

Foreign direct investment in biofuels and sustainable development: The case of jatropha in the Boeny region, Madagascar

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Abstract

The past decade has seen the rapid spread of market-based approaches to address climate change mitigation, adaptation and poverty alleviation. In the first decade of the 21st century, the enthusiasm for pursuing mitigation through green alternatives to fossil fuels contributed to a spike in global investments in biofuel crops. The tropical plant jatropha (*Jatropha curcas* Linn.) was promoted as the ideal 'green' biofuel because of its multiple qualities. It was a non-food crop that was seen to grow easily in poor soils without requiring fertiliser or heavy demand for water and, most importantly, it could not be diverted from food consumption to biofuel production. Foreign direct investment (FDI) in jatropha cultivation was thus considered a potentially winning strategy for sustainable development and poverty alleviation in poor countries.

This thesis investigates how FDI in jatropha has contributed to sustainable regional development in northwest Madagascar. Madagascar was one of the major destinations for FDI in jatropha cultivation in the 2000s and, in particular, the northwest region of Boeny was targeted for large-scale production of the crop and as a node for biofuel-based industrial development. Using the framework of political ecology and global value chain analysis, the thesis examines three critical dimensions of jatropha investments in Boeny: first, the broader political-economic conditions that led Madagascar to become a favoured global destination for jatropha investment; second, the processes by which foreign companies launched into jatropha production in Boeny; and third, the experiences and outcomes of jatropha production and their impact on sustainable regional development in northwest Madagascar. The study uses a combination of field interviews, observations, and secondary data on jatropha investment and government policies to explore these dimensions.

The thesis shows that jatropha investment in Madagascar resulted from a convergence of interests of the Madagascar presidency, bilateral aid agencies, global environmental

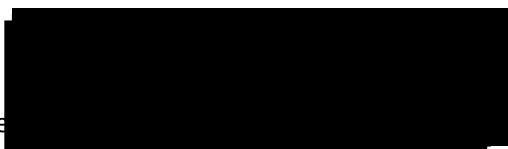
organisations, and investors seeking to profit from an emerging global carbon economy. The expectations were similar to a gold rush, where everyone hoped to reap windfall profits as early-movers in the alternative fuel industry. The reality of jatropha cultivation proved the opposite and companies struggled to meet the targets outlined in their business plans. Poor knowledge of the crop's agronomy and the regional economy undermined the profit expectations of companies, and a subsequent fall in petroleum prices and financial crisis led many to withdraw from jatropha cultivation altogether. These outcomes provided negligible benefits for sustainable regional development in the Boeny region.

This study offers significant insights on the risks associated with market-driven initiatives aimed at climate change mitigation and sustainable development. Its findings indicate that despite vigorous promotion of sustainable development through the emerging global carbon economy, 'green' foreign investments in innovative biofuel crops such as jatropha provide negligible economic or ecological benefits to regions in poor countries.

Declaration

This thesis contains no material which has been accepted for the award of any other degree or diploma in any university or other institution and affirms that to the best of my knowledge, the thesis contains no material previously published or written by another person, except where due reference is made in the text of thesis.

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The research for this project received the approval of the Monash University Standing Committee for Ethical Research on Humans (Reference Number CF12/1301 – 2012000684).

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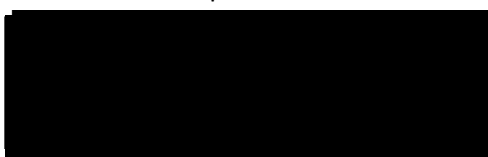
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List of Acronyms

BAMEX:	Business and market expansion
CER:	Certified Emission Reduction
ERA:	Eco-Regional Alliance
ERI:	Eco-Regional Initiatives
FDI:	Foreign Direct Investment
GEXSI:	Global Exchange for Social Investment
GIZ:	<i>Deutsche Gesellschaft für Internationale Zusammenarbeit</i>
GVC:	Global Value Chains
GPN:	Global Production Networks
IMF:	International Monetary Fund
IPCC:	Intergovernmental Panel on Climate Change
MAP:	Madagascar Action Plan
MCA:	Millennium Challenge Account
MCC:	Millennium Challenge Corporation
MDG:	Millennium Development Goals
NGO:	Non-governmental organisation
PLAE:	<i>Programme de Lutte Anti-Érosive</i>
PRSP:	Poverty Reduction Strategy Paper
RSB:	Roundtable on Sustainable Biofuels
SOLTS:	State-Owned Land and Topographic Services
UNFCCC:	United Nations Framework Convention on Climate Change
USAID:	United States Agency for International Development
VER:	Voluntary Emission Reduction
WWF:	World Wildlife Fund

1 Introduction

In 1987, the World Commission on Environment and Development reported that Western industrialisation models cause the degradation of the global human environment and the natural resources on which it depends. Urging countries to make amends and collaborate on their common future, the commission coined the term 'sustainable development' to describe the ability to satisfy the requirements of current generations without compromising the ability of future ones to meet their own needs. The climate was of particular concern because of its links to the viability of other resources such as ecosystems, water and air.

In the years following the report of the commission, the scientists of the Intergovernmental Panel on Climate Change presented evidence on a shift in the climate system influenced by the anthropogenic emission of greenhouse gases (GHGs) (e.g., carbon dioxide, methane) into the atmosphere. In order to address this global concern, the 1992 United Nations Framework Convention on Climate Change (UNFCCC) expressed the commitment of signatory countries to reduce GHGs. Entering into force in 2005, the Kyoto Protocol implemented the UNFCCC by binding signatory parties to emission reduction levels that would avoid dangerous interference with the global climate system.

Based on carbon accounting and market principles, the Protocol established several market-based mechanisms to allow GHG reduction projects to flexibly take place where it is cheaper to implement them, especially in developing countries. Among emission abatement projects, the production of renewable fuels from plants (biofuels) quickly gained prominence because the consumption of their fossil counterparts is a major contributor to GHG emissions (30% within Europe). In the early 2000s, the enthusiasm for pursuing climate change mitigation through biofuels

led governments worldwide to create dedicated mandatory consumption targets in their domestic transport sectors to accelerate the global transition to a low carbon economy.

The international arena became permeated by debates on Foreign Direct Investment (FDI) to cultivate biofuels in developing countries, which was viewed as a direct outcome of the carbon economy and the artificial creation of a market for these products. Governments and institutions such as the World Bank viewed these green investments as a sustainable development initiative to stimulate rural welfare and economic growth through the 'modernisation' of the agricultural sector of poor countries. In a context of soaring oil prices and shocks, proponents also suggested that investments reduced global dependency on fossil fuels, thus reducing the risk of energy shocks worldwide.

Disputing the concept of a 'win-win' scenario for biofuels, organisations such as the International Land Coalition, La via Campesina, and Friends of the Earth questioned the development potential of these green investments. They reasoned that the cultivation of biofuels is unsustainable and amounts to a 'land grab', in which industrialised countries dispossess the rural poor's livelihood assets in order to acquire 'offshore' energy facilities in the global South. Biofuels became associated with the idea of a modern 'carbon colonialism' that diverts resources away from food production in countries with a high incidence of hunger.

Intrigued by the background of these investments and the debates surrounding them, I chose to orient my research toward the question: Is FDI in biofuels a viable strategy for regional development in poor countries? The challenge was to approach data collection with an analytical framework and a set of objectives appropriate to providing an original answer to this question. After reviewing the literature on investments in biofuels, I noted that studies lack comprehensive grounding in the processes through which export-oriented agribusinesses interact with policy frameworks and institutions, as well as in the processes through which they enter regional rural

contexts and attempt to create an industry. These processes are critical in determining both the viability and the outcomes of FDI flows as a development strategy.

A series of questions about the viability of foreign investments in biofuels became evident. What types of firms are involved, and how do they organise activities and reconnect to global networks of production? What are the investment motives and how do they link to governmental objectives? How does FDI operate on the ground and fit into local and regional economies? What are the relationships between local communities, the land and its exploitation for the production of biofuels? How is the emerging industry affecting regional economies? These questions underlie three research objectives: the investigation of industry creation; the modality of production on the ground; and the links between production, regional economic activities and institutions in terms of outcomes.

Political ecology and global value chain analysis provide grounding to explore these research questions. They complement each other in the exploration of firms' linkages with the international, national and regional institutions, local communities and the environment. On such a basis, I chose to form a multidisciplinary framework based on these two analytical approaches to the study of human, economic and environmental change. This allows a level of integration of their key analytical strengths, and it enhances the empirical breath and insight of the resulting investigation.

The International Land Coalition produced an inventory of FDI in land for the cultivation of biofuels. This provided me with sufficient information to identify an appropriate case study for my research. The database featured investments in crops to produce the two existing categories of biofuels: bioethanol through processes of fermentation and biodiesel via the transesterification of vegetable oil. Within the second group, my attention was captured by a crop called jatropha (*Jatropha curcas* Linn.), which in the first decade of the 2000s was targeted for cultivation on more than 11 million ha of land – about the size of Eritrea, Africa – in tropical and subtropical areas worldwide. I was particularly surprised because, not only was 'jatropha' a crop I had never heard of

before, but also that the area targeted for its cultivation around the world was only second to that of the well-known Oil Palm (*Elaeis guineensis*).

A comparison between the ILC database and other inventories of jatropha investments, such as the one by the NGO *Global Exchange for Social Investment*, drew my attention to Madagascar. The country attracted the greatest quantity of FDI in jatropha worldwide (18 firms) for one of the largest amounts of land cultivated within Africa (35,700 ha). The main region targeted for receiving these investments within Madagascar was Boeny in the country's northwest, and I decided that this would be the region on which I focussed my research.

Between 2005 and 2008, Boeny was targeted by several domestic and foreign jatropha ventures. The foreign investments originated mainly from Europe and were presented as part of Madagascar's national strategy for a rapid and sustainable development endorsed by the World Bank. FDI flows in biofuels were particularly important in the development context characterising the country and region, as Madagascar is one of the poorest countries in the world. It is most widely known for the cartoon movies bearing its name and as a global biodiversity hotspot, and not normally considered as a location for the development of major global industries. The narrow corridor in the highlands between the capital city, Antananarivo, and Antsirabe encompasses the area within which most of the country's industrial activities occur. There is mining in the southern parts of the island and, more recently, substantial logging of precious hardwoods from the rainforests in the eastern regions. The Boeny region in the northwest of the country has a small vegetable oil, cashew and rice industry, but has largely been neglected by the national government in terms of regional economic development.

Through the case of the jatropha industry in Boeny, this thesis makes a significant theoretical and methodological contribution to the scholarship on political ecology and global value chains. It provides insights for policy-makers, development practitioners, corporate managers and

NGO representatives who engage with sustainable development initiatives – may they involve FDI in biofuels, the carbon economy or other green, market-based initiatives.

1.1 Thesis outline

In order to present the information outlined above and to provide an answer to my research question and objectives, I have divided this manuscript into nine chapters. The chapter two reviews the literature on FDI in biofuels. It describes the concerns raised by academics and the global outcomes of investment flows to date. I discuss the multidisciplinary framework that integrates political ecology and the global value chain analysis to guide my investigation. Accordingly, the third chapter presents my research design and methodology. It delves into the rationale for focussing on a single case study approach, its location, and it also outlines the field research protocol, data sources and analytic strategies.

The fourth chapter provides an introductory compendium on jatropha and its economic history from colonial times to the present. Following on from that, the fifth chapter sets out the historical context preceding the arrival of FDI in the cultivation of jatropha to Madagascar. I present the history of the country and the northwest regions from the pre-colonial period to the 2000s. The chapter focuses on themes of development and agricultural production, trade relations and economic growth, peasantry and land reform, and conservation efforts.

The sixth chapter describes how a range of governmental, non-governmental and private sector organisations – whether foreign or domestic – contributed to establishing the jatropha industry in Madagascar. It explains how jatropha FDI emerged at the intersection of national discourses of conservation, energy security and sustainable development in the early 2000s. It introduces the actors involved in the promotion of the crop – companies, the Madagascan government, development institutions, international and environmental NGOs – and their interactions to facilitate the emergence of the industry.

In the seventh chapter, I present the way in which the jatropha industry was created in the Boeny region. This includes evaluations of the background of the companies that entered the industry, their land access strategies and the operations that they put in place. The chapter explores the involvement of firms with the regional government, ministries, parastatal institutions, bilateral aid agencies and their supportive NGOs to put production underway. The description of the regional environment set forth in the chapter enables the analysis of the challenges faced by the jatropha industry in Boeny and the sustainable development outcomes that it delivered.

Accordingly, chapter eight examines the obstacles encountered by jatropha enterprises while entering the regional political, social and economic contexts. I describe how factors such as land, the government and local communities influenced corporate operations and contributed to determine several production and marketing outcomes. After evaluating the consequences of corporate operations for regional development, which includes their impacts on local communities and the environment, I describe the coping mechanisms put in place by surviving enterprises.

The concluding chapter discusses the empirical findings of this thesis in the light of the specific academic debates around jatropha and the general literature on FDI in biofuels. After reflecting on this thesis' multi-disciplinary framework, I provide a novel understanding about the fortune of the global jatropha industry, corporate operations and their development outcomes worldwide. This provides significant insights into the viability of 'green' foreign investments and market-based approaches to sustainable development.

2 Biofuel debates and analytical framework

For the past two decades, policy circles have been abubble with initiatives to reduce human-driven climate change and address sustainable development in poor countries. Governments worldwide established international market-based mechanisms to stimulate a private sector response to those global problems. In the 2000s, the interest in biofuels escalated due to the convergence of several debates about their sustainable development benefits and drawbacks.

Proponents of biofuels held that foreign investments targeting widely-cultivated crops in developing countries could supply the international community with bountiful amounts of clean, renewable fuel. They were seen as a solution to improve energy security, reduce air pollutants and contribute to rural development. Critics of biofuel investments described them as an ethically debatable initiative that diverted resources away from the production of edible crops in food-insecure countries and undermined their agro-ecological systems.

This chapter reviews the literature on biofuels through the lens of six themes. The positive discourse about biofuels is generally articulated in terms of solutions to ‘fossil fuel crises’, mitigating climate change through the creation of a ‘carbon economy’, and as a means for ‘sustainable agro-industrial development’. The negative discourse around biofuels has been articulated in terms of threats to ‘food security’, the need for ‘triple bottom-line assessment’, and the use of biofuel crop cultivation as a means of ‘global resource enclosure’. Following this discussion, I outline three research objectives that are important for examining the viability of biofuel investments as a sustainable development strategy. These objectives link the study of sub-national regional processes of biofuel industry creation, the investigation of productive activities on the ground, and the exploration of their development outcomes. Political ecology and global value chain analyses are then presented as the integrated, multidisciplinary analytic framework of this thesis.

2.1 Literature on biofuels

Sustainable development is a broad concept that is linked to biofuels and other public-private sector initiatives. The concept encompasses equity considerations across generations to account for the value of the environment in decision-making (Pearce & Barbier 2000; Lele 1991; Pearce, Markandya & Barbier 1989). It requires that humankind's welfare and economic opportunities, which are represented by the total capital stock available to society, do not decline over time (Barbier, Burgess & Folke 1994). This stock comprises physical (e.g., machinery), human (e.g., workforce), and natural capital (e.g., climate system). Policy should avoid the irreversible depletion of natural capital because of the catastrophic consequences of losing, for example, key ecological services (Daily & Ehrlich 1992; Meadows, Dennis & Randers 1992; Barbier 1989). Technological innovation, including biofuels (Kuhn & Pritchard 2009), can replace nature with the physical capital used in production (Grossman & Krueger 1995; Barro & Sala-I-Martin 1995; Shafik 1994; Romer 1990).

Biofuels are a renewable alternative to fossil fuels created millions of years ago by geological processes. Their consumption prevents the atmospheric increase in carbon dioxide (CO₂), which is one greenhouse gas contributing to climate change, and reduces dependency on fossil fuels. Biofuels are defined as any fuel "with an 80% minimum content by volume of materials derived from living organisms harvested within the ten years preceding its manufacture" (Speight 2010, p. 321). When they derive from trees, as opposed to annual crops such as corn, their production might temporarily reduce CO₂ levels in the atmosphere because plants absorb it to grow throughout their lives.

Table 2.1 presents the main crops for the production of biofuels in the 2000s. It shows their processing methods, fuel yield per acre, alternative industrial applications, geographical distribution and by-products. Most biofuels are derived from food crops widely cultivated in tropical and subtropical countries. They are part of a multitude of agribusiness commodity chains. The by-products from their processing are used in a range of industries such as animal feed, fertilisers, and cosmetics.

Table 2.1: Description of the main raw materials for biofuel production in the 2000s

Common feedstock	Type of end-product and processing method	Alternative productive uses of the plant	Optimal cultivation latitudes and temperature	Fuel yield (Gal/acre/ year)	By-products
Sugarcane (food)	Bioethanol from fermentation	Sugar; spirits; syrup; molasses.	36N-31S 20-30 °C	727–870	By-products of ethanol distillation such as the fusel are used in the flavour industry.
Sugar beet (food)		Sugar; spirits; syrup; molasses; the leaves are used as animal feed.	30N-60S 20-25 °C	400–800	Dried beet pulp/the remains after the fermentation can be used as animal feedstock.
Corn kernels (food)		Food; flour; syrup.	45N-26S; 20-25 °C	330–424	By-products from corn processing are used as animal feedstock and by the biotechnology industry.
Oil Palm fruits and kernel (food)	Biodiesel from oil transesterification	Cooking oil; soap; food; animal feed.	20N-20S 25-30 °C	610	It is possible to recover vitamin E, carotenes and glycerine after processing. Empty fruit branches and kernel are compacted in solid fuel briquettes for oil mills, cooking or exports. Kernel cakes can be used as animal feed. Empty fruit branches are used in mulching.
Jatropha seeds (non-food)		Marginal soil reclamation; living fence; small-scale soap production; traditional medicine.	30N-35S 24-28 °C	194	The seedcake could be deployed as fertiliser or input for solid biomass power plants. There are patents to detoxify it and use it as animal feed. The glycerine recovered from the transesterification process can be utilised by the cosmetics industry.
Soya beans (food)		Cooking oil; margarine; soy beans.	45N-20S 20-30 °C	46	After oil extraction the cake it is mostly used in animal feed.

(Source: adapted from Kurki, Hill & Morris 2010, p. 4 Table 1, p. 5 Table 2; and Elbehri, Segerstedt & Liu 2013, pp. 16, 63)

The International Energy Agency divides biofuels into three basic types (IEA 2011). As the Table shows, bioethanol derives from the fermentation of cereal or sugar crops in a manner similar to spirits. Biodiesel is produced through a more complicated process called transesterification, which involves the processing of vegetable oils or tallow. Biogas is an experimental technology to produce methane from anaerobic digestive processes of bio-material such as ligneous residues. Biofuels are also classified in 'generations' on the basis of the characteristics of the raw material (feedstock) from which they are produced. First-generation biofuels derive from agricultural crops such as soy (Suurs & Hekket 2009). The second and third generations are experimental and are produced from non-food sources (e.g., jatropha, algae, lingo-cellulosic biomass) to produce fuels for transport or electricity production (Antizar-Ladislao & Turrion-Gomez 2008; Schenk et al. 2008).

Table 2.1 points out that most domestic and foreign investments in biofuel production targeted food crops in developing countries. The United Nations Conference on Trade and Development (2002, p. 291) defines Foreign Direct Investment (FDI) as an investment of foreign assets into "a country's domestic organizations, equipment and structures". In the case of biofuels, it can be tentatively defined as "FDI in land by a foreign company or state that is based on a lasting interest in taking control over land use rights. The transaction includes either rights of land-use or land-ownership. The land-use rights are generally valid for a limited period and can be possibly extended" (Görge et al. 2009, p. 9).

FDI in land to cultivate the biofuel crops presented in Table 2.1 was not a novel phenomenon, but its intensity in the 2000s created a sensation among civil society groups, researchers and policy circles. After the Second World War, foreign ownership of land for agricultural production progressively lost momentum and economic importance due to factors such as decolonisation, conflicts with the labour force and declining international prices of primary commodities (Cook 1994). From the 1980s to the 2000s, looser forms of vertical coordination such as contract farming, also known as outgrowing, have formed the bulk of agricultural commodity

chains (Rama & Wilkinson 2008; Watts 1994). Agribusinesses preferred to reap steady profits by purchasing farmers' agricultural produce at a fixed price based on a contract to provide technical assistance, inputs and finance (Freidberg 2004). Some contract farming arrangements involved a degree of direct foreign control over land in developing countries (Eaton & Shepherd 2001, pp. 46-52). In areas where contract-farming practices could be improved to match favourable agricultural conditions, these commercial arrangements targeted high-value commodities and new production niches (Birthal, Joshi, & Gulati 2005, pp. 25-30; Humphrey & Memedovic 2006, pp. 32-33).

Against an average of about 2 million hectares (ha) in 2005, FDI in biofuel cultivation in developing countries targeted up to 28 million ha of land in 2009 (Deininger et al. 2010; Mann & Smaller 2010). Companies acquired land-leasing arrangements lasting 30-99 years on more than 5,000 ha each (Borras, McMichael & Scoones 2010; Cotula et al. 2009). The literature that describes these 'green' investments converges around six main, interlinked themes ranging from petroleum crises to global resource enclosure.

The arguments in favour of biofuel investments are linked to three themes. 'Fossil fuel crises' such as oil shortages are the point of departure of the pro-biofuel discourse. 'Climate change mitigation' mechanisms are established by international policy initiatives that view biofuel as an environmentally benign investment. 'Sustainable agro-industrial development' perspectives on biofuel investments view the cultivation of energy crops as an effort to modernise the agricultural sector, industrialise rural areas and promote economic growth in developing countries. These three dimensions of the pro-biofuel discourse temporarily overlap and progressively reinforce one another.

Arguments that question the development potential of these green investments have been brought forth by a variety of case studies. Researchers evaluated one or more development aspects of foreign investments, such as the alternative utilisations of the land dedicated to energy crops in the light of 'food security' issues; their sustainability outcomes in terms of 'triple bottom line

assessment'; and the 'global resource enclosure' that they imposed in developing countries. The so-called "food versus fuel" dispute is the departing point for criticism to FDI in biofuels (Zhang et al. 2010; Lam et al. 2009; Abbott, Hurt & Tyner 2009).

2.1.1 Fossil fuel crises

Fossil fuels such as coal and petroleum are the key mediums and benchmarks of modernity. They enabled humankind to free itself from the rhythm of seasons, day and night, and naturally occurring phenomena such as the wind and currents that influence sailing technologies. In the past 100 years, the social mastery of energy supported exponential population and economic growth (Giampietro & Mayumi 2009). Measures such as rural electrification in developing countries symbolised the spread of the promethean fire, a means of dragging the population out of the darkness of backward traditions, and a powerful national vision (Bridge 2011).

Fossil fuel and energy crises hit the modernisation discourse at its core (Bridge 2011). In the popular imaginary, petroleum shortages prophesy the end of such spectacular human advancement because they represent the wind blowing out the candle of development. The first international energy crises date back to 1973 and 1979. They were linked to the petroleum supply crunches created by geopolitical configurations within Middle Eastern producing states. Soon after the oil shocks of the 1970s, there was a discussion among the Group of 7 countries on the need to finance research on alternative energy sources in developing countries (Henning 2009). It is within this context of energy security that biofuels first gained prominence in international discussions. Brazil became an international leader in the production of bioethanol from sugarcane due to a government-led renewable energy programme (Wilkinson and Herrera 2010). By the mid-1980s, the Brazilian industry produced about 12 billion litres of ethanol supplying about 25% of the liquid fuel needs of the country. Biofuels became a potential solution to petroleum shortages.

In the 1990s, a new kind of fossil fuel crisis captured the people's and policy-makers' imagination. In a Malthusian fashion, the extraction rate of petroleum was portrayed as being near

its maximum, thus marking the outset of an enduring shortage relative to global demand and the end of cheap energy supply (Bridge 2011). This time the crisis was different from a supply crunch: it symbolised the irreversible end of the petroleum era. Rising petrol prices in the 2000s added to this doomsday discourse (Bridge 2011). Biofuels made their comeback as one among the international solutions to the problem, which also included greater energy efficiency in productive and transportation activities, and a larger exploitation of natural gas reserves.

2.1.2 Climate change mitigation

In 1987, the World Commission on Environment and Development (the Brundtland Commission or WCED) proposed long-term strategies to achieve sustainable development. Fossil fuel crises and climate change are especially relevant among the sustainability issues touched upon by the Brundtland report. The Commission recognised the international need to alleviate the risks of exhausting petroleum reserves and, besides actions to improve energy efficiency, it suggested reclaiming degraded land utilising energy crops. According to the report, “‘a petroleum plantation’ need never run dry” (WCED 1987, Chapter 6, para. 35).

The high-energy future of humankind was threatened by the progressive exhaustion of fossil fuels. But their combustion by global economic activities, for the first time in human history, seemed to have overtaken the ability of the earth’s carbon sinks (e.g. forests, oceans) to sequester CO₂ from the atmosphere. The Commission recognised the “serious probability of climate change” linked to CO₂ emissions from the consumption of fossil fuels (WCED 1987, Chapter 7, para. 11). It recommended countries to take international action to prevent a radical climatic shift because it would be catastrophic for social welfare, economies and ecosystems worldwide.

Based on the recommendations of the Brundtland report (see WCED 1987, Chapter 7, para. 24), the Intergovernmental Panel on Climate Change (IPCC) was created in 1988 by the parties to the United Nations Environment Programme and the World Meteorological Organisation to provide compelling research on the current and future impacts of climate change (IPCC 2015). Informed by

the evidence presented by the IPCC in 1992, one hundred and ninety-four governments worldwide participated in the creation of the milestone United Nations Framework Convention on Climate Change (UNFCCC) (UNFCCC 1992). The Convention committed parties to reduce so-called greenhouse gas (GHG) emissions to mitigate and prevent the consequences of irreversible climate change. Most parties to the UNFCCC decided that they required binding emission reduction targets and more stringent guidelines to achieve those objectives.

The 1997 Kyoto Protocol bound its 192 signatories to reduce GHG emissions to 5% against 1990 levels and foster sustainable development outcomes in poor countries (UNFCCC 1998). The Protocol imposed more stringent targets for emission reductions on the members of the Organisation for Economic Cooperation and Development than developing countries because they had historically contributed more to global GHG emissions (UNFCCC 2015b). Its first commitment period, lasting from 2005 until 2012, aimed to transition participating countries to a low carbon, environmentally benign and efficient economy. In 2012 the Doha amendment to the Kyoto Protocol aimed to create a new commitment period (2012-2020) pending the ratification by at least 144 parties. Since only 36 countries have ratified the amendment, it has not yet entered into force.

The Protocol established an intergovernmental Emission Trading Scheme (ETS) as a market-based approach to accomplish climate change mitigation objectives (UNFCCC 2015a). The Scheme can be understood as a sanction and incentive mechanism. If countries that ratified the Kyoto Protocol were not able to achieve their emission reduction targets within their respective mandates, they would incur indirect, non-economic sanctions. Those countries able to exceed their emission reduction targets would receive carbon credits representing savings of one tonne of CO₂-equivalent each. Carbon credits are the incentive of the ETS because they can be profitably traded to countries struggling to meet their GHG abatement goals.

The Clean Development Mechanism (CDM) of the Kyoto Protocol represents an additional, market-based incentive mechanism linked to the ETS (UNFCCC 2015b). The mechanism allows

developed nations to establish projects that maximise GHG emission reductions in cost-effective locations, especially within developing countries. Certified Emission Reductions (CERs) are a type of carbon credit assigned by host country authorities to foreign private, public or non-government organisations that implement CDM projects. Authorities follow a series of GHG accounting methodologies to provide implementing organisations with CERs that can then be traded at a profit (Bakker 2006). The CDM viewed the private sector and public-private partnerships as potential vehicles for investment and implementation of profitable emission reduction projects (Food and Agriculture Organisation [FAO] 2008).

The private sector and NGOs developed a market parallel to the intergovernmental Emission Trading Scheme (ETS) that enables firms and individuals to voluntarily compensate for their GHG emissions. This market is based on the national and international exchange of Voluntary Emission Reductions (VERs) through principles similar to the Kyoto Protocol. The VERs are traded at lower prices and volumes than CERs because they cannot be utilised in the ETS (Bayon, Hawn & Hamilton 2007). VERs and CERs are both referred to as 'carbon offsets' and they are traded in what constitutes an overreaching 'carbon economy' that includes biofuel investments (Bumpus & Liverman 2011).

CERs can continue to be traded within the international ETS to comply with greenhouse gas reduction targets until the end of the so-called 'true-up' period of the first commitment of the Kyoto Protocol. During this period, expert review teams provide a comprehensive technical assessment of the implementation of the Protocol by the ratifying parties. The true-up period was set to end 100 days after the completion of the expert review process, which took place on 10 August 2015 (UNFCCC 2015c). VERs are not subject to this restriction.

Developed countries such as the United States and the member states of the European Union (EU) considered renewable fuels to be an easy-to-implement strategy to abate emissions that should be pursued with enthusiasm. Biofuels could be blended with fossil fuels, the burning of which is a major contributor to GHG emissions, without altering the existing distribution networks and

consumption practices (Ponte 2014a). A total of sixty-four countries worldwide established ambitious mandatory consumption targets for these renewable fuels in their transport sector. Mandates were a large incentive for biofuel production because they represented a form of subsidy that allowed them to compete with fossil fuels (Steenblik 2007). Through its mandates, the European Union created the largest biofuel market and it dominated international demand for these alternative fuels (Pradhan & Mbohwa 2014; Borrás, Fig & Suárez 2011; Borrás & Franco 2011).

In 2003, the European Parliament and Council (EPC) mandated member states blend at least 5.75% of biodiesel and bioethanol in their transport sector by 2010 (EPC 2003). Companies began building biofuel refineries in the EU to capture a stake in the coming biofuel ‘boom’ (D’Orazio & Pontoni 2010). The mandate was later increased to a share of 10% by 2020 (EPC 2009). Employing 2006 data for EU energy consumption by fuel type, this figure compares to increasing the use of biofuels from 5 to 37 million tons of oil equivalent (Eurostat 2009), which is on par with the petroleum consumption of Malaysia in 2013 (Central Intelligence Agency [CIA] 2015). The EU consumption targets had to be met through large imports of raw materials from developing countries, contribute to global GHG emission reductions and, critically, diversify energy sources to hedge against potential shocks in fossil fuel prices (EPC 2009).

Following disasters such as the EU heatwave in 2003, biofuels were again promoted as a source of clean, renewable energy and technological solution for mitigating the risks of climate change. International governmental treaties such the Kyoto Protocol and biofuel mandates ensured that money and clean fuels could, indeed, grow on trees. Investments in renewable fuels could supply the global energy industry from the global South and mitigate climate change.

2.1.3 Sustainable agro-industrial development and FDI

The Brundtland Commission report recognised that the prevailing low petroleum prices in the mid-1980s undermined the competitiveness of the Brazilian biofuel industry. But it observed that the government’s initiative saved the nation foreign exchange and it provided “the additional benefits of

rural development, employment generation, increased self-reliance, and reduced vulnerability to crises in the world oil markets” (WCED 1987, Chapter 7, para. 79).

The policy developments of the UNFCCC increased the international diffusion and economic appeal of the technologies within the emerging renewable energy industry. Sustainable development outcomes and assistance to North-South investments in biofuels in poor countries ensued from the general provisions of the UNFCCC, the Emission Trading Scheme (ETS) of the Kyoto Protocol and the linked Clean Development Mechanism (CDM). The UNFCCC requires the global North to provide financial resources in addition to their official development assistance to aid economies in transition and developing countries in their quest to reduce emissions and adapt to the impacts of climate change. This provision aims to promote the development, transfer and implementation of ‘green’ technologies such as biofuels. The 49 states classified by the United Nations (2014) as Least Developed Countries (LDCs) are given additional consideration because of their limited capacity to respond and adapt to climate change. The ETS and CDM were viewed as providers of ulterior benefits for developing countries. Investments within the carbon economy could promote sustainable development outcomes ranging from employment to climate change mitigation (Sutter & Parreño 2007; Lecocq & Ambrosi 2007).

Biofuel technologies and crop cultivation became promising solutions to promote energy security, reduce GHG emissions from the transport sector, and contribute to rural development in poor countries (UNFCCC 2007). According to the United Nations Conference on Trade and Development, biofuels could provide additional benefits to developing countries, including the modernisation of their agricultural sector; economic growth; the stimulation of exports; the reclamation of degraded land; and the production and consumption of energy in rural areas (e.g. electrification) (Assunção 2005). The International Federation of Agricultural Producers viewed biofuels as the “best option currently available to bring down emissions from the transport sector” and “a good opportunity to boost rural economies and reduce poverty” (FAO 2008, p. 97).

At the onset of the carbon economy in 2005, biofuels gained prominence as one of the most favoured international climate change mitigation and poverty alleviation strategies due to peak oil narratives and climate change concerns worldwide. Many of these expectations were driven by global discussions identifying various ‘miracle’ crops that would solve multiple development and environmental protection problems in poor countries and contribute to their national economies (for example, McMichael 2014; Von Maltitz, Gasparatos & Fabricius 2014; Kant & Wu 2011; Low & Booth 2007; Rakotondralambo & Rabemananjara 2000). The crops considered for alternative fuel production were widely cultivated in developing countries and could be processed as either bio-ethanol (80-90% of global biofuel production) or bio-diesel (IEA 2011).

Prevailing high and volatile food prices in the second half of the 2000s determined a context of increasing uncertainty with far-reaching effects for the nascent biofuel industry (Ponte 2014a; Bridge 2011; Rapsomanikis 2009, pp. 14-28). Biofuel processors in countries such as EU member states complained about the scarcity of raw materials and the unreliability of international supply contracts (D’Orazio & Pontoni 2010). The global area under crop cultivation had to be expanded (IPCC 2007), but most developing countries could not afford to invest in the establishment of a dedicated biofuel industry (Gerlach & Liu 2010). Companies from the global North and emerging economies became interested in acquiring the control of land in developing countries to cultivate energy crops and secure their supply (Deininger et al. 2010; Berti 2010). In order to achieve this purpose, coherent with the requirements of the UNFCCC, EU firms received technical assistance, facilitated access to land, and preliminary supply contracts with refineries (Ponte 2014a).

Biofuel companies performing FDI aimed to profit from feedstock exports and, in case of host country utilisations, Certified Emission Reductions. The Clean Development Mechanism executive board decided that fuel exports to developed countries should be excluded from receiving carbon credits to avoid double counting of emission reductions (UNFCCC 2006). In addition to local sales of biofuels, carbon sequestration through the use of by-products in host country could also be

awarded CERs (Sayer et al. 2012; Verchot et al. 2010). This had to comply with the carbon balance of emissions deriving from land-use changes, the use of fertilisers and pesticides, and fuel to power, for example, agricultural machinery (CDM Methodology Panel 2009). Voluntary Emission Reductions were sought mainly by companies investing in Sub-Saharan Africa (GEXSI 2008).

Governments and institutions such as the World Bank viewed FDI in biofuels in a positive light. Similarly to the early promoters of these 'green' technologies in 2005, they proposed that foreign investment could stimulate rural welfare, employment, and economic growth through the modernisation of the agricultural sector of poor countries (Deininger et al. 2010). Proponents suggested that investments contributed to a diversification of fuel sources, international trade and the energy security of firms' home and host countries (World Bank [WB] 2008).

2.1.4 Food security

The Brundtland Commission report remarked that biofuels competed with "food crops for good agricultural land" (WCED 1987, chapter 7, para. 83). In the 2000s, the appeal of cultivating biofuels was increased by climate change mitigation and energy security policies. Soaring petroleum prices contribute to determine such context, but they contemporarily increased the cost of food production. As international prices for primary food commodities rose rapidly in the mid-2000s, biofuels were blamed for diverting edible crops to the production of fuel for developed countries' markets (Pramanik & Chattopadhyay 2015; Birur, Hertel, & 2009; Dauvergne & Neville 2009).

Panic ensued from the idea that the era of cheap food was coming to an end. The benign, sustainable picture portrayed by supporters of FDI in biofuels drastically changed after the food riots in 2007-2008, which took place in over 60 countries (e.g., Bolivia, Mozambique, Yemen) (McMichael 2009; Rosegrant 2008; Mitchell 2008). Civil society groups started pointing to biofuel production as the main culprit for the increase in food prices, with estimates of the actual impact reaching up to 75% (Smith 2010). Researchers emphasised that some investments took place on fertile land located in excellent position vis-à-vis physical infrastructure and water availability. In countries that had a

high incidence of hunger, especially in a context of soaring food prices, it appeared unethical to divert water, labour and arable land away from the domestic production of food crops to the export of biofuel raw materials (Anseeuw et al. 2012; Hall 2011; Borras, Fig & Suárez 2011).

2.1.5 Triple bottom line assessment

Beyond the food versus fuel debate, a substantial number of case studies highlight that FDI in biofuels provided limited economic benefits and undesirable environmental impacts for developing countries. These studies showed that there were procedural inconsistencies in the implementation of socio-environmental policies regulating investments. There was red tape and overlapping between the institutional responsibilities of the national government agencies regulating biofuel industries (Matondi, Havnevik & Beyene 2011; Vermeulen & Cotula 2010). The ability of host countries to retain the income generated by the biofuel industry was reduced by the profit repatriation policies underlying export-oriented FDI.

Especially in Sub-Saharan Africa, governments and their agencies took the lead in welcoming foreign companies and facilitating land access (Cotula et al. 2011; Schut, Slingerland & Locke 2010; Ramiamanana 2010). But they appeared to have weak regulatory frameworks and a limited institutional capacity to ensure sustainable development outcomes from biofuel industries (Von Maltitz, Gasparatos & Fabricius 2014; Anseeuw et al. 2012; Cartwright 2010). This may have been partly because most bilateral and multilateral development programmes in host-countries were created at the inception of the carbon economy. They were not designed to contribute specific know-how and institutional capacity on the management of this new industry (Jumbe, Msiska & Madjera 2009).

The profitability of biofuel projects per se was constrained by the long gestation period required to establish large-scale plantations and fluctuations in petroleum and food prices (Van Eijck et al. 2014; Cotula 2012; Dufey & Grieg-Gran 2010; Amigun, Muller-Langer, & von Blottnitz 2008). Firms invested in countries that purported to have suitable un-forested and un-cultivated land

(Deininger 2011), but the development of land markets in those nations was plagued by weaknesses in rural land tenure recognition (Anseeuw et al. 2012). Access to land and labour by foreign companies proved problematic and conflict-ridden (Borras & Franco 2010; Sulle & Nelson 2009; Cotula, Dyer & Vermeulen 2008). This increased investment costs, created lags in production, and undermined the economic sustainability of investments (Burger & Peters 2010; Schut, Slingerland & Locke 2010).

Investments also resulted in limited development outcomes because they aimed to take advantage of low labour costs and small agricultural productivity gaps in host countries (see Deininger 2011). For this reason, some observers referred to them as “speculative” financial ventures (Cadmus Group 2014, p. 44; Neimark 2013; McMichael 2012, p. 682). Foreign plantations created fewer jobs than expected by policy makers, and workers’ pay was kept at minimal agricultural wage levels (Richardson 2010; Von Brown & Meinzen-Dick 2009; Buenner 2009; Peters 2009; Osen & Fenhann 2008). Local rural economies were often adversely impacted by competition for employment across agrarian sectors (Chu 2011; Lavers 2012; Behrman, Meinzen-Dick & Quisumbing 2012). This increased income inequality at the local, regional and national levels and interfered with the livelihood of some of the world’s poorest farmers, who became more vulnerable to economic and environmental shocks (Anseeuw et al. 2012; Hall 2011; Giampietro & Mayumi 2009).

The impacts of biofuel investments on GHG reductions, which framed their objective within the carbon economy, began to be questioned (Slingerland & Schut 2014; Boche & Anseeuw 2013; Pimentel et al. 2010). A number of studies pointed out that FDI projects were not carbon neutral or helpful in reducing GHG emissions (IPCC 2012). This was evident when investments made extensive use of mechanisation and agricultural input, or converted natural land covers such as forests, grassland and peat land into plantations (Bailis & McCarthy 2011; Finco & Doppler 2010; Wahl et al.

2009). Such industrial agriculture approach compromised the environmental sustainability of investments and negatively impacted local livelihoods (Richards 2013; Hall 2011; Gibbs et al. 2008).

2.1.6 Global resource enclosure

The unfolding evidence on the impacts of FDI in biofuels induced organisations such as the International Land Coalition (2012), La via Campesina (2011), and Friends of the Earth (2010) to question the development potential of these green investments. Disputing the conception of a ‘win-win’ scenario for biofuels, they contended that these ventures represented a “land grab” (Boche & Anseeuw 2013; Cotula et al. 2009), a new form of colonialism in which industrialised countries dispossess the rural poor of their livelihood assets to acquire “offshore” energy facilities in the global South (McMichael 2012, p. 688; Zoomers 2011, p. 343). Invoking the concept of financial “accumulation by dispossession” (Harvey 2003, pp.139-144), the practice was then compared to a novel form of “carbon colonialism” driven by peak oil narratives and the creation of the carbon economy (Bumpus & Liverman 2011, p. 212).

Within this discourse, investments reap profits from two market-oriented solutions to sustainable development involving the commodification of nature. First, under the influence of climate change mitigation initiatives, GHG emissions became a commodity to be traded nationally and internationally to mitigate climate change. Carbon offsets represented an information-based commodification of the atmosphere (Smith 2007). Second, as part of the promotion of many development and pro-FDI policies in developing countries, development organisations and agencies such as the World Bank have been funding and implementing land policy reforms to create liberalised land markets (Zoomers 2011; Deininger 2003).

In the 2000s, land in developing countries became a commodity that was priced, brokered and exchanged nationally and internationally with an unprecedented ease and pace. Local communities were often marginalised in the process of land allocation and other decision-making processes such as consultations about the rural welfare prospects of biofuel investments (Neville &

Dauvergne 2012; Hall 2011; Matondi, Havnevik & Beyene 2011; Burley & Bebb 2010; Vermeulen & Cotula, 2010). The creation of local infrastructure such as roads, schools, clinics and wells were positive aspects of FDI projects' implementation. However, they were an inadequate compensation for the resettlement costs and the loss of agricultural land incurred by locals (Schoneveld, German & Nutakor 2011; Nhantumbo & Salomão 2010; Hall 2010; Ribeiro & Matavel 2009; Cotula et al. 2009; Aarts 2009; Mota 2009).

The 'land grab' literature highlights that the natural and human resources of developing countries – land, forests, water, labour – were appropriated by companies. Biofuel investments led to local conflicts because they diverted those resources away from the production of other commodities, especially food crops (Neimark 2013; Anseeuw et al. 2012; Hall 2011). The initial conception of FDI in biofuel as a land grab left space for 'water grabs', as corporate access to water was often granted without restriction by local governments. Companies reduced the availability of this key resource for farmers and sometimes excluded them from accessing it (Mehta, Veldwisch & Franco 2012; Woodhouse 2012; Hertzog et al. 2012; Borras, Fig & Suárez 2011).

Local rural economies were often adversely impacted by the loss of agricultural land, competition for employment across agrarian sectors and environmental degradation (Iiyama et al. 2013; Lavers 2012; Behrman, Meinzen-Dick & Quisumbing 2012; Chu 2011). Some researchers considered that the production of biofuels was an unviable alternative to fossil fuels and an ineffective solution to energy security, rural development and climate change mitigation altogether. The cultivation of biofuel crops, their processing and international exchange all require large input of land, fertiliser and fossil fuel, the costs of which are considered greater than their energy output, social and environmental benefits (Giampietro & Mayumi 2009; Russi 2008; Pimentel & Patzek 2005). Cheap land, labour and water resources were sought by investors to get production underway. Since FDI also aimed to profit from biofuel mandates and GHG emission reductions,

investments in the cultivation of energy crops can be described as a government-supported initiative to attain a 'global resource enclosure'.

Supporters of FDI in biofuels held that investments contributed to sustainable development by alleviating the risks of fossil fuel crises, mitigating climate change and inducing agro-industrial modernisation. Critics of this discourse pointed out its fallacies and contradictions through the dimensions of food security, sustainable asset governance, and global resource enclosure. They directed policy-makers' attention to the necessity of regulating FDI in biofuels in order to ensure its sustainability. The resulting debates led to the creation of dedicated international biofuel governance structures (Egbendewe-Mondzozo 2014; Sorda, Banse & Kemfert 2010). These structures include, for example, voluntary industry guidelines such as the Responsible Agricultural Investment principles proposed by the World Bank and the Food and Agriculture Organisation; certification schemes such as the Roundtable on Sustainable Biofuels (RSB) funded by the World Wildlife Fund in 2006; and policies that require investments to meet sustainability criteria such as those introduced by the European Union in 2009 (Hunsberger & Ponte 2014; Ponte 2014b; RSB 2012; De Schutter 2011; Li 2011).

2.2 Research objectives and analytical framework

Researchers, governance institutions and policy-makers have spent considerable effort studying the technicalities of biofuel production and its impacts on land-use, food security and rural livelihoods. However, despite comprehensive schemes such as the RSB that attempt to account for a wide range of social, economic and environmental factors in the certification of sustainable biomaterials (Hunsberger & Ponte 2014; Ponte 2014b) the literature on FDI in biofuels has largely overlooked the analysis of "existing investments" (Ponte 2014a, p. 355).

The development of biofuel industries has been studied at national and international levels rather than focussing on the regions where energy crops are cultivated (for example, Levidow & Paul

2010; McMichael 2010; Smith 2010; Vermeulen & Cotula 2010; Dauvergne & Neville 2009; Mol 2007). Studies largely have focussed on the grassroots level to evaluate investment impacts on local communities and the environment. As the first step, researchers have used these results to provide commentaries on the development outcomes of FDI in biofuels at the national level of developing countries. Following on, as a second step, geographic regions have been discussed by merging insights from national-level case studies grounded within geographical areas such as Sub-Saharan Africa, South America and South East Asia (for example, Johnson & Matsika 2006). When researchers have referred to regions, or to other sub-national political scales, a limited number of companies within each area have been taken into account to generalise results at the national level (for example, Nhantumbo & Salomão 2010).

The structure of investments, their participation to regional industries, their activities on the ground, and their development outcomes have not been examined in an integrated manner. The literature has generally compartmentalised the institutional influences shaping foreign companies' operations through descriptions about their contributions to development policies or individual corporate projects. National, regional and local government institutions are presented in these analyses largely in terms of their pro-biofuel disposition, pro-FDI policies, and their role as central agents facilitating land access (for example, Habib-Mintz 2014, 2013, 2010; Fatimah 2011; Ariza-Montobbio et al. 2010). However, the roles of these government institutions has not been sufficiently analysed to see how policies that incentivise FDI are linked to other policy areas such as biofuel frameworks, bilateral trade agreements, land reforms, tax exemptions and rural development incentives (Baka 2012).

While some research has focussed on the role of state agencies as policy orchestrators, it does not examine their direct contribution to biofuel industries and the external influences exerted on them (for example, Hunsberger et al. 2014; Schut, Slingerland & Locke 2010; Chachage 2003). The practicalities of firms' engagements with government institutions and policies also remains largely

unexplored. With few exceptions (for example, Hunsberger 2014, 2010; Habib-Mintz 2013; Caniëls & Romijn 2011; Messemaker 2008), most researchers have tended to overlook the role played by NGOs, bilateral and multilateral development agencies, and research and industry organisations that formed a kind of ‘coalition’ to facilitate investments and to support them across regional, national and international levels.

Research on FDI in biofuels can benefit from comprehensive insights into the background of investments; the network of organisations that support them; their productive activities; their participation to the sustainable development strategies of regions; and their economic, social and environmental outcomes. Some observers called the global biofuel industry a “complex” underlain by human-environmental relations (Borras, McMichael & Scoones 2010, p. 576; McMichael 2010, p. 626). A ‘biofuel industrial complex’ comprises assemblages or integrated networks of governmental and non-governmental organisations that – from different countries, regions and cities – regulate production and exchange within a global biofuel value chain (e.g., sugarcane) (Altenburg 2011; Levidow & Paul 2010; Smith 2010; Mol 2007). This notion is a useful entry point to examine the dynamic creation of biofuel industries by multiple policies, regulations, incentives, and agents such as financiers, government agencies, development organisations, NGOs, farmers and, critically, companies.

This thesis provides insight for all six themes highlighted by the literature on biofuels because it investigates the fluid relationships between participants in regional biofuel industrial complexes that operate across different levels. It examines the policy effort to attract and support investments; the business case of the companies undertaking them, including their financial sources, investment motives, expectations from cultivating energy crops and operations on the ground; and the regional development outcomes that they accomplished vis-à-vis facilitating institutions, rural economies and communities, and the environment. This analytical project engages with broadly defined political economy to explore three research objectives.

The first objective of this study to investigate industry creation is developed in chapters four to six through examination of the effort by a variety of geographically-dispersed organisations to establish 'green', export-oriented industries in developing countries. This involves an exploration of the history that led to the creation of biofuel industries, the political economic processes that established them and the delineation of their participants. The second objective to understand the modality of production on the ground focuses on the corporate operations and facilitating organisations forming biofuel industrial complexes at the sub-national, regional level. Accordingly, chapter seven juxtaposes the background, investment motives, production model and expectations of companies with the support that they received, their local activities, and their interaction with the regional economy and the environment. The final research objective is to evaluate the outcomes of FDI in biofuels as a strategy for sustainable regional development in poor countries. Chapter eight presents the constraints faced by firms and the influence of their productive activities on government revenues, regional economic activities, rural welfare and the environment.

In the following section I present the analytical approach that I use to address these objectives. I use the framework of political ecology and combine it with the economic geography approach to global value chain analysis. The latter is developed at the intersection of the Global Value Chains (GVC) and Global Production Networks (GPN) literature.

2.2.1 Political ecology

Political ecology serves as a useful analytical framework for examining the effects and regional outcomes of biofuel projects. Within the context of the carbon economy, it emphasises an understanding how local human and ecological agency react to "institutional rules and structures"; it engages the material nature of "on-the-ground" investments; and it integrates "multi-level and networked environment-development interests as its core" (Bumpus & Liverman 2011, p. 211). "Political ecology is an analytical approach that explains the biogeographical outcomes of social relations in the context of particular spatial and political configurations" (Rangan 2000, p. 63). It

focuses on the dynamics through which ecological and social change occurs across and within spatial, policy and economic networks.

Political ecology can provide insights for all six themes characterising the literature on FDI in biofuels. The approach provides an alternative interpretation to “apolitical ecologies” such as modernisation discourses underpinned by a “win-win rhetoric” (Robbins 2004, p.10). This is the case for the themes of energy security, climate change mitigation and sustainable agro-industrial development outcomes of biofuel investments. Political ecologists focus on the reality of social practices on the ground and contrast it with dominant discourses and approaches to sustainability promoted by corporations, governments and international institutions. They evaluate the differential power dynamics, conflict, and the distribution of losers, winners, costs and benefits arising from environmental change (Robbins 2004). Such analytical focus provides insight into the biofuel themes of food security, triple bottom line and global resource enclosure.

The political ecology analysis “combines the concerns of ecology and broadly defined political economy” and “the constantly shifting dialectic between society and land-based resources” within rural contexts in the global South (Blaikie and Brookfield 1987, p. 17). Researchers focus on how social discourse, economic growth and production, and contestation shape the trajectory of human-environmental change (Rangan 2000, pp. 64-65).

Within the framework of political ecology, discourse analysis is employed to untangle issues of knowledge, values and power that arise from the materiality of social-environmental interactions. This rests on the proposition that discourse and reality both influence and construct one another. The ability to control knowledge – whether scientific or discursive – is a key source of power to shape the activities of people and organisations according to one’s agenda (Hay & Rosamond 2002; Adger et al. 2001; Stott & Sullivan 2000). Social practices and science transform discursive claims into truths and suppress alternative forms of value such as the ones expressed by local communities (Martinez-Alier 2009). Political ecologists contrast the truth claims made by scientific experts and

policy-makers with the reality on the ground (Martin 2001). They question such dominant discourses as the existence of unused wasteland to assess alternative realities (Robbins 2004).

This is evident in what can be called a “degradation and marginalisation” research theme in political ecology (Robbins 2004, pp. 129-132). Researchers evaluate how impoverished communities who live at the economic and environmental fringe of societies may extract their livelihood from marginally productive lands (Blaikie & Brookfield 1987). Some studies on FDI in biofuels point out that a multiplicity of actors, including the state and foreign companies, exploited the concept of unused, unoccupied wasteland to support the establishment of energy crop plantations as an ideal solution for sustainability problems of climate change and development (for example, Baka 2014; Ariza-Montobbio & Lele 2010). Consistent with the argument of political ecology, this interfered with the local agrarian economy, the equity of resource access and distribution, and the environment.

Political ecology evaluates how economic activities shape human-environmental change. It explores how economic growth and production occur through processes of resource extraction, processing and consumption within different political and spatial configurations. Legal, extra-legal and customary social practices represent mechanisms of institutional control over human and natural resources. They shape how labour and technology are employed in economic activities (Rangan 2000). Researchers can contextualise productive activities in one or more segments of a relational network comprising agents such as financial institutions, international development agencies, the state, regional government departments, NGOs, companies, producers’ communities and the ecology of the landscape (Robbins 2004). The framework allows them to address the relationship between knowledge, power, and control of resources as a crucial element in the explanation of environmental problems and the solutions being proposed (Rocheleau 2008).

For example, within a second “conservation and control” research theme of political ecology (Robbins 2004, pp. 147-142), global and national sustainable development efforts are shown to wrest away local communities’ control over resources. Case studies in the literature on FDI in

biofuels illustrate that the effort to reclaim wasteland through energy crops interfered with the local allocation of land, water and labour resources for food production (for example, Borras, Fig & Suárez 2011). Discourse analysis is relevant to this theme. Political ecologists evaluate whether local production practices that may have been historically benign are characterised as unsustainable or backward in the struggle of various stakeholders to justify policy and institutional control over resources. The outcomes of this process could be the loss of sustainable local production systems, the marginalisation of local producers and some degree of landscape degradation. The literature on biofuels indicates similar results while assessing the impacts of land allocation to foreign companies in developing countries.

The final process that shapes social-environmental change in the lens of political ecology analysis is contestation (Rangan 2000). Contestation is the reaction (feedback) of the landscape ecology or local communities to the regional human-environmental change produced by economic activities and policies. Researchers evaluate how regional and local production choices are constrained within international political economic forces (Blaikie & Brookfield 1987). In the case of biofuels, these could be linked to prevailing discourses such as energy security that favour FDI and factors like increasing food prices that inhibit it. Against that backdrop, political ecologists examine how dominant social relations and institutional control are contested “within classes and groups within society itself” due to the change they produce (Blaikie & Brookfield 1987, p. 17). “[T]he outcomes of such contestation reshape biogeography, social discourse, economic activity, and institutional practices, as well as the networks and boundaries of spatial and political configurations” (Rangan 2000, p. 65).

Elaborating on the “environmental conflict” aspect of human-environmental change (Robbins 2004, pp. 172-175), political ecologists contend that the enclosure of marginal land through the combination of political action and the interests of foreign companies may create scarcities and conflicts between social groups (gender, class, ethnicities) occupying the landscape. Conflicts within

and between communities are underpinned by environmental struggles linked to changes in such areas as economic development or environmental conservation policies. This argument is reflected in the local conflicts experienced by foreign companies while accessing land and in the broader international disputes about the sustainable development potential of biofuel investments.

Political ecology examines the process through which state authorities support certain forms of value extraction from natural resources (e.g., large plantations versus contract farming, strip mining versus clear-cutting) under the pressures exerted by external and domestic agents (Robbins 2004). Due to its roots in agrarian and peasant studies, it shows the consequences of institutional arrangements on farmers' livelihood and adaptation to the landscape (see, among others, Ekers 2015, pp. 547-549; Akram-Lodhi & Kay 2010a, 2010b; Araghi 2009; Isakson 2009; Bernstein 2006, 2004; McMichael 2006; Peet & Watts 2004; Robbins 2004, pp. 52-55; Brass 2000). In the political ecology approach, such explanations of social-environmental change are contextualised through historical analysis and critical realism.

Historical analysis is employed in conjunction with broadly defined political economy to explore who profits from changes in the control of resources and labour, and who obtains what from whom (Robbins 2004, pp. 45-51). The approach highlights that social and cultural relationships characterising the context of production are rooted in deeper economic interactions between people, resources and systems linked across scale levels. New ways of organising economic development and conservation are rooted in previous attempts of states and elites to achieve their political and economic objectives. Production for foreign markets is seen as one path-dependent driver of social and environmental change in developing countries. Depending on the context, the imposition of mechanisms of value creation, enhancement and capture that are external to particular locations – such as the creation of large biofuel plantations on 'unused' or 'marginal' state land – may result in either social and environmental stress or profitable arrangements for local populations (Moreno-Peñaranda & Kallis 2010; Grossman 1993).

The political ecology analysis of historical and contemporary events is based on critical realism, which is an approach to theory building and reconstruction that is widespread in human geography (Yeung 1997). Critical realism warns about the fallibility of knowledge and the contingency of truth claims (Peet & Watts 2004; Sayer 2004). By employing critical realism, political ecology promotes a stratified understanding of phenomena that encompasses social discourses, organisations and events that are linked all the way to their underlying triggers such as chemical reactions in the atmosphere. When political ecologists create representations about the world, they describe the context relevant to their explanation and ground research variables in empirical categories that clarify their causal properties and features. Quantitative and qualitative evidence equally contribute to processes of identifying the extent of phenomena (generalisation) and understanding what produces change (reduction) intrinsic to the creation and reconstruction of theory.

A key research challenge in political ecology centres on the selection of an appropriate analytic scale level (e.g., local, regional, national, international). Blaikie and Brookfield (1987) originally referred to the need for a regional approach to political ecology, but their approach largely focused on 'chains of explanation' linking different spatial levels, rather than the variables that differ according to the scale of explanation (see, among others, Rangan & Kull 2009; Robbins 2004; Turner 2003). The literature on biofuels operates a similar analytic reduction when linking different spatial levels from local to international. Focussing on the regional level of analysis highlights different variables and interconnections linked to locally specific political and ecological outcomes.

Regions are political territorial constructions and sub-national operational units of strategic economic organisation (Jonas 2012; Paasi 2004; Allen, Massey & Cochrane 1998). Institutional control mechanisms such as national economic policies are translated into regional development frameworks that influence and connect productive activities occurring in a variety of localities within defined political boundaries (regions). Within human geography, regions are also observational and

interpretive levels of scale. They relationally connect political and economic processes that, operating across different levels, form a configuration that influences local social-environmental changes. This study combines political-territorial and relational approaches to examine biofuel production at the regional level (Jonas 2012; Paasi 2004; Allen, Massey & Cochrane 1998).

This thesis considers that the cultivation of energy crops occurs across political, economic and ecological processes that unfold at particular sites or localities within regions. Such regional political and relational nexus permits an examination of policy frameworks, extended production networks, and organisations that operate across scale levels. Their action carves out new 'environments' for FDI and biofuel plants, industries, and thereby shape production strategies, industrial and commercial linkages, and regional development outcomes. Within the economic geography literature, the approach of value chain analysis provides valuable guidance about the variables involved in such explanation.

2.2.2 Global value chains

Global value chains analysis comprises various chain- and network-based approaches to study how industries function and production networks are articulated in the global real and financial economy (Bair 2005). It orients research towards empirically grounded variables that describe how policies, regulations, governments, non-governmental organisations, and companies form industries, determine production practices and deliver development outcomes. Studies include the productive and policy-related aspects of agricultural value chains linked to primary producers in developing countries (Daviron & Ponte 2005; Daviron & Gibbon 2002; Gibbon 2001; Vargas 2001; Dolan & Humphrey 2000; Hughes 2000). Some political ecologists have engaged with this analysis to gain insight into the consequences of the shifting economic geography of globalisation (Bridge 2008; Bridge 2008). Bumpus and Liverman (2011, p. 215) emphasise that value chains analysis offers an "interesting possibility" for political ecology studies that aim to understand the productive processes, and the winners and the losers linked to the creation of the carbon economy.

Broadly defined global value chains analysis features various frameworks, the most prominent of which are the Global Commodity Chains (GCCs), the Global Value Chains (GVCs) – which can be considered a follow up to the GCCs – and the Global Production Networks (GPNs). The GPN emerged as a critique to the GCC and GVC, but the advocates of these frameworks are part of the same research network (see Global Value Chains 2015). Organisational sociology, the international business literature and the new economic sociology are, respectively, the main distinctive foundations of these approaches to the analysis of production networks. These frameworks provide insights about the role of corporate networks and political processes in promoting development outcomes (Bair 2008). They employ similar methodologies and are seen both as convergent and complementary in their analysis of global production (Ponte 2014a; Barrientos, Gereffi & Rossi 2010; Bair 2008; Wilkinson 2006). Coe and Hess (2010) suggest that regional development is best understood through an analysis that works at the intersection of GPN and GVC.

The foundational work of Gereffi and Korzeniewicz (1994) on GCCs focussed on value-addition dynamics determining geographically fragmented production and distribution networks. The GCC and GVC frameworks portray production as an essentially linear, vertical process from raw materials to final products (Timmer et al. 2014; Henderson et al. 2002). Gereffi (1994, p.2) defines GCC/GVC as “sets of inter-organisational networks clustered around one commodity or product, linking households, enterprises and states to one another within the world-economy”. These production networks are situated in specific locations, shaped by the practices of the participants to each segment along the value chain, and underscore the social embeddedness of economic activities. Similarly, a GPN is defined as a complex organisational and geographical network that coordinates production, distribution and consumption activities dispersed worldwide across regions (Dicken 2011, p. 15; Henderson et al. 2002). The framework emphasises the social processes intrinsic to producing goods and services and reproducing value, knowledge and labour (Coe, Dicken & Hess 2008; Henderson et al. 2002).

According to Gereffi (1995) there are four dimensions that should be taken into account by GVC analyses: first, the chain of value-added processes, resources (e.g., labour, raw materials, intermediary products), services and products linked together across a variety of relevant industries; second, a geographically dispersed network of production and marketing activities, which is made up of companies of different types and sizes and which spans national, regional and global levels; third, a governance structure that links firms together through power relationships that determine the allocation of human, financial and material resources within a chain; and fourth, an institutional framework that represents how global, national, regional, and local policies and conditions shape each stage of the chain.

Research on the GVC has focussed on investigating the firm-to-firm governance mechanisms of industrial activities in order to understand the coordination of cross-border production (Bair 2008; Dicken et al. 2001). Gereffi (1999, 1994) highlights two main governance mechanisms of GCC, which he describes as buyer-driven and producer-driven chains coordinated by leading firms. Buyer-driven commodity chains prevail when retailers such as Nike or supermarkets play a pivotal role in establishing decentralized production networks. In producer-driven chains, large industrial enterprises control production and subcontracting from their administrative headquarters. Within the GVC framework, Gereffi, Humphrey and Sturgeon (2005) take into account more forms of inter-firm coordination than buyer- and producer-driven chains. They propose five types of governance that range from market (spot transactions) to hierarchy (vertically integrated firms). After the early critiques of buyer- and producer-driven commodity chain dichotomies (Raikes, Jensen & Ponte 2000), Ponte (2014a, pp. 364-369) argues that biofuels represent a case of “multipolar chain”. He suggests that biofuel value chains are regulated by complex governance mechanisms involving governments, industry organisations, NGOs, and stakeholders linked to a variety of industrial contexts (e.g. aviation, automotive industry) and located in various countries.

My research uses the GVC approach to link the governance of biofuel value chains to their regional development outcomes. Such analysis depends on the exploration of two critical dimensions set out in the work of Gereffi (1995) that scholars have generally overlooked. First, to a large extent, the existing research operates at high levels of spatial aggregation of industrial production networks (e.g. international, macro-regional, state) without exploring their sub-national foundations (Ponte 2014a; Bair 2008). Second, scholars have focussed on firm-to-firm governance mechanisms and largely disregarded the importance of different institutions and regulations, especially national and regional governments, in shaping international production networks and their outcomes (Henderson et al. 2002; Dicken et al. 2001).

Researchers such as Humphrey and Smith (2000), Bolwig et al. (2010) and Henderson et al. (2002) attempt to address these shortcomings in their formulation of global value chain analysis. By combining their insight with a political ecology approach, my research links the dimensions of value chain activities and governance with the analysis of social discourse, economic growth and production, and contestation processes.

Humphrey and Schmitz (2000, 2002) describe the influence of firm-to-firm governance mechanisms on broader institutional and economic frameworks supporting local industrial clusters in developing countries. In the context of this thesis, the facilitation of FDI to cultivate energy crops can be considered an attempt to create export-oriented, regional industrial clusters in the global South. Humphrey and Schmitz explain that companies (e.g., local business associations, leading firms), public institutions (e.g., government agencies, the World Trade Organisation or WTO, the EU) and public-private governance forms (e.g. local policy networks, international standards, and international NGOs guidelines) regulate the contribution of local industrial clusters to global value chains. The organisation of these agents, policies and frameworks within and across spatial and political configurations provide context for political ecology analyses of economic activities.

Successful regions are characterised by an alignment of institutions with firms and governance forms that are conducive to important industrial development outcomes called ‘upgrading’ (Humphrey & Schmitz 2000, 2002), which are overlooked by political ecologists. There are four types of economic upgrading: process, product, inter-chain and functional. Process upgrading is about increasing the efficiency of local production processes by re-organising activities or introducing new technologies. Product upgrading occurs when local industrial clusters along the value chain capture greater value by moving into more sophisticated product lines. Inter-chain upgrading takes place when firms apply competencies that they acquired from one industry within a different sector. Functional upgrading is the acquisition of new functions within a value chain segment such as product marketing and design.

The conceptual framework by Bolwig et al. (2010) considers upgrading processes alongside the impacts of productive activities on poverty and the environment as development outcomes. Compatible with political ecology analysis, their framework focuses on the local (sub-national) level. As Figure 2.1 shows, the “vertical” elements of value chain productive processes are integrated with the “horizontal” conditions that influence them (e.g., economic frameworks, international, national and local institutions, NGOs) (Bolwig et al. 2010, p. 177).

Vertical elements are the linkages between value chain points, which are nodes within production networks or broader segments comprising the primary sector, processing and export activities. These connections are mediated by economic relationships among firms and flows of finance, information and goods. The resulting vertical impacts depend on the influence of several factors on productive activities and their profitability (Bolwig et al. 2010): firm-to-firm governance mechanisms; product, social and environmental standards; and economic upgrading processes.

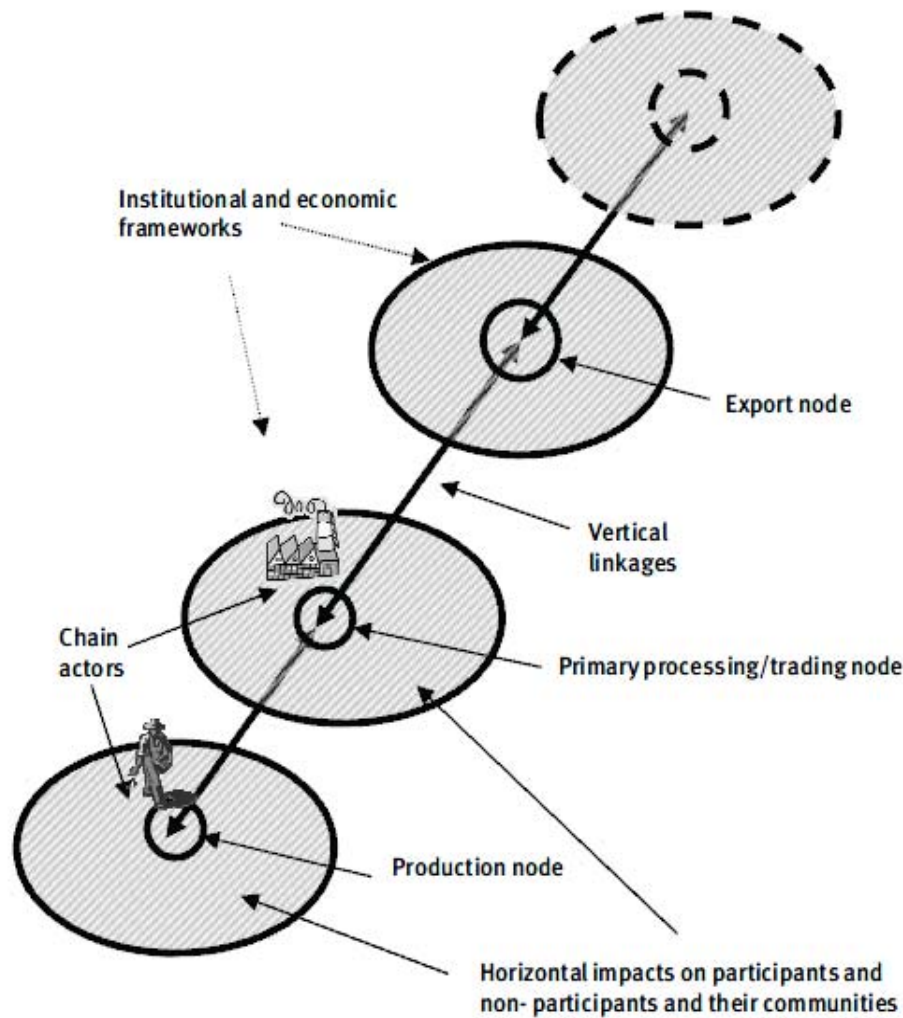


Figure 2.1: Stylised value-chain mapping highlighting horizontal and vertical linkages (Source: Bolwig et al. 2010, p. 187)

Horizontal conditions include institutional and economic frameworks operated by “individuals or organisations that do not directly handle the product but that provide services, expertise and exert influence, such as NGOs, financial institutions, advisers, standard-setting bodies and government agencies” (Bolwig et al. 2010, p. 185). The horizontal impacts of GVCs are linked to poverty alleviation and environmental outcomes. They can derive from the marginalisation of community groups from production or local inter-institutional decision-making processes (e.g., land allocation procedures to foreign companies). Households may participate in multiple value chains to diversify and stabilise their income, but they may experience competition for labour across these value chains and suffer losses of income, well-being, or access to key productive assets (e.g.,

marginal land). More generally, local communities' livelihoods may become more vulnerable to economic and environmental shocks due to their participation in a particular value chain.

Environmental outcomes are linked to the interaction of primary production with the resource base (soil, water and biodiversity), land-use changes, and the pollution arising from chemical fertilisers, toxic substances and GHG emissions from transport and productive activities (Bolwig et al. 2010).

The GVC horizontal conditions linked to the social and environmental outcomes of productive activities can be integrated with political ecology assertions on property rights, access to resources, and dynamics of inclusion and exclusion (marginalisation) of local community groups (see, among the many, Neimark 2012; Bair & Werner 2011; Ribot & Peluso 2003; Guthman 2002). The approach is well-suited to complement GVC analyses of power and profit distribution with questions of access to resources (e.g., land and intellectual property rights), policy, and consumption of green, sustainable products in the Global North (Guthman 2009; Friedberg 2004; Ribot 1998). The resulting analysis is defined as "'disarticulations' perspective" by GVC scholars (Bair & Werner 2011, p. 1000). It accommodates for the tensions, expressed by processes of contestation within political ecology, linked to the social and environment desirability of industrial upgrading in developing countries.

The GPN framework operationalises and clarifies the variables considered by the GVC to address perceived inaccuracies on the role of national, regional and local institutions in shaping development outcomes and the spatial embeddedness of productive activities. Adding an additional layer of integration between the two literatures, the local actors considered by political ecology acquire prominence in GPN analyses of industrial spatial embedding and economic upgrading.

The institutions considered by GPN scholars reflect those governance mechanisms, external actors and economic frameworks described by Humphrey and Smith (2000) and Bolwig et al. (2010). Governmental and non-governmental institutions are situated at various scale levels, that is, within the region under analysis or other ones (e.g., WTO, national government offices). Consistent with political ecology and the literature on biofuels, aid and development agencies, and local

communities' customary institutions, are included in the analysis because they play a role in facilitating biofuel investments. The group of institutions considered by my analysis also comprises development consultancies under contract to bilateral aid agencies. They are the managers and architects shaping the delivery of development programmes (Radelet 2006; Martens et al. 2002; Legendijk & Cornford 2000).

Assisted by a variety of institutions, the national and regional governments operate dependable transformations on regional assets to 'plug' a region into a GVC/GPN and attract, produce, reproduce and capture financial value (Mackinnon 2012). Coe et al. (2004, p. 470) derive the concept of regional assets from the "holy trinity of technology–organization–territory" elaborated by Storper (1997, p. 26-28). Storper refers to technology as the capacity for standardisation, differentiation, reflexive learning and innovation across companies. Organisations are firms or groups of companies that form industrial complexes dependent on physical or intangible input. They are tied together by proximity, transactions, and economies of scale and scope. Territories are characterised by different levels of local interactions between firms and synergies between production factors, organisations or technologies. Investments in biofuels could be attracted to regions where there is available land, labour and, in terms of innovation-territory-organisation, pre-existing local knowledge about the energy crops being cultivated, services of agricultural assistance, and firms that can reach economies of scale in milling or vegetable oil extraction.

The transformations operated by institutions may create mutual benefits between regional assets and the strategic needs of trans-local actors participating in global networks of production. This alignment indicates successful regions in the framework developed by Humphrey and Smith (2000). Such mutual benefits underlie a process of "strategic coupling" that drives regional development (Coe 2012; Yang & Coe 2009). The process is strategic because it requires intentional and active intervention on the side of both inward investors and institutions; it transcends local

boundaries because it involves actors that operate at various levels of scale; and it is dynamic because it is based on complex interactions within the context of changing institutional, economic and productive governance structures (Yeung 2009; Coe et al. 2004).

The two main categories that shape strategic coupling and regional development are value creation, enhancement and capture, and power (Henderson et al. 2002). The elaboration of the concepts of value and power by the GPN framework is useful to contextualise different economic growth and social control mechanisms within political ecology. By adding awareness of financialisation processes, the framework adds contextualisation to the dynamics of firms' profitability and spatial development outcomes considered by the GVCs.

Value creation refers to the conditions underpinning the process of transformation of labour into output through the production process. Value enhancement derives from technology transfers involving firms and institutions; the coordination of suppliers to improve the sophistication of products; and the increase in the demand for skill in labour processes. Value-capture opportunities by regions are critical to development and are affected by government policies, corporate ownership structures (e.g., FDI, foreign-domestic joint venture), and the typology of property rights underlining production assets (Henderson et al. 2002).

Corporate, institutional and collective power influence processes of value creation, enhancement and capture (Henderson et al. 2002). Political ecology enriches the discussion of power of the GPN framework with processes of social discourse and, especially in terms of collective power, contestation. Corporate power can be defined as the ability of firms to consistently shape the resource allocation of other companies or the policy choices of institutions with their own objectives. Institutional power is asymmetrically distributed and it varies across five typologies of agency: supranational institutions (e.g., the EU); international institutions (e.g., IMF); the WTO, which impacts communities, companies and workforces in an indirect way; and national and local governments. Collective power is the ability of a series of agents (e.g., NGOs, grassroots collective

movements), which may be internationally organised or locally specific, to influence companies, governments or international agencies such as the WTO (Henderson et al. 2002).

Financial flows regulate the activities occurring within and across each production network's node (Coe, Lai & Wójcik 2014; Coe 2012). The GPN framework understands financialisation as "an all-pervasive system of values based on the overriding prioritisation of an equity culture, in which 'shareholder value' and profitability have become central to all aspects of economic activity to the virtual exclusion of all other interests in a free-market ideology" (Dicken 2011, p. 59). This means that companies' investment decisions are driven by the requirement of corporate owners (e.g., public or private shareholders) to obtain the highest returns within defined timeframes. Alongside institutional and policy frameworks, financial systems 'lubricate' production networks and shape decisions about where and what to invest to gain the highest return, sometimes in the quickest manner possible (Dicken 2011).

Financialisation is the bottom-line of regional development. It is linked to economic growth and productive activities, the transformations operated by institutions on regional assets, and the influence of policy and governance frameworks on production networks. From a political ecology perspective, the pervasiveness of financialisation contextualises the way in which political economic forces constrain regional and local production choices. The GPN framework approaches it by investigating corporate business cases, investment motives, financial sources and the geography of their organisation (Yeung 2015). Coe et al. (2014) elaborate that financialisation shapes GPNs through three building blocks: Advanced Business Services (ABSs), World Cities (WCs) and Offshore Jurisdictions (OJs). ABSs encompass finance (e.g. banks) and professional business services (e.g. consultancy). WCs are the command and control centres of global economic activity because major international institutions, ABSs and leading firms cluster in them. OJs such as Seychelles and Mauritius influence flows of profits and investments within GPNs. More than 30% of global FDI flows are channelled through OJs to reduce the taxation burden, raise funds, incorporate companies

quickly and lower the cost of accessing capital markets. These jurisdictions disconnect the geography of economic activities from profit registration and reduce the capacity of governments to capture value (Coe et al. 2014).

Figure 2.2 presents my analytical framework. I have drawn upon the representation of the factors at play in regional development by Coe et al. (2004, p. 470, Figure 1) and included insights derived from political ecology, Bolwig et al. (2010), Henderson et al. (2002) and Coe et al. (2014). Each box in the Figure contains the main variables considered in the analysis. Economic and institutional frameworks – including NGOs, government agencies, aid programmes and institutions, and other organisations – enter the analysis insofar as they stimulate FDI, facilitate access to land and other resources, and provide support to put production underway. Leading firms and the customers that they address, financialisation, regional assets and regional development variables are also represented in the Figure. The boxes in which institutions, the building blocks of financialisation and production networks are represented lie across the territorial encircling of the regions under analysis. This is because WCs and OJs can also be considered regions, and some organisations considered in the boxes may influence production activities across scale levels, that is, from locations outside the one where development outcomes are considered.

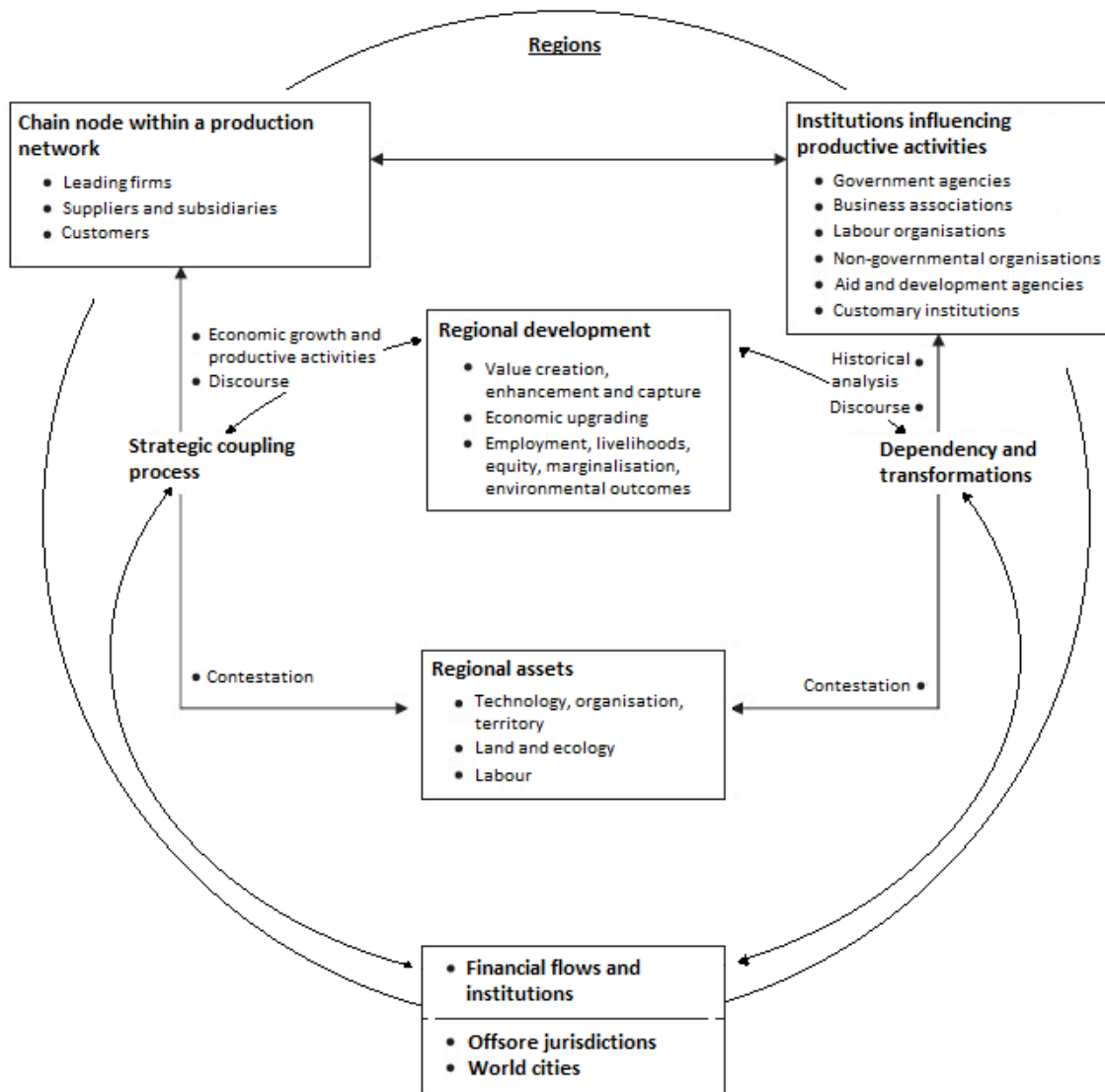


Figure 2.2: Analytical framework (Source: author)

Within the analytical framework of this thesis, the impacts of biofuel value chains on regions are linked to processes of production networks' strategic coupling with, and institutions' transformations on, regional assets. Historical and discourse analyses are largely employed to examine the dependable transformations operated by institutions, in particular, government agencies. Financialisation influences these processes and, hence, regional development outcomes. The framework also accounts for the possibility of feedback effects or 'contestation'. These originate from the broader context underpinning regional assets, that is, the ecology of the landscape and the social groups inhabiting it. Workers and their communities, the climate and soil conditions of regions, the crops being cultivated, and clusters of supportive firms such as regional processors

could each reveal a misalignment with the profit motives and business plans of FDI projects. In the context of the multipolar biofuel value chain, this may result in the reshaping of the spatial, economic and political configuration of institutional control mechanisms – strategic coupling and dependable transformations – on regional assets, thus development outcomes.

The next chapter indicates the case study to which I apply this analytic framework. It introduces the research design and methodology employed in this thesis. Following this, it presents the research protocol, the data gathered and the methods of analysis.

3 Research design and methodology

The biofuel sector is highly heterogeneous. There are many crops used as raw material input for biofuel manufacturing, each of which undergoes a different industrial process for the production of fuel. The FDI in the biofuel sector can include distinctive complexes of crop cultivation, raw material processing, and refinement prior to distribution as an alternative fuel. Based on the data available on energy crops cultivated in developing countries, I decided to focus my study on jatropha (*Jatropha curcas* Linn.) in Madagascar.

The data showed that jatropha was targeted for biodiesel production on 11.7 million ha of land – about the size of Eritrea, Africa – in tropical and subtropical countries worldwide (see International Land Coalition [ILC] 2012; Global Exchange for social investment [GEXSI] 2008). I found it interesting because the area targeted for jatropha production was only second to oil palm (*Elaeis guineensis*), which had projects covering 13 million ha worldwide. Africa was targeted for maximum amount of jatropha cultivation projects and Madagascar was one of the countries with the largest number of these proposed FDI initiatives.

This chapter provides the rationale for my case study of jatropha production in the Boeny region of northwest Madagascar. I describe the data collection procedures envisioned prior to my departure, the obstacles I faced during my field research overseas, the data gathered, and methods of analysis.

3.1 Design and method

My research seeks an answer to the question: Is Foreign Direct Investment (FDI) in biofuels a viable strategy for regional development in poor countries? I decided to follow a case study approach, which Yin (2009, p. 18) defines as “an empirical inquiry that investigates a contemporary

phenomenon in depth and within its real-life context, especially when the boundaries between phenomenon and context are not clearly evident". Biofuels are, to use Yin's reasoning for a case study approach, a "complex and contemporary social phenomenon" (p.4). They are first generation renewable energy products, a recent and heterogeneous spinoff of technologies that rely on the agricultural sector.

Foreign direct investments are not only targeted toward a variety of biofuel crops, but also towards tropical and sub-tropical developing countries. Each biofuel crop is an agricultural commodity characterised by a distinctive agronomy (i.e., soil and crop management practices including input requirements) that is embedded within a specific political ecological context. The crop has a range of end-uses that, including the by-products, are linked to a variety of industries (e.g., agrochemicals, pharmaceuticals, lubricants, varnishers, flavour enhancers). The cultivation of energy crops occurs within particular local, regional, national and international commodity networks and industrial policies. Given this empirical complexity, focusing on a single commodity within clear 'spatial, temporal, and other concrete boundaries' (Yin 2009, p. 32) – a region – allows richer analysis and insights for understanding the viability of FDI in biofuels for regional development.

My main research question can be broken down into three objectives: how is a biofuel industry created, how is production organised and, as a result, how does it contribute to regional development outcomes. These objectives inspire an exploration (i.e., how), a description (i.e., what), and an explanation (i.e., why). This requires a heuristic approach for understanding the ways in which the different agencies and actors involved in the biofuel sector come together to determine production and development outcomes. Although several studies have highlighted the local impacts of FDI in biofuels in developing countries, they have not provided much insight into the creation of what can be called a biofuel industrial complex involving financial investors, government agencies, and local and international companies setting up crop plantations and processing units, facilitating organisations, and contract farmers. As my analytic framework outlines, such biofuel-industrial

complex is my unit of analysis and firms, government agencies and non-government facilitators are embedded subunits. I focus on factors at play in regional development such as land reform, economic policy environment, and the relationships between enterprises themselves.

3.2 Case study: jatropha in northwest Madagascar

In an article published in the *Scientific American*, Rebecca Renner (2007) described the emergence of jatropha as the new “Green Gold in a Shrub” for foreign direct investment. She noted that mainstream biofuels such as sugarcane, corn, canola, soy and oil palm had been criticised for undermining food security by diverting these crops to fuel production, and for establishing large-scale plantations that caused tropical deforestation and environmental degradation. Jatropha was promoted as an alternative biofuel that could bypass these problems for the production of biodiesel (see Table 2.1).

Although the oleaginous jatropha provided lower yields than the oil palm, it was not a food crop and its cultivation did not require clearing large swathes of tropical forests. It grows well on marginal lands unsuitable for the cultivation of other crops; it thrives in hot, dry climates; it is a hardy shrub that prevents soil erosion and toxicity of which reduces the need for pest management; and it requires little water and fertiliser input (see also IPCC 2007). Jatropha was considered the best investment for resource-based industrialisation in developing countries, especially those in Sub-Saharan Africa. It embodied an easy to cultivate, cash crop, with low input costs and high significant income opportunities for the rural poor. Many countries in Sub-Saharan Africa such as Cape Verde, Gambia, Mozambique, Madagascar, Mali and Burkina Faso, included the cultivation of the plant in their national development strategies endorsed by the World Bank (Von Maltitz, Gasparatos & Fabricius 2014).

Table 3.1 shows that FDI in the cultivation of jatropha was one of the main investment motives for companies aiming to produce biofuel raw materials. In the 2000s, Africa was as a leading target across the geographical regions interested by those investments, which are mapped in Figure 3.1. On comparing the ILC (2012) database with the global market study by GEXSI (2008), I saw that Madagascar stood out as a key destination for FDI in jatropha cultivation. The country attracted the greatest volume of FDI (18 firms) on 35,700 ha of cultivated land (GEXSI 2008). Within Madagascar, between 2005 and 2008, around half of the jatropha FDI projects were centred in the Boeny region.

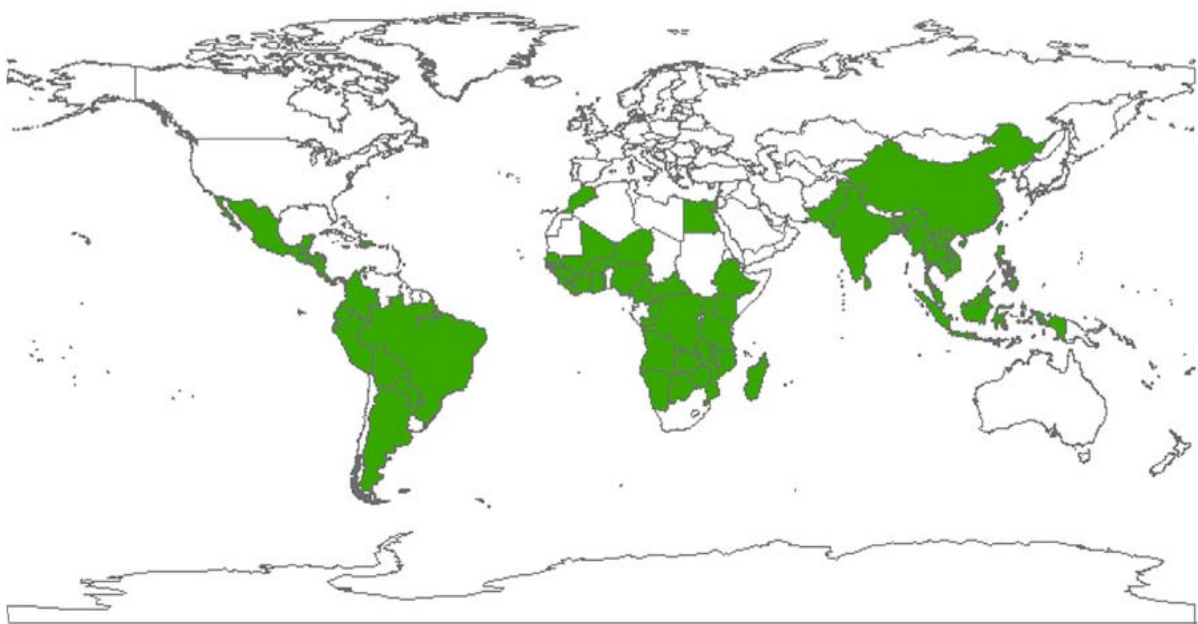


Figure 3.1: Countries where jatropha activities have been reported (Source: Van Eijck et al. 2014, p. 782, Fig. 1)

The United Nations' Human Development Report ([UN] 2013) ranks Madagascar among the 50 poorest countries in the world. Since the signing of the country's first structural adjustment agreement in June 1980 (Brown 2000), Madagascar suffered a 35% decrease in Gross National Income per capita and, according to the World Bank ([WB] 2014) a 155% demographic increase. About 70% of the population is located in rural areas and practices subsistence agriculture; around 90% survives with less than \$2 per day (WB 2014).

Table 3.1: Estimate of global jatropha investments in the 2000s

Geographic region	Announced investments in land to cultivate biofuel crops ¹		Number and type of jatropha investments							
	Global percentage ²	Jatropha share	EU	EU-domestic partnerships	EU-foreign partnerships	Foreign ³	Foreign-domestic partnerships	Domestic investments	Unknown	Total
Africa	40.66 %	22.80 %	49	8	1	21	7	17	8	111
Asia	45.11 %	17.53 %	4	2	0	19	3	18	0	46
Central and South America	12.25 %	0.29 %	3	1	0	1	0	1	0	6
Eastern Europe and Middle East	1.67 %	0.00 %	0	0	0	0	0	0	0	0
Australia and Melanesia	0.31 %	0.00 %	0	0	0	0	0	0	0	0
Total	100 %	40.62 %	56	11	1	41	10	36	8	163

(Source: author)

Notes:

1) Data derived from the detailed databases of ILC (2012), Görgen et al. (2009) and GEXSI (2008). The entries are expressed as a percentage of the land targeted by international biofuel investments, which totalled about 28,810,974 ha. This estimate is lower than the summary provided by Anseeuw et al. (2012), who proposed a total of 37.2 million ha comprising biofuel investment shares of 50.54% in Africa, 42.47% in Asia, 5.38% in Latin America, and 1.61% in the rest of the world.

2) The biofuels crops considered include the 'food/fuel switch' crops Oil Palm, Coconut, Soy, Rapeseed, Cassava, Sugar cane, Sorghum and Croton.

3) The estimate includes Foreign-Foreign partnerships in the host country.

Madagascar is known as a global biodiversity hotspot for conservation, national parks and tourism rather than a location for major industries. The small manufacturing sector is concentrated in the areas surrounding the nation's capital and the city of Antsirabe. Mining mostly occurs in the south; hardwood timber is extracted from the rainforest areas in the East. The Boeny region in the northwest of the island has some cashew plantations, a small vegetable oil industry, and cash cropping of rice. The region was largely neglected for economic investment until it was targeted for FDI in *jatropha* cultivation.

3.3 Data collection

I conducted my fieldwork from August to October 2012 between the capital city of Madagascar, Antananarivo, and the northwest region of Boeny. Since French is the main language of formal Madagascan communication and administration, I needed to learn it and reach an intermediate level so that I could read the reports and understand the specialised vocabulary used by policymakers and officials on topics related to renewable energy, agriculture, development, and environmental issues. Since Italian is my native language, I succeeded in gaining competency in a fairly short period.

Using global investment databases as the starting point, I collected information about the *jatropha* industry in Madagascar through the websites of various private companies, government departments, parastatal institutions, development programmes, and conservation NGOs. I obtained published reports on development programmes, corporate business plans and financial statements associated with the *jatropha* industry. I examined these sources with a critical awareness of their limitations. For example, in the databases on global investments in land, some of the proposed projects listed might not have proceeded for various reasons ranging from lack of financing to political turmoil; they may not have gained access to the land areas indicated in the reports due to various legal issues relating to titles; and finally, they might not disclose the full details of the projects for fear of scrutiny of activists or corporate competitors (Deininger et al. 2010; Mann & Smaller 2010).

I used these reports to build a contextual picture of how the jatropha industry was established in Madagascar, and looked for areas of congruence and difference in the various accounts. I then identified the gaps in information which I needed to obtain from my fieldwork. I focussed on obtaining qualitative and quantitative data through semi-structured interviews, company documents, government reports, archival records and direct observations. The preliminary investigation phase produced a list of participant organisations, which included around forty contacts for semi-structured interviews. I relied mainly on semi-structured interviews because they provide a structured approach with the flexibility and spontaneity of the unstructured, conversational interview (Salmons 2012). Interviews pose the challenges of reflexivity, which is the risk of being told what one wants to hear. I planned to reduce this risk by not sharing my views or the views of others I had interviewed. In accordance with the university approval of the ethical aspects of my research, before travelling to Madagascar, I emailed the contact persons in the identified organisations informing them of my research project and attached an explanatory statement and interview consent form. Only one person responded to my email before I arrived in Antananarivo in August 2012. When I made my way to these organisations and sought meetings with the relevant contact persons, they explained their reasons for not responding to my emails.

First, they pointed out that due to their busy schedules and meetings outside their offices, they rarely had time to respond to email requests for research and information collection. Second, because of the sensitive political situation at the national level (a coup d'état), they felt uncomfortable about agreeing to provide information for research. Finally, the formal consent form that was required by the Monash Ethics Committee was, for most of them, a put-off because it made them feel that anything they said could be used against them. The terms 'research' and 'interview' were often regarded as euphemistic expressions that journalists, consultants, or activists used to try to gain access to confidential information. Nevertheless, after meeting with me in their office, most of them were extremely helpful and open to being interviewed about the jatropha industry. They voluntarily contacted some of the other participants to let them know about my arrival and

requested them to help me with my research. However, they did not want to be identified in the thesis, or have their conversation recorded due to the political situation in the country. I responded to these conditions by taking notes during the meeting and transcribing them at the end of each day. I followed up by discussing my notes with the interviewees to make sure I had understood the conversation in French correctly. To maintain the anonymity of respondents and their organisations, I used a categorised numbering system for interviewees (e.g., Government official #1). The firms D1-Oils and JSL-Biofuels were named because I did not interview any of their employees.

Table 3.2 shows the evidence that I collected in Antananarivo and the Boeny region. Appendix one contains the questions and discussion topics used in the interviews. Appendix two provides the interview dates and locations. Respondents were divided into four groups (i.e., academics and government officials; corporate managers; NGO representatives; and farmers) and each was interviewed with a slightly different set of open-ended questions. As Salmons (2012) predicted, respondents were free to propose their own thoughts, impressions, and add new topics that I did not previously conceive. Even across participant groups, respondents often brought up facts that, as Yin (2009) notes, allowed me to explore the topic from multiple angles.

The majority of respondents suggested other persons to interview, other sources of evidence that I could retrieve in the country, and they frequently shared with me documents and private archival evidence that would not have been available for my study otherwise. Some respondent directed me to online sources that were complementary to the views they expressed during interviews. In retrospect, the documentary information that I retrieved became even more important than the topic-focussed semi-structured interviews that I administered. The direct observations that I made were taken in the field, where I could note the activities taking place to complement other evidence with real-time, contextual information about jatropha cultivation.

Table 3.2: Summary of the data collected in August-October 2012

Type of source	Quantity	Description
Semi-structured interviews	15	Government officials, five key respondents in Antananarivo, including the head of a parastatal organisation, and the remaining ones in Boeny (i.e., Mahajanga and Marovoay)
	4	Academics with experience in foreign agri-business investments and jatropha in Madagascar
	20	Corporate managers
	14	Rural and environmental NGO representatives
	5	Plantation workers and large farmers cultivating jatropha in Boeny
	58	Total
Documents	8	Newspaper articles that appeared on the <i>Express du Madagascar</i>
	5	Reports produced by a consultant for the German Technical Cooperation Agency about the evolution of the jatropha industry in Madagascar from 2007-2009
	3	Regional development plan of Boeny for the years 2005-2015 and minutes about one corporate plantation
	7	Documents from the public archives of the Ministries of Agriculture and Environment and shared by interviewees
	20	Development reports about investments in land, the operations of German and American aid organisations
	13	Reports related to the operations of one Environmental NGO in Boeny
	4	Theses about Boeny: three Master of Science detailing the case study of one company each, and one PhD explaining the composition of the landscape and agro-pastoral systems
	60	Total
Archival record	29	Files detailing the required steps to access land in Madagascar
	6	Documents related to the business plans of four companies in Boeny
	2	Consultancy reports developed by one parastatal organisation in support of the operations of one company in Boeny
	3	Videos about the operations of two companies and one promotional video created by an NGO in Boeny
	40	Total
Direct observation	1	I kept a diary containing the direct observations I made such as the non-verbal communication by respondents; the price of fuel, energy sources such as charcoal, and food in urban and rural markets in Antananarivo and Boeny; and the state of corporate operations in four plantation sites
	1	Photo album about all of the places I visited
	2	Total

(Source: author)

The information and the unfolding facts about the FDI in jatropha in Boeny changed some aspects of my original approach to fieldwork. I intended, initially, to interview and administer a survey to about thirty farmers and interview about ten respondents within each of the other groups. As Table 3.2 shows, those proportions largely changed. In order to understand the organisation of jatropha production I examined corporate business plans, reports on activities, three completed Master of Sciences theses on jatropha plantations in Boeny and one doctoral thesis on the regional agrarian economy. The Master of Science theses provided sufficient empirical data in regards to the social and economic impacts of jatropha agribusiness activities on local communities. I thus reaffirmed and complemented their findings with five semi-structured interviews with key informants. I visited four plantation sites to observe on-ground activities and talk with local managers, and interviewed several NGOs representatives that assisted firms' operations. The interviews with all the groups provided information about the regional development outcomes.

3.4 Data analysis

The heated debates about FDI in biofuels can create the tangible risk of confirmation bias in data analysis. Confirmation bias is defined as the possibility of collecting and presenting information to “justify a conclusion already drawn” (Nickerson 2011, pp. 179-181). I addressed this problem in my analysis by examining multiple sources of evidence, executing data triangulation and cross-checking the evidence in relation to a range of theoretical perspectives as per my analytical framework.

Starting from the contents of the semi-structured interviews, I created a spreadsheet that I categorised according to research objectives and themes of the responses (the answers to each open ended question). I added new themes based on the thoughts and ideas that respondents added during the course of field research. I searched for patterns of correspondence and differences within the responses to the questions. The patterns revealed particular topics that were most frequently mentioned by respondents such as the government policy, production constraints, agricultural extension support and marketing.

I used Nvivo software for qualitative data analysis. I created a single database comprising the digital documents that the respondents gave me, my field notes and pictures. Based on the year in which documents were produced and/or interviewees mentioned that a certain event took place, I was able to put information into chronological order. I compared government and consultancy reports along with interview contents. This provided quantitative estimates about issues such as the amount of land targeted by companies; area under cultivation, input costs and cultivation expenditure; contract farming and wage labour. I compared these estimates to come up with a broad range of costs involved in jatropha production. I created thematic nodes to organise the data around the topics identified and examine information related to the research objectives of understanding industry creation, cultivation and development outcomes. This process produced findings through “data triangulation” from multiple sources (Yin 2009, p. 116), and enabled me to map the dynamics and outcomes of the production network.

The analysis reveals the particular configuration of environmental, energy, and economic policies that facilitated FDI in jatropha and led to the establishment of plantations in the Boeny region. To provide conclusions, I compare these findings with the larger body of knowledge about FDI in jatropha in developing countries and the wider literature on biofuels. The following chapter introduces jatropha, its agronomy, its economic history and how it has been the object of FDI in poor countries. It is the entry point for understanding the crop in the context of my case study.

4 A compendium about jatropha

Jatropha curcas is the scientific name given to the plant by Linnaeus. It comes under the family of *Euphorbiaceae*, which comprises about 8,000 different species across 312 genera (Heller 1996; Dehgan 1982). Table 4.1 lists some of the species within the family that have gained economic importance. While geographic, palaeo-botanic and genetic evidence suggest that the centre of diversity for jatropha is in Central and South America (Mitchell 2011; Aponte 1978; Standley & Steyermark 1949), the pan-tropical distribution of the genus – comprising around 170 endemic jatropha species – may have resulted from the separation of Gondwana (Dehgan & Schutzman 1994).

Jatropha is a large deciduous shrub that can reach 5-8 m in height and 40-50 years in age. It grows in tropical and sub-tropical areas between the latitudes of 30° N and 35° S (Jongschaap et al. 2007), within an annual rainfall range between 250 and 3000 mm (Chachage 2003). The plant can grow at elevations of up to 1800 m, but it thrives best at altitudes below 500 m and slopes of less than 25°. The optimal climatic conditions for its growth are an annual average rainfall of about 1000-1500 mm and temperatures between 20°-28° C (Tinguely 2012; Brittain & Litaladio 2010; WeiGuang, Huang & XiangZheng 2009). Jatropha can also grow on marginal lands and eroded soils, but it appears to require water and fertilisers for viable commercial production (Openshaw 2000).

Table 4.1: Several crops of economic importance within the family of the Euphorbiaceae

Product of interest	Common name	Scientific Name
Edible roots	Cassava	<i>Manihot esculenta</i>
Rubber	Hevea	<i>Hevea brasiliensis</i>
Edible Fruits	Emblic	<i>Phyllanthus emblica</i>
	Otaheite gooseberry	<i>Phyllanthus acidus</i>
	Tjoopa	<i>Baccaurea dulcis</i>
	Rambai	<i>Baccaurea motleyana</i>
	Mafai	<i>Baccaurea ramiflora</i>
	Chinese laurel	<i>Antidesma bunius</i>
	Njangsa	<i>Ricinodendron heudelotii</i>
	Mongongo	<i>Schinziophyton rautanenii</i>
Edible Nuts	Tacay	<i>Caryodendron orinocense</i>
Leaf vegetables	Katuk	<i>Sauropus androgynus</i>
	Chaya	<i>Cnidoscolus chayamansa</i>
Oils	Castor	<i>Ricinus communis</i>
	Tung tree	<i>Aleurites fordii</i>
	Chinese tallow tree	<i>Sapium sebiferum</i>
	Jatropha	<i>Jatropha curcas</i> Linn.

(Source: Heller 1996, p. 7)

As Figure 4.1 shows, the root system of the plant consists of four lateral roots and a vertical taproot, which can reach a depth of 5 m into the soil. It can be vegetatively propagated (i.e., from a cutting), but the clone does not develop a taproot. The leaves of the plant have 5-7 lobes. Flowers can be male, female or hermaphrodite, and are formed on the extremities of the branches. Pollination is by insects and gives rise to fruits that remain fleshy until mature and contain three black seeds each (Heller 1996).

Jatropha is not a food plant. It is highly toxic, and this endows it with a natural resistance to pests and diseases. The toxicity of the plant is linked to curcin and phorbol esters, which are particularly abundant in the seeds and roots of the plant. Curcin is a toxic protein similar to ricin, a poisonous compound found in castor oil (Heller 1996). Cattle do not eat the plant, and humans can be poisoned if they ingest the seed (Abdu-Aguye et al. 1986).

The plant generally attains seed bearing capacity from 3 years onwards, depending on local ecological conditions. Heller (1996) notes that the plant, when cultivated, requires weeding and is susceptible to infestation by insects during the early stages of growth. Studies report a large variation in seed yield, ranging from 0.1 to 15 tons/ha per year (Openshaw 2000; Heller 1996; Jones & Miller 1993). The wide variation in yields depends on whether the seeds are collected from the wild or from cultivated plants (Von Maltitz, Gasparatos & Fabricius 2014; Van Eijck et al. 2014; Gasparatos et al. 2012). Recent studies conducted by Lapola, Priess and Bondeau (2009), Teixeira (2005) and Arruda et al. (2004) indicate a maximum seed yield of 2 t/ha/year under favourable conditions.

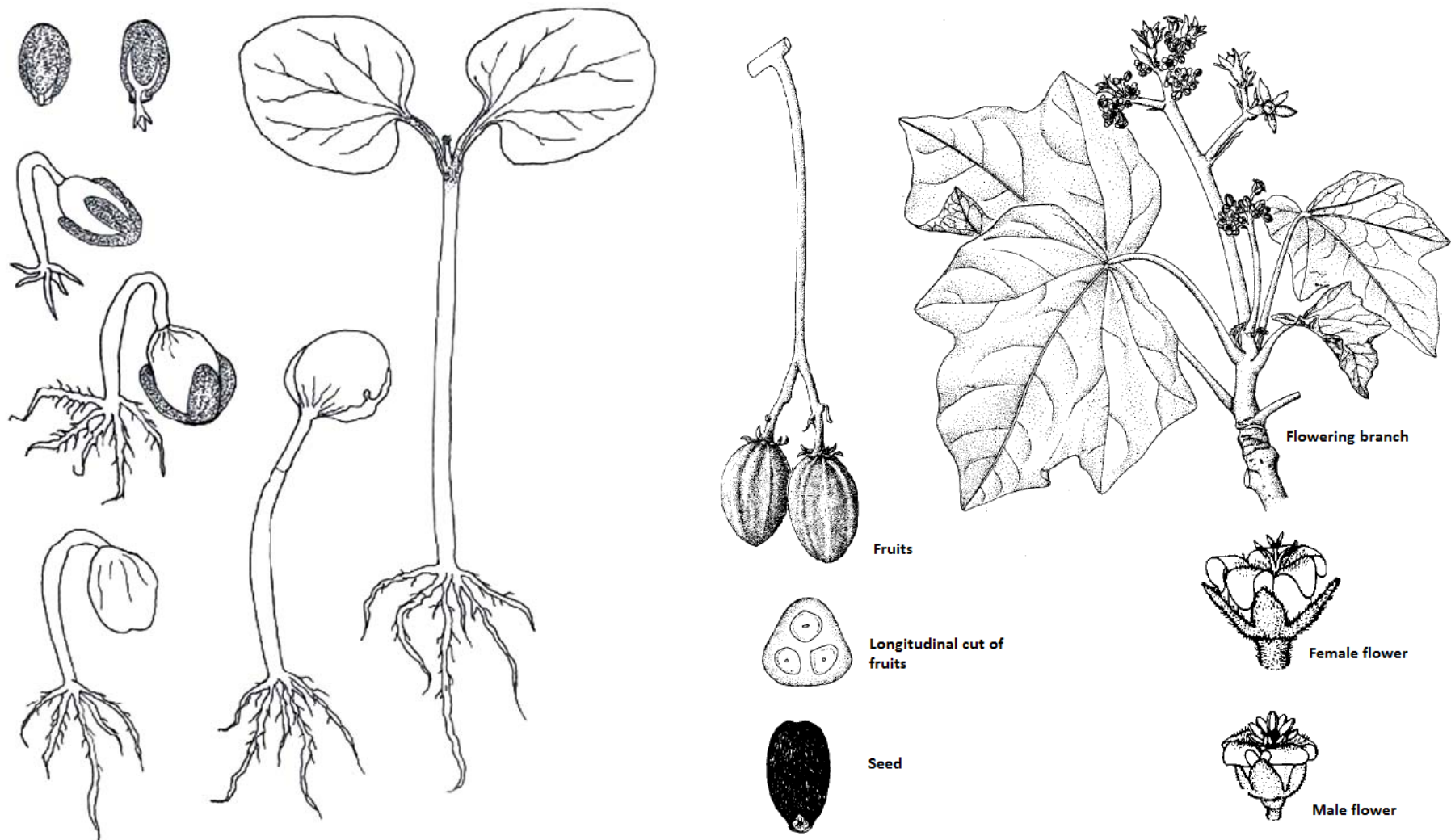


Figure 4.1: *Jatropha*'s seedling development and mature plant (adapted from Brasileiro et al. 2012, Figure 1, p. 560; and Heller 1996, Fig. 2, p.11)

4.1 Colonial cultivation of jatropha

It is commonly accepted that Portuguese seafarers brought the plant from the Caribbean to their colonial bases of Cape Verde and Guinea Bissau. Heller (1996) notes that the earliest historical reference to the plant's introduction in West Africa is in the early 1800s, even though the plant was already under cultivation before that date.

It is not known how the Portuguese discovered the possibility of extracting oil from jatropha seeds. According to Freitas (1906) and Serra (1950), the Portuguese colonial government encouraged the creation of jatropha plantations in Cape Verde in the 17th century to export seeds for the production of soap in Lisbon. Between 1910 and 1955, jatropha was cultivated on 8,000 hectares in Cape Verde and the maximum seed exports were around 5000 tons (Silveira 1934; Grillo 1951). The French, too, exported jatropha seeds from their colonies in Guinea, Benin and Madagascar for the production of the *Savon de Marseille* (Henning 2009; Heller 1996). Jatropha was also used as a climbing support for the vanilla vine due to the depth of its taproot, the resistance of its branches to wind, and its deciduous nature (Henning 2009; Correll & Correll 1982). The French colonial government also planted jatropha as fire-break to protect forestry plantations (Sodikoff 2005). However, they did not consider the plant economically important (Jumelle 1916, p. 21), and exports of seeds to Marseille were about 1,000 tons per year in the early 20th century (Dandouau 1908, p. 305).

Rural communities in the tropics used the plant as a living fence to protect food crops or demarcate the boundaries of their households. A wide range of studies mention many more uses of jatropha: as a purgative, for skin diseases, rheumatic pains, leaf decoctions as antiseptic, latex to stem the bleeding of wounds and seedcake as fuel (Diallo 1994; Lutz 1992; Budowski 1987; Zan 1985). The plant was not commonly used as fuel wood (Heller 1996).

During the Second World War, the Japanese Imperial Government and the French imposed the planting of *jatropha* to produce lubricant oil and fuel in occupied Indonesia and Mali respectively (Afiff 2014; Henning & Kone 1998). After these utilisations, the industrial exploitation of *jatropha* came to an end. International exports of seeds from Cape Verde significantly decreased after the 1940s and ceased by the 1970s (Heller 1996). The rise of synthetic detergents may have resulted in the decline of this early *jatropha* industry (Henning 2009).

4.2 Revival of interest in *jatropha* from the 1970s until the late 1990s

After the oil shocks of 1970s, the Group of 7 countries recognised the need to finance research on renewable energy sources in the global South. Since there were emerging technologies that could modify diesel engines to function with vegetable oils (Münch & Kiefer 1986), donor funding was provided to a global research network exploring the fuel potential of neglected oleaginous crops such as *jatropha* (Nasir et al. 1988; Teixeira 1987; Banerji et al. 1985; Aponte 1978).

During the 1980s and 1990s, most of the research focused on *jatropha* cultivation techniques for increased oil production and exploration of non-fuel uses for poverty alleviation in developing countries. In 1989, the Austrian government sponsored the *Proyecto Biomasa* (Biomass Project) in Nicaragua. By 1995, the project included the cultivation of *jatropha* on 1,000 ha and the creation of a semi-industrial-scale plant for the extraction and conversion of the oil into biodiesel (Foidl et al. 1996). A study of the project by Foidl and Eder (1997) concluded that the profitability of *jatropha* was contingent on the utilisation of its by-products (e.g. seedcake from oil extraction, glycerol from the process of transesterification of the oil into fuel) in other value-added activities.

In Africa, the German bilateral aid agency (GIZ) attempted to utilise the crop within an Integrated Rural Development Approach through two successive trials in Cape Verde and in Mali (Heller 1996; Henning 2009). Following the trials on the Cape Verdean islands of Fogo and Brava, the agency determined that the industrial production of soap was not economically competitive (Von

Cossel, Lehmann & Schütz 1982). The plans for scaling up production were not followed through and the crop was utilised mainly for small-scale artisanal soap-making. In Mali, jatropha cultivation was promoted between 1987 and 1997 by GTZ under its women's empowerment and poverty alleviation programmes. The plant was grown as a living fence and in areas experiencing soil erosion, with the fruit harvest to be utilised for renewable energy production. However, this program also determined that jatropha production was unlikely to be profitable beyond a small-scale artisanal industry (Henning 1994).

This assessment of jatropha as an oil crop was reiterated by Openshaw (2000), who concluded that the plant could give rise to commercially viable utilisations only in exceptional circumstances and that its cultivation could be promoted as part of a multi-use 'system' for rural development in poor countries as described by Henning (2000). Henning produced a GTZ manual for an integrated exploitation of jatropha for rural development. His integrated system proposed that the plant could be used as fencing to protect farmers' crops from cattle and for stemming soil erosion. The oil and seedcake could be used as fuel for cooking and lighting, and as high quality fertiliser. Households could earn additional income from selling seeds, oil and soap in local markets. By the end of the 1990s, most of the reports emerging from these experiments with jatropha shared the view that it could be part of small-scale rural development projects, but not viable for large-scale commercial cultivation.

4.3 The millennium 'boom'

Economic interest in jatropha saw a renewed 'boom' in the 2000s (Pearce 2013). This was substantiated by research on its cultivation techniques, processing and marketing possibilities (see, for example, Nazir et al. 2009; Akbar et al. 2009; Atchen et al. 2008; Santoso & Purwoko 2007), and it was in large part due to the conclusion of negotiations for the Kyoto Protocol. In response to Kyoto commitments to lower greenhouse gas emissions, European and other countries worldwide mandated the consumption of biodiesel and bioethanol in their transport sector. In this context, the

Indian government aggressively targeted the cultivation of the jatropha plant for domestic consumption and exports. China and other developing countries followed suit from the year 2004 onwards (Ariza-Montobbio et al. 2010; Kant & Wu 2011). The private sector reacted quickly to the creation of the carbon economy and biofuel mandates. The two largest jatropha enterprises worldwide – D1-Oils (2004) and Green Energy Madagascar Biofuels ([GEM] 2007) – were formed in the same year to supply jatropha as a raw material for biodiesel refineries in accordance to the biodiesel quality standards of the European Union (EU).

Jatropha gained further prominence when the international prices for edible oils rose dramatically in 2005 and in the following years. Oil palm, which formed the bulk of raw material input for biodiesel production, was so expensive that refineries could not afford it (Berti 2010). At the same time, critics pointed out that the biofuel mandates, especially the EU ones, were taking land away from food production and driving tropical deforestation in developing countries (Naylor et al. 2007). Some companies seized on the possibility of growing jatropha as an alternative to oil palm because it was a non-food crop that could be used to produce a second-generation biofuel (Sorda, Banse & Kemfert 2010). Firms such as GEM Biofuels promoted their investment in jatropha by highlighting that the crop could grow on marginal land and prevent soil erosion, and would not be in competition for land needed for food production (GEM 2007). In short, jatropha could provide a more stable supply of raw material to biodiesel refineries (Berti 2010).

The spike in international food prices in 2007 further contributed to the jatropha 'boom'. A report produced by Goldman Sachs that very year listed the plant as one of the best choices for future biofuel production (Barta 2007). FDI in jatropha escalated in developing countries (Caniëls & Romijn 2011). Until then, the bulk of jatropha cultivation was centred in government-promoted outgrower schemes in Asia. From 2008 onwards, most of the FDI for new jatropha projects was targeted for Africa (GEXSI 2008). When I was planning my field research in 2011, there were 163

projects proposed worldwide, targeting 11 million ha, of which 111 projects were to be launched in Africa.

Jatropha already had a history in Madagascar from the colonial period. But its resurgence as a commercial crop for export production needs to be understood in the historical and geopolitical context of the country's engagement in the global economy. To understand how the Madagascan state created conditions for attracting most of the FDI targeted for Africa, the following chapter takes a look backwards at its historical role in promoting export-oriented agriculture.

5 The history of export agriculture in Madagascar

The economic development of Madagascar has a long history of influence from foreign commercial interests. Over the past five centuries, especially from the 1820s onwards, the rulers of the island constantly sought to attract foreign capital to service economic development and other political ends. This chapter traces the evolution of foreign influences on the economy of Madagascar over the pre-colonial, colonial and post-independence eras. I rely on Brown (2000) as a main reference within this chapter because of his detailed articulation of themes relevant to the narrative.

The discussion of the pre-colonial period extends from the 17th to the 19th centuries. The section includes the trade of the Sakalava in the west and northwest from the 1600s to the 1760s, the rise of the central highland kingdoms and their trade with the Mascarene colonies from the 1770s to the 1820s, and the expansion of the Merina Empire until French colonial rule was imposed in 1895. The colonial period extends from the 1895 until independence in 1960. The section accounts for the economic situation of the country prior to, during and after the two World Wars. These first two sections largely draw insight from the historical accounts of Alpers (2009), Larson (2000), Verin (1972), Kent (1962) and Deschamps (1961).

The last section of the chapter discusses the economic policies in place after independence in three phases: the nationalist government of President Philibert Tsiranana from 1960 to 1972; the socialist phase under President Didier Ratsiraka from 1972 until 1980; and the shift to economic liberalisation and environmental conservation, under the government of Albert Zafy from 1991 until 1996 and the re-election of Ratsiraka until 2001. This section derives its information mainly from Covell (1987), Duruflé (1989) and Barrett (1994).

5.1 Slaves, cattle and guns: the Sakalava and the Merina civilisations

Madagascar's location in close proximity to East Africa made it an important base for the supply of valuable resources within the western Indian Ocean trade. The northwest and north-eastern coastal areas of the island were drawn into the Swahili and Arab trade networks that extended down the East African coast from Mombasa in present-day Kenya to the port of Sofala on the central coast of present-day Mozambique (Alpers 2014). Most of the dhow-based trade concentrated on the northwest and the north, linking them to the Comoros and Mozambique, and to Kilwa and other east African ports. The west and east coasts of the island were linked by sea via the south cape of Madagascar and through land-based settlements (Deschamps 1961). Larson (2000, pp. 52-54) explains that such economic configuration emerged due to geographical factors linked to the island's position in the southwest Indian monsoon system. Sailing technologies could not easily overcome the strength of the South Equatorial Current in the northern cape of the island due to the unpredictability of eastward trade winds.

The earliest inhabitants of Madagascar arrived by sea from the islands of Southeast Asia to the east coast of Africa (Alpers 2014). They are said to have mixed with the population of the East African coast, crossed the Mozambique Channel between the 8th century and the first millennium CE, and established the earliest settlements in the northwest and west of the island (Verin 1972, pp. 83-86). There were subsequent waves of oceanic migration from the islands of Southeast Asia until 1200 CE. By this time, most of the population of Madagascar had moved up to the highlands and was concentrated in the northern and central parts, where rice cultivation became the mainstay of agriculture. As early Madagascan kingdoms formed and became more established, several coastal towns in the east emerged as ports. Trading networks extended between the highlands and ports such as Mahilaka and Mahajunga (modern Mahajanga) in the northwest, and eastern ports such as Tamatave (Toamasina) and Mananjary. Deschamps (1961, pp. 85-90) suggests that the exports from the island consisted of slaves, who were deployed in domestic and agricultural tasks, rice, chlorite

schist, precious woods and livestock. The main destinations of trade routes were the East African coast and Persia. Imports mainly involved Indian, Islamic and Chinese pottery, beads and glassware.

5.1.1 The Sakalava kingdom of Boina: 1600-1750

Verin (1972, pp. 115-140) reports that Bantu and Swahili seafarers continued to interact and trade with the population of the west coast of Madagascar from 1200 until 1600 CE. They formed the Sakalava kingdom, which was centred on the Menabe region in the mid-west of the island and gradually extended north to Marovoay (see Figure 5.1). Provoked by internal disagreements, the Sakalava expansion brought about the creation of the independent kingdom of Boina in the northwest, which possessed extensive grazing land on the highlands stretching towards the interior and fertile acreages for the cultivation of rice (Deschamps 1961). Marovoay became the kingdom's capital because of its strategic location overlooking River Betsiboka, which connected it to the prosperous port of Mahajanga and the interior of the island (Brown 2000).

Until colonisation, the northwest and the eastern coast of Madagascar were the most important areas for economic activities and commerce (Larson 2000, pp. 53-62). However, the sea route from the north was rendered difficult by the unpredictability of the eastern trade winds and the violent storms, while land-based journeys were obstructed by diseases and logistical difficulties brought on by the Madagascan rainy season between December and April. The eastern coast could mainly provide rice and timber. The number of cattle was limited by the lack of grazing land, while the number of slaves available for sale was restricted to the prisoners captured during warfare between coastal kingdoms. At the time of the Sakalava kingdom of Boina, the northwest coast was the favoured destination by trade routes with East Africa and across the south Indian Ocean.

After early Portuguese explorations in the 16th century, according to Verin (1972, pp. 152-170) and Larson (2000), the Sakalava emerged as a powerful empire through commercial exchanges with Europeans. Throughout the 17th and the 18th centuries, trade with the Dutch, the English and the French resulted in an increase in rice cultivation and herding, the logging of precious timber such

as palissander, and the exchange of weapons and ammunition for slaves. The Sakalava obtained large numbers of slaves by raiding the interior of the island and the eastern African coast, especially Mozambique, by sailing via the Comoros (Alpers 2009). Large European ships would dock in Mahajanga and enter the River Betsiboka, which connects to Marovoay, to meet the Sakalava sovereigns and receive their approval to trade in slaves (Deschamps 1961). The Sakalava also marched slaves and cattle across the island to load the few ships docking in the Antongil Bay and southern towns on the east coast.

5.1.2 The rise of the Merina and imperial Madagascar: 1750-1895

The fortunes of the two coasts were reversed by the shifting geographies of colonialism. New patterns of conquest and trade linked to the French Empire allowed the rise of the Merina, who originated from a kingdom based around Antananarivo. Figure 5.1 shows the geography of early Madagascar with reference to the Sakalava and the kingdoms of the interior.

The French declared the Mascarene Islands a colony in 1746. After allowing citizens to freely commerce and establish themselves there by an act of the crown in 1767, the number of settlers on Reunion and Mauritius drastically increased (Alpers 2009). During the process of colonisation of the Mascarene, since the islands lacked an indigenous population to support the development of plantation agriculture, Madagascar became their reservoir of slave labour and food (Larson 2000, pp. 55-56).

As Larson (2000, pp. 52-53) explains, the French started trading intensely with the eastern Madagascan coast because, in contrast to the northwest, it lacked established intermediaries and it was closer to the Mascarene Islands. The power of the kingdoms of the interior increased to the point that, in the 1740s, they started expanding in the east and northwest to acquire the control of resources and trade nodes (Brown 2000). Conversely, the prosperity of the Sakalava kingdom in the northwest and the importance of Mahajanga as a port began to decline due to internal disagreements among its elites and the commercial competition of the eastern coast (Verin 1972).

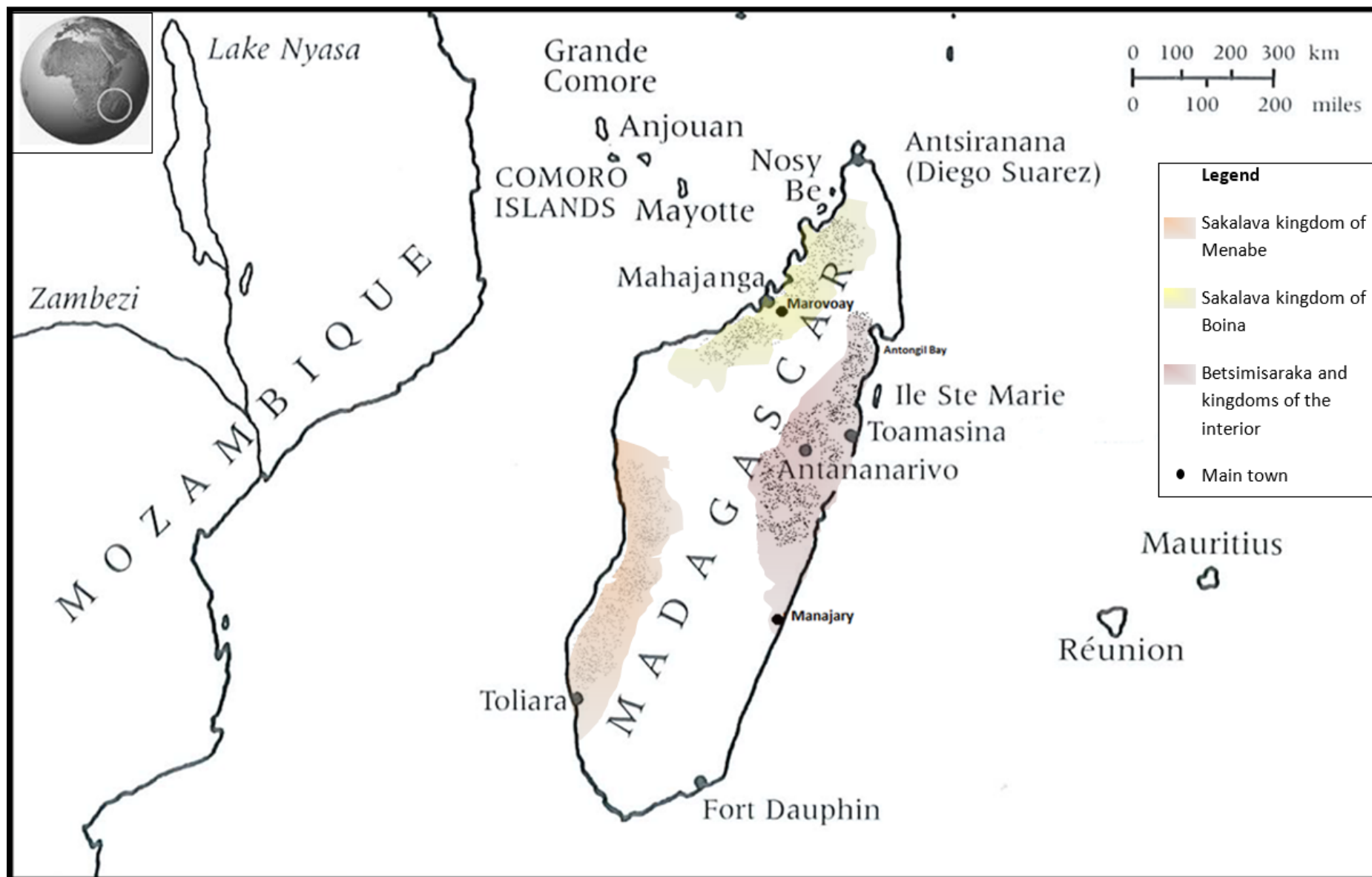


Figure 5.1: Map of Madagascar in the 17th century (Source: Brown 2000, p.9)

The Merina emerged from the highland kingdoms of the interior between the 1770s and the 1820s. Their capital was Antananarivo. They conquered fractured Betsimisaraka kingdom on the eastern coast and consolidated an empire that supplied more than two-thirds of the resources necessary to the plantation economy of the Mascarene through the port of Toamasina, where highlanders settled in large numbers to coordinate commercial activities (Larson 2000, p. 65-70). After the English took control of Mauritius in 1810 and until their abolition of slavery in 1833, the expansion of foreign sugar cane plantations in the Mascarene translated into a larger commerce in slaves by the Merina (Alpers 2009).

According to Deschamps (1961, pp. 155-162), although the Merina annexed Marovoay, Mahajanga and their territories in 1824, the Sakalava did not disappear from the northwest; from the 1840s onwards their northern-most territories formed a tripartite zone of influence alongside the new Madagascan elite and the French. The French established bases and plantations of sugar cane and vanilla in the archipelago of the Mitsio in the northwest, including the island of Nosy Be (Verin 1972). Slavers docked in Nosy Be and Mahajanga before sailing to the Mascarene or, due to the complication of circumnavigating northern Madagascar, marching their slaves towards the eastern coast to Antongil Bay or the French Island of Ste. Marie. This trade continued until slavery was formally abolished in all French colonies in 1848 (Alpers 2014).

The Merina tried to control commerce and increase the availability of currency for trade in a variety of ways. Instead of allowing European ships to dock in the main ports and freely conduct trade, they demanded foreigners to establish trading houses to enable taxation (Verin 1972). A very important share of commerce was captured by the British, French, Americans and Germans (Brown 2000). Foreigners were sold concessions to exploit mines, forests and agricultural land in the north and east of the country (Brown 2000). The Madagascan elite declared that trees were state property to control the exchange of precious timber and secure the resource against local communities' exploitation. However, the measure went without real application: traditional slash-and-burn

agriculture on the eastern coast and fire-related deforestation by herders and farmers on the highlands continued undisturbed (Kull 1996).

The sovereigns created additional mines that used forced labour to extract gold both for sale and the production of coins (Brown 2000). They increased the fiscal burden on farmers to induce them to cultivate cash crops for sale to the Europeans (Campbell 2005). Although slave trade was unlawful, until the early 20th century Mozambican slaves were sold in the highlands in order to purchase cattle which could be resold to Europeans (Alpers 2009). Slaves were also sold on Nosy Be to the French, who were keen to recruit 'volunteers' for plantation and sailing purposes (Deschamps 1961). The elite from Antananarivo forbade trading in livestock and imposed duties on beef products to increase the share income that they could capture from commerce (Verin 1972).

In the northwest, the Merina aimed to increase their control over resource extraction and trade (Verin 1972, pp. 169-175). They reduced the Sakalava to fishermen and herders, and forbade them from engaging in commerce. This left room for the rise of Muslim Indians from Gujarat to gradually become the main regional traders, which was perhaps in greater alignment with the economic objectives of the rulers. The Merina also facilitated the intensification of rice production for export and domestic consumption by creating irrigation infrastructure around Marovoay (Campbell 2005).

Although the creation of better infrastructure would have facilitated trade relationships, the sovereigns preferred not to build roads and bridges to Antananarivo for fear of a foreign invasion (Brown 2000, pp. 153-161). The path between Toamasina and Antananarivo was the most frequently travelled track in Madagascar: it was cheaper and it required three days' travel against the four-day journey from Mahajanga to the Merina capital. Toamasina was more accessible to transoceanic routes and the Mascarenes, and it possessed an established population of merchants from the highlands. The port became a favoured destination for trade and infrastructure development on the island (i.e., 2/3 of national imports and exports). Mahajanga shifted into third position after Mananjary in the southeast. During the period of Merina imperialism, Madagascan ports traded with

eastern Africa, Europe, the Mascarene Islands, the Middle East, India and China in products such as leather, skins, raffia, rice, beef, sweet potato, sugar cane, corn, bananas, precious woods and gold. Imports included gunpowder, rifles, pottery of various origins, dates, spices, English and American fabrics and Indian textiles, and other European manufactured goods.

Brown (2000, pp. 203-215) writes that the Merina sovereigns avoided losing control over the island by pushing the French and the English to balance each other out. In exchange for protection and training of the Madagascan army, the British were maintained as major trade partners. The success of this foreign policy was dependent on the strategic importance of Madagascar along the trade routes towards India, so that the opening of the Suez Canal in 1873 reduced its effectiveness. With the creation of the Canal, Madagascar became more and more peripheral to English interests, which focussed on controlling Egypt (Deschamps 1961).

Paris pushed for the annexation of Madagascar to its colonial empire for economic rather than strategic commercial reasons. French planters pressured the metropolitan headquarters to colonise the island in order to ensure sufficient supply of labour throughout Sub-Saharan colonies (Pétre-Grenouilleau 2004). The French could foster their colonial agenda due to the development of a British East African policy, which aimed to defend Egypt through the securitisation of Uganda and Zanzibar (Brown 2000, pp. 208-225). The French participation in the Anglo-German convention of 1862 gave them the right to be consulted about any change in the independent status of Zanzibar. As a means of compensation for their assent, the British recognised a French protectorate over Madagascar through a treaty signed in London in 1890 (Brown 2000, pp. 208-225).

The French began the formal invasion of the island in December 1894 with the bombing and occupation of Toamasina (Brown 2000, pp. 208-225). They disembarked their troops from the northwest because the gentle slopes of those highlands provided less cover for the Madagascan army compared to the track Antananarivo-Toamasina. In 1895 Mahajanga was occupied and the French troops proceeded towards Marovoay via land and the River Betsiboka. Later that year, after the French built the first road to reach the capital Antananarivo, the sovereigns surrendered to a

treaty of indirect colonial rule. Since the protectorate began with a violent rebellion, the French exiled the Madagascan sovereigns and established themselves in the ex-Merina capital in 1896 (Brown 2000).

5.2 The French colonial era: 1896-1960

During the first decade of colonisation, the French focussed their efforts on creating physical infrastructure and generating internal revenue by establishing a colonial economy supported by exports of primary resources. They modernised the port facilities of the country, extended the coverage of the telegraph, set up the postal service, and built both a road and railway linking Toamasina with the capital. Investment was directed to establish an economic regime based on plantation agriculture, forestry and mining (Brown 2000, pp. 235-240).

The colonial agricultural policy introduced the cash crops that would become the mainstay of future exports from the island: coffee, vanilla and cloves. To support the development of plantation agriculture, the government granted concessions to retired soldiers, French businessmen and settlers from Reunion and Mauritius (Deschamps 1961). Robusta coffee was cultivated mainly in plantations on the eastern coast and, similarly to other colonies in British and francophone Africa, it was grown to meet the large demand for the home market (Dinham & Hines 1984, pp. 52-55). Vanilla was grown in combination with jatropha and became an economically important crop along with cloves in the north and northwest (Dandouau 1908). In addition, sugarcane was cultivated in the west and northwest and rice, the indigenous staple, was mainly produced around Marovoay in the northwest and Lac Alaotra northeast of the capital (Deschamps 1961).

In 1897 the French created the first forestry regulations with the aim of reserving timber for logging (Sodikoff 2012, pp. 94-97). The first forest plantations were situated on the highlands along the eastern railroad mainly to fuel locomotives and supply raw materials for infrastructure development. They planted species such as acacia, Mexican pines and eucalyptus. In terms of

mining, Madagascar exported gemstones and gold extracted in the north, and graphite and mica mainly from the south (Deschamps 1961).

Two world wars and the Great Depression had important repercussions in the country. During World War I, Madagascar supported the French war efforts through the shipment of large quantities of rice, beef, leather and graphite from Toamasina (Deschamps 1961). The resulting scarcity of food and imports provoked considerable price inflation and widespread hardship which ignited early nationalist animosities (Brown 2000).

During and after the interwar period the French colonial government left its development priorities substantially unchanged (Deschamps 1961, pp. 280-287). It intensified the development of infrastructure to support export-oriented economic activities, created conservation areas for logging, and continued to grant large concessions to support plantation agriculture. The road system was extended to link together all main urban centres on the island (Brown 2000). The northwest and the east coast were prioritised for asphalted road upgrades and the creation of smaller tracks. Trucks, buses and lighter vehicles were introduced during this period. On the eastern coast of the island, the government created a new railroad linking the capital with the rice-growing area of Lac Alaotra, which supported the dense population of the interior, and another one south towards Antsirabe; Fianarantsoa was also linked by railroad and roads to the port of Manakara (Sodikoff 2005) (see Figure 5.2).

Forestry became particularly important during the interwar period. Colonial infrastructure development, forestry concessions and the creation of plantations proceeded hand-in-hand (Sodikoff 2012, pp. 95-97). The Forest Service was created in the 1920s to enforce a colonial conservation regime through woodland and fire policies (Kull 2004, p. 174, pp. 215-219). The traditional Madagascan uses of fire for herding and agriculture was banned because they were seen as detrimental to silviculture plantation and commercial exploitation of timber resources. The forestry department delineated a nationwide system of ten major forest reserves, including the Ankarafantsika forest in the region of Boeny (Tyson 2000, pp. 170-171). Forest protection was also

enforced through the creation of forest plantations using labour recruited via military conscription (Sodikoff 2005).

The interwar agricultural policy focussed on land reform, the granting of large concessions and a fiscal lever to force the peasantry to produce cash crops (Brown 2000). In 1926, the French colonial government declared all land without recognised owners – open or wasteland – property of the state (Klein et al. 2007). The creation of a land registry had the official intention to defend Malagasy property, but it supported the establishment of concessions because most peasants did not possess land titles (Deschamps 1961, pp. 257-260). Concessionaires exploited forestry resources and created plantations, which produced two additional crops: tobacco and cotton. Tobacco was added as a domestic cash crop mainly in the northwest. Cotton was important in the northwest and southwest. The cotton industry supported a nascent garment industry in the centre of Madagascar and became a major contributor to the domestic production of vegetable oil in the west of the country (De Laulanié 2003, pp. 179-180). Exports were supported by the creation of quality standards for coffee, vanilla, cloves, graphite and mica (Brown 2000).

The policy of budgetary self-sufficiency imposed by the French translated into burdensome taxation for those peasants living outside the monetary economy (Brown 2000). The fiscal lever aimed to develop the economy by inducing subsistence farmers to take formal employment and develop crops for domestic consumption or export. Levies were imposed on assets such as rice fields and livestock (Deschamps 1961). The French introduced a personal tax targeting the population who fell below the exemption levels of the standard tax code (Kaufmann 2001). These agricultural and fiscal policies contributed to the migration of many Madagascan peasants to urban areas and the surroundings of French-owned plantations, and to their increasing involvement with yearly cash crops such as tobacco (Brown 2000).

World War II brought the closure of the Suez Canal in 1941, thus renovating the strategic position of Madagascar in the Indian Ocean for trade and military purposes (Brown 2000, pp. 257-260). The British invaded the country to prevent Japan from establishing military bases on the island.

During the war imports were almost nil, while the country exported primary resources such as rice, coffee and beef required to support France (Thompson & Adloff 1965, pp. 34-38). Local industries such as garments, vegetable oil and soap continued to supply domestic needs, while plantation owners received loans from the government to maintain production for export. The rice industry was controlled through the government-owned *Office du Riz* (rice office), which obligated farmers to sell at low prices only to export the product or resell it domestically at higher prices. This caused widespread hardship and revived nationalist sentiments amongst the populace.

After WWII, an agricultural development plan increased mechanisation and the number of agricultural corporate giants on the island (Brown 2000, pp. 240-250). Perhaps due to the climate of hostility and economic stagnation prevailing in the country, the French colonial policies targeted the development of the domestic market in addition to exports (Deschamps 1961, pp. 288-291). Sugarcane plantations were expanded in the north and northwest, coffee plantations were redeveloped in the east, while tobacco became a farmers' cash crop in the mid and northwest of the island. Sisal began to be cultivated in the arid south in the late 1940s, and cotton plantations were extended nationally. Herds of cattle over the entire island were not particularly exploited, apart from a limited local production of meat and some exports to Mauritius and Reunion. Coffee was the leading crop, with an export rate of 80% of the domestic production. Albeit to a lower extent, vanilla and cloves remained valuable. Tobacco and cotton figured little in export statistics.

The French increased the value of exports and local production by strengthening light agricultural industries nationwide (e.g., de-husking of rice, oil pressing) and allowing for the consolidation of the textile sector in Antsirabe, south of the capital (Fukunishi & Ramiarison 2014). Despite the efforts of the government and foreign investors to create abattoirs, the livestock sector remained a traditional and domestically-oriented activity as it was during the pre-colonial period (Thomson & Adloff 1965, pp. 382-383). Industrial production at large was stunted by a lack of technicians, petrol and spare mechanical parts (Deschamps 1961). Roads and other infrastructure were in chronic need of maintenance and investment (Brown 2000).

The colonial government instituted autochthonous and directly controlled areas for agricultural modernisation in an attempt to target the development of the whole island (Kent 1962, pp. 116-118). While about 8% of the working population was engaged in salaried farming and fields other than agriculture, 87% of Madagascans were traditional smallholders living in rural communities of fewer than 2,000 inhabitants. The main crop cultivated was rice. People's purchasing power was low and monetary exchanges were still secondary in the economy at large. The initiative of the French targeted both production for exports and domestic consumption in an effort to stimulate agricultural productivity and the light industrial sector.

The Rural Autochthonous Communities were extensions of the powers of the traditional village assemblies and were assigned the duty to develop agriculture, maintain stockbreeding and increase the production of local crafts (Kent 1962, pp. 123-124). About 125 of these were elevated to the status of Rural Autochthonous Modernised Communities, which were endowed with extension services such as additional training, access to finance, and agricultural equipment such as tractors (Brown 2000, pp. 271-272; Thompson & Adloff 1965, pp. 149-150). These native areas contributed to increasing agricultural productivity and production for export, but they did not stimulate any substantial uptake of modern agricultural techniques (Deschamps 1961, pp. 273-274). The exception was made for seven experimental development zones directly controlled by the French. These areas coincided with high growth zones in the northwest and east of the country and were characterised by an advanced productive stage (Le Bourdieu, Battistini & Le Bourdieu 1969). Figure 5.2 below is an economic map of Madagascar before independence. It also shows the location of several cities mentioned in the discussion, the borders of the main administrative divisions of the country (i.e., provinces) and its transport infrastructure.

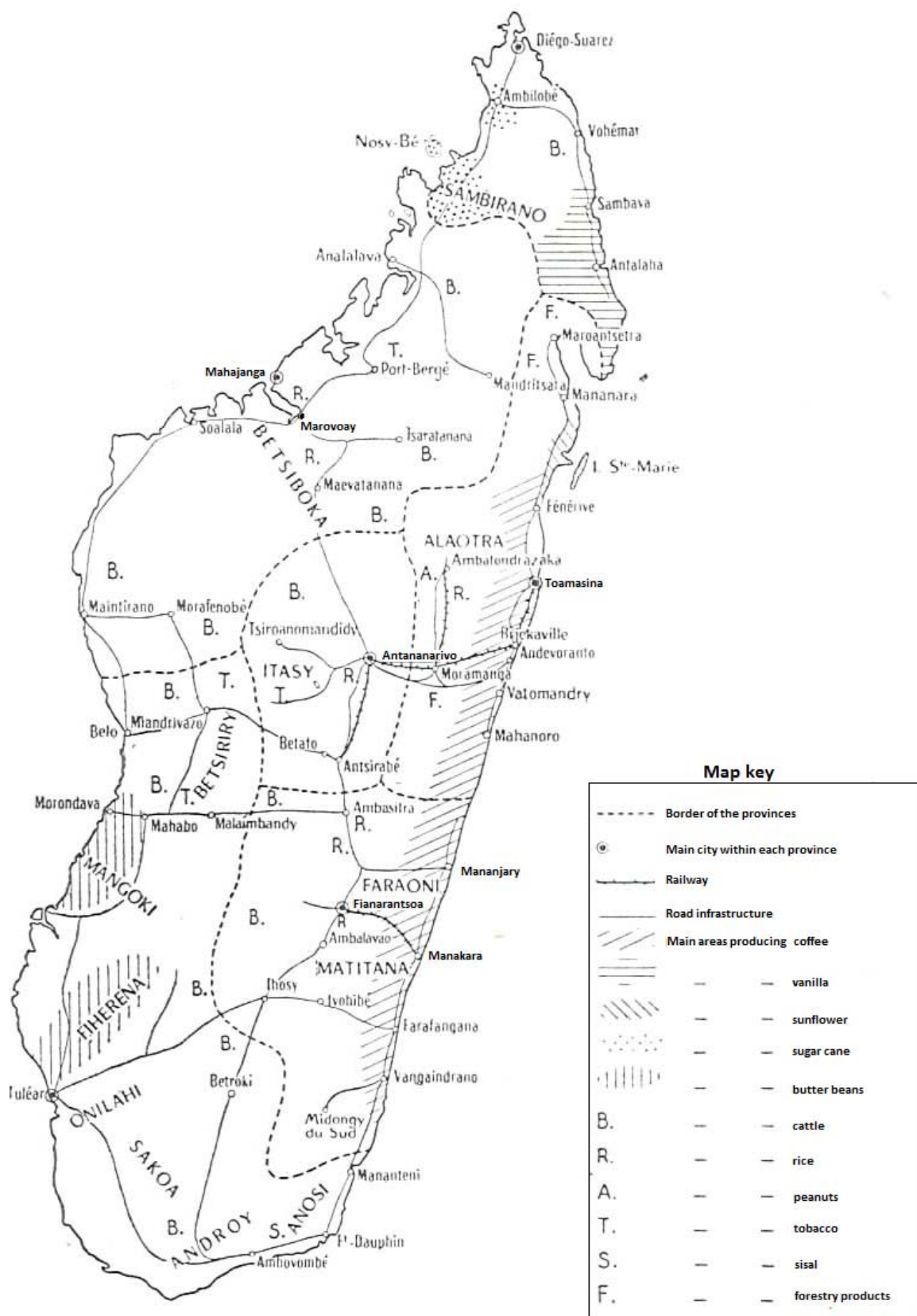


Figure 5.2 Geographic distribution of Madagascar's main economic activities in 1958 (Source: Deschamps 1961, p. 279)

5.3 Madagascar after independence

5.3.1 Tsiranana, soft socialism and the colonial economic legacy

After independence in 1960, the first Madagascan government was a benign socialist dictatorship under President Philibert Tsiranana (Brown 2000, pp. 294-300). He prioritised economic development through friendly relations with France, exports and the expansion of the light industrial sector. The private sector was allowed to develop on the basis of foreign investment: nationalisation was frowned upon because foreign companies brought important currency inflows. According to Duruflé (1989), the state implemented development policies aimed at strengthening the agricultural sector through large rural development schemes and the creation of industries that, protected by customs legislation, could substitute for imports while promoting economic development.

Dandoy and Coquet (1969) explain that the government aimed to induce the peasantry to increase productivity and adopt novel farming methods. Agricultural development efforts focussed mostly on the advanced areas in the north and east of the island that produced large quantities of rice and cash crops (Brown 2000, pp. 301-303). The government taxed unused plantation land to redistribute it to landless farmers, whose agricultural techniques were modernised by providing extension services, tractors, agricultural machinery and setting up marketing cooperatives. According to Marshall (2008, pp. 112-113), livestock maintained a prime economic position within the island economy. However, she notes that the sector remained under-funded in terms of investment, thus leaving basic production largely in the hands of traditional herders and limiting exports.

Forestry conservation became a lucrative business due to the tourists attracted by the first national parks and the exploitation of timber resources in an increased number of dedicated areas on the eastern coast and in the interior (Marcus & Kull 1999). Logging contributed to the traditional basket of exports from the country, albeit marginally compared to products such as coffee (Deschamps 1961). As Raharimaniraka (2010) describes, the government established afforestation

programmes in areas suitable for the commercial exploitation of economically important trees species such as the cultivation of cashew trees on 23,000 ha of land in the northwest of the country. The project aimed to increase exports and the productivity of two processing plants built near Mahajanga during colonial times.

The government favoured the expansion of light, agriculture-based industries around the main urban centres. For example, following the colonial legacy, Mahajanga was targeted to process beef, cigarettes, vegetable oil and sugar (Le Bourdieu, Battistini & Le Bourdieu 1969). The industrial cultivation of cotton was intensified in the northwest and southwest, with the products being channelled to Antsirabe to produce garments and to Mahajanga to extract oil and produce soap (Delorme & Le Bourdieu 1969). The small mining sector mainly extracted graphite and mica in the south (Rabenja, Karche & Petit 1969).

As a result of development efforts, industrial production grew by 13.5% per year and the related employment more than doubled during the first Republic (Brown 2000, pp. 305-306). Coffee, vanilla and cloves all continued to see the predominance of French plantations (Covell 1987, pp. 53-54). While the exports of these commodities more than tripled, the decreasing international prices of agricultural goods meant that their value only doubled. In conjunction with the oil shocks, the early 1970s saw an economic recession and the rise of protests that ended the Tsiranana regime.

5.3.2 Ratsiraka's socialism

In 1975 the Foreign Minister Didier Ratsiraka became president, proclaimed martial law and created a Socialist dictatorship. He broke the country's alliance with France by exiting the Franc zone and establishing a fixed exchange rate regime (Brown 2000). His government prioritised investment to expand state infrastructure, stimulate rural development to finance export agriculture, and strengthen import-substitution industrialisation (Duruflé 1989). The state took possession of abandoned colonial concessions, expropriated some plantations in the southeast near Fianarantsoa (Brown 2000), and directly owned industry and trade activities (Covell 1987). Export companies were nationalised, parastatals were created to collect agricultural products such as rice, but traditional

intermediaries continued their role in agriculture (Covell 1987, pp. 137-139). The new regime believed that agricultural development was hindered by the division of land in smallholdings and that subsistence farmers were not capable of productivity and scale economies sufficient to satisfy national requirements. It neither prioritized extensive redistribution of land, nor was there a systematic attempt to collectivise peasants' holdings.

As Duruflé (1989) explains, coupled with the deteriorating terms of trade for agricultural commodities, these economic manoeuvres initiated a cycle of crisis. The nationalisation of production led to a drop in exports, a contraction of foreign trade, a decline in state revenue, a limited public expenditure and the increase of taxes imposed on agriculture. The low level of economic growth achieved during the Tsiranana regime became stagnation, and peasants withdrew in large numbers from the monetary economy. In an effort to counter the deteriorating economic situation, in 1978-1979 Ratsiraka undertook an investment program heavily financed by borrowings from abroad (Covell 1987, pp. 143-144). The State aimed to change the composition of economic activities and double the country's gross domestic product through heavy industrialisation, food self-sufficiency and the export of manufactured goods (Barrett 1994).

This initiative failed due to the oil shocks, the further downturn in international prices of agricultural primary commodities, the appreciation of the US dollar, and a lack of spare parts to support mechanisation and the highly capital intensive techniques encouraged by foreign equipment suppliers and financiers (Covell 1987, pp. 67-68). Foreign borrowings were not matched by solid investment prospects, the transport and communication infrastructure on which the Plan relied needed maintenance, and the rural peasantry was reluctant to change agricultural techniques (Brown 2000, pp. 334-340). The export basket of Madagascar had the same composition as during colonial times, but its size shrank in response to crises. While many rural villages reverted to subsistence, the ceiling rice prices granted by the government to town dwellers made farmers lose interest in producing a surplus: rice supply declined by 50%, and large imports were required to fill the gap.

By the end of 1980 the country was experiencing a difficult fiscal situation due to the stagnation of economic production, substantial food imports and a large trade deficit (Covell 1987, pp. 148-149). Since the Soviet Union was no longer in a position to support the country, Ratsiraka had to resort to the assistance of the International Monetary Fund (IMF) and the World Bank (WB) to survive the national economic crisis (Barrett 1994). Donors agreed to reschedule Madagascar's debt under conditions involving several conservative stabilisation measures (Berg 1989): freely floating exchange rate; budget austerity; increased taxation and charges for public services; the maintenance of the road, telecommunication and energy networks; and some degree of economic liberalisation.

The Malagasy economy displayed plunging terms of trade despite injections of foreign aid and the rescheduling of debt (IMF 1991). Natural disasters, a steady economic decline, price inflation and failures in product distribution announced a larger economic crisis in 1980-1982 (Duruflé 1989). The adverse economic climate resulted in a decline of industrial production and mining; the deterioration of the transport infrastructure; speculation on agricultural prices, the development of parallel markets, and the breakdown of commercial networks controlled by parastatal institutions. This increased the influence of traders and the reliance of the peasantry on subsistence agriculture at the detriment of production in rural areas (Duruflé 1989).

From 1982 onwards, economic rehabilitation measures prioritised the repair of the road network and the liberalisation of agricultural production (Covell 1987, pp. 140-146). Donors advocated the elimination of market distortions in agriculture and the creation of a more competitive economy through the re-opening of crop collection to traders. The measure aimed to restore the production of existing primary commodities and to allow prices to fluctuate based on market conditions. The liberalisation of the rice sector promoted the fall of regional price differences and increased the competitiveness of traders and mills (Berg 1989). Developed areas like Marovoay and Lac Alaotra experienced drastic changes: more land was put into production; big farmers gained more wealth and assets than small peasants; and wage labourers, lessees, and sharecroppers grew

in number. The government decided to maintain lower prices for coffee, cloves and vanilla in order to encourage exports. The measure allowed cash crops to earn foreign exchange at levels compatible with the stagnating world market, but production dropped because their low retail price discouraged contract farmers' participation and investments in the maintenance of plantations (Duruflé 1989).

According to Barrett (1994), both the government's and donors' initiatives in agricultural liberalisation neglected a fundamental aspect characterising Madagascar's agriculture under every government prior to the 1980s: the island's strong peasant economy is based on small-scale agriculture, lacks modern technologies and is spatially segmented. Even under multilateral funding conditions, the dilemma of Madagascan agricultural policies consisted in their execution by and for almost everyone but the peasantry (Covell 1987). As Huntington (1986) describes, agricultural liberalisation perpetuated a quasi-subsistence context characterised by short-term returns on the main crops: it reduced certain aspects of communities' social capital encouraging egalitarianism; it increased peasants' vulnerability to market fluctuations and climate swings; and it amplified rural inequality.

5.3.3 The rise of environmental interests in the endangered paradise

Amidst the climate of crisis, environmental interests and conservation rose as agenda items of the government alongside economic development. The status of Madagascar as a unique global heritage for biodiversity was coupled with a major switch in institutional thinking about the island's primary resources, which became an additional avenue for the government to attract foreign capital. In 1984, Madagascar was the first country in Sub-Saharan Africa to draft a National Strategy for Conservation and Development (Kull 1996). Concerns for the preservation of Madagascar's unique plant and animal life – under threat by population growth and deforestation – led to the establishment of a special conservation aid program coordinated by the World Bank (Brown 2000).

The year before the 1988 presidential elections, Madagascar drafted its National Environmental Action Plan (NEAP) with the assistance of foreign consultants and stakeholders in

Antananarivo (Brinkerhoff & Yeager 1993). The natural wonders of the country were used to establish conservation projects that attracted foreign aid and, to a smaller extent, tourism. As Barrett (1994) explains, environmental interests provided almost three times more inflow of foreign currency than the IMF, World Bank and bilateral donors together. Donors such as United States Agency for International Development (USAID), the German technical cooperation (GIZ) and the World Wildlife Fund (WWF) substantially shaped the government's development and environmental agendas due to the prominence of their financial contributions (Horning 2008; Duffy 2006; Kull 1996).

Bringing forth a new era of cooperation between the two countries, USAID undertook a leading role in the implementation of this program (Larson 1994). While France historically financed economic development activities based on agriculture, the Americans financially 'carved out' an environmental niche through which they could influence the government's policies (Horning 2008). The WWF, which is an influential institution over national environmental policies, teamed up with the government to shift the model of forest conservation from secluded national parks to greater forms of community engagement (Austin & Bradt 2011, pp. 72-73). The NEAP became operational in the early 1990s and it was divided into three phases for an extraordinary duration of 15-20 years. The presidency of Madagascar and the World Bank thus committed to long-term actions reconciling the population with the environment (Razafindralambo & Gaylord 2006).

After Ratsiraka was confirmed as president for an additional term in 1989, Madagascar completely lost Soviet support due to the fall of the communist regime. The President resorted to the West – particularly France – for the cancellation of a large part of the national debt (Brown 2000). Madagascar was in a situation of crisis due to food insecurity, strikes, and civil unrest (Barrett 1994); rice became a major contributor to the trade deficit of the country, inflation increased, production dropped, and tax income decreased because of the political disturbances. Opposition against Ratsiraka broke into a series of protests and the proclamation of a shadow government led by Albert Zafy in 1991 (Marcus 2004). This situation caused Ratsiraka to step down from power, and

Zafy became president of a transitional government (Brown 2000, pp. 350-355). In order to avoid further social animosities, the transitional authorities adopted a new constitution and changed the multi-party electoral code to allow Ratsiraka to stand for election. In 1993, Zafy emerged the winner but, after three years of steady economic decline, his attempt to centralise authority in the figure of the President led to his impeachment. Ratsiraka was re-elected and remained in power until 2001 (Marcus 2004).

Alongside the traditional focus on export-oriented agriculture, Foreign Direct Investment (FDI) became a major focus of the government's effort to attract foreign capital to the country. Consistent with the market-oriented privatisation and competitiveness policies promoted by the World Bank, export taxes on cash crops were eliminated and the maintenance of irrigation systems became a responsibility of producers' organisations (Randrianarisoa & Minten 2001). State-owned enterprises were privatised or put into liquidation (WB 1999). The fishing industry and mining were targeted for private sector reform in order to attract investment and create jobs (WB 1999). According to Bird (2004), the prospects for FDI in mining compelled the government to update its legislation in line with international standards and transform the country into a more attractive investment destination.

The parliament passed a series of laws, decrees and orders that established a *Zone Franche* (free zone), which is the equivalent of an Export Processing Zone (Cling, Razafindrakoto & Roubaud 2004). The Zone was not restricted to any specific geographical area: it was applied to enterprises that, subject to approval by the government (Andrianasoloniriana 2006), intended to export at least 95% of production (Cling et al. 2004). *Zone Franche* companies could benefit from Madagascar's low labour costs and the trade advantages established by bilateral and multilateral agreements (e.g., the World Trade Organisation's Multi-Fibre Agreement) (Fukunishi & Ramiarison 2014). In view of developing the primary commodity industry through FDI (WB 1999), the government also eased the procedures and costs of obtaining land leases. These policies were intended to revitalise the

economy, especially the textile industry of Antsirabe, through investments from abroad (Fukunishi & Ramiarison 2014).

Following the implementation of these policies, clothing accounted for 90% of *Zone Franche* production, and Madagascar entered the global fresh vegetable industry mostly through outgrower arrangements to produce green beans for Europe (Minten, Randrianarison & Swinner 2009). By the end of the 1990s FDI to Madagascar increased to about USD 30 million. Non-traditional commodities (e.g., ylang ylang, sugar) constituted about 63% of total exports, which were still dominated by ex-colonial products (WB 1999). The production of rice and cattle remained substantially domestically-oriented activities.

5.3.4 The National Environmental Action Plan

While liberalisation and other policy reforms were tackling the economic rehabilitation of the country, the NEAP addressed donors' conservation priorities and aimed to stimulate grassroots rural development. The first phase of the NEAP began in 1991. It aimed to create several agencies to carry out environmental objectives, including the *Office National pour l'Environnement* (National Office for the Environment or ONE), *Silo National des Graines Forestières* (National Silo of Forestry Seeds or SNGF), and the Ministry of the Environment (Kull 1996). Under the coordination of the Ministry, ONE was in charge of promoting and executing conservation projects and policies, while the SNGF was responsible for improving (i.e., research and development) and managing (i.e., collection, production and distribution) Madagascan genetic forest resources (Vaneberg & Ramamonjisoa 1996).

Acknowledging the link between socio-economic marginalisation and environmental degradation – poverty as the main enemy of the environment – the first phase of the NEAP encouraged the creation of *Integrated Conservation and Development Projects* to reconcile the needs of local communities with the management of protected areas (Larson 1994). The strategy attempted to obviate the threats posed to forests by practices such as slash-and-burn agriculture, pasture burning and charcoal production by providing alternative economic activities (Kull 1996).

In 1996, the second phase of the NEAP mandated a shift from ICDP to more regional, landscape-based approaches targeting a larger population base to reverse environmental degradation (Razafindralambo & Gaylord 2006). Conservation extended beyond ICDP's buffer zones to create, for example, biodiversity corridors (Gezon & Freed 1999). Conservation operations were managed by national and local government offices with the participation of bilateral aid agencies and multiple economic sectors (Kaufmann 2008).

The Plan touched upon themes of land reform and agriculture through the *Gestion Locale Sécurisée* (secure local management or GELOSE) legislation. After years of top-down approaches to conservation, GELOSE represented an important step forward in grassroots primary resource management undertaken within a climate of liberal decentralisation policies (Andriamalala & Gardner 2010; Kull 2002). Taking advantage of a traditional rule-enforcement process called *dina*, the reform allowed the creation of land-use certificates recognised by the State for the exploitation and management of local resources (Andriamalala & Gardner 2010).

In 1999, decree N° 99-954 – also known as *Mise En Compatibilité des Investissements avec l'Environnement* or MECIE – was enacted to ensure the compatibility of investments with the environment. It required companies to conduct an Environmental Impact Assessment (EIA) before they could receive leases targeting more than 1000 ha of land (Andrianirina-Ratsialonana et al. 2011). The *Office National pour l'Environnement* was given the responsibility to implement the MECIE decree, deliver environmental permits for firms to operate on small parcels of land, and form a commission with the Ministry of the Environment to validate EIAs over larger acreages. Acting across local, regional and national levels, the EIA examined the economic, social and environmental impacts arising from investments in land through consultations with regional government authorities as well as local communities (Andrianirina-Ratsialonana et al. 2011).

Razafindralambo and Gaylord (2006) explain that the new phase of the NEAP was increasingly bundled with the economic development strategies of the World Bank, donors' projects and other initiatives. Slowly, the principles of NEAP were introduced in the Rural Development

Action Plan, which was supported by the Malagasy government, the World Bank and French Aid to improve administration, access to resources, agricultural productivity and develop new markets in rural areas (Rakotoary 2013). The structural adjustment instruments of the World Bank became a means to coordinate all of the activities undertaken by donors and the government in support of the integrated sustainable development of the country (WB 1999). For example, USAID sponsored the Landscape Development Interventions (LDIs), which focussed on the creation of 'eco-regions' linking protected areas with the surrounding landscape in two major forest corridors near Fianarantsoa in eastern Madagascar (Sodikoff 2009). The programme also supported the privatisation of the cashew sector in the northwest, where it participated to the distribution of seedlings and agricultural techniques (Raharimaniraka 2010).

Environmental interests and conservation activities entered a well-established trend in the foreign political and economic affairs of Madagascar. Since pre-colonial times, the Madagascan elites pushed for participation in international trade flows in order to attract foreign currency and consolidate the economy of the island based on their agenda. The successive governments exploited agricultural policies, land reforms and fiscal instruments to wrest away control over allocation and use of resources from the small farmers. Despite the creation of large plantations and a light industrial sector, agricultural production largely remained a dominion of traditional traders and peasant producers in rural areas.

The rise of environmental interests in the 1980s provided the government with a new lucrative strategy to attract foreign exchange, stimulate the economy and control the island's resources. Conservation and rural development policies began to converge under the belief that poverty is detrimental to environmental preservation as promoted by international donors' agencies. In the next chapter I continue this narration through the first decade of the 2000s, which assisted the acceleration of this process and the participation of FDI to conservation initiatives.

6 The greening of the Red Island

During the first decade of the new millennium, the government attracted foreign currency to Madagascar by raising the issue of environmental protection and focussing its discussion on energy security and poverty alleviation. FDI in the cultivation of biofuel crops offered a market-led conservation approach compatible with sustainable development objectives. *Jatropha* projects came about at a time when the concept of a carbon economy was also appearing.

The first section of this chapter looks at Madagascar's political economy during the first decade of the 21st century. It explores how the conservation discourse of the government was merged with narratives of energy security, self-sufficiency, rural development and poverty alleviation to create new environments for agribusiness investment. It then goes on to discuss how government agencies, foreign aid and international environmental organisations promoted *jatropha* cultivation and the region of Boeny to prospective investors.

6.1 The rise of Ravalomanana and the Madagascan development

corporatism

The new millennium began with a political crisis centred on the results of the 2001 presidential elections. The two main candidates were the incumbent Ratsiraka and the challenger Mark Ravalomanana (Marcus 2004). The elections took place but results were disputed. Ravalomanana obtained the majority of votes, but Ratsiraka did not accept this result. The stalemate led to unrest and a scenario whereby Ravalomanana proclaimed himself President in February 2002. Ratsiraka declared martial law and then Ravalomanana formed an alternative government. When the UN described Ravalomanana's actions as a coup d'état, many international businesses, bilateral and multilateral donors left the country. Madagascar appeared to be divided into two states: Ratsiraka set up his capital in Toamasina, while Ravalomanana held power in Antananarivo. Both contenders used security forces, protesters and the military to gain influence over the main provincial cities.

Ravalomanana's supporters had taken control of all major cities by mid-2002, making him the de-facto President of the country (Marcus 2004).

Ravalomanana's background was that of a successful businessman who built a large national dairy company called Tiko (Marcus 2004). Prior to contesting the presidential elections, he had also served as mayor of Antananarivo. There was widespread expectation among the populace that Ravalomanana would use his business acumen to develop the country. During his two terms as president, Ravalomanana reoriented Madagascar's foreign relations and aid to include US and Germany as important players alongside France (Duffy 2006). Marcus (2004) noted that the new president's move aimed to attract foreign capital from the USA and Germany while maintaining economic ties with France as Madagascar's largest trading partner.

6.1.1 The convergence of conservation and economic development in 2003-2005

Ravalomanana's government received official international recognition in late 2002. The government prepared a Poverty Reduction Strategy Paper (PRSP), which presented a new approach to structural adjustment based on socially inclusive development principles (Craig & Porter 2003). The PRSP outlined a strategy that linked the international donor support and national policy to achieve the targets set by United Nations' Millennium Development Goals (MDGs). The MDGs were aimed at eradicating extreme poverty through a series of indicators such as gender equality, education, hunger and sanitation (Sachs & McArthur 2005). The Paper stated the intention of the Ravalomanana's government to exceed the MDGs targets through a plan for "rapid and sustainable" development (International Monetary Fund [IMF] 2003, pp. 49, 86). In outlining this strategy, the government aimed to obtain additional funding from the Millennium Challenge Corporation (MCC) (IMF 2003), which was being established as an independent entity from USAID in order to provide grants for development projects (Phillips 2013). The IMF and World Bank endorsed the Madagascan PRSP in July 2003.

A few months later, at the Durban World Parks Congress in September 2003, the President declared the intention of increasing the size of protected areas in the country from 1.7 to 6 million

ha (Neimark & Schroeder 2009; Gaffikin, Ashley & Blumenthal 2007). The announcement was welcomed with enthusiasm by many government and environmental organisations, who pledged additional assistance to achieve this goal (Duffy 2006). Both this conservation pledge and PRSP were guided by the President's vision *Madagascar Naturellement* for rapid and sustainable development of the country (Neimark & Schroeder 2009). The vision portrayed population growth and rural poverty as the main causes for underdevelopment and environmental degradation. Ravalomanana claimed that by threatening Madagascar's "unique and rich biodiversity", "this poverty costs [...] the world" (Ravalomanana 2006, pp. 8-9). He described how the slash-and-burn methods of cultivation by subsistence farmers threatened to make the island's rich biodiversity go up "in smoke and ashes" (p. 9). Investments in conservation, forestry, and other income-generating activities in rural areas were thus required in order to heal Madagascar and build a strong economy.

The conservation discourse of Ravalomanana was not new to Madagascar. It involved narratives of deforestation and soil erosion that, as Figure 6.1 shows, made the Island appear as though it were "bleeding into the ocean" (National Aeronautics and Space Administration [NASA] 2004, para. 1). Through statements such as "we will become a 'green' island again" (IMF 2007, p. 24), the conservation narratives of the Ravalomanana government called on an idealised pristine state that, as Kull (1996) argues, may never have existed. Kull notes, however, that soil erosion has always been a problem in the Malagasy highlands where *lavaka* or erosion gullies are present in the landscape (Figure 6.2). Burning land for grazing contributes to soil instability and siltation of irrigation channels, flooding, and infrastructure damage during the rainy season. Ravalomanana's plea of burning and soil erosion derived its power from such images.



Figure 6.1: Satellite view of River Betsiboka, Boeny, 'bleeding into the ocean' during the rainy season (Source: NASA 2004, para. 1)



Figure 6.2: Erosion gullies (*lavaka*) in the Ankarafatsika National Park, Boeny (Source: Vassen 2009)

Ravalomanana's proposal for sustainable development occurred at a time when there was an overlap between the pre-existing National Environmental Action Plan (NEAP) and the PRSP (Lindermann 2004). The third phase of NEAP sought to mainstream environmental concerns in the national economic policy and regional development (Razafindralambo & Gaylord 2006). Conservation was tackled by the creation of biodiversity corridors, landscape approaches and Integrated Community Development Programmes (Duffy 2006). The budget allocation for the new phase of the NEAP was drastically reduced but foreign donors stepped in to fund it (Horning 2008).

The government's approach to conservation was broadened to include market-oriented regional and rural development. Economic policy focussed on environmental interests alongside an emphasis on fiscal management, currency stability and the promotion of tourism, mining, fisheries, and energy sectors (IMF 2003). Economic growth was to be promoted by revitalising regional economic poles or centres. The government prioritised urbanisation, increased private investment in leading export sectors, and increased inter-sectoral integration in regions with strong growth potential. Regional governments were encouraged to attract private investments, revive rural cooperatives and create public-private partnerships in lucrative industries (IMF 2003).

Agricultural modernisation was to be jumpstarted by removing taxes on the import of agricultural equipment and attracting domestic and foreign investment in agribusiness (IMF 2003). Regional governments were encouraged to exploit regional resource endowments (e.g., land) and economic activities (e.g., a vegetable oil industry, livestock or textiles) to increase exports. Regions or government agencies could apply to the national government to allocate the category of *Zone Franche* to any agribusiness or dedicated industrial zone that was producing commodities for exports. In order to ensure conservation goals, all new projects were required to complete an Environmental Impact Evaluation before starting operations (IMF 2003).

Sustainable development focussed on agricultural and conservation initiatives grounded in the framework of the 1990s Rural Development Action Plan (IMF 2003). The poorest rural areas were targeted for conservation, reforestation and the development of secondary activities which would create income from non-timber products. This strategy intended to improve water supply in catchments for irrigating commercial agricultural areas (IMF 2003). For example, reforestation around the Ankarafantsika national park in Boeny aimed to support the irrigation of rice fields in Marovoay (Renner 2012).

The German (GIZ) and US (USAID) aid agencies played a prominent role in conservation and sustainable development programmes (Duffy 2006; Horning 2008). GIZ provided policy advice for protecting biodiversity and introducing systems of sustainable resource exploitation, agroforestry and preventing soil erosion (GIZ 2015; Randriamamonjy 2007). In 1998-2012, GIZ was involved in the *Programme de Lutte Anti-Érosive* (PLAE) targeting soil erosion and *lavaka* formation. It used various plant species to prevent siltation around rice fields and soil erosion on hill terraces (PLAE 2012; Görgen 2011).

In 2004, following on from the previous Landscape Development Interventions and creation of Eco-Regions, USAID commissioned the consultancy Chemonics International to implement a Programme of Eco-Regional Transition (PET) (Styger 2006). The PET was to function as a transitional strategy towards a new approach to integrated economic development and conservation called Eco-Regional Alliance (ERA) (Chemonics 2004). The ERA comprised two parts: the conservation-focused Eco-Regional Initiatives (ERI) and the economic-focused Business and Market Expansion (BAMEX) programmes. A company called Development Alternatives Incorporated implemented the ERI along two rainforest corridors between Fianarantsoa and Toamasina by providing economically sound alternatives to slash and burn agriculture (USAID 2009). Chemonics (2004) received the contract to implement the BAMEX. The BAMEX programme provided technical assistance, capacity building and support to the government for establishing the legal and institutional framework for export-oriented industries and regional development

(USAID 2007). It created Business Centres *Ivoharena* (BCIs) (*Ivoharena* meaning source of wealth) in the provincial capitals of the country to boost domestic production and exports through agriculture, mining, craft and ecotourism (USAID 2008a). Later, the programme shifted its focus to market-based poverty alleviation (USAID 2009).

In 2005 the government signed an agreement with the MCC to create the Millennium Challenge Account (MCA), a state-run organisation responsible for implementing projects funded by the corporation. The MCA supported projects aimed at land reform, agricultural modernisation and diversification (MCC 2012a; MCC 2012b). The MCA established Agricultural Business Centres (ABCs) in five zones of action (Figure 6.3). The ABCs provided farmers with training in new agricultural techniques and identified international, regional and local market opportunities for domestic entrepreneurs and foreign investors (Agrifood Consulting International [ACI] 2008a). The large overlap with the activities of the Business and Market Expansion programme meant that the Millennium Challenge Account took over some of its BCIs (ACI 2006).

Land tenure insecurity was seen as the central obstacle to private sector investments in agribusiness and the development of rural areas. The government aimed to institute a transparent land tenure policy to provide long-term leases for FDI projects without disadvantaging local communities. It created decentralised departments called State-Owned Land and Topographic Services that were independent of the Ministry of Agriculture. These offices provided topographic and cadastral services using latest information technology. Allocation of land titles to farmers was contingent upon proof of utilisation for crop cultivation, afforestation and the payment of taxes (Andrianirina-Ratsialonana et al. 2011).

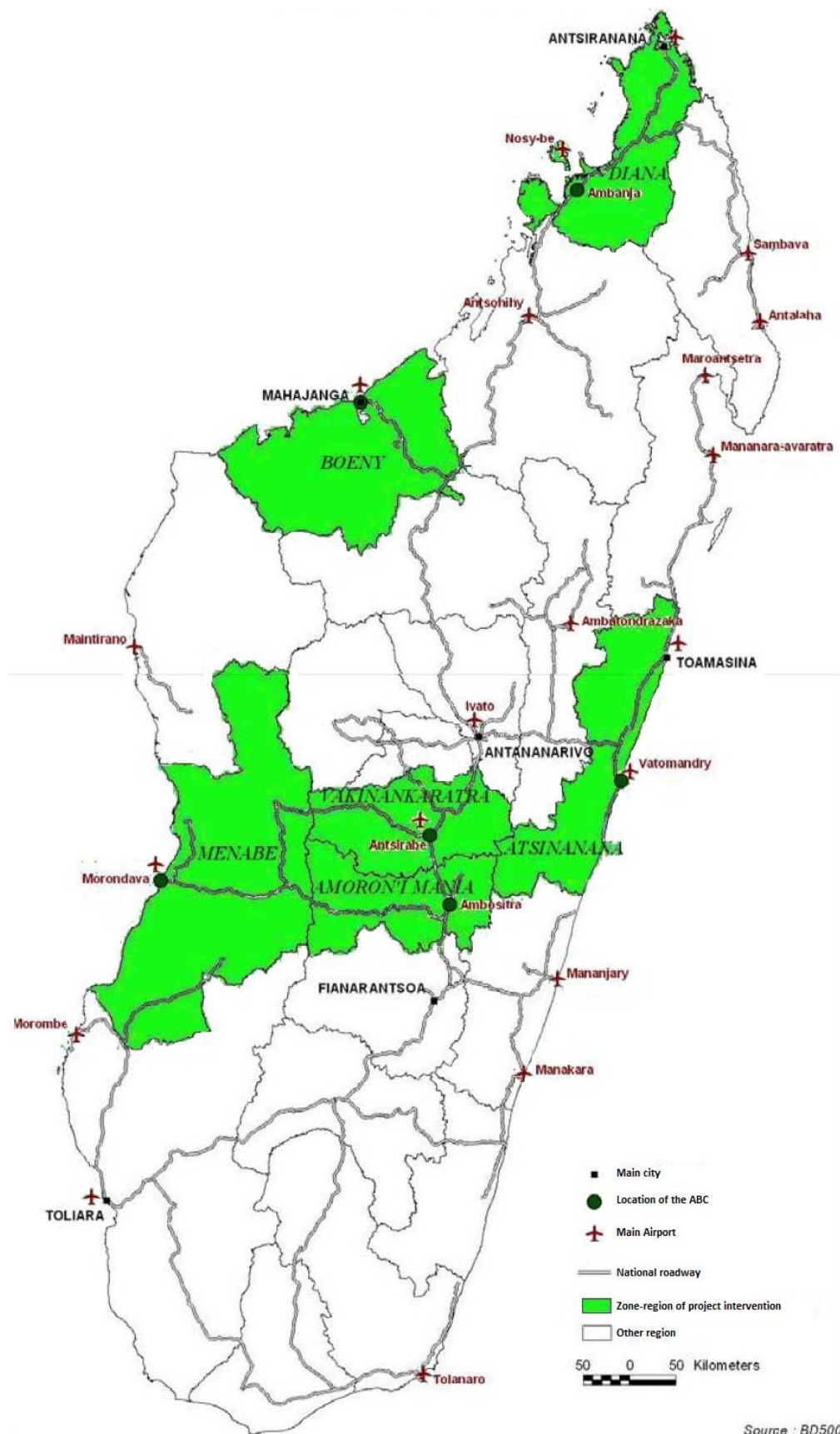


Figure 6.3: Map of the zones of intervention of the Millennium Challenge Account of Madagascar (Source: Smith 2008, p. 1)

The MCA aimed to support rural communities to move from subsistence to market-oriented agriculture through land reform and linkages with agribusiness (Danilovich 2007). Laws 2005-019 and 2006-031 allowed farmers to lodge a claim on customary land and receive a certificate, which had a legal standing similar to a land title (Andrianirina-Ratsialonana et al. 2011). Such land would then be registered as untitled property. Foreign investors were allowed to lease state land that was unregistered, vacant, or registered under the ownership of government agencies. Both laws received enthusiastic support at the grassroots level and secured Ravalomanana's presidency following the elections in 2006 (Neimark 2013; Teyssier et al. 2008).

6.1.2 The Madagascar Action Plan

In his second term, Ravalomanana proposed a "Quantum Leap" in sustainable development for the nation (IMF 2007, p. 3). This was outlined in the Madagascar Action Plan (MAP), which was an extension of the Poverty Reduction Strategy previously endorsed by the World Bank and IMF. The MAP was grounded in the government's Madagascar Naturally vision and set forth eight commitments to achieve the government objectives of exceeding the MDG targets (Figure 6.4).

At this time Madagascar faced a trade deficit and export-oriented production became even more important. This was because the country's main agricultural exports – vanilla, cloves, cotton and coffee — experienced an overall decline in value (International Trade Centre [ITC] 2015). Textile exports also dropped in value because of the dismantling of the multi-fibre agreement (IMF 2007). The rising cost of food, agricultural equipment and petroleum imports contributed to the widening trade deficit (ITC 2015). Fiscal discipline, self-sufficiency and diversification of exports were seen as critical for sustainable economic development (IMF 2007).

Responsible Governance	Connected Infrastructure	Educational Transformation	Rural Development and a Green Revolution
We will have a government that every citizen and the international community can trust and have confidence in. This government and the civil service will have integrity, be efficient, and act professional in all pursuits, activities, and the provision of services.	We will be a connected nation. We will build quality roads, railroads, ports, airports, and information technology systems all across the country to enable the process of rapid development, the facilitation of business and trade, communication amongst our citizens and visitors, and to ensure that the standard of living and the access to resources and global knowledge will improve for all.	We will create an education system with world class standards in quality and in effectiveness, which stimulates creativity and helps our students to actually transform their dreams into reality, and which provides Madagascar with the necessary human resources to become a competitive nation and a successful player in the world economy.	Dynamic rural development and real poverty alleviation is at the core of the government's endeavors. Our rural areas will flourish and prosper through a green revolution production. Agri-business centers will be established in every region to assist in training and the provision of needs such as irrigation, seeds, fertilizer and storage facilities. To further support rapid rural development, better roads and communication networks will be established and the Government will provide favorable conditions for the flourishing of entrepreneurship and private sector initiatives.
Health, Family Planning and the Fight Against HIV/AIDS	High Growth Economy	Cherish the Environment	National Solidarity
We will work to ensure that all of our people are healthy and can contribute productively to the development of the nation and lead long and fruitful lives. The problems of malnutrition and malaria will be brought to a halt. HIV and AIDS will not advance any further; safe drinking water will become accessible; and, through education and the provision of health services the average size of the Malagasy family will be reduced.	Madagascar will have a high growth economy with growth rates reaching between 7% and 10% by 2012. We will ensure that we have a diversified and strong private sector driven by local and international investment and trade. The Government will generate the fundamental conditions that will support the facilitation of business. We will encourage the pursuit of the best ideas and cutting edge techniques, technologies, and strategies to ensure that we as a nation are responsive to the challenges of globalization, productive in the workplace, and gain a competitive advantage.	Madagascar will be a world leader in the development and implementation of environmental best-practice. After many decades of exploitation and neglect, we have begun to turn the tide. We will become a "green island" again. Our commitment is to care for, cherish and protect our extraordinary environment.	We will continue to forge a strong, unified national identity that honors the multitude of cultures and traditions of all the people of Madagascar and promotes participation and partnership. Our people must be proud of who they are, stand with their heads held high, display confidence in the face of the many challenges facing us, and take full and shared responsibility for guiding the nation into the future.

Figure 6.4: The eight commitments of the Madagascar Action Plan (Source: adapted from IMF 2007, pp.24-25)

When MAP was created, the bulk of agricultural production was for domestic consumption and included rice, beef and cassava (Food and Agriculture Organisation Statistics [FAOSTAT] 2014). The government therefore aimed to diversify agriculture by attracting FDI for new export-oriented crops. A 'One-Stop-Shop' called Economic Development Board of Madagascar was created to guide foreign companies through appropriate public institutions, land acquisition procedures, and fiscal requirements (see IMF 2007, pp. 87-91; Andrianirina-Ratsialonana et al. 2011). The government continued to allow extension of the *Zone Franche* to export-oriented firms.

6.1.3 The promotion of FDI in biofuels

It was in this context that the MAP mentioned the promotion of FDI in biofuels. Invoking the earlier discourses of integrated conservation and economic growth, the MAP outlined commitments to create a 'Connected Infrastructure', 'Cherish the Environment', promote 'Rural Development and a Green Revolution', and support a 'High Growth Economy' (see IMF 2007, pp. 37, 63, 83, 97).

Under the commitment to create a Connected Infrastructure, the MAP identified the key challenge of "ensuring accessible and adequate energy supply at affordable costs" (Figure 6.5). Fossil fuels were almost entirely imported from overseas and formed an increasing share of the national trade deficit (ITC 2015). Petroleum supply was a matter of national security because energy shocks historically caused unrest, especially in urban areas (Brown 2000). The Ministry of Energy was put in charge of promoting biofuels to support economic growth and reduce Madagascar's vulnerability to oil shocks (IMF 2007).

In addition, population growth also created a higher demand for energy, particularly for electricity and household fuel demand. Only 5% of rural households had access to electricity (IMF 2007). Most rural households used charcoal for cooking, which put pressure on forests (Renner 2012). The Ministry of Energy was responsible for expanding the electricity network to cover a larger number of rural households and, in addition, to reduce their dependence on charcoal by providing alternative sources of energy such as biofuel.

PRIORITY PROJECTS AND ACTIVITIES	PROJECT LEADER
1. Restructure JIRAMA to become a reliable and efficient producer and distributor of energy	Minister responsible for Energy
2. Increase the capacity of electricity production through: <ul style="list-style-type: none"> • new thermal generator using oil with 40 MW • a third generator in Andekaleka • accelerated development of new hydroelectric station from Lily to Ampefy 	Minister responsible for Energy
3. Set up Independent Power Producers: <ul style="list-style-type: none"> • 5 hydroelectric station with 75 MW • new thermal generator using Fuel oil with 80 MW 	Minister responsible for Energy
4. Extend access to electricity in rural, semi urban area and high economic growth areas	Minister responsible for Energy
5. Reduce the negative environmental effects on forestry resources, especially the use of the charcoal	Minister responsible for Energy
6. Promote and use alternative and/or renewable sources of energy (eg: jatropha, ethanol)	Minister responsible for Energy

INDICATORS	2005	2012
Ratio of hydro energy production	64%	76%
Electricity coverage of communes	4%	10%
Composite index on energy price trends	To be determined	To be determined
Ratio of energy production through renewable sources (other than hydro)	0%	3%
Average households expenditure on energy	To be determined	To be determined
Energy unit price (kwh) to business	To be determined	To be determined

Figure 6.5: Connected Infrastructure, challenge four: ensuring accessible and adequate energy supply at affordable costs (Source: IMF 2007, p. 47)

The section outlining the commitment to Cherish the Environment stated that “Madagascar has not escaped from the increasing degradation of natural resources by irresponsible practices” (IMF 2007, p. 100). Under the key challenge to “reduce natural resource degradation”, the document assigned responsibility to the Ministry of the Environment for transforming the country into an international “leader in biofuel production” (IMF 2007, p. 101). Deforestation was to be reduced by promoting the use of alternative energy sources to households. Soil erosion was to be tackled by planting windbreaks and crops that could provide cover and additional income to rural communities.

The Ministry of Agriculture was made responsible for “Rural Development and a Green Revolution” that would encourage the peasantry to cultivate crops for domestic and foreign markets (IMF 2007, p. 63). This required the Ministry to identify lucrative crops and arable state lands in rural regions for piloting export production and provide extension services to farmers (Figure 6.7). Soil conservation was to be included as part of these activities.

The MCA, in collaboration with the Ministry of Agriculture, was required to promote agribusiness by encouraging processing, marketing and supply chain management activities through its Agricultural Business Centres (IMF 2007). The mandate of these centres included attracting domestic and foreign investors in new agricultural industries and implementing the government’s commitment to a High Growth Economy. Attracting FDI was one of the strategies for transforming Madagascar into “the best place to invest in sub-Saharan Africa and the Indian Ocean” (IMF 2007, p. 86) (Figure 6.8).

PRIORITY PROJECTS AND ACTIVITIES	PROJECT LEADER
1. Refine forest zoning	Minister responsible for Environment
2. Inventory natural resources	Minister responsible for Environment
3. Implement the Sustainable Forest Management Sites [Sites de Gestion Forestière Durable (SGFD)] - Koloala	Minister responsible for Environment
4. Intensify management transfer of natural resources	Minister responsible for Environment
5. Reorganize the management of traded/ tradable species	Minister responsible for Environment
6. Support the use of improved charcoal making techniques	Minister responsible for Environment
7. Promote the use of alternative energy	Minister responsible for Environment
8. Motivate the population on wild fire preventions	Minister responsible for Environment
9. Strengthen the implementation of anti- fire and clearing laws	Minister responsible for Environment
10. Implement soil erosion control (by wind and water) by planting windbreaks and cover crops	Minister responsible for Environment
11. Improve soil fertility with agroforestry systems, cover crops and conservation of ground and surface water	Minister responsible for Environment

12. For the better management of freshwater resources, watersheds and ecosystems develop an integrated Water Resource Management Plan that includes the promotion of reforestation to protect catchment areas, the monitoring of wells and groundwater, and increasing the efficiency of cropping systems	Minister responsible for Environment
13. Establish land reserves for reforestation [réserves foncières pour le reboisement (RFR)]	Minister responsible for Environment
14. Promote actions for reforestation, bush covering, and grazing prohibition	Minister responsible for Environment
15. Manage the pilot sites for carbon sequestration	Minister responsible for Environment
16. Promote research and development opportunities to ensure Madagascar becomes a leader in bio-fuel production by using palm oil, soy, maize, jatropha, and sugar cane	Minister responsible for Environment

INDICATORS	2005	2012
Number of developed sustainable use plans	8	219
Percentage of household using alternative energies	10%	25%
Rate of reduced burnt areas	17%	70%
Reforested area	360,000ha	540,000ha

Figure 6.6: Cherish the Environment, challenge two: reduce the natural resource degradation process (Source: IMF 2007, p. 101)

Rural development and a green revolution, challenge 5: diversify rural activities

PRIORITY PROJECTS AND ACTIVITIES	PROJECT LEADER	
1. Encourage partnerships between research centers and private producers	Minister responsible for Agriculture	
2. Decentralize services of seeds certification	Minister responsible for Agriculture	
3. Stimulate producers' organization in each new sector	Minister responsible for Agriculture	
4. Organize the supports to new sectors : inputs and technological package	Minister responsible for Agriculture	
5. Identify potential zones and specialize them in organic produce	Minister responsible for Agriculture	
6. Carry out campaigns of information and popularization relating to biological agriculture	Minister responsible for Agriculture	
7. Promote the approach « One village – One product » within pilot zones, develop leading sectors in the regions	Minister responsible for Agriculture	
INDICATORS	2005	2012
Average income of rural households (\$US)	123	370

Rural development and a green revolution, challenge 6: increase the agricultural value added and promote agribusiness

PRIORITY PROJECTS AND ACTIVITIES	PROJECT LEADER	
1. In each specific sector, bring together key stakeholders to maximize value chain	Minister responsible for Agriculture	
2. Across sectors, organize key actors across different value chains to increase efficiency and benefit from economy of scale	Minister responsible for Agriculture	
3. Set up agricultural productivity centers : agro-technopoles	Minister responsible for Agriculture	
4. Set up Agribusiness Centers to connect producers to market	Director Millennium Challenge Account	
5. Implement system of Hazard Analysis and Critical Control Point	Minister responsible for Agriculture	
6. Ensure the system of products tracking : zoning, varieties, genetics	Minister responsible for Agriculture	
7. Promote branding of regional products	Minister responsible for Agriculture	
8. Open up and and make viable zones for agribusiness investment	Minister responsible for Agriculture	
9. Set up and secure large agricultural investment areas	Minister responsible for Agriculture	
INDICATORS	2005	2012
Number of agri-industrial units	To be determined	To be determined

Figure 6.7: Rural development and a green revolution, challenge five and six: diversify rural activities; and increase the agricultural value added and promote agribusiness
(Source: IMF 2007, pp. 68-69)

PRIORITY PROJECTS AND ACTIVITIES	PROJECT LEADER
1. Render EDBM fully operational to actively promote FDI and improve investment climate	CEO of the Economic Development Board of Madagascar
2. Carry out a "Guillotine" approach of administrative procedures that are an impediment to investment	CEO of EDBM
3. Implement the new law on investments	CEO of EDBM
4. Develop a new and targeted marketing strategy for attracting FDIs	CEO of EDBM
5. Set up an industrial zone to speed up and facilitate investment in export-oriented activities	CEO of EDBM
6. Create a land bank to facilitate and speed up investment project implementation in tourism and agribusiness	CEO of EDBM
7. Initiate and ratify priority bilateral, regional and international investment protection agreement and non-double taxation agreement to increase investor confidence	CEO of EDBM
8. Strengthen the industrial arbitration court to solve disputes between employers and employees and between investors and government agencies/other investors	CEO of EDBM
9. Extend the insurance system on international transactions (Trade Insurance Agency)	CEO of EDBM

INDICATORS	2005	2012
Foreign Direct Investments (Millions US\$)	84	500
Ranking in investment climate	131	80

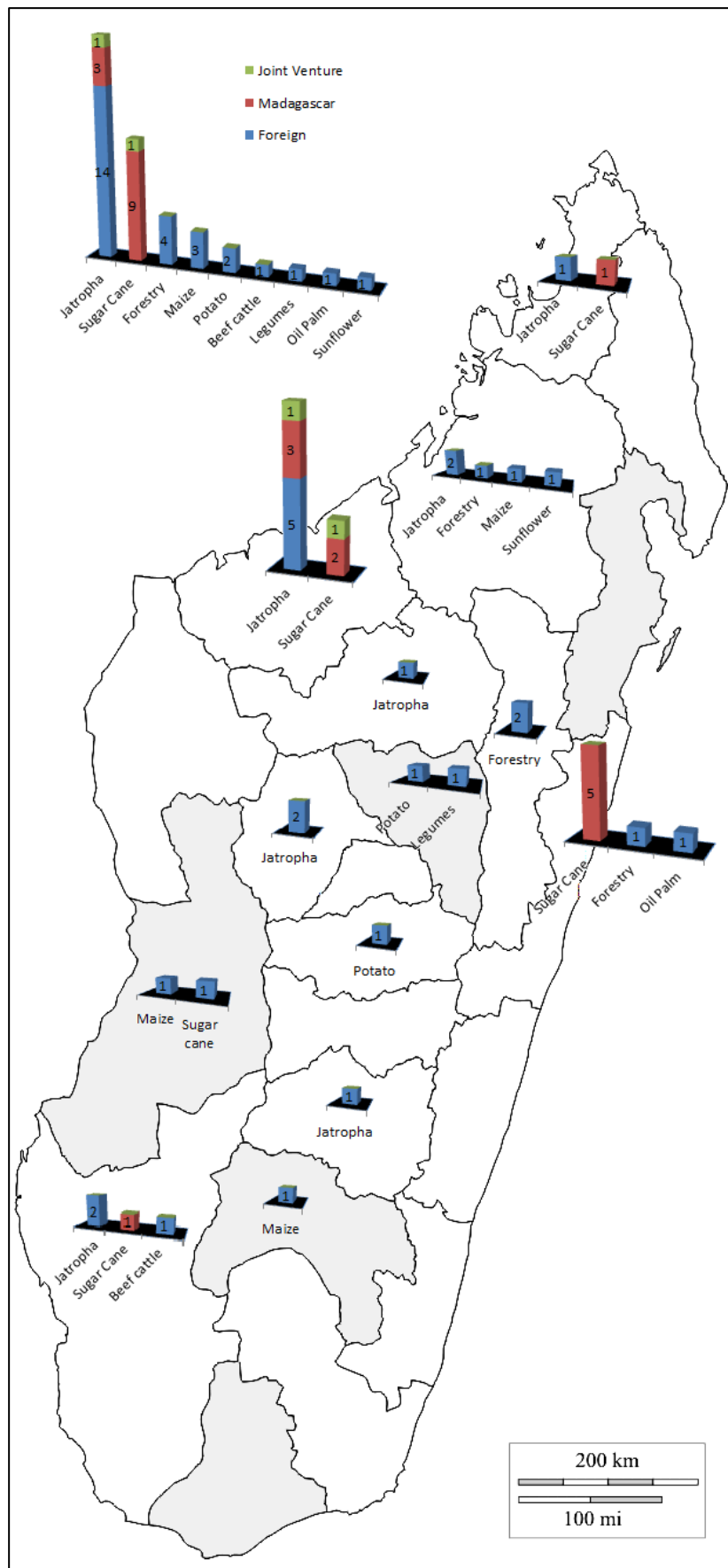
Figure 6.8: High growth economy, challenge two: increase foreign direct investment (Source: IMF 2007, p. 86)

Land was the key resource sought by foreign agribusinesses for export crop production and the government reinforced its importance in spelling out the MAP challenges. Under rural development, the government identified the creation of “land banks for investments in tourism, agribusiness and manufacturing” (IMF 2007, p. 64). Under ‘High Growth Economy’ and attracting FDI, the document reiterated the need to “create a land bank to facilitate and speed up investment project implementation in tourism and agribusiness” (IMF 2007, p. 86). The land reform that followed the endorsement of the MAP by the World Bank and IMF (Law 2007-036 and 2008-014) established the mechanism through which the majority of foreign investors could receive long-term land leases and set up agribusiness operations in the country (Üllenberg 2009).

Figure 6.9 maps the quantity and distribution of Madagascar’s agribusiness investments in 2003-2008. It is based on the information provided by Görgen et al. (2009), the International Land Coalition (2012) and Andrianirina-Ratsialonana et al. (2011). Around 70% of domestic and foreign investments targeted the cultivation of biofuel crops. *Jatropha* and sugar cane emerged as leading biofuels in the regions of Boeny and Antsiranana (Toamasina) where the MCA was functioning (see Figure 6.3). Sugarcane was largely cultivated by domestic firms in the Toamasina area, whereas investments in *jatropha* were mainly pursued by foreign companies in Boeny. Overall, *jatropha* had the highest number of projects nationwide and in the Boeny region.

6.2 *Jatropha*: the green gold of Madagascar

Jatropha’s first appearance in the MAP was within the portfolio of the Ministry of Energy (see Figure 6.5), where the plant was effectively used as a substitute term for biodiesel. The popularity of the crop within policy circles and among foreign investors derived from the collaborative groundwork of aid organisations, international environmental NGOs, government agencies and the private sector.



USAID had already collected some fact on the commercial potential of jatropha in Sub-Saharan Africa in 1990 (Fintrac 1990). In the early 2000s it had compiled information on early crop trials by the GIZ in Mali and Cape Verde, and it kept contacts with Indian institutions about the plant agronomy (USAID 2006). In 2003 Chemonics (the consultancy working for USAID) commissioned the Ministry of Agriculture to prepare a report on the potential of biofuel production from jatropha for addressing regional agro-ecological development (see Randriamorasata 2003). This was the same year when the CDM negotiations of the Kyoto protocol were completed, the EU established biofuel mandates, and India started targeting jatropha for biodiesel production.

The report echoed those studies that, in the 1990s, advocated smallholder cultivation of jatropha. It stated that the plant had widespread distribution and was well-known by farmers across the country. It was commonly called *vala-velona* – living fence – because it was largely used as a boundary marker around houses. Jatropha could grow on a wide range of soil types without needing irrigation. It could be cultivated as a biofuel and contribute to reforestation, environmental protection and the provision of income to local communities, especially women and children. The oilseed could be used for traditional medicine and soap-making. The report emphasised the multiple ways in which jatropha oil could be used as biofuel. The seedcake obtained after processing could be used to produce fertilisers, pesticides, biogas and, when detoxified, animal feed. Although it did not provide much evidence of commercial viability or market surveys of the crop, the report concluded that jatropha was an ideal raw material for national biofuel production (Randriamorasata 2003).

After receiving the report, Chemonics (2004) recommended USAID that jatropha oil could be used “as a green substitute for diesel oil used in engines” since it was a “well-known plant in Madagascar that grows easily in most regions of the country and can help farmers as a source of renewable energy and additional income” (p.12). It stated that small farmers could cultivate the plant and contribute to environmental protection, energy security and rural development (Chemonics 2004). Figure 6.10 recaps jatropha’s multiple uses promoted in Madagascar.

6.2.1 Leading jatropha companies and the promotion of the crop in 2004-2007

The arrival in 2004 of the first two foreign investors pursuing jatropha cultivation came as a bold signal for large-scale commercial biofuel production for the government and aid agencies (Government official #1). A development consultancy report for the Millennium Challenge Account (MCA) noted that “[j]atropha increasingly raised interest after 2004 due to the arrival of foreign investors looking for seeds and oil to produce biodiesel for European and Madagascan markets” (ACI 2008a, p. 33). Foreign investors were seen as the “only ones capable of sustaining all of the risks and demonstrate the economic viability of this value chain” (ACI 2008b, p.55).

The investors were Green Energy Madagascar Biofuels (GEM) and D1-Oils, the two largest jatropha companies worldwide (Hawkins & Chen 2011, 2012). D1-Oils was incorporated in the UK and listed on the London Stock Exchange (D1-Oils 2004). The firm indicated its interest in cultivating jatropha through large plantations and contract farming schemes in the regions of Alaotra, Vakinankaratra, Haute Matsiatra and Boeny. D1-Oils was supported by Daimler Chrysler Corporation, USAID and experts from the University of Hohenheim (Martin 2005). GEM Biofuels was also incorporated in the UK and listed on the London Stock Exchange. It indicated interest in large-scale plantations in the Atsimo-Andrefana region of southwest Madagascar (GEM 2007, p. 11). The World Wildlife Fund (WWF) provided support to the company for establishing plantations in this area (Üllenberg 2007).

The USAID programmes claimed credit for making Madagascar the most favoured destination for FDI in jatropha cultivation in Sub-Saharan Africa (USAID 2008a). Following the recommendations provided by Chemonics, jatropha was incorporated into the Business and Market Expansion (BAMEX) programme and the Eco-Regional Initiatives (ERI). ERI promoted the cultivation of jatropha as a form of community-based forest management to reduce poverty and diversify agricultural production (USAID 2009). It disseminated information provided by D1-Oils to the farmers’ cooperatives *Fédération Koloharena* (FKH) (USAID 2009). The FKH cooperatives distributed

the information across their national network, organised the collection of wild jatropha seeds to be sold to foreign companies, and produced oil for local cosmetic purposes (USAID 2009; ACI 2008a). The BAMEX programme promoted the crop as an investment opportunity to produce biodiesel for domestic consumption and export towards the EU (Rakotoarivelo 2007). It allocated a budget of USD 83,000 to support jatropha projects, which included the establishment of D1-Oils' plantations, nurseries, and the distribution of seedlings to contract farmers (USAID 2008c).

The connection between USAID and D1-Oils broadened to include the World Bank and the parastatal *Silo National des Graines Forestières* (SNGF). A memorandum of understanding between the BAMEX, D1-Oils, FKH and the ongoing *Projet de Soutien au Développement Rural* (Rural Development Support Project) secured an additional USD 62,000 from the World Bank to establish contract farmers' jatropha plantations and nurseries (USAID 2008c). The parties to the memorandum commissioned two milestone jatropha reports to SNGF. The first report analysed the productivity of jatropha in several regions across the country (Ramamonjisoa, Andrianoelina & Anfriamahay 2004). The second study provided advice on the promotion of jatropha through contract farming (Andriamahay 2004). The SNGF set up a collaboration with USAID and D1-Oils to organise the collection of jatropha seeds and establish nurseries with local farmers (Ramamonjisoa et al. 2004). The seeds were included in the genetic inventory of national forestry species and sold to NGOs, companies and farmers nationwide (Henning & Ramorafeno 2005).

GIZ began promoting jatropha in 2005 through its PLAE programme. It organised a series of workshops on the cultivation of jatropha as a sustainable energy crop that would provide multiple income-generating opportunities and also control soil erosion (Henning & Ramorafeno 2005). PLAE circulated this information during its national expansion. The PLAE's workshop areas were attended by "officers and peasant cooperatives" involved with the cultivation of jatropha (NGO representative #2). GIZ began collaborating with USAID to create the jatropha industry and exchanging information about various products (ACI 2008a). A government official interpreted the support of USAID and GIZ

to the jatropha industry as their intention to expand their portfolios from conservation activities to include more market-oriented strategies for the development of the country (#10). According to an NGO representative, PLAE collaborated with ERI in Fianarantsoa to find out whether jatropha seedlings or cuttings offered the best survival rates for propagation (#6).

Following its creation in 2005, the MCA took over the promotion of jatropha for biofuel production from BAMEX. The MCA worked with BAMEX and D1-Oils to set up a demonstration project to attract more investors' interest in jatropha cultivation (USAID 2007, pp. 9-10). The national government encouraged regional governments to provide expressions of interest for attracting FDI in jatropha. The MCA selected Boeny from its five Zones of Action (see Figure 6.3) for FDI in jatropha because of land availability, a favourable climate, and the presence of the commercial port of Mahajanga (Government official #9, #12; Corporate manager #2; ACI 2008a, 2008b). In addition, Boeny had several vegetable oil and soap factories and was also the base for PLAE, an ABC and a local branch of D1-Oils.

From 2006 onwards, donors organised a series of conferences in Antananarivo to present jatropha cultivation as an integrated development strategy. The Business and Market Expansion and PLAE highlighted the range of opportunities that the crop provided for energy security, environmental protection and rural development (USAID 2007). BAMEX also facilitated the exchange of information between government institutions and companies about the crop (USAID 2007). In 2007, the WWF joined up with BAMEX to promote the benefits of jatropha and called for increased investments in its cultivation (Rakotoarivelo 2007; USAID 2007).

In 2007, the Madagascar Action Plan provided an overarching framework to coordinate the activities of aid programmes, NGOs, companies and government agencies. The Ministry of the Environment took the lead in promoting the development of the industry because it saw jatropha as a forestry species that could earn carbon credits from biofuel production (Government official #4), but not from afforestation (Üllenberg 2007). The Ministry of Agriculture was involved because

jatropha plantations were seen as soil conservation projects and as providers of organic fertiliser (Government official #12). The Ministry of Energy entered the arena because the plant was providing biofuel for the transport and electricity sectors (Government official #11). The companies saw their role as delivering MAP's objectives (Ecosolutions 2008b). NGOs provided information and extension support for the BAMEX, *Programme de Lutte Anti-Érosive*, and Millennium Challenge Account projects.

The Madagascar Action Plan thus came to embody Ravalomanana's *Madagascar Naturellement* discourse of environmental protection linked to rapid, sustainable and export-oriented development. The greening of the Red Island was to occur through the tripling of forest reserves alongside diversification of export-oriented agriculture and attraction of FDI into the agribusiness sector. Biofuels were to be the saviours that would stem the flow of *lavaka* bleeding into the ocean, alleviate rural poverty and promote new industrial development in the country. And jatropha was the chosen agent to deliver these multiple outcomes in regions like Boeny.

7 The jatropha rush in Boeny

Jatropha made its first entry to Boeny in 2005, with the arrival of the foreign leading firm D1-Oils. With the guidance of the Business and Market Expansion (BAMEX) programme and the newly established Millennium Challenge Account (MCA), the company had come to set up its jatropha venture. During the following two years, it obtained land leases, procured seeds, began making contract arrangement with farmers, and established a pilot plantation. It set a baseline price for jatropha seeds at 100 Ariary per kg, which was about 5 US cents per kilogram (ACI 2008a).

In 2007, the plant appeared as the favoured biodiesel crop for Foreign Direct Investment (FDI) in the Madagascar Action Plan. Jatropha was the green gold for Madagascar's future. This was the time when petroleum prices were drifting to the new heights of USD 100 per barrel and investment bank Goldman Sachs declared that jatropha was one of the best raw materials for biodiesel. Boeny was abuzz with the news that several new companies were entering the market to produce jatropha.

Like pioneers in a gold rush, firms appeared quickly and in large numbers to capture a stake in the boom. They applied to the government for leases and sought the help of aid programmes and NGOs to start cultivation. Each of them thought that it had "the silver bullet for cultivating jatropha" and operated autonomously (Corporate manager #2; Üllenberg 2008b). On the ground, the popular view was that "companies and people involved in the cultivation of the plant said that jatropha grew on its own everywhere" (NGO representative #8). The price of jatropha seeds rose steeply to 450 Ariary per kg (ACI 2008a). Local politicians were thrilled. The mayor of a local commune exclaimed: "We are going to produce fuel here, in Madagascar, not in Saudi Arabia!" (Energyplus 2011).

By 2008 nine firms had established operations in the Boeny region. This chapter describes these jatropha pioneers: where they came from, their interest in jatropha, and how they went about setting up on the ground and getting production underway.

In the first section I present companies' financial sources and motivations for investing in the cultivation of the crop. I also explain the manner through which they accessed land, the business model that they followed, and the expectations that they raised about the outcomes of their operations. The second section focuses on the lessons that firms learned when getting started and establishing a calendar of activities. The adaptation of their operations to the biophysical and social characteristics of the regional environment shaped the process of value creation in the commodity chain. It stressed the logistical challenges of establishing an operational biofuel industrial complex and defied the construction of jatropha as an ideal, input-efficient crop for cultivation on marginal land.

7.1 Origins and interests of jatropha ventures

In 2008 there were nine companies operating in Boeny. Five of them were foreign, three domestic and one was a joint foreign-domestic venture. Table 7.1 presents information on these companies in terms of operations, financing, incorporation and headquarter locations. According to the corporate managers of the firms, most of them, including two of the domestic companies, had financial branches in Europe or in the offshore centre of Mauritius (D1-Oils 2009; Corporate Manager #2, #4, #6; #19). Only one drew on financing solely from within Madagascar.

Table 7.1: Typologies, headquarters and financial sources of the companies encountered during field research

Name	Type	Incorporation	Headquarters	Financial branch	Sources of finance and affiliations
D1-Oils	Sole production of jatropha seeds and oil for processing in the UK	London, United Kingdom	Middlesbrough, UK	Mauritius	The firm was publicly listed on the Alternative Investment Market of the London Stock Exchange. Financers include entrepreneurs like Karl Watkin and internationally-based hedge funds such as Lansdowne Partners, Majedie Asset Management, Principle Capital, and BlackRock Investment Managers.
JSL-Biofuels	Agribusiness and agro-forestry operations, reforestation	Antananarivo, Madagascar	Munich, Germany	NA	The company was created in Madagascar as a joint venture with the NGO GEXSI. It is financed through the philanthropic venture capital fund of GEXSI Capital Partners and the Daey Ouwens Fund, which was established by the Netherlands Ministry of Foreign Affairs to provide poor countries with job creation opportunities through renewable energy projects.
Ecosolutions	Reforestation and agribusiness	Munich, Germany	Munich, Germany	Mauritius	The enterprise was listed on the Frankfurt Stock Exchange as a spin-off of an Israeli agri-business and farm management group. After the creation of a Madagascan branch, the hedge fund Athanor Equities acquired the majority of shares. The firm had a working capital of USD 25 million. Operations in Madagascar were financed 40% by local sources and 60% via a consortium with two reforestations NGOs.
Energyplus	Agribusiness operations	London, United Kingdom	Port Luis, Mauritius	Mauritius	The firm is financed by entrepreneurs in Mauritius and secured loans from a bank in the UK. It created partnerships with key clients in Reunion and Mauritius.
Novalands	Sole production of jatropha seeds for processing and exports	London, United Kingdom	Tours, France	NA	The company was financed by the founding entrepreneur and attracted more capital through partnerships with manufacturers in the UK, Germany and other investors in Madagascar.
Greenoils	Sole production of jatropha seeds for processing and exports	Aix-en-Provence, France	Marseille, France	NA	The company was financed by the founding entrepreneur and non-specified additional sources.
Mahabib	Vegetable oil extraction, agri-business and industrial operations	Antananarivo, Madagascar	Antananarivo, Madagascar	NA	The firm's jatropha activities were financed as a pilot for the production of the plant and its by-products through internal corporate revenues.
Redsols	Vegetable oil extraction, agribusiness and industrial operations	Antananarivo, Madagascar	Antananarivo, Madagascar	Mauritius	The company is the branch of a corporate group operating in Madagascar. The jatropha activities of the firm were financed through a consortium with a large French fuel retailing business and an import-export company.
Soavadia	Agribusiness operations, reforestation	Antananarivo, Madagascar	Rome, Italy	Mauritius	The company was created by a Madagascan NGO that focuses on foundational, vocational and professional education. Planting activities were financed as part of a reforestation project sponsored by a partnering ENGO.

(Source: compiled from published information and field interviews)

Financing came from venture capital, corporate sector funds and international environmental NGOs. Venture capital is the finance invested in a project where there is a substantial element of risk such as a start-up (Rubin et al. 1999). It was provided by entrepreneurs and hedge funds interested in alternative investments. Hedge funds have relatively large amounts of capital at their disposal and substantial freedom to invest in unproven technologies in the expectation of reaping large profits from first mover advantage (Brunnermeier & Nagel 2013; Edwards 1999). They usually mobilise their finances from wealthy individuals and institutional investors such as pension funds (Karmel 2005). Corporate funding is the strategic use of a firm's internal finances to invest in projects deemed to be profitable (Blonigen 2005; Froot, Scharfstein & Stein 1993; Hubbard, Kashyap & Whited 1993). For the companies relying on corporate funding, the capital of domestic or foreign investors came from sources such as petrol distributors. Large international NGOs such as the World Wildlife Fund and smaller counterparts such as Eden Reforestation Projects can provide funding to implement activities that contribute to their conservation agendas (Kull 2014; Merrill & Corell 2008).

D1-Oils and *Jeune, Sociale et Loyale* (JSL)-Biofuels were among the largest regional players of the jatropha industry and attracted significant interest from government and bilateral aid agencies. D1-Oils's main shareholders comprised millionaire entrepreneurs such as Karl Watkin and several hedge funds including Lansdowne Partners, Majedie Asset Management, Principle Capital and BlackRock Investment Managers. In 2007 the company created a partnership with British Petroleum to set-up biodiesel refineries in Europe (D1-Oils 2007). JSL-Biofuels was set-up as a socially responsible German-Madagascan joint venture created by the Global Exchange for Social Investment (GEXSI), a UK NGO (GEXSI 2006). It was financed by a philanthropic venture capital fund called GEXSI Capital Partners to implement an agro-forestry scheme (Heijnen 2010). GEXSI capital partners received funding from wealthy individuals and, in 2008, the Daey Ouwens Fund. The fund was created by the Dutch Ministry of Foreign Affairs to provide energy access to people in the least developed countries through eco-friendly projects such as biofuels (Heijnen 2010).

The leading position of D1-Oils and JSL-Biofuels was facilitated by their connection with the Roundtable of Sustainable Biofuels (RSB), which was founded by the WWF, and the Jatropha Sustainable Biofuels Alliance (JA), which is an industry support platform created by GEXSI (RSB 2010; JA 2009). This governance configuration allowed the two companies to access international best practices for cultivating jatropha. For example, the global jatropha market study by GEXSI (2008) aimed to support the RSB in the sustainability certification of the crop. The study was performed with the financing provided by British Petroleum, D1-Oils' partner. While D1-Oils had operations in 11 countries worldwide and considerable experience with the crop (D1-Oils 2009), JSL-Biofuels accumulated it by participating to GEXSI's market study (Corporate manager #2).

The financial sources of the remaining jatropha companies in Boeny are more straightforward than the ones of D1-Oils and JSL-Biofuels. The ventures of Novalands, Greenoils and Energyplus attracted financing from individual entrepreneurs who saw jatropha as a lucrative crop and Madagascar as a land of opportunity (Corporate manager #2; Redsols 2012; Üllenberg 2007). Redsols was financed by a European petrol company that wished to control a stake in the implementation of the EU biofuel mandates (Redsols 2012). Mahabib employed its corporate finances to produce biofuel and power its small-scale industrial activities (Corporate manager #6). Ecosolutions and Soavadia joined forces with EU-based environmental NGOs to create jatropha plantations as part of reforestation schemes. Jatropha was planted as fire-break to reduce the risks of wildfires in their larger forest plantations (Corporate manager #7, #19). As compared to D1-Oils and JSL-Biofuels, these companies had limited access to international expertise about jatropha cultivation besides the institutions facilitating the creation of the industry in Boeny.

7.1.1 Interest in jatropha

Based on my interviews, there was a range of reasons of varying importance that companies cited for investing in jatropha in Boeny. Table 7.2 provides a summary of the different reasons for investing in the crop. One very important reason highlighted by the foreign companies was the expectation of large profits gained from being the pioneers in jatropha production. They noted that the projected EU consumption targets created the possibility for first movers to capture a large share of the biofuel market. Venture capitalists financed most jatropha companies; they “considered that there was a high risk but potentially a huge amount of profits for the survivors to the industry establishment phase” (Corporate manager #2). For Mahabib, a domestic company, the most important reason for investing in jatropha cultivation was producing enough biodiesel to generate electricity for its operations and not being subjected to the irregular power supply of *Jiro sy Rano Malagasy* (JIRAMA) the national utility provider (Corporate manager #11).

Other important reasons were related to the characteristics of the crop and its ability to meet the EU biofuel quality standards. Some companies highlighted the importance of jatropha as an efficient crop because of its low requirement for agricultural inputs and high yields per hectare. They also noted that the crop met the quality standards of the EU biofuel mandates and it did not compete with food production (D1-Oils 2004; Ecosolutions 2008b).

Table 7.2: Corporate motives to invest in jatropha

Reason to invest in Jatropha in Boeny	Importance	Explanation
1) Pioneer or first mover advantage	Very important	Firms that survive the industry establishment phase and undertake the large risks of establishing the novel technology can capture large profits before competitors catch up.
2) EU biodiesel consumption targets	Very important	The EU mandatory biofuel consumption targets have guaranteed a large biofuel market.
3) Energy independence (domestic firm)	Very Important	Independence from the national energy utility provider JIRAMA
4) Efficiency of the crop	Important	Jatropha is the most price-competitive raw material for biodiesel production based on oil-yield per hectare, inputs and pedo-climatic requirements.
5) Satisfaction of EU quality standards	Important	Jatropha fulfils the EU biofuel quality standards and, since it does not compete with food production, it satisfies sustainability criteria in a better way than other crops.
6) Specialised energy crop	Less important	Jatropha is not affected by swings in food prices.
7) Trade agreements between developed and Least Developed Countries	Less important	The EU Cotonou Agreement and Everything but Arms initiative allow Madagascar duty-free access to the European market.
8) WTO trade rules	Less important	Biodiesel is not subsidised but subject to fewer trade restrictions than bioethanol.
9) Carbon financing	Of some relevance	Businesses are interested in receiving carbon offsets in the future.
10) Investment climate and regional assets	Of some relevance	Madagascar and the region of Boeny offered a favourable investment climate, appropriate cultivation conditions and suitable land and labour at low cost.

(Source: compiled from published sources and fieldwork interviews)

Surprisingly, companies did not consider trade regulations and agreements to be of much importance, even though they formed a governance context for global jatropha investments. The World Trade Organisation imposed fewer trade restrictions on biodiesel than bioethanol because the former was categorised as a chemical (Mortensen 2012). The EU Cotonou Agreement and Everything But Arms initiative granted duty-free access to the EU market for Madagascar because of its classification as a Least Developed Country (ACI 2008a). Jatropha was also regarded as a crop that was not subject to massive fluctuations in price as was the case for food crops. These reasons were considered 'a plus' for investing in jatropha (Corporate manager #2).

Although investments in biofuel production were linked to the Kyoto Protocol and the emergence of a carbon economy linked to the Clean Development Mechanism (CDM), companies considered carbon financing to be of minor importance for cultivating jatropha (Corporate manager #2). They did not see carbon offsets as relevant at this stage because they had not yet started jatropha oil production and they mainly wanted to produce biodiesel that was competitive with the prevailing high petrol prices (Corporate manager #18; Ecosolutions 2008b; D1-Oils 2004). According to a corporate manager, carbon offsets could have come at a later stage after a restructuring of international corporate operations to satisfy the criteria of the CDM (#2).

The regional assets and investment climate in Madagascar were regarded as advantageous because they contributed to the ability of companies to raise finance for their jatropha projects. Firms chose to invest in Boeny because it stood out as the best location for their operations due to the favourable foreign direct investment policies created by MAP, the availability of suitable land and labour at low cost, and appropriate cultivation conditions (Corporate manager #2, #6, #8).

7.1.2 Access to land

Companies had to access land to cultivate jatropha and create an industry. The government departments at the national and regional levels facilitated this process. After the demonstration of the technology by BAMEX and D1-Oils in 2005, the regional government created the *Plan Régional*

de Développement – Region Boeny (Regional Development Plan – Region Boeny [RB]) (RB 2005a).

The development zone of Marovoay was selected as a “pilot area for the jatropha value chain” to accommodate FDI projects (RB 2005b, p. 121). In the following years, the regional branch of the State-Owned Land and Topographic Services (SOLTS) and local government authorities identified potential plantation areas for cultivating the crop. In 2007 the national government implemented a land reform to simplify the procedure required to receive long-term land leases for foreign investors.

Seven out of nine companies targeted land in the development zone of Marovoay. Figure 7.1 shows the areas that they planned to cultivate. The plantations were to be located in proximity of the *Route National 4*, which is the main roadway that connects the port of Mahajanga with Antananarivo. Redsols and Mahabib owned land close to Mahajanga since the 1990s (Redsols 2012; Corporate manager #11). The other jatropha companies applied for land leases to set up plantations in the surroundings of Marovoay and the Ankarafantsika national park.

The land that firms targeted is called *tanety* (meaning hills in Malagasy) by locals. Randrianjafy (2001) describes *tanety* as a savannah originating from the regression of forests. The landscape is both the result of cultural and physical forces: centuries of agricultural and herding practices by local communities have made it fire-prone as herders rejuvenate the grasses to provide food for their cattle (Kull 2004, 2002). At the same time, local farmers sometimes burn the grass to open plots and cultivate cassava or rainfed rice for their households necessities. *Tanety* is inextricably important to the local agrarian economy. However, government officials do not appear to see it in the same way as local communities. They see it as “marginal” (Government official #2), “non-productive” state land (IMF 2007, p. 66). Corporate managers share a similar view and define the ‘marginal’ land they targeted as “eroded” and “deprived of organic matter” because it cannot accommodate the commercial cultivation of valuable crops such as corn (#2, #9; Renner Andreas 2007).

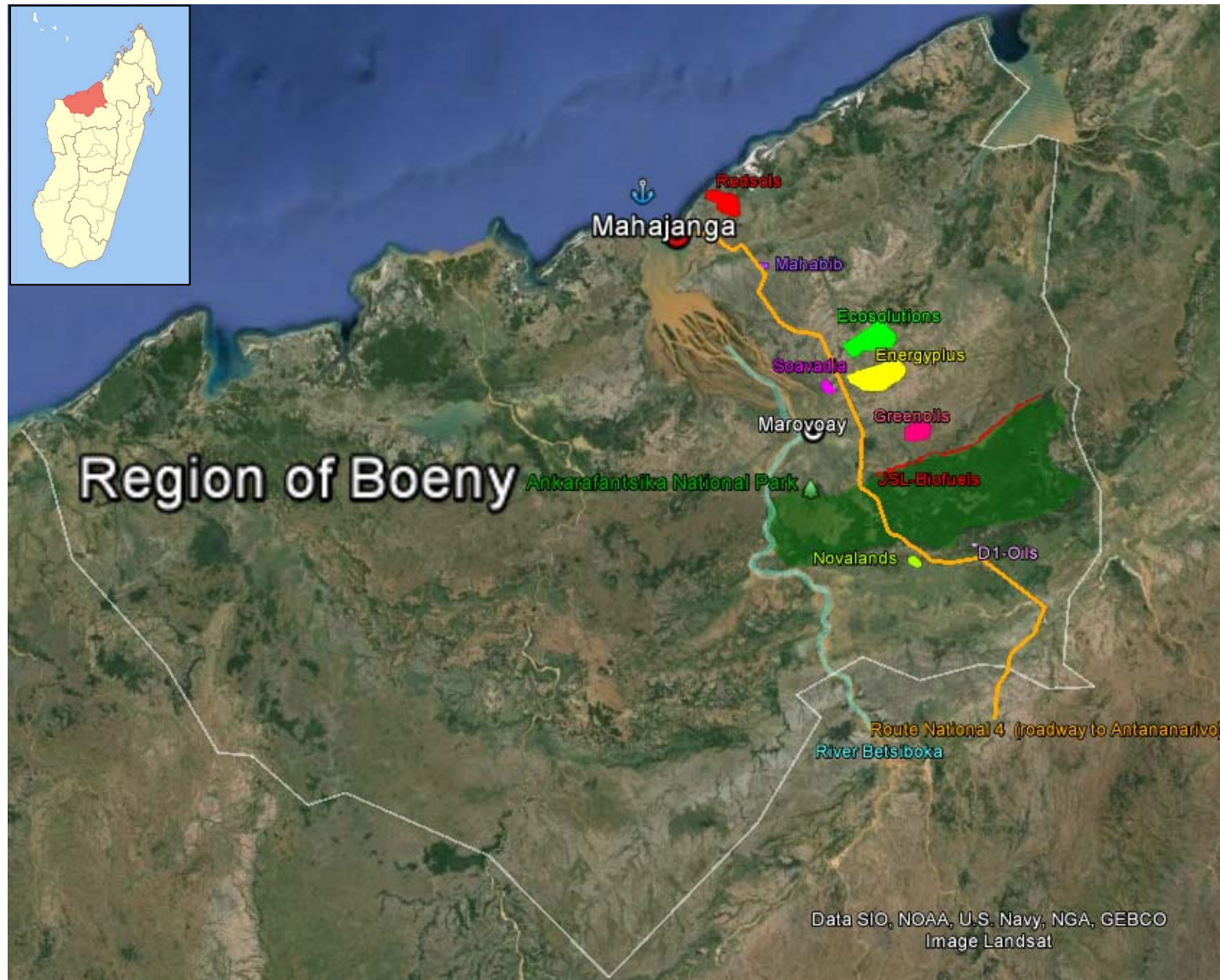


Figure 7.1: Mapping jatropha plantations in Boeny (Source: author; copyright Google 2015)

The government established that companies could only acquire long-term leases on *tanety* or any other land after proving they resolved conflicts with traditional tenure systems (Andrianirina-Ratsialonana et al. 2011). The process illustrated in Figure 7.2 shows that companies had to apply to different government departments based on the amount of land that they sought to access. I elaborated the Figure from a large range of documents provided by the SOLTS (2012) and the discussion of Üllenberg (2010). The regional branch of the SOLTS was linked to the Ministry of Decentralisation and played a considerable role in the application process for long-term leases.

The collaboration between companies and the SOLTS in Mahajanga unfolded in six steps that could last for a minimum of 2 months and cost at least USD 200 (SOLTS 2012). In the first stage, companies were expected to work with the Topographic Services to make an initial request for land, create a map of the property, obtain a cadastral plan and map, and establish land boundaries. Secondly, companies had to consult with the commune (i.e., local government authorities that control the area of many villages) and local villages affected by their project before obtaining a report about conflict resolution from the government of Marovoay (i.e., district authorities). In the third step, the report had to be reviewed and endorsed by the regional government in Mahajanga. Stages four to six could involve other government authorities based on the amount of land requested by firms. The stages were led by the Land Services, which would establish a request for the land, recognise its boundaries, reserve it to the company and provide an act of change in its status if applicable.

D1-Oils received a long-term lease from the State to cultivate land in various regions; in Boeny the company's plantation covered an area of 250 ha (Andrianirina-Ratsialonana et al. 2011). The other firms did not follow the trajectory to access land envisioned by the government because they aimed to start production as soon as possible. After having begun the six-step process to receive a long-term lease, the Ministry of Environment allowed them to access some land in the areas that they targeted to perform "early crop trials" (Government official #5).

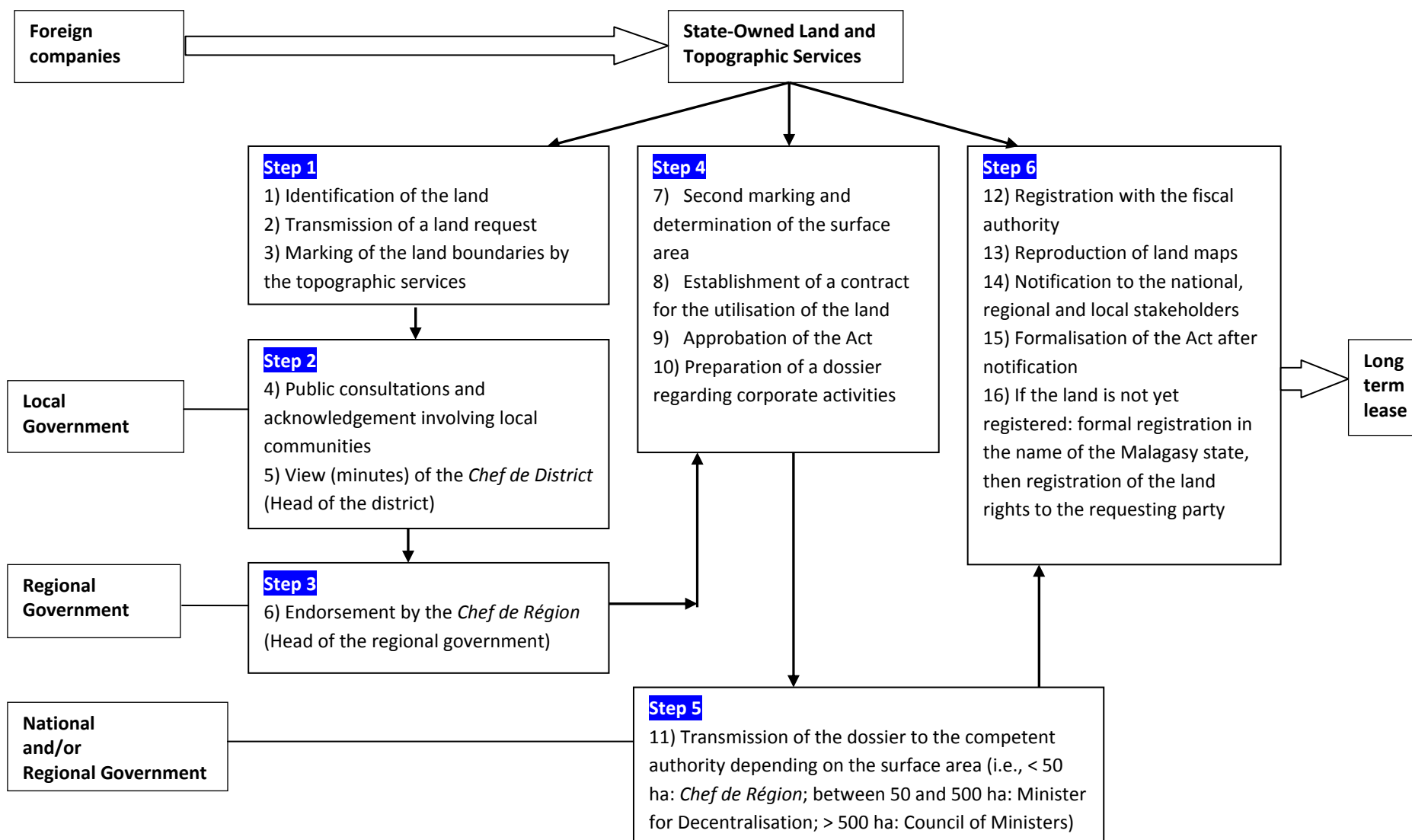


Figure 7.2: The process of corporate access to land in Madagascar in 2007-2008 (Source: author)

The long-term lease of JSL-Biofuels was obtained with the collaboration of the Ankarafantsika national park, the regional government and local authorities, which were its partners in the creation of a large agro-forestry project. The government of the commune affected by the project was the main party involved in the negotiations to allocate land. Traditional village authorities were not considered for the resolution of potential conflicts on the ground but were informed about the plans of the company. The firm acquired land-use rights from the commune on an area of 1,000 ha in exchange for a football field, a satellite TV, and annual shares of future jatropha oil production (Heijnen 2010).

Both Novalands and Energyplus initially leased small land areas from the regional government and later obtained larger leases from the national government (Üllenberg 2008b; Rivoarivelo 2012). They did not consult with village authorities about the status and use of the land that they were going to cultivate, but they informed local communities about their business plan (Rivoarivelo 2012; Medernach, Burnod & Rakotomalala 2011). Novalands received a lease on 3,500 ha from the central government in 2007 (Üllenberg 2008b). Energyplus obtained a to exploit 30,000 ha from the national government in early 2009 (Andrianirina-Ratsialonana & Teyssier 2010).

The remaining companies followed different strategies to access land. Ecosolutions received a long-term lease on 3,500 ha of land titled in the name of the Ministry of Environment, which the company could develop under agreement with the regional government (Ecosolutions 2012). The firm aimed to extend cultivation on larger areas after demonstrating the commercial viability of the crop (Corporate manager #8). Greenoils leased 400 ha of land from a private owner to create a medium-size plantation before applying for a lease for public land from the central government (Corporate manager #2). Soavadia accessed 2000 ha divided between two plots destined for reforestation by the Ministry of Environment (Corporate manager #19).

7.1.3 Production models

There are two main models for the cultivation of tree crops in developing countries (Mandy & Msangi 2009; Nigel & Runsten 1999; Simon & Fernando 1989): contract farming and large plantations. Contract farming is the practice of outsourcing agricultural production to farmers (Clapp 1994). It involves the creation of a contract about the provision for input such as finance, fertilisers, pesticides and seeds, and the specification of the purchasing price for the crop. In large plantation schemes companies internalise the costs and the risks of production by cultivating land directly (Lohmann 1990). A combination of the two approaches is called nucleus estate and it is a common practice for tree crops such as the oil palm (Fleming & Coelli 2004). The model aims to create contract farming arrangements that supply a core estate, which contributes to the crop output and serves as a demonstration and trial farm (Eaton & Shepherd 2001).

In Boeny, companies cultivated jatropha by establishing nucleus estates and large plantations. These two models could specialise in the mono-crop cultivation of the plant or include other cash crops and reforestation species. Figure 7.3 shows these models in a matrix that categorises firms' operations.

		Production model	
		Nucleus estate	Large plantation
Type of production	Mono-crop	D1-Oils	Ecosolutions; Mahabib; Greenoils; Novalands
	Diversified crops	JSL-Biofuels	Soavadia; Redsols; Energyplus

Figure 7.3: Range of jatropha production models in Boeny (Source: author)

D1-Oils aimed to create a small nucleus estate occupying an area of 250 ha. Figure 7.4 represents the model that the company put in place. The plantation was to be surrounded by satellite growers that were to be provided finance, technical support and inputs to create jatropha nurseries and plantations (Corporate manager #1). After receiving manual oil presses, outgrowers would have supplied both seeds and oil to the company's central estate (Corporate manager #1; Chemonics 2009). Besides contracting large and small farmers, D1-Oils was interested in signing contracts for the supply of seeds with other jatropha companies (Corporate manager #1; ACI 2008a).

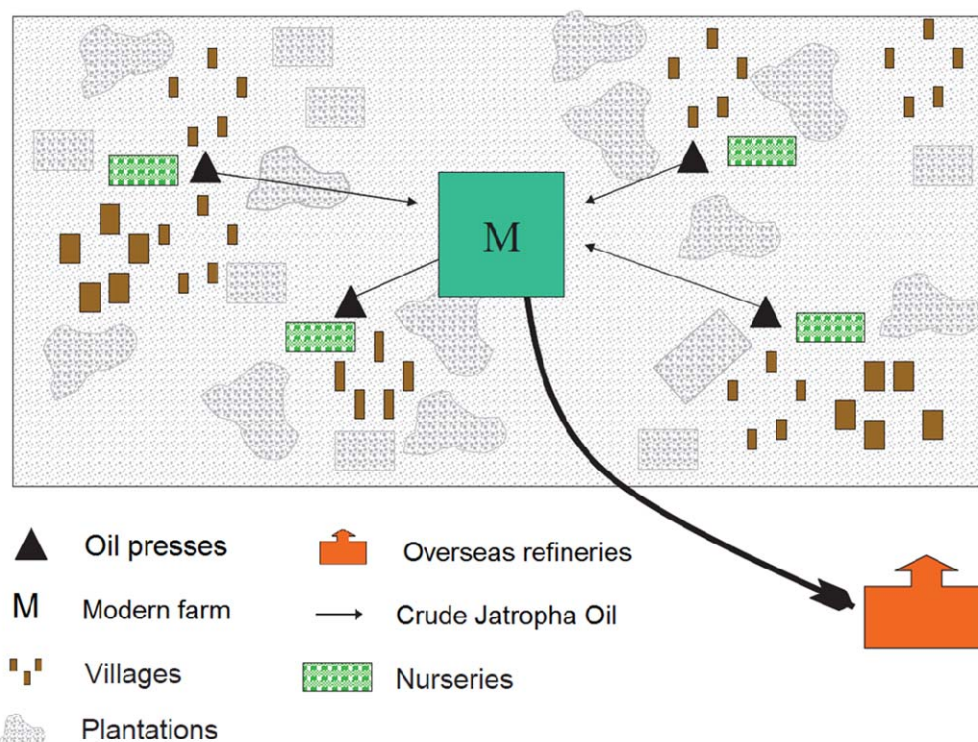


Figure 7.4: The mono-crop nucleus estate of D1-Oils (Source: Chemonics 2009, p.12)

D1-Oils entered Boeny two years before other companies. As a result of that it received a lot of attention from aid institutions, NGOs and government departments. BAMEX provided finance, manual presses and cultivation techniques to contract farmers (USAID 2007, 2008a, 2008b). The Ministry of Agriculture was also involved in the diffusion of additional agricultural techniques (Government official #12). By 2008 D1-Oils established thirty contracts to purchase seeds from farmers, Novalands and the cooperative of the *Fédération Koloharena* (ACI 2008a; Üllenberg 2008b).

JSL-Biofuels aimed to create a large agro-forestry scheme supplying timber, food and biofuel for local sales and exports (Renner 2012; Heijnen 2010). The nucleus estate production model of the company is illustrated in Figure 7.5. The firm's core estate provided the additional benefit of a fire-break to protect the Ankarafantsika national park, which is an important water catchment basin for the rice fields of Marovoay (Renner 2012). The cultivation of jatropha was also considered as a means to provide income to local communities through plantation wage and outgrower contracts, which were promoted as a jatropha system similar to the one by Henning and Ramorafeno (2005) (see also Renner 2012). The firm aimed to diversify crop production by encouraging the cultivation of trees and crops at short, medium and long distances from the villages involved in the project. Near the villages, the company was to promote the cultivation of cassava for local consumption and chillies and indigo for exports. At a medium distance, the firm planned to plant trees providing sales for local constructions, cooking and essential oils. Furthest away, JSL-Biofuels planned to plant trees for the provision of firewood and favour the cultivation of shadow and forage crops.

Government agencies, development programmes and NGOs were involved in JSL-Biofuels' production model (Heijnen 2010). One GIZ staff member sat in the advisory board of the firm to assist the creation of the company's outgrower scheme. The signing of contracts with farmers was also facilitated by the BAMEX and the Food and Agriculture Organisation of the United Nations (Renner Andreas 2007). The Ministries of Agriculture and the Environment supported the company by liaising with *Agence du Développement de l'Electrification Rurale* (ADER) and local communities (Heijnen 2010). The NGO *Marzava*, which hosted the activities of *Programme de Lutte Anti-Érosive* (PLAE) in the region, assisted the company by promoting the cultivation techniques of the plant through its workshop area in the city of Marovoay (Henning & Ramorafeno 2005; Renner 2012). In 2007 *Marzava* produced 10,000 jatropha seedlings (Üllenberg 2008a), which were used in the GIZ programme to prevent soil erosion and to create JSL-Biofuels' plantation (Heijnen 2010).

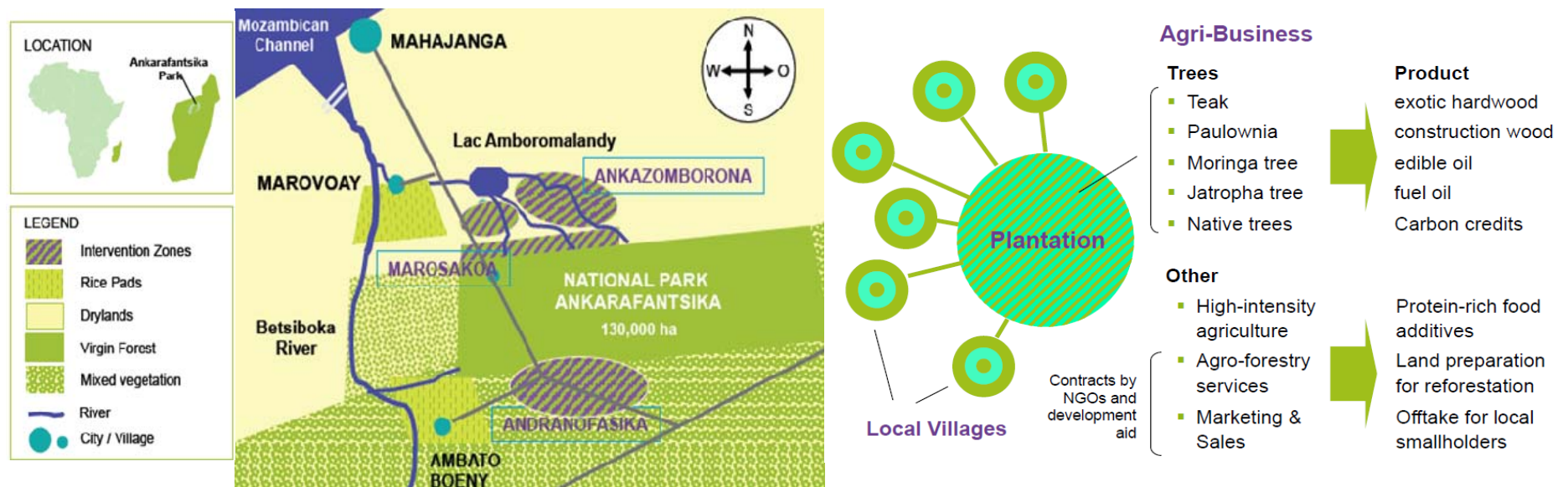


Figure 7.5: The diversified agro-forestry nucleus estate of JSL-Biofuels (Source: Renner 2012, p.4, p.7)

Novalands, Mahabib and Greenoils entered Boeny in 2007-2008 and intended to cultivate jatropha in a mono-crop plantation scheme (WWF 2011; Üllenberg 2008b, 2007). They lacked pre-arranged production agreements involving government institutions, aid programmes or NGOs. Ecosolutions was the last entrant to join the ranks of companies targeting large, mono-crop plantations schemes in 2008. Differently from its peers, the company established the *Integrated Bioenergy Project of Boeny* in agreement with two European environmental NGOs, the regional government, and the Ministries of Agriculture and Justice (Ecosolutions 2008a). The Ministry of Justice was involved due to a prisoners' rehabilitation programme that would have provided the company's plantation with labour. The regional government facilitated the creation of land-use contracts. The Ministry of Agriculture ensured the status of *Zone Franche* to the enterprise and the framing of correct agricultural techniques to cultivate the crop. In the medium term, the company aimed to expand the cultivation of jatropha using contract farming schemes and to diversify production through food crops and livestock activities for local sales (Ecosolutions 2008a).

The remaining companies adopted a large plantation scheme that aimed to produce jatropha and a variety of other crops for local sales and exports. Soavadia's business model included the planting of trees such as palissander, eucalyptus and acacia for local sales (Corporate manager #19). Redsols planned to cultivate cashew and black-eyed beans for export to Europe and domestic sales (Corporate manager #18). Energyplus was going to cultivate dwarf Indian chillies and corn for sales to the local market and export to Reunion and Mauritius, and Indigo to supply the global natural dye industry (Corporate manager #2).

7.1.4 Expectations

In 2005 there were 73,000 ha cultivated with cash crops in Boeny (RB 2005a). With the arrival of jatropha companies and their business plans, that area would have more than doubled within a decade. This was considered a very important change in the development prospects of a region like Boeny, and it was an ambitious plan on the side of companies (NGO representative #12).

Ecosolutions called its venture a “double green revolution” targeting the production of biofuels, rural development and the prevention of soil erosion (2008b, p. 2). Table 7.3 show the expectations that companies formed through their production model.

Firms had varying projections for how long the plant would have taken to produce commercial yields and what the quantity would have been. D1-Oils considered that jatropha was capable of producing commercial yields after 2 years of planting (2004, p. 15). The other companies provided more conservative estimates for the plant’s ability to sustain the commercial production of biodiesel. The Agricultural Business Centre (ABC) of the MCA – which was hosted by the NGO *GREEN* – proposed that jatropha could produce commercial yields of 3-7 tonnes per hectare after 3-5 years from planting (ACI 2008a, p. 151).

Companies planned to extract jatropha oil in a variety of ways. In the short term, D1-Oils and JSL-biofuels were to rely on the manual oil presses that NGOs were to provide to their contract farmers (Heijnen 2010; Chemonics 2009). Soavadia purchased a semi-industrial press before trialling the crop (Corporate manager #20). Energyplus intended to set up a contract with a local soap producer to extract the oil. Part of the oil was to be retained by the soap producer, but all of the seedcake was to be returned to the company (Corporate manager #14). Mahabib and Redsols already possessed facilities to extract jatropha oil due to other industrial activities that they were undertaking (Corporate manager #6, #18). Novalands would have supplied seeds to D1-Oils; Greenoils’ business plan was vague in those regards (Corporate manager #4). Once seed production reached commercial levels, D1-Oils, JSL-biofuels, Eco-solutions and Energyplus planned to purchase semi-industrial presses (Corporate manager #2; Rivoarivelo 2012; Heijnen 2010; Chemonics 2009).

Table 7.3: Land targeted and corporate expectations about jatropha

Firm name	Total and targeted for plantation (ha)	Land cultivated by contract farmers (ha)	Total (ha)	Projected commercial yield (tons of seeds per ha)	Timeframe (years)
Ecosolutions	30,000	20,000	50,000	1-3	6
JLS-Biofuels	1,000	30,000	31,000	2	5
Energyplus	30,000	0	30,000	3	5-7
Redsols	20,000	0	20,000	6-7	3-5
Greenoils	14,000	0	14,000	NA	NA
Novalands	3,500	0	3,500	NA	5
Soavadia	2,000	0	2,000	3	NA
D1-Oils	250	1,000	1,250	5-8	2
Mahabib	800	0	800	NA	NA
Total	101,550	51000	152,550	3-7	5

(Source: compiled from published information and field interviews)

Companies considered that the domestic market for jatropha products was small, but useful for generating some income until production reached sufficient levels for exporting biofuel oil. Companies aimed to reduce their fuel costs by using the oil on their tractors, their own electricity generators, and small trucks and mini-buses. JSL-Biofuels, Ecosolutions, and D1-Oils further aimed to supply the government's *Agence du Développement de l'Électrification Rurale* (Heijnen 2010; Ecosolutions 2008a; ACI 2008a). D1-Oils entered into a preliminary agreement to provide jatropha oil to the national electricity provider JIRAMA and the national railway company (ACI 2008a). The company did not exclude the possibility of investing in a biodiesel transesterification plant to supply refined biodiesel for local sales (Corporate manager #1; ACI 2008a). Energyplus (2012) aimed to supply local soap producers and fishing fleets (Corporate manager #13). All companies intended to use the seedcake as a fertiliser on the fields; JSL-Biofuels and Energyplus planned to use it also to produce biogas and electricity for rural areas (Government official #12; Heijnen 2010).

JSL-Biofuels was the sole company to provide a profitability forecast for its investment, provided an internal rate of return of 12% over a period of 25 years (Renner 2012). Energyplus planned to amortise the cost of creating its plantations with every 700 ha cultivated with jatropha and other crops in the short term (Corporate manager #2). Economies of scale across the various agricultural operations undertaken by the firm would have provided the returns required by investors over time, but the company did not provide an indication of those amounts. The profitability of all jatropha companies depended on the prevailing international price for biodiesel and petroleum vis-à-vis the cost structure of their operations and the exact yields that the plant would have provided at maturity (Corporate manager #4).

7.2 Getting started: creating and managing jatropha plantations

Firms began pioneering the agronomy of the crop soon after their arrival in the region. Apart from Redsols – which possessed the land of an ex-plantation (Redsols 2012) – companies had to manage a ‘marginal’ soil that had never been exploited for commercial agricultural production before and a crop that was, as a corporate manager stated, “wild to a large extent” (#2).

Since companies could not benefit from pre-existing jatropha varieties and cultivation techniques for commercial production, they faced the challenges of choosing plants that would yield sufficient amounts of seeds, utilising land or planter bags as a propagation medium, and using cuttings or seedlings for their purposes. A corporate manager stated:

Planting Jatropha is not easy. If you start from seed you will get plants that are of random quality and of different shapes, basically random plants. If you start from the cuttings of a good plant you will create a more homogeneous plantation. Yet, you do not know which ones are good plants. (#20)

Managers had to guess the quality of the seeds that they utilised when they purchased them in Boeny. In an attempt to reduce this uncertainty, three companies purchased jatropha seeds from the Silo National des Graines Forestières in Antananarivo (Government official #5). Three other firms, convinced that the local plants had a lower oil content, sourced their seeds from India, Togo, Ethiopia and Mali (Corporate manager #8, #5, #18; Redsols 2012).

7.2.1 Creating nurseries

Companies experimented with cuttings and seedlings, land and poly-ethylene bags to identify the combination that would establish a nursery suitable for their commercial aims. They discovered that, while their demand for labour remained substantially unchanged, both cuttings and seedlings posed opportunities and challenges from an agronomic perspective. A government official stated that “seedlings grow into well-developed plants; cuttings require more pruning efforts because their development is more disordered, but plants bear fruits in a quicker way than seedlings” (#1). By

contrast, a corporate manager noted that “cuttings do not develop a taproot, and without it the plant is hardly going to provide commercially viable seed yields in the medium-long term” (#2).

During their experiments with the propagation of jatropha, D1-Oils and JSL-Biofuels distributed cuttings to their outgrowers (Heijnen 2010; USAID 2008a). Greenoils, Energyplus and Ecosolutions created their plantations utilising both cuttings and seedlings (Corporate manager #2, #8). The remaining companies utilised seedlings as indicated by the Eco-Regional Initiatives (USAID) and *Programme de Lutte Anti-Érosive* (GIZ) (NGO representative #5).

Firms tested different mediums to establish nurseries. Figure 7.6 presents the experiments of three firms that focussed on the large plantation model. In 2007 Energyplus started operations by establishing nurseries into the *tanety* soil, on which it created “elevated seedbeds” by year 2012 to “facilitate the root development of the seedlings” (Corporate manager #2) (Figure 7.6a). Redsols began nursery operations in 2007 utilising grow bags, but it eventually switched to planting nurseries via direct seeding into the soil (Figure 7.6b). Ecosolutions initially established nurseries by sowing jatropha seeds directly into the soil, but it later decided to conduct the operation using planter bags (Figure 7.6c). A corporate manager indicated that jatropha would have developed more quickly by using poly-ethylene bags, which were easier to handle for propagation purposes (#8).



Figure 7.6: The evolution of three jatropha nurseries (Source: author)

7.2.2 Preparing the land

Companies became aware that not all of the land that they accessed was adequate for their commercial purposes. They started to evaluate the soil quality in different parts of the landscape to find the optimum areas where to transplant the crop. A corporate manager explained that jatropha could not mature within short timeframes on *tanety* hilltops because erosion removed the humus layer from the topsoil (#16). With the aid of a plantation map (Figure 7.7), he highlighted that the hilltops were the white-coloured areas, while the areas where jatropha could be cultivated were circled in blue. Companies discovered that jatropha could grow “on the gentle *tanety* slopes in low elevation areas” (Corporate manager #2). This view is supported by a report of the regional government (RB 2012). These areas are, however, a fraction of the land that firms accessed.

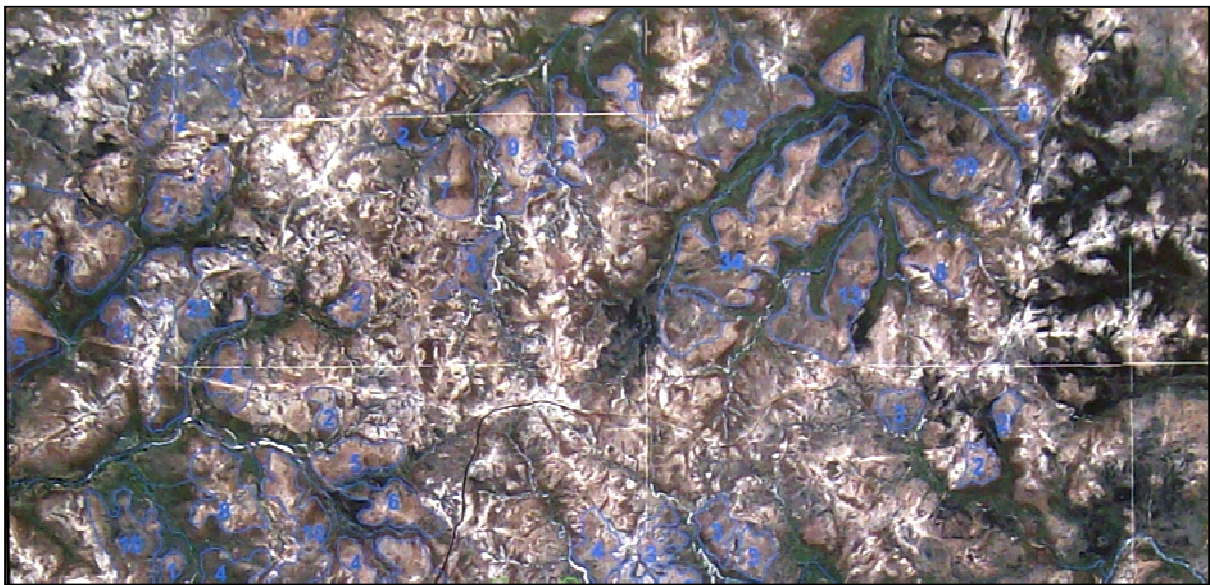


Figure 7.7: Map of a jatropha plantation (Source: Energyplus)

Companies also discovered that the nutrient composition and compaction levels of the *tanety* subsoil changed “from one plot of land to another even within the same plantation area” (Corporate manager #2, #17). They started analysing the structure of the subsoil to ensure the successful establishment of their plantations. During a plantation visit, a manager pointed out various plots of land to explain the importance of performing pedological analyses of the *tanety*

before transplanting jatropha. The pictures contained in Figure 7.8 were taken inside an erosion gully near a jatropha plot.



Figure 7.8: Stratification, erosion and subsoil structure (Source: author)

He indicated the sedimentation strata of the subsoil and explained how their compaction levels change at different depths. He recounted that he once removed several plants that were not growing according to the schedule established by the company to examine their roots. The high compaction level between soil strata underneath the plants altered their root development and stunted their growth (Corporate manager #16).

During a trip to a plantation established in the proximity of Mahajanga, I observed a major difference in the plant-development between the *tanety* and coastal flatland. Figure 7.9 shows that a jatropha plot located on the flatland of an ex-plantation experienced less transplant failures and a greater homogeneity in plant development as compared to the “eroded *tanety*” (Corporate manager #2, #8, #18). The plantation plots created on the flatland enjoyed a more fertile soil that had a more consistent structure comprising a balanced mixture of sands and loams (Corporate manager #18).



Figure 7.9: Jatropha cultivated on *tanety* (left) versus coastal flatland (right) (Source: author)

Companies also discovered by trial and error that, like every other crop, jatropha needed nutrients to grow (Corporate manager #15, #18; Üllenberg 2008b). Since chemical fertilisers can kill the microbiological activity in the soil and enhance erosion (Rodale 1949), companies considered that they were “too strong” for the “poor” *tanety* soil (Corporate manager #18). A government official stated the importance to rely mostly on organic fertilisers (#12), which is an advice that most firms followed. Two companies trialled combinations of chemical and organic fertilisers. JSL-Biofuels used a mixture of compost (85%) and Nitrogen (N), Phosphorus (P) and Potassium (K) (15%) (Heijnen 2010). Energyplus experimented with different ‘NPK combinations with organic fertilisers based on the growth stage of the plant’ (Corporate manager #2).

7.2.3 Transplant

Firms attempted to set a jatropha agricultural calendar and decided that the establishment of nurseries would take place in the two months before the rainy season. Transplanting was to occur during the early rains at the end of December until the beginning of January. Slightly ahead of that period, workers had to prepare plantation grounds by creating holes 40 x 40 centimetres large filled with humus, compost, sand and loamy soils (ACI 2008a). Most companies followed the advice of the MCA and used a plantation spacing of 2 x 2 m or 2 x 3 m – the latter to allow a small tractor to pass across the plants. Ecosolutions and Energyplus utilised a spacing of 4 x 3m or 4 x 4m because they discovered that narrower settings would have created “competition in the root development system of jatropha” (Corporate manager #2).

When it came the time to transplant jatropha, companies faced a labour shortage. They discovered that the local rice agricultural calendar overlapped with their activities. Table 7.4 illustrates the overlay between the two calendars. Rice farming is a demanding activity that takes advantage of kin relations, family labour, crop sharing and wage arrangements (Randrianjafy 2001). While in December farmers prepare their rice paddy and nurseries, the rainfed rice calendar enters the critical stage of transplant in January.

Table 7.4: The rice agricultural calendar in Boeny and jatropha nursery activities

JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
Rainy season		Sporadic rain			Dry season				Sporadic rain		
Rainfed rice											
Transplant			Harvest							Nursery preparation	Sowing of the nursery
Irrigated rice											
		Nursery preparation	Sowing of the nursery		Transplant		Harvest				

<i>Jatropha nurseries</i>											
Trans-plant								Identification of the terrain and removal of grasses	Preparation of land- or grow bag-based nurseries, fertilising and irrigation of seedlings or cuttings	Trans-plant	

(Source: Randrianjafy 2001, p. 118, tableau 15; field interviews)

7.2.4 Crop management during the rainy season

During the months of January to April, the southwest Indian Ocean monsoon starts descending on the Boeny region. The yearly average rainfall is about 1100 mm and this was considered adequate by the jatropa pioneers (ACI 2008a). Firms learned, however, to “look for annual precipitation and the precipitation over a three month basis” (Corporate manager #2). They discovered that the rainfall was excessive for their purposes because it was almost entirely concentrated within the months of January-March (Government official #12). The high temperatures and humidity reduced plant growth by depleting the crop’s capacity to germinate and develop (Üllenberg 2008b). In the words of a corporate manager, companies learned that jatropa “does not like too much water within a short period of time” (#2).

The jatropa plants that survived transplant started sprouting and flowering. At peak intensity, however, the “heavy rains” destroyed jatropa flowers and complicated firms’ logistics by making some plantation difficult to reach (Corporate manager #2, #3). When firms further discovered that jatropa fruits ripened “at different points in time within the same tree” (Corporate manager #2), they had to decide when it would have been appropriate to collect them. Corporate managers tentatively chose to harvest jatropa from “March until July” (#18) “as soon as fruits start ripening” (#2) because “during the rains collection is problematic” (#8).

In absence of specialised mechanical means to collect jatropa fruits, all companies opted for labour-intensive handpicking operations. In April and May, however, local communities in the development zone of Marovoay are busy with harvesting rainfed rice as well as transplanting irrigated rice crops. Companies faced another labour shortage because, as a corporate manager noted, everybody went into the paddy fields, “including women and children” (#2).

7.2.5 Plantation operations during the ‘fire’ season

The dry season is a period of relative tranquillity for local farmers. They eat the reserves of harvested rice and grow cassava and other crops on *tanety* to ensure that their households have sufficient food supplies when the stock of the staple runs low (Randrianjafy 2001). During this period they welcome job opportunities offered by agribusinesses such as jatropha companies.

Herders have a different calendar of activities from farmers’ communities. Table 7.5 explains that when the savannah grasses become stringy and dry, cattle (*zebu*) become skinnier and skinnier due to the scarcity of food, and herders start working to ensure that they do not starve. They lead their *zebu* to eat grasses and shrubs in forests’ undergrowth, along rivers and lakes, and in low elevations areas as the one portrayed in Figure 7.10. At the peak of the hungry season, the moment of which depends on the intensity of grazing activities and climatic factors, herders burn the savannah grasses to rejuvenate them and provide their cows with a fresh bite (Kull 2004).



Figure 7.10: Zebu eating fresh grasses in low elevation areas during the dry season
(Source: author)

Table 7.5: The *zebu* calendar in Boeny

MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	JAN	FEB	MAR	APR
Dry Season					Sporadic rain		Rainy season			Sporadic rain	

Pastures location

Scarcity of green grasses: the herds go on low lying areas, the borders of rivers and lakes, and in the forest undergrowth	Abundance of green grasses: herds go on the savannahs of the highlands and <i>tanety</i>
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Main nutrition for the cows and herders' actions

Herders regenerate the savannahs grasses through fire.	Herding in semi-freedom that let the cattle roam
The cows eat regenerated grasses, shrubs, and herd in the humid, low-lying areas between hills	The cows eat the green and soft grasses of the savannahs

(Source: Randrianjafy 2001, p. 130, Tableau 18)

Kull (2004) begins his book *Isle of Fire* by stating ‘MADAGASCAR IS AFLAME’. With a similar emphasis, one corporate manager referred to the dry season in Boeny as the “fire season” (#8). Other respondents shared the view of the manager. A rural NGO representative stated that “towards the end of the year everything between Mahajanga and Antananarivo burns” (#4). I could observe why interviewees had the impression that the Red Island was going up, as President Ravalomanana stated, “in smoke and ashes”. Figure 7.11 shows the outlook of *tanety* stretching from the interior of Boeny towards Antananarivo at the time of my field research.



Figure 7.11: The appearance of *tanety* in the interior of Boeny in October, dry season (Source: author)

Companies became aware of the crucial influence that fire had on the landscape. The strong dry winds coming from the sea ensure its rapid spread; the dry savannah’s grasses and plants “burn like gasoline” (Corporate manager #2). A corporate manager noted that “fire can burn one hectare of land every ten minutes” in those conditions (#18).

Jatropha was a good fire-break but, as companies discovered, it was not fire-proof. Figure 7.12 shows the spread of a wildfire on *tanety* and the damage that it caused to an establishing plantation plot and a land-based nursery. Plants cultivated for longer than one year would survive wildfires, but they would “suffer like an Olympic athlete that survived first degree burns”; they would not develop and bear fruits until recovery (Corporate manager #18). Younger plants such as the ones that remained in the nursery after transplant operations could not survive.



Figure 7.12: Fire on a young jatropha plantation plot and a nursery (Source: author)

Responding to this threat, corporate managers started creating fire-cut corridors up to 50 meters wide around plantation grounds (#2, #9, #19). One of them stated that the creation of fire-cut corridors did not afford sufficient protection to the crop because the strong winds could carry burning debris into plantation grounds and ignite new fires (#6). Energyplus and Redsols had similar views when they decided to clear newly established plots of savannah grasses and hire additional personnel to ensure that plantation activities continued according to schedule (Corporate manager #2, #18).

7.2.6 Irrigation

During the dry season, the wildfires and the long drought affect every plant in the landscape, including jatropha. While jatropha could survive with little water, companies discovered that the

“plant shed its leaves” to survive the dry season (Academic #2). Some irrigation was necessary to prolong the plant’s vegetative growth and get back to the agenda of producing commercial yields within five years. JSL-Biofuels and Soavadia resorted to building wells (Heijnen 2010; Corporate manager #19), and most of the other companies may have done the same (ACI 2008b). Since the creation of wells on *tanety* was considered particularly costly (Government official #12), some companies identified additional solutions. Energyplus tapped water from underground springs, which it used to irrigate plantation plots and nurseries with a cannon sprinkler. Redsols created a small artificial lake and Ecosolutions linked its sprinklers to an existing weir.

7.2.7 Phytosanitation

The use of irrigation during the dry season allowed *jatropha* plants grown in plantations to develop for additional time as compared to their wild counterparts, but companies discovered that this increased the risk of attack by insects. While *jatropha* was portrayed as a pest-resistant species based on observations made on standalone plants (ACI 2008a), a plantation “gives rise to all sorts of problems with insects. Flea beetles do not pose any threat to wild plants, but when plantations were created they became a serious problem” (Corporate manager #3).

The key *jatropha* pests in Boeny include aphids, leaf miners, mites, locusts, mealy bugs, webbing insects, and flea beetles (Üllenberg 2008b). These insects thrive throughout the year and they can put operations at risk by feeding on the plant’s extremities and sprouts, which are not particularly toxic (see Caon & Burnfield 2006; Evaristo et al. 2013; Parsa, Kondo & Winotai 2012; Brittain & Litaladio 2010; Lopes 2009; James 2008; Ambika et al. 2007; Kavitha et al. 2007; Knodel & Olson 2002; Gerson 1992). In extreme infestation cases such as the one depicted in Figure 7.14b, entire plantation plots had to be pruned back to ensure the survival of plants.

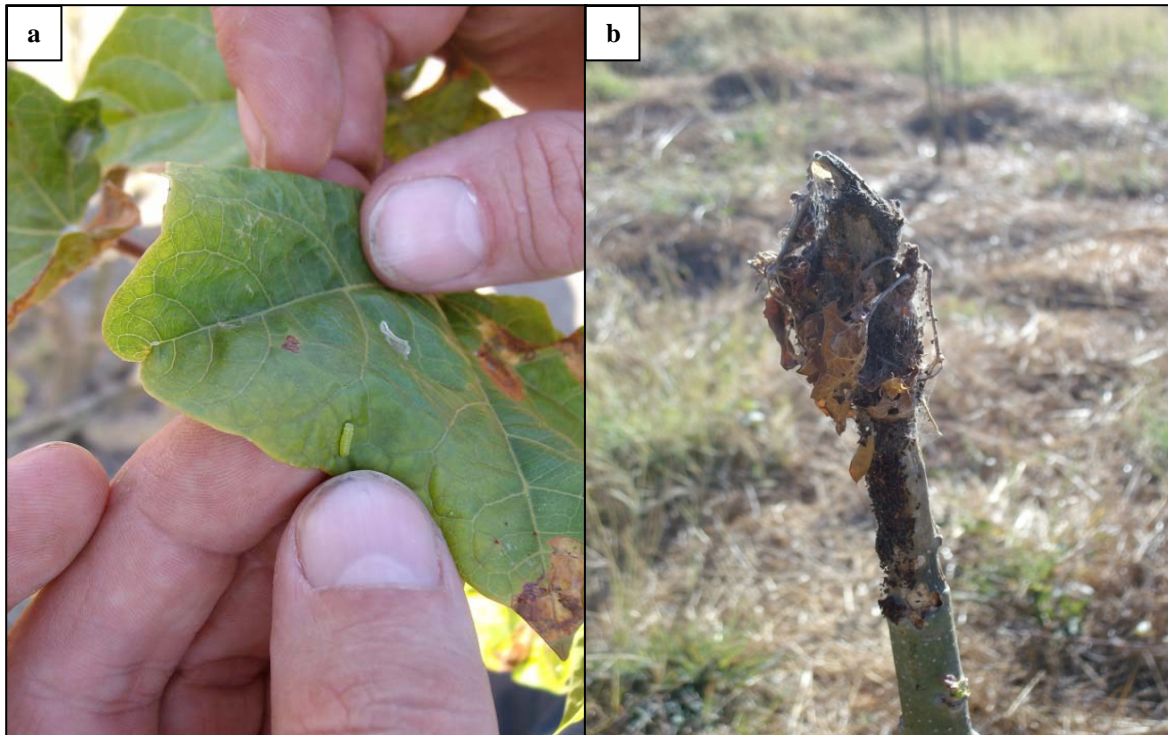


Figure 7.13: Damage inflicted by leaf miners (a) and webbing insects (b) to jatropha plants (Source: author)

Firms decided to put in place incidental phytosanitation measures to avoid the damage wrought by these insects (Redsols 2012; Heijnen 2010; Üllenberg 2008b). The application of pesticides was to become a year-round activity performed by hand or tractor (Corporate manager #2, #5, #6 #8, #18; Heijnen 2010). Some corporate manager indicated that clearing of plantation grounds from savannah grasses reduced the spread of wildfires and the risk of infestations at the same time (#2, #8, #18). Nevertheless, the average intensity of pesticide treatments was “3-4 times per year” (#6), which is comparable to one of the more demanding crops such as palm oil (Drooge, Groeneveld & Schipper 2001; Page & Lord 2000). Pesticides had to be applied “within 4 days after a problem is reported” to avoid pruning back plantation plots (Corporate manager #18).

The regional biofuel industrial complex was meant to become the goldmine of Boeny. Venture capitalists, government agencies and departments, aid programmes and NGOs were eager to set firms up to pioneer the large-scale cultivation of jatropha. Companies expected to radically change the face of the region and profit from the international biofuel market.

Before long, however, it became clear that jatropha was not a golden, wonder plant. It was not going to grow everywhere on its own and produce cheap fuel. The first movers had to face a number of unforeseen problems. Jatropha propagation, the selection of appropriate cultivation areas and the rainfall distribution throughout the year proved to be the first stumbling blocks. Later on, plantations recognised that labour shortages, wildfires and pests contributed to the difficulty of getting production underway and creating value. Jatropha was not a golden nugget waiting to be picked up. Companies and other participants to the biofuel industrial complex realised that they had to be there for the long haul to make it yield a profit.

8 **Jatropha pioneers' fortunes**

On paper, the jatropha industry in Boeny seemed well-positioned to flourish. In practice, when I reached Boeny in 2012, only Redsols and Energyplus continued to operate at a relatively small scale. Ecosolutions was attempting to restart operations. What happened to the regional biofuels industrial complex? Government officials often laughed when I introduced the objectives of my research to them. One of them explained to me:

I will tell you why we laugh. Seven year after the main promotion of the crop there is not a single project that demonstrated the commercial viability of jatropha. We are poor in Madagascar and we cannot wait 10 or 20 years before seeing some cash! (Government official #14)

Firms could only be profitable if they strategically engaged with the natural, political, social and economic contexts of the region. While explaining to me the challenges faced by the industry, however, interviewees portrayed a picture in which everything that could possibly go awry did so and doomed the financial sustainability of most projects.

This chapter investigates the obstacles that companies encountered while they were trialling the crop and it describes the production and development outcomes of the industry. The last section presents the strategies put in place by the two industry survivors.

8.1 The perfect storm

8.1.1 The national and international landscape

There are a series of international and national events that converged to ruin the fortunes of the green pioneers in 2008-2009. The political transition in Madagascar occurred at the same time as the global financial crisis and the fall of oil prices, which were the benchmark for the selling price of jatropha oil and the profitability of the enterprises selling it (ACI 2008a). The global financial crisis induced international financiers to reduce the risk of their investments, thus pushing companies such as JSL-biofuels to look for financing. Respondents also indicated that the slower pace of industrial activities worldwide had contributed to a fall in carbon credits prices, which drained the potential profitability of investments further (Corporate manager #2, Ecosolutions 2012). The findings of the World Bank (2014, p. 39, Figure 6) confