in turtle hunting nor inclined to do so, rather than those that are. Turtle hunting is already disregarded by most in consequence of PA regulations or its perceived shortcomings.

Current commercial turtle hunters are likely to be more inclined towards their main activity than towards agroforestry due to the more immediate returns and lower labour investments associated with the former. From the hunters' perspective, those advantages would probably outweigh the unreliability of hunting returns due to fluctuating productivity and to fines. Therefore, I argue that it is unlikely that hunters would add agroforestry to their specialised livelihood portfolios. In the literature on strategies to counter illegal hunting, offering payments for not hunting and for patrolling hunted areas, as well as promoting alternative activities such as ecotourism and wildlife management under natural and captive conditions have been examined as possible mechanisms (e.g., Bodmer & Lozano 2001, p. 1168; McAllister *et al.* 2009, p.121; Broadbent *et al.* 2012, pp. 737-739, 741; Challender & MacMillan 2014, pp. 488-489). The role of agroforestry as an alternative activity has been overlooked, and this thesis makes a contribution in that sense, though in this case it seems an unlikely mitigating option.

On the other hand, some of the current and potential cattle raisers showed some willingness to combine cattle and agroforestry. Advantages attributed to both included good financial returns to labour. However, there is no evidence that adding the latter to livelihood portfolios would induce the former to be reduced in scale. That aligns with the findings of the few studies that examine the interaction between cattle raising and agroforestry in livelihood portfolios (e.g., Connelly & Shapiro 2006, p.134; Blinn *et al.* 2013, p. 177).

CHAPTER 7 Discussion and Conclusions

The research and analysis presented in this thesis has addressed primarily the relationship between agroforestry extension and the conservation of biodiversity in protected areas. Different aspects of that relationship were explored in Chapters 3 to 6; in the present chapter, I relate those findings to the wider literature and bring them together as I discuss my final conclusions and considerations for future research.

7.1 Extensionists' discourses on agroforestry's role in deforestation reduction

In Chapter 3, I examined extensionists' discourses on agroforestry's potential to contribute directly to conservation. Project documents tended to reproduce public policy crisis narratives depicting shifting cultivation as an important driver of deforestation. Against that background, agroforestry was promoted as a contrasting land use that would recover deforested areas and would not contribute further to deforestation. That discourse can be seen as an attempt to legitimise the project's focus on agroforestry for an audience of funding bodies, despite contradictory empirical evidence. The case discussed is one of just a few studies examining policy narratives on shifting cultivation and agroforestry, specifically in the context of the Amazon and Atlantic Forests (e.g., Hecht 1985, Collins 1986), and also quite rare in exploring the extent to which those are reflected in conservation and development practice (e.g., Pollini 2009).

The present research builds upon the body of work that has examined narratives portraying shifting cultivation as an important driver of deforestation. I sought the roots of those narratives in government policy, as did Dove (1983), examined forest cover history and the extent to which it supports or contradicts policy discourses, as did Fairhead and Leach (1995) and Kull (2000), and then investigated alternative deforestation drivers, as did Dressler (2006). However, my analysis differs from those landmark studies, in examining a different link in the discourse chain and also challenging other aspects of policy discourse.

Firstly, while Dove (1983) discusses how past policy narratives are reflected in current policy, I analyse dissemination of that perspective to ground-level agents, namely the extensionists, implementing activities underpinned by the explanations that are embedded in those narratives. Secondly, while Fairhead and Leach's (1995) and Kull's (2000) aim is to question the policy portrayal of deforestation as a problem and of shifting cultivation as its cause, as in fact I do too, I also challenge the lack of a clear distinction between shifting cultivation and more relevant drivers. Thirdly, Dressler (2006) does not focus on the analysis of shifting cultivation's actual role in deforestation, which is a primary aim of this work.

Thus, Chapter 3 reveals two of the challenges likely to be posed in attempts to adjust misguided cases of agroforestry promotion as a solution to deforestation. Firstly, an evidence-based assessment of deforestation, its drivers and possible solutions at the policy design level would find resistance among those who benefit from current policies. In the Atlantic Forest, I have suggested that policy legitimises interventions aimed at the conservation of remaining forest areas as pristine areas, by presenting those deforestation estimates that create the greatest sense of urgency. In the Amazon Forest, I have argued that policy echoes the history of government allegiance with the cattle ranching sector, by failing to prioritise their land use in deforestation reduction guidelines despite acknowledging it as one of the main drivers of deforestation. In both biomes, policy portrays agroforestry as one of the solutions, as it could restore deforested lands and substitute undesirable land uses.

That stance aligns with Dressler's (2006), Kull's (2000), Fairhead and Leach's (1995) and Dove's (1983). Similarly to the present thesis, the first three studies attribute to policy narratives the ability to legitimise an agenda of interventions, which would include the protection of certain areas, banning shifting cultivation and agro-technology support. Furthermore, the first and fourth studies argue that policy narratives represent a government attempt to favour a particular land use (in those cases, intensive wet-rice cultivation). However, the last study focuses on economic benefits deriving from policy, arguing that intensive cultivation would be better suited to control and to extraction of part of the

agricultural produce by the Indonesian central government; whereas I have suggested that benefits to the Brazilian government resulting from policies (in that case, favouring cattle ranching) included not only economic aspects but also geopolitical ones.

Secondly, good policy may not be enough for the achievement of concrete results in terms of deforestation reduction, as it may shape the discourses of the actors in charge of policy implementation, without influencing their actual interventions. I found that extensionists of the Federal University of the Southeast (UFSE)¹³¹ had been flexible in designing the promoted practices, and addressed local households' concerns at the expense of consistency with their conservation discourses. That finding stands at odds with those of Pollini (2009), one of the few authors, within the body of works examining discourses linking shifting cultivation and deforestation, who analyses the contrasting portrayals of that land use and of agroforestry. Pollini (2009) has investigated narratives crafted within the context of an international research effort – the Alternatives to Slash and Burn Program (ASB, mentioned in Chapter 1). That study indicates that ASB discourses picturing shifting cultivation as unsustainable (at least at high population densities) were associated with the design of agroforestry solutions that are rigid, complex, labour intensive rather than flexible adaptations of the shifting cultivation system.

Therefore, rather than shaping locals' participation or projects' livelihood outcomes, I have suggested that extensionists' discourses reproducing certain aspects of biome level policy narratives may have contributed to secure funding. The present study provide support for Fairhead and Leach's (1998, p.180) argument that agroforestry programs are often justified and gain their funding by reinforcing views underlying concerns about forest loss. Future research, here and elsewhere, could pursue that issue by assessing the perspectives of funding institutions and examining the extent to which biome level policy narratives are actually reflected in the guidelines followed by those institutions in the analysis of agroforestry project proposals.

¹³¹ Fictitious name

In broader terms, Chapter 3 demonstrates the relevance of discourse analysis to the study of environmental policy. Following the review on the theme conducted by Hajer and Versteeg (2005, pp. 178-181), the chapter assumed that: a) nature, and more specifically forest cover dynamics, is a socially constructed concept and thus, subject to interpretation and dispute; b) the way in which a deforestation problem and its solutions are framed can influence policy outcomes; and c) powerful actors such as governments, businessmen, scientists and environmental organisations can mobilise bias in policy discourses in their self-interest. That allowed for the identification of conflicts between extensionists' discourses on agroforestry's role in deforestation reduction and empirical evidence, the analysis of how that conflict may echo powerful voices in the wider policy environment and the examination of the purposes served by extensionists' discourses. Ultimately, discourse analysis allowed for the unveiling of constraints to alternative, less optimistic and more evidence-based interpretations of agroforestry's potential to contribute directly to conservation.

7.2 Participation in agroforestry extension activities

The way in which agroforestry is framed by extensionists' discourses constitute one of the various factors that can potentially shape local people's participation. In Chapter 4, I examined the issue of participation and the factors that underlie it, based on local perspectives and explanations. Evidence suggests that participation was influenced both by broader, community-level factors concerning participation in development projects in general – such as those related to past experience with external actors and social dynamics – and by factors regarding UFSE's project in particular – such as local perceptions of agroforestry. The literature on participation in development and on adoption of agricultural innovations provided the theoretical basis for the analysis of participation in UFSE's project. The two fields have been comprehensively reviewed (e.g., Cooke & Kothari 2001; Pattanayak *et al.* 2003; Hickey & Mohan 2004; Mercer 2004 – see Chapter 1 for a discussion on the relevance of those studies for the present thesis); however, the contributions of both fields have rarely been brought together.

Firstly, results presented in Chapter 4 suggest that the community with the most conflictual history concerning PAs' implementation tended to be the hardest to get involved in projects aimed at improving local livelihoods. That challenges the widespread argument (examined in a review by Adams & Hutton 2007, p. 161) that people should be compensated for the costs of living with PAs. The costs experienced by the study communities include removal from homes and restriction of access to PA resources, both of which have been considered as forms of displacement, in its broadest sense (Cernea 2006; Adams & Hutton 2007, p. 157). The displacement of human populations has been portrayed as the greatest social impact of PAs (Adams & Hutton 2007, p. 157). According to local people, displacement was followed by little or no direct financial compensation; the implementation of development projects would be another possible way of providing compensation.

I do not mean to question the need to compensate households for their displacement, but instead the fortress approach to conservation that underlies displacement. I argue that this approach, consisting of an authoritarian state-led PA management based on the assumption of separation of humans and nature (Vedeld *et al.* 2012, p. 20), has imposed costs that morally should, but may prove hard to, be compensated.

Future research, perhaps applied research, could examine whether and how relationships based on legitimacy and trust could be built between extensionists and communities with conflictual histories. Greater efforts to promote involvement of local people, not only in the implementation stage but also in the choice of which communities needs should be addressed and how, might contribute. That argument is an attempt to avoid an "individual-blame bias" (examined by Rogers 1983, pp. 106-110) as it recognises that adaptations in the extension project approach and in the promoted technology may contribute to foster participation/adoption. Additionally, concrete and positive livelihood outcomes deriving from project implementation may also encourage trust and participation of those communities in the project under study and in subsequent ones.

Secondly, Chapter 4 corroborates the importance of social networks, particularly social capital in the form of kinship ties to gatekeepers, in shaping participation in rural extension projects. A coordinator or 'gatekeeper' is elected among community members to act as a bridge between outsiders and the community. I argue that strong ties to gatekeepers that support extension activities tended to facilitate participation by mediating (and translating) communication about the agroforestry project. Communication is likely to have included both verbal exchange of information within the network of gatekeepers and their close kin and also direct observation of each others' relationship to the project. Engaging key supporters across other networks of close kin could enhance participation within those groups.

The importance of social networks has been explored in the diffusion of innovations literature. At least since the 1950s, the relevance of interpersonal communication channels at the different stages of innovation diffusion has been examined. In the 1970s, studies attributing importance to both verbal and non-verbal communication in that context were conducted (Rogers 1983, pp. 199-200, 304). However, compared to other aspects of diffusion research there have been relatively few studies of how communication network patterns affect diffusion, according to Rogers (2003, pp. 24-25). Those studies include the ones carried out by Foster and Rosenzweig (1995), Bandiera and Rasul (2006) and Conley and Udry (2010), which, similar to the present one, indicate that the technology adoption choices within networks are correlated. Those authors interpret those correlations as derived from learning, rather than imitation; in the case of this research, on the other hand, neither of the two transmission pathways is completely applicable. Thus, support for imitation as a mechanism overlooks communication or information sharing, which, I argue, has contributed to shape participation in the study communities. On the other hand, differently from the case of learning, communication in the study communities concerned not only assessment of seedlings performance, but also of project implementation and of extension staff motivations.

An alternative approach, which could guide future work seeking a better understanding of the communication between UFSE extensionists and the

study communities, would be based on the concept of ‘development brokerage’, as discussed by Bierschenk *et al.* (2002, p. 17) and Mosse and Lewis (2006, p. 13). According to those authors, development brokerage consists of mediation through a “chain of translations”; brokers “translate the discourses and actions of given actors in terms which make sense to partners situated far away at the other end of the brokerage chain”. The ones I have called ‘gatekeepers’ can be considered as members of that chain, acting as one of the links between UFSE extension staff and the study communities and translating interests of one to the other. The process of tying in supporters/participants through translation could be examined, for instance, in terms of how explicit consensual interpretations about the extension program are sustained within a network of extensionists, brokers and (non)participants with heterogeneous implicit interests.

Thirdly, the findings in this analysis indicate that the possession of material wealth did not facilitate participation significantly, rather social and human capital mattered more. That diverges both from the broader literature on adoption of innovations (analysed by Rogers 2003) and from the more specific one on agroforestry adoption (reviewed by Pattanayak *et al.* 2003). In the former, the association of earlier adoption with a wealthier status has been explained by the greater ability of the wealthier to cope with risks and absorb the possible loss resulting from an unprofitable innovation. The fact that UFSE project required mainly labour rather than cash investments, as seedlings were donated, can have contributed to make the project accessible also to the poorer.

Fourthly, perceptions that manioc-based agriculture is more advantageous than agroforestry among non-participants may indicate that adaptations to the promoted technology may be needed. Their concerns about the initial gap in financial returns could be addressed by incorporating annual species or earlier producing tree species into the *cupuaçu*-based (*Theobroma grandiflorum*) agroforestry system. Here, I attempt to avoid a “pro-innovation bias” (examined by Rogers 2003, pp. 106-107) in which it is assumed that farmers need to be persuaded to accept the innovation as it is promoted.

More widely, Chapter 4 illustrates that the literature on participation in development and on adoption of agricultural innovations can provide complementary perspectives in the analysis of the drivers and constraints to participation/adoption. Critiques to aid and development are useful in the sense that they help us expand our views and not overemphasise technical issues, though the latter should not be dismissed. As Crewe and Harrison (1998, p. 33) suggest, it should not be assumed that “poverty is caused by a technological gap and is solved by technological improvements”, nor that “no link between poverty and technology exists”. Lack of participation may indicate that constraints in local institutions, markets and public policies are not being adequately dealt with, but also that genuine local demands for technological improvement are not either. By shaping participation, those aspects may also indirectly shape agroforestry’s social and environmental outcomes.

7.3 Agroforestry’s contribution to livelihoods

In Chapter 5, I analysed the potential livelihood outcomes of participating in agroforestry extension. The analysis indicated that contribution to incomes is highly constrained by poor market access. In a best-case scenario in which those constraints can be overcome, the agroforestry promoted by UFSE extensionists was shown to have the potential to reduce the gap between the worse and better-off significantly. The analysis also highlighted the importance of the engagement of both men and women in agroforestry activities for these to fit into diversified livelihoods. Assessments of concrete impacts of agroforestry in terms of income generation have been expanding significantly in the literature since the 2000s (e.g., Murniati *et al.* 2001; Franke *et al.* 2008; Tuihedur Rahman *et al.* 2013 – see Chapter 1 for other examples); prior to that decade, such assessment seems to have been rare. However, those assessments have focused on contribution to overall incomes, rather than on implications in terms of reduction of local inequalities, and have rarely discussed interactions with other livelihood activities. The chapter enriches that discussion, although potential impacts, rather than concrete ones were examined in this thesis as the experience analysed is so new.

The case study explored in this thesis indicates that commercialisation constraints to Amazonian agroforestry products continue to be overlooked, although they have long been a matter of concern (e.g., Fearnside 1995; Smith *et al.* 1998; Clement & van Leeuwen 2004). Case studies of agroforestry implementation efforts in the Amazon region, initiated in the late 1980s and 1990s, have repeatedly suggested that failure to properly address issues related to processing, transportation and access to fair and robust markets played crucial roles in hindering income generation from agroforestry (Smith *et al.* 1998; Clement & van Leeuwen 2004; Browder *et al.* 2005; Hoch *et al.* 2012¹³²).

The analysis of other income generating projects implemented in the study communities reveals that some of assets that may prove important in addressing those commercialisation constraints have been building up, while others are still lacking. I suggest that the communities have managed to establish partnerships with NGOs that have been facilitating access to grants, capacity building and potential buyers. On the other hand, evidence indicates that local institutions still need to be strengthened. Several households still preferred selling to intermediaries to selling to the local cooperative.

The studies conducted by Souza-Filho *et al.* (2004) and by the Association of Small Agroforestry Producers of the Economic Intercropped Dense Reforestation Project – RECA (2003) corroborate the importance of those assets. Souza-Filho *et al.* (2004) compared four types of supply chain arrangements in Rondônia state in terms of the levels of isolation/integration among fruit producers and between fruit producers and the processing sector. The analysis of isolation/integration considered, for example, the proportion of producers organised in associations or cooperatives and whether those

¹³² In reference, respectively, to: Economic Intercropped Dense Reforestation Project (*Projeto Reflorestamento Econômico Consorciado Adensado*) in Acre state, Brazil; Rondonia Agroforestry Pilot Project/ RAPP, in Rondonia state, Brazil; a project led by a non-governmental organisation in Northern Bolivia. Concerning the first initiative, other studies argue that it has managed to successfully overcome some of the marketing constraints it faced, as will be later discussed.

organisations themselves conducted the fruit processing. The authors concluded that the higher levels of integration presented by RECA were associated with the best performance in terms of transaction costs and of financial returns to the producer. RECA (2003) suggests social capital played a fundamental role in overcoming obstacles that were initially faced by the cooperative in the commercialisation of agroforestry products and led to considerable production loss. According to that publication, farmers have relied strongly on relations with relevant external actors (donor, extension and research institutions; industry) across the project's history; an extensive social network seems to have been incrementally built. Moreover, local institutions have apparently facilitated collective actions aimed at infrastructure improvement. It should be noted, however, that the study communities find themselves particularly isolated from main road networks and thus, face additional challenges when compared to those works.

The findings in Chapter 5 support those of previous studies and indicate that, in a best-case scenario in which those commercialisation constraints are overcome, agroforestry can make an important contribution to local livelihoods. However, while previous studies have focused on agroforestry's share of households' total income (51¹³³ to 73%, according to Franke *et al.* 2008, Rice 2011 and Jagoret *et al.* 2011¹³⁴), this thesis provides an alternative perspective by looking at agroforestry's potential impacts on the poorer households in particular, in terms of reducing the gap between them and the wealthier ones.

Additionally, the present study has highlighted how potential conflicts between agroforestry and other livelihood activities may affect men and women.

¹³³ That amount typically refers to agroforestry systems, but also includes monocultures of perennial species (Franke *et al.* 2008, p. 11-12).

¹³⁴ The first study was conducted in Acre state in the Brazilian Amazon; the second, in southern Peru and in various sites in Costa Rica; and the third, in central Cameroon. Similarly to the present thesis, the agroforestry systems analysed by the last two studies are dominated by one single species (coffee and cocoa, respectively); also, in the systems examined by the first study, *cupuaçu* (*Theobroma grandiflorum*) is one of the (up to four) main species.

According to Kiptot and Franzel (2012), gender roles in agroforestry tend to shift according to the activity's importance in the household income and to become unbalanced. In a review of gender issues surrounding agroforestry in Africa (Kiptot and Franzel 2012, p. 43)¹³⁵, it is argued that women's participation in indigenous fruit enterprises is greater than in the other agroforestry types analysed because indigenous fruits in sub-Saharan Africa are considered a domain for women and children. The authors explain this is probably related to the fact that markets for those products are not well developed and highlight the concern that as products become more of a cash crop, benefits may shift from women to men. In the case of the *cupuaçu*-based systems examined in the present thesis, shifts from experimental scale to expanded plantings and from retail to wholesale trade can be accompanied by shifts in gender roles and, consequently, in competition levels with other male and female livelihood activities.

From a wider perspective, Chapter 5 also addresses debates in the literature on the contribution of forest incomes¹³⁶ to rural livelihoods (reviewed by Angelsen *et al.* 2014, pp. 13-14). It aligns with the work of Belcher *et al.* (2005) by suggesting that failure to address poor market access and potential gender imbalances would constrain agroforestry impacts on poverty alleviation. Belcher *et al.* (2005, p. 1446) question the assumption that "because an NTFP [non-timber forest product] is important to the poor, efforts to develop it will help the poor". Their analysis of 61 cases of commercial NTFP production in 25 countries (pp. 1440-1443) suggests that worse transportation infrastructure tended to be associated with lower NTFP management intensity and also with lower incomes overall and from NTFPs in particular. Moreover, the study

¹³⁵ Studies on the relation between agroforestry and gender are scarce in Latin America (Howard 2006, p. 159).

¹³⁶ According to the definition of 'forest' presented by Angelsen *et al.* (2014, p. 14), income from *cupuaçu*-based agroforests would be considered a type of forest income. The authors (citing FAO 2000), define 'forests' as "lands of more than 0.5 ha, with a tree canopy cover of more than 10%, where the trees should be able to reach a minimum height of 5 m in situ, and which are not primarily under agricultural land use", including "both [...] native and exotic species, natural and planted forests [...]".

indicates that women's participation tended to be higher in systems of intermediate management intensity. The authors argue that in those systems, a "certain degree of forest domestication and a higher labour requirement when compared with [low intensity] wild systems both allows and demands more female involvement", and at the same time, "incomes tend to be smaller than in [high intensity] cultivated systems and so may be less attractive for male labour".

Additionally, Belcher *et al.* (2005, p. 1446) suggest that the wealthier would be better placed to take advantage of enhanced access to stable markets for forest products by intensifying management, as they tend to have more assets such as "land and/or capital, as well as [...] skills and connections". Therefore, agroforestry interventions concerned with poverty alleviation should also be concerned with the lack of those assets among the poorer. I have argued earlier in this section that those assets have been building up at the study communities; future work could explore whether the poorer have been benefitted in that process and if not, how to tackle that.

7.4 Agroforestry's role in reducing activities perceived as threats

In cases where commercialisation constraints are overcome, not only beneficial livelihood outcomes but also positive conservation ones can follow. In Chapter 6, I examined the potential of agroforestry to contribute to conservation (indirectly, in contrast to the potential direct contribution analysed in chapter 3) by substituting livelihood activities perceived as threats. Evidence indicates that the two activities analysed – turtle hunting and cattle raising – may be among the relevant threats to turtle population and forest cover, but are unlikely to be reduced by agroforestry. The present thesis adds to the scarce literature on perceptions of and motivations for river turtle hunting (e.g., Conway-Gómez 2008) and on interactions between agroforestry and cattle raising in livelihood portfolios (e.g., Sá *et al.* 1998; Ruf & Schroth 2004; Franke *et al.* 2008; Blinn *et al.* 2013).

In my analysis of commercial turtle hunting, I take the ‘categorising the crime’ approach (as defined in a review conducted by von Essen *et al.* 2014). The authors contrast it with the other approaches they have demarcated within existing literature on illegal hunting and argue it would require “the most holistic account of the crime” as it takes into consideration “the characteristics of the perpetrator and the overall context for the criminal act, which is in turn predicated upon motives” (von Essen *et al.* 2014, p. 640). As in the ‘livelihood crime’ category identified by the authors within the approach (von Essen *et al.* 2014, p. 640), I consider multiple motivations for hunting; however, I do not assume that they are predominantly economic as the authors propose as typical for that category. It was beyond the scope of the present thesis to examine whether turtle hunting could also be considered a ‘sociopolitical crime’, defined by von Essen *et al.* (2014, p. 641) as a form of resistance or protest in response to perceived marginalisation of lifestyles, distrust of authority and unfairness surrounding legislation.

In the present research, drivers of turtle hunting seemed to have a strong cultural component, indicating that the availability of alternative income sources may not be sufficient to lower the scale of the activity significantly in some cases. Gibson and Marks (1995, pp. 944, 950) and Kaltenborn *et al.* (2005, pp. 215, 218, 221) have described cultural incentives to hunt and argued that those tend to be underestimated by initiatives aimed at reducing illegal hunting. By exploring cultural aspects, I build upon Conway-Gómez’s (2008) focus on economic motivations and its recommendation to search for “cash-generating alternatives”.

That study, carried out in two Bolivian communities, indicated that wealth was negatively related with turtle sale intensity. The author interprets the result as a higher dependency of poorer households upon turtles, due to a lack of access to other income sources such as employment. Similarly, in the present research, local accounts suggest that the few households relying on commercial turtle hunting were among the worse-off. However, I argue that a worse-off condition is a consequence of turtle hunting, rather than the other way around. Narratives indicate that constraints faced in the activity and the way the income

generated (sometimes highly profitable) was managed contributed to the worse-off condition locally attributed to hunting households; moreover, differently from Conway-Gómez's (2008) study, the vast majority of the households considered as worse-off did not engage in turtle hunting.

As studies on interactions between agroforestry and illegal hunting are rare, I examine this thesis' findings in the context on the broader literature on livelihood alternatives to illegal hunting. Those findings indicate that, among the drivers of the specialisation of current hunters, lies the perception that turtle hunting involves lower demands on labour and more immediate returns than both manic-based agriculture and agroforestry. That aligns partially with van Vliet's (2011, p. 19) argument that illegal hunting is associated with low production costs. According to the author, that applies to cases in which wildlife is abundant; however, the present study presents evidence that hunting of scarce wildlife may also be associated with low labour demand or "light work". For Brown (2003, p.1), other attractive characteristics of hunting would include: easy storage and transportation, compatibility with diversified income-earning strategies and high social inclusivity both in wealth and in gender terms. The first would apply to this thesis' study site, as turtles are kept alive during storage and transportation and can, thus, be considered as non-perishable products. The other two find limited applicability, as turtle hunters tend to specialise in the activity and as the financial returns of hunting usually do not reach the wives and children of male hunters. Also, this thesis' findings suggest that agroforestry tended to be viewed as more advantageous than turtle hunting among households that already did not engage in those two activities or did not aspire to attempt them in the future. That is one of the factors that can explain why the successful adoption of alternatives is not accompanied by substitution of hunting, according to van Vliet (2011, pp. 19-20).

Regarding cattle raising, the attractiveness of that activity to small producers has long been identified; authors have stressed its low labour requirements and the reduction of risk associated with the fact that animals can be quickly sold for a relatively large amount in emergencies, acting as savings that can be easily retrieved (Hecht 1989, p. 232; Browder 1994, p. 52). The latter was

corroborated in the present thesis; on the other hand, there was no consensus about the former. Evidence indicates that perceptions of high demands of cattle raising on labour was associated with a worse-off condition, indicating that even a relatively small scale of 40 to 50 animals (corresponding to the largest herd found locally) may be out of reach to the poorer.

The largest ranchers of the study communities seemed satisfied with the activity; this research found no evidence that agroforestry would substitute for it or contribute to lowering its impact, in concordance with the studies conducted by Connelly and Shapiro (2006, p.134) and Blinn *et al.* (2013, p. 177). It has also long been argued by Fearnside (1995, p. 139-140) that while pasture planting produces greater returns, farmers are unlikely to invest in agroforestry and other sustainable land uses. Although the author referred specifically to high profits arising from land speculation, the argument might also apply when considering other benefits derived from cattle raising.

Similarly with turtle hunting, agroforestry tended to be viewed as more advantageous than cattle raising among households that already did not engage in it or did not aspire to attempt it in the future. Future work should explore whether, by improving those households' income, agroforestry might end up contributing to the adoption of cattle raising, by attenuating some of the constraints identified in the present study, and thus inducing the expansion, rather than the reduction, of deforestation as suggested by a few studies. Authors have observed an increase in the scale of cattle raising, despite agroforestry's major share in households' total income (Sá *et al.* 1998; Franke *et al.* 2008), and suggested that a boom-and-bust cycle affecting an agroforestry product may induce small farmers to diversify by adding cattle raising to their livelihood portfolio and larger ones to convert entire agroforestry areas to pastures (Ruf & Schroth 2004, p. 126; Connelly & Shapiro 2006, p.123-124; Salisbury & Schmink 2007¹³⁷).

¹³⁷ Although that study refers specifically to rubber extraction from natural forests, its conclusions can be of relevance to rubber agroforests.

More broadly, Chapter 6 contributes to the literature on Integrated Development and Conservation Projects (ICDPs). By arguing that the introduction of agroforestry in the study communities may not be followed by the reduction of activities perceived as threats to PAs, I align myself with critics of the 'win-win solution' label attached to attempts to combine conservation and development. However, by no means do I intend to support people-free park advocates who suggest that community approaches to conservation waste scarce conservation resources (see Adams & Hutton 2007, pp.164-166 for a discussion on those views). As Wells and McShane (2004, p. 514) conclude, I do not question the principle of linking PA management with development, but its implementation is in need of rethinking (see also discussion in section 7.2 on compensation for displacement). As those authors point out (pp. 515-516), site-specific interventions should be nested within broader strategies; in the study case explored in this thesis, the latter might include supporting stronger law enforcement of hunting bans and policy change aimed at lowering subsidies to the cattle value chain. The authors also suggest that the trade-offs concerning the interests of major stakeholders (PA staff, local communities, conservation and development NGOs) should be identified and negotiated. Payments for ecosystem services, certification schemes and formal agreements resulting from such negotiations can contribute to close the link between improved incomes derived from agroforestry and conservation outcomes (as discussed by van Vliet 2011, pp.19-20 in the context of illegal hunting, which would also be applicable to the case of cattle raising).

7.5 Recommendations for future extension work

I conclude this chapter by presenting some recommendations for future rural extension work in the region. Those recommendations may be particularly relevant to rural extension efforts that focus on agroforestry, are aimed at PA conservation, and/or target the communities that took part in the present study. With some careful consideration of local context, some of those recommendations might also apply to extension work promoting agroforestry elsewhere.

Extension project aims should be carefully and clearly defined based on an assessment of the main issues faced locally. That assessment would investigate, for instance: whether income generation, food security or conservation aspects are important issues and in what sense; what exactly are the constraints faced in pursuing subsistence, income and sustainability, how they are related and which should be tackled as priorities; and whether agroforestry can be part of an effective strategy to address them.

Potential conflicts over labour and land (see Chapter 5 for a discussion on those conflicts) can be avoided by paying particular attention to local households' portfolio of livelihood activities; discussions are needed with local people on how they already, or could, manage the conflicts (e.g., reducing weeding in agroforestry areas in years of peak production of brazil nuts) and how that would affect agroforestry. It is important to take into account the division of labour within the household; women's role, particularly regarding tree planting and tending, should not be overlooked. Involving women in the planning of the agroforestry areas and taking their needs into consideration may be crucial for the satisfactory development of the plantings. As one of the extensionists points out, the presence of women in the extension staff can facilitate its approach towards local women, especially when the contact between outsider men and local women is culturally problematic.

In cases where income generation is included in the project aims, it is fundamental to plan how marketing constraints, such as the type examined in Chapter 5 – both regarding specifics concerning technology design and wider structural factors – will be addressed in the short, medium and long term. There may be much to be learned from shortcomings faced by past projects in that respect, as discussed in Chapter 4. It is important that project staff are aware of the expectations the project is likely to create among local people, and that it makes informed efforts so that negative perceptions of development and conservation projects are not reinforced. In Chapter 5, I stressed, for example, the relevance of conducting market surveys, of agroforestry species diversification and of arranging the necessary infrastructure for processing and transportation and of strengthening local institutions. The strengthening of social

capital, as discussed earlier in this chapter, may include encouraging partnerships with external institutions for training and purchase of infrastructure for processing, storage and transportation. Prioritising species that require little processing and are less problematic to transport should be considered.

In cases where project aims include conservation, expectations about agroforestry's direct and indirect contribution should both be defined. As Chapter 3 indicates, it is important that initial assumptions about local and introduced practices are calibrated by confronting them with local empirical evidence. Priorities can be identified and a misguided optimism towards agroforestry can be avoided by assessing the extent of perceived problems, such as biodiversity declines, and the contribution of local livelihood activities to those declines. Also, it is important that extensionists consider that agroforestry may not lower the scale of activities perceived as threats when cultural motivations are strong or when benefits of the latter are particular to that activity and cannot be substituted, as the analysis presented in Chapter 6 suggests.

Addressing some of the issues presented in this section may have positive consequences on local people's participation in a given extension project, considering that demands on labour, economic returns and other agroforestry characteristics may be among criteria used by locals to assess agroforestry, as discussed in Chapter 4. Moreover, addressing those issues could contribute to clarify how the project in question is different from and will not repeat some of the same shortcomings of past interventions by external actors.

In addition to tackling marketing constraints already examined in this section, local perceptions of past projects analysed in Chapter 4 indicate that new projects could differentiate themselves from past ones in a positive way by: clarifying project aims, avoiding delays in payments to producers, securing high enough prices to compete with local intermediaries, and encouraging the transparent management of funds received by local institutions.

The investigation of social networks and local institutions' dynamics can also be fundamental for the project to find its way to its intended beneficiaries. That investigation may yield the identification of local people with influence and a willingness to contribute to the project, but also of power relations and rival groups that could prevent the project from reaching some the most interested and most in need. It can be challenging to engage with opposing sides; it may not be possible to do so and the project may have to opt to prioritise one of them. It is important that the project sets clearly the criteria that define their target group and are to be used to inform that choice.

In summary, in the present thesis I argue that, although there are factors favouring local people's participation in agroforestry extension and agroforestry's positive contribution to livelihoods and to conservation, constraining factors are severe and likely to hinder the fulfilment of optimistic expectations. By taking those factors into consideration in the design of extension interventions, I hope that expectations can be reassessed and agroforestry interventions can be improved.

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Annex 1. Agroforestry extension project



c) Agroforestry extension project's *cupuaçu* seedlings being carried to be planted near banana trees; b) project's *cupuaçu* tree, two years after planting; c) *cupuaçu* tree planted a few years before the project; d) project's *cupuaçu* tree, two years after planting. (c) and (d) refer to the same area and same day.

Annex 2. Housing and means of transportation



a) Wooden house, recently built to substitute previous palm thatched one; b) brick house; c) wooden canoe; d) wooden canoe powered by small engine (*rabeta*); e) covered boat (owned by a local household); f) community covered boat; g) covered boat (owned by an outsider and used for commercial transportation).

Annex 3. Household survey

Date of interview: ____ - ____ -201__ Community: _____ House GPS coordinates: _____
Interview no.: _____ House no.: _____

1. How many families live in this house? ()1 ()2 ()3 ()4 **[if only 1, go to 3]**
2. How many of those families own an agricultural field? ()1 ()2 ()3 ()4 **[if >1, apply questionnaire to each family that owns an agricultural field]**

Demography:

[Interviewee]

3. Name: _____
4. Nickname: _____
5. Gender: ()M ()F
6. Age: ____ years
7. Have lived in this place for: ____ years **[place=clearing]**

8. Do you have kin in this community? ()Y ()N **[If N, go to 10]**
9. Among the houses of this community, you have kin in how many of them?
()few/almost none ()some ()many, almost all or all
10. Do you have kin in the neighbour community? ()Y ()N **[If N, go to 12]**
11. Among the houses of the neighbour community, you have kin in how many of them?
()few/almost none ()some ()many, almost all or all

12. You consider ()black ()indian ()white
yourself: ()mixture ()don't know **[if not mixture, go to 14]**
13. Mixture of which ()black+indian ()black+white/'mulato' ()indian+white/'caboclo'
ones? ()black+indian+white ()other _____ ()don't know

14. Did you have the opportunity to study? ()Y ()N **[if N, go to 16]**
15. Until which grade? ____ grade **[if secondary education or higher, equivalent in years of study]**

16. Do you have a religion? ()Y ()N **[If N, go to 18]**
17. Which religion? ()catholic ()evangelical ()other _____

[Spouse or other]

18. Do you have a spouse? ()Y ()N **[If Y, go to 20]**
19. Is there someone in the house who helps you in providing for your family? ()Y ()N **[If N, go to 35]**
20. Name: _____
21. Nickname: _____
22. Gender: ()M ()F
23. Age: ____ years
24. Lives in this place for: ____ years **[place=clearing]**

25. Do you have kin in this community? ()Y ()N **[If N, go to 27]**
26. Among the houses of this community, you have kin in how many of them?
()few/almost none ()some ()many, almost all or all
27. Do you have kin in the neighbour community? ()Y ()N **[If N, go to 29]**
28. Among the houses of the neighbour community, you have kin in how many of them?
()few/almost none ()some ()many, almost all or all

29. You consider ()black ()indian ()white
yourself: ()mixture ()don't know **[if not mixture, go to 31]**
30. Mixture of which ()black+indian ()black+white/'mulato' ()indian+white/'caboclo'
ones? ()black+indian+white ()other _____ ()don't know

31. Did you have the opportunity to study? ()Y ()N **[if N, go to 33]**
32. Until which grade? ____ grade **[if secondary education or higher, equivalent in years of study]**

33. Do you have a religion? ()Y ()N **[If N, go to 35]**
34. Which religion? ()catholic ()evangelical ()other _____

[Household composition]

35. Besides the couple, who else lives in this house? What are their names // kinship ties with the couple // and age? **[probe: Is there someone else that is not here now, but lives here most of the time?]**

First name	Gender	Kinship tie	Age (years)

Sources of subsistence and cash income

36. Besides what is bought, where do you get what to eat for you family around here during the year? **[after the answer, probe each of the items that were not mentioned]**
37. For each of those, I would like to know if the family eats few, many or some times during one year. **[repeat items mentioned] [rate: 1=few times, 2=some times, 3=many times]**
38. What type of work do you do to provide for your family during the year? **[after the answer, probe each of the items that were not mentioned] [probe: not only the couple, but also other family members]**
39. For each of those, do you receive for it few, many or some times during one year **[repeat items mentioned] [rate: 1=few times, 2=some times, 3=many times]**

36.	37.	38.	39.	
				Agriculture
				Trees near house – Homegarden
				Large livestock raising (cattle)
				Medium livestock raising (sheep, goat)
				Small livestock raising (chicken, duck, pig)
---	---			Extraction of wood (for house, canoe, oar)
				Extraction of other things from the forest [probe: brazil nut]
				Fishing
				Hunting
---	---			Handicrafts (non-wood: 'cipó', etc.)
---	---			Trade
---	---			Transportation of passengers
---	---			Informal job (specify: _____)
---	---			Formal job (specify: _____)
---	---			State pension
---	---			Other social service payments (specify: ()bolsa família ()other:_____)
				Help from someone that does not live in the house

Agriculture - fields

40. Did you work with agriculture last year (2010)? ()Y ()N **[If N, go to 47]**

41. Who worked then? ()husband ()wife ()other_____

42. Who usually works? ()husband ()wife ()other____

[If interviewee did not work in the current field, go to 47]

[Interviewee]

43. Have you started working in agriculture as a child? ()Y ()N **[If Y, go to 45]**

44. How old were you when you started? ___ years

45. Since that time until today, did you spend any period (> 1 year) without working in agriculture?
()Y ()N **[If N, go to 53]**

46. How much time? ___ years **[go to 53]**

47. Have you ever worked with agriculture? ()Y ()N **[Se N, ir para 53]**

48. Have you started working in agriculture as a child? ()Y ()N **[If Y, go to 50]**

49. How old were you when you started? ___ years

50. Which was the last year you worked with agriculture? _____

51. Since you started working with agriculture until that last year, did you spend any period (> 1 year) without working in agriculture?

()Y ()N **[If N, go to 53]**

52. How much time? ___ years

[Spouse or other] [If not applicable, go to 63]

[If spouse or other lives in the house, and did not work in agriculture in 2010, go to 57]

53. Have you started working in agriculture as a child? ()Y ()N **[If Y, go to 55]**

54. How old were you when you started? ___ years

55. Since that time until today, did you spend any period (> 1 year) without working in agriculture?
()Y ()N **[If N, go to 63]**

56. How much time? ___ years **[go to 63]**

57. Have you ever worked with agriculture? ()Y ()N **[Se N, ir para 63]**

58. Have you started working with agriculture as a child? ()Y ()N **[If Y, go to 60]**

59. How old were you when you started? ___ years

60. Which was the last year you worked with agriculture? _____

61. Since you started working with agriculture until that last year, did you spend any period (> 1 year) without working in agriculture?

()Y ()N **[If N, go to 63]**

62. How much time? ___ years

[If more than 5 years without working in agriculture, go to 96]

63. In the last 'roça' you planted, you: ()only helped ()are the owners **[if owners, go to 65]**

64. How many years ago did you plant the last 'roça' in which you were the owners?
_____ years **[if more than 5 years, go to 96]**

65. What do/did you have in the last 'roça' you owned? **[probe: something else that you had but already harvested?] [probe: each of the items]**

66. What else do you usually plant, but you do/did not have in that 'roça'? **[probe: each of the items]**

67. Who chooses what to plant in each year? ()wife ()husband ()other_____ **[probe: the item not mentioned]**

68. You planted: ()some of those plants mixed with others
()each plant in a separated place **[if separated, go to 70]**

69. Which were planted separated? **[number: same number=mixed]**

70. Do you sell any of them? ()Y ()N **[If N, go to 73]**

71. Which ones?

72. For each of those products, do you sell it few, many or some times during one year? **[rate: 1=few times, 2=some times, 3=many times]**

Agriculture – homegardens and casa de farinha

95. Are there trees near the *casa de farinha*? ()Y ()N
 96. Are there trees around the house? ()Y ()N **[If no to 95 and 96, go to 105]**
 97. What kind of trees are there around the house (whether bearing fruits or not)? Which other ones do you have near the *casa de farinha*?
 98. Those trees: () were all planted by you
 () some grew spontaneously or were planted by a previous family **[go to 100]**
 99. Which ones you did not plant yourselves?
 100. Do you sell any product from those trees? ()Y ()N **[If N, go to 103]**
 101. Which ones do you sell?

97.	99.	101.		97.	99.	101.	
			Avocado (<i>abacate</i>)				<i>Pequiá</i>
			Pineapple (<i>abacaxi</i>)				<i>Pimenta-de-cheiro</i>
			<i>Abiu</i>				<i>Pitanga</i>
			<i>Açaí</i>				<i>Pitomba</i>
			<i>Acerola</i>				Peach palm (<i>pupunha</i>)
			<i>Andiroba</i>				<i>Taioba/tajoba</i>
			<i>Araçá</i>				<i>Tamarindo</i>
			<i>Ariá</i>				<i>Taperebá</i>
			<i>Azeitona</i>				<i>Tucumã</i>
			<i>Bacaba</i>				<i>Umari</i>
			<i>Bacuri</i>				<i>Urucum</i>
			Banana				<i>Uxi</i>
			Sweet potato (<i>batata doce</i>)				
			<i>Biribá</i>				
			Cocoa (<i>cacau</i>)				
			Coffee (<i>café</i>)				
			Cashew (<i>caju</i>)				
			Sugar cane (<i>cana</i>)				
			<i>Cará</i>				
			<i>Carambola</i>				
			Brazil nut (<i>castanha</i>)				
			Coconut (<i>coco</i>)				
			<i>Copaíba</i>				
			<i>Cuieira</i>				
			<i>Cupuaçu</i>				
			<i>Fruta do conde</i>				
			Guava (<i>goiaba</i>)				
			Soursop (<i>graviola</i>)				
			<i>Inajá</i>				
			<i>Ingá</i>				
			<i>Jabuticaba</i>				
			Jackfruit (<i>jaca</i>)				
			<i>Jambo</i>				
			Pumpkin (<i>jerimum</i>)				
			Orange (<i>laranja</i>)				
			Lemon (<i>limão</i>)				
			Manioc (sweet) (<i>macaxeira</i>)				
			Papaya (<i>mamão</i>)				
			Mango (<i>manga</i>)				
			<i>Maxixe</i>				
			Watermelon (<i>melancia</i>)				
			<i>Mucajá</i>				
			<i>Murici</i>				

102. Who chose most of the trees? ()wife ()husband ()son/daughter ()other _____
 103. Who planted most of the trees? ()wife ()husband ()son/daughter ()other _____
 104. Do you weed among the trees? ()Y ()N **[If N, go to 106]**
 105. Who weeds most of the times? ()wife ()husband ()son/daughter ()other _____

NTFP and timber extraction

127. Do you sell any product extracted from the forest? ()Y ()N **[If N, go to 130]**

128. Which ones?

129. Do you sell each of those products few, many or some times during one (typical) year **[rate: 1=few times, 2=some times, 3=many times]**

128.	129.		128.	129.	
		Brazil nut			
		<i>Copaíba</i>			
		<i>Andiroba</i>			
		<i>Breu</i>			
		<i>Cipó</i>			
		<i>Açaí</i>			
		<i>Cumarú</i>			
		Honey			
		<i>Preciosa</i>			
		<i>Itaúba</i>			
		<i>Louro</i>			
		<i>Tento</i>			

Domestic livestock

130. Do you raise any animal? ()Y ()N **[If N, go to 137]**

131. Which ones and how many of each do you raise?

()chicken ()duck ()pig ()sheep ()goat ()cattle **[if does not own cattle, go to 137]**

()other _____

132. Is the pasture (at least part of it) where you keep the cattle yours? ()Y ()N. Whose is it? _____ **[If N, go to 137]**

133. What is the total size of your pasture? _____ *quadras*

134. Are there trees there? ()Y ()N **[If N, go to 137]**

135. Those trees: ()were planted ()grew spontaneously

136. Why did you leave those trees? _____

Commercialisation

137. Where do you sell your production? **[probe: only there?]**

()Oriximiná ()PortoTrombetas ()at this community ()at other community. Which one? _____

()other _____ **[if only at this community, go to 140]**

138. What type of means of transportation do you use?

139. Whose is that means of transportation?

137.	138.
()covered boat	()private, passenger boat ()community ()own ()rented ()borrowed. From whom? Name: _____ Kinship: _____
()canoe w/ rabeta	()own ()rented ()borrowed. From whom? Name: _____ Kinship: _____
()canoe w/o rabeta	()own ()rented ()borrowed. From whom? Name: _____ Kinship: _____

140. Who do you sell your production to?

()person in charge of passenger boat ()*regatão* ()other intermediary ()final consumer

()other _____

Social dynamics

141. In the community, you participate in:
 football *mutirão* to weed the community center church service other meetings
142. During one year, you go: **[rate: 1=few times, 2=some times, 3=many times]**
 football *mutirão* church service other meetings
143. Have you ever been the community coordinator? ()Y ()N **[If N, go to 145]**
144. How long for? ___ years
145. Are you a member of the brazil nut cooperative? ()Y ()N **[If Y, go to 147]**
146. Have you ever been a member? ()Y ()N
147. Have you participated in the brazil nut project? ()Y ()N
148. Have you ever sold to the brazil nut cooperative? ()Y ()N **[If N, go to 150]**
149. You have sold: ()few times/ almost never ()some times ()many times, almost always or always
150. Did you work in the brazil nut cooperative? ()Y ()N
151. Are you a member of the Mãe Domingas association? ()Y ()N **[If Y, go to 155]**
152. Have you ever been a member? ()Y ()N
153. Are you part of the board of Mãe Domingas association? ()Y ()N **[If Y, go to 157]**
154. Have you ever been part? ()Y ()N
155. Are you a member of ARQMO? ()Y ()N **[If Y, go to 159]**
156. Have you ever been a member? ()Y ()N
157. Are you part of the board of ARQMO? ()Y ()N
158. Have you ever been part? ()Y ()N

Durable goods

159. House walls are made of: ()palm thatch ()palm trunk ()wood ()wattle and daub ()bricks
160. House roof is made of: ()palm thatch ()*fibrocimento* ()clay ()aluminium

	Do you own?
161. Hoe	()Y ()N
162. Machete	()Y ()N
163. Axe	()Y ()N
164. Flat spade	()Y ()N
165. Post hole digger	()Y ()N
166. Wheelbarrow	()Y ()N
167. Chainsaw	()Y ()N
168. Canoe	()Y ()N
169. Fishing net	()Y ()N
170. Power engine for canoe (<i>rabeta</i>)	()Y ()N
171. Covered boat	()Y ()N
172. Power engine to grate manioc	()Y ()N
173. Wheel to grate manioc (<i>rodete</i>)	()Y ()N
174. Gas stove	()Y ()N
175. Power generator	()Y ()N
176. TV	()Y ()N
177. DVD player	()Y ()N
178. Fridge	()Y ()N
179. Freezer	()Y ()N

Annex 4. Local agroforestry practices



Homegarden (above) and agricultural field planted with manioc and banana and with some trees that were spared when the field was cleared (below)

Annex 5. Outcome and explanatory variables considered in logistic regression analysis – descriptive statistics

Description of the outcome variable and quantitative explanatory variables considered in the logistic regression analysis in terms of their categories and respective frequencies (freq.) (nominal variables) or their unit of measure and mean and standard deviation (SD) values (continuous variables)

Variable	Measurement	Freq. (%)	Mean ± SD
Participation in agroforestry project	1 = yes	27.6	
	0 = no	72.4	
COMMUNITY-LEVEL			
Place of residence			
Relative to the protected area	1 = inside	46.6	
	0 = outside	53.4	
Community	1= Abuí	38.8	
	2 = Paraná do Abuí	14.7	
	3 = Tapagem	31.9	
	4 = S. Coração (ref. group)	17.7	
HOUSEHOLD-LEVEL			
Demography			
Age of adult male (years)	Number of years		43.5 ±15.3
Age of adult female (years)	Number of years		39.5 ±15.4
Formal education of adult male	Number of years		3.2 ±2.5
Formal education of adult female	Number of years		4.1 ±3.5
Household size – total	Number of members		5.6 ±2.7
Household size – 14-60 years	Number of members		2.8 ±1.7
Gender roles			
Choice/planting of homegarden trees by adult male	1 = yes	54.3	
	0 = no	39.7	
	-1= n/a (adult male absent)	2.6	
	-2= n/a (homegarden absent)	3.4	
Choice/planting of homegarden trees by adult female	1 = yes	79.3	
	0 = no	12.9	
	-1= n/a (adult female absent)	4.3	
	-2= n/a (homegarden absent)	3.5	
Weeding of homegarden by adult male	1 = yes	52.6	
	0 = no	41.4	
	-1= n/a (adult male absent)	2.6	
	-2= n/a (homegarden absent)	3.4	

Variable	Measurement	Freq. (%)	Mean ± SD
Weeding of homegarden by adult female	1 = yes	79.3	
	0 = no	12.9	
	-1= n/a (adult female absent)	4.3	
	-2= n/a (homegarden absent)	3.5	
Livelihoods – activities portfolio			
Brazil nut extraction as income source	1= many or sometimes / year	77.6	
	0= few times or never	22.4	
<i>Copaíba</i> or <i>breu</i> extraction as income source	1= many or sometimes / year	33.6	
	0= few times or never	66.4	
Wood extraction as income source	1= many or sometimes / year	21.6	
	0= few times or never	78.4	
Agriculture as income source	1= many or sometimes / year	32.8	
	0= few times or never	67.2	
Cattle as income source	1= many or sometimes / year	9.5	
	0= few times or never	90.5	
State pension as income source	1= many or sometimes / year	25.0	
	0= few times or never	75.0	
Medium to long term job as income source	1= many or sometimes / year	25.0	
	0= few times or never	75.0	
Livelihoods - assets – social capital *			
Close kinship ties with supportive gatekeeper	1 = yes	28.4	
	0 = no	56.9	
	-1= not applicable (supportive gatekeeper absent)	14.7	
Participation in the brazil nut project	1 = yes (present or past)	50.9	
	0 = no	49.1	
Use of <i>mutirão</i> for own <i>roça</i>	1 = yes	69.0	
	0 = no	19.8	
	-1= n/a (<i>roça</i> absent)	11.2	
Participation in <i>mutirão</i>	1 = many times in a year	68.1	
	0 = some, few times or never	31.9	
Participation in football match	1 = many times in a year	55.2	
	0 = some, few times or never	44.8	
Participation in church service	1 = many times in a year	80.2	
	0 = some, few times or never	19.8	
Participation in other meetings	1 = many times in a year	85.3	
	0 = some, few times or never	14.7	
Participation as community coordinator	1 = yes (present or past)	31.0	
	0 = no	69.0	

Variable	Measurement	Freq. (%)	Mean ± SD
Membership in local association	1 = yes (present)	51.7	
	0 = no	48.3	
Membership in umbrella association	1 = yes (present)	67.2	
	0 = no	32.8	
Livelihoods - assets - human capital			
Household labour used in <i>roça</i>	Number of members		4.0 ±2.7
Experience of adult male with <i>roça</i>	Number of years		26.4 ±14.9
Experience of adult female with <i>roça</i>	Number of years		22.8 ±15.0
Tree planting in <i>roça</i>	1 = yes	38.8	
	0 = no	61.2	
Tree tending in <i>roça</i>	1 = yes	58.6	
	0 = no	41.4	
Species diversity in <i>roça</i>	Number of species		9.1 ±4.0
Species diversity in homegardens	Number of species		8.4 ±4.2
Livelihoods - assets - natural capital			
Type of soil in <i>roça</i> – <i>terra preta</i> or <i>areia preta</i>	1 = yes	20.7	
	0 = no	68.1	
	-1= n/a (<i>roça</i> absent)	11.2	
Type of soil in <i>roça</i> – <i>areia</i> or <i>areia</i> with <i>barro</i>	1 = yes	49.1	
	0 = no	39.7	
	-1= n/a (<i>roça</i> absent)	11.2	
Type of soil in <i>roça</i> – <i>barro</i>	1 = yes	29.3	
	0 = no	59.5	
	-1= n/a (<i>roça</i> absent)	11.2	
Livelihoods - wealth and well-being			
Index based on livelihood portfolio	1 = pension, job or cattle as income source (better-off)	47.4	
	0 = none of the previous as income source (worse-off)	52.6	
Index based on possession of key durable goods	1 = possesses 0-1 goods (worse-off)	28.4	
	2= possesses 2-3 goods (in-between)	46.6	
	3 = possesses 4-6 goods (better-off)	25.0	

* Certain aspects of social capital were also analysed at the community level

Annex 6. Livelihood activities



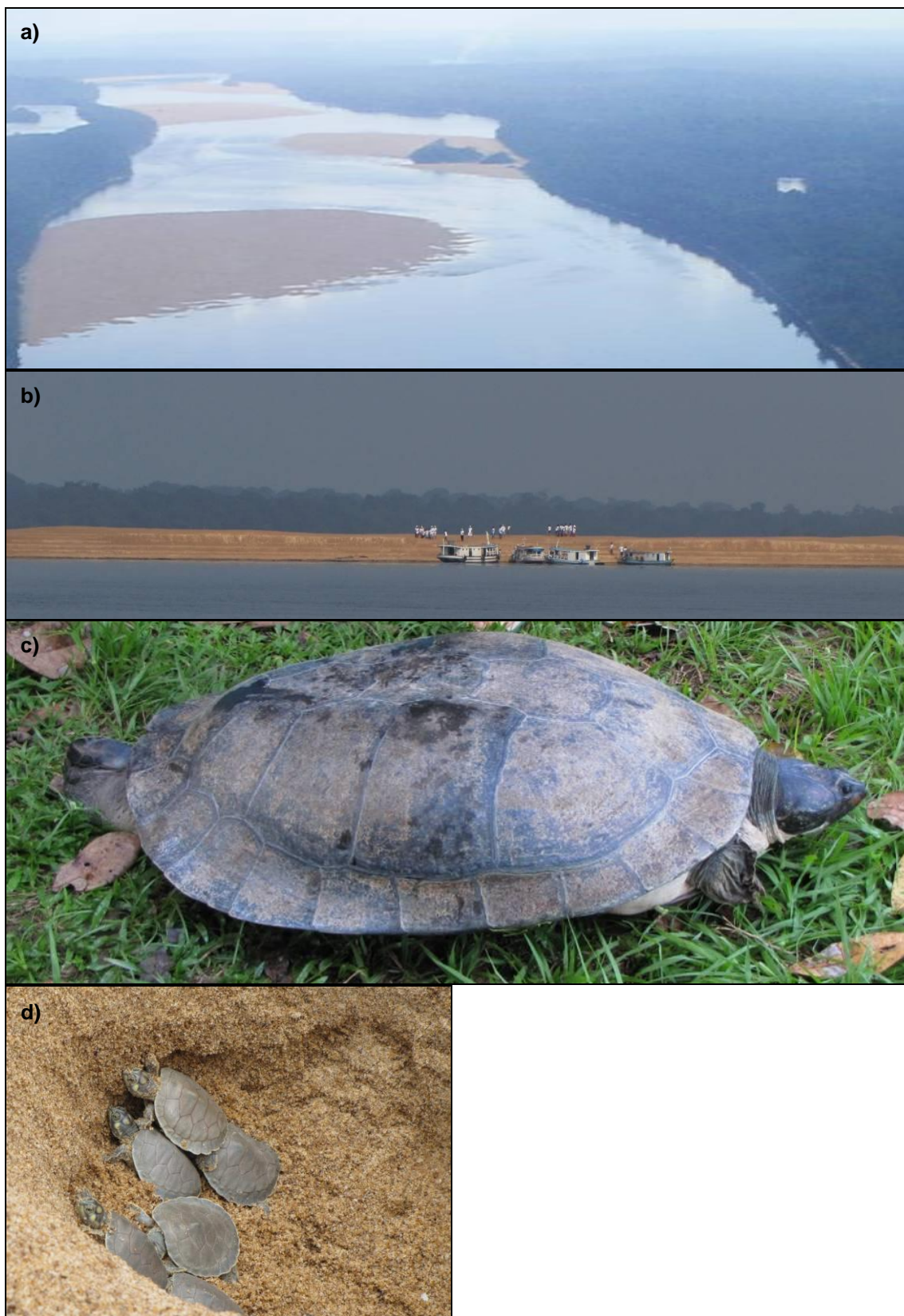
a) Secondary forest being cleared for agriculture; b) peeled, grated and dried manioc being roasted to make *farinha*; c) basket to carry brazil nuts being woven; d) brazil nut fruit (*ouriço*) being opened with a machete; e) to h) canoe making with the use of a chainsaw (e), an axe (f) and an *enxó* (h).

Annex 7. Cattle pasture



Cattle pasture, at the river margin, owned by one of the four main cattle raisers in the study communities

Annex 8. South American river turtle



a) Sand banks of Trombetas River (source: Silva *et al.* 2011b). The larger ones have an area of approximately 120 ha each; b) one of the main turtle nesting sites; c) adult turtle; d) turtle hatchlings before leaving the nest.

Annex 9. Bauxite carrier ship



Bauxite carrier ship.
(Source: Renato 2013)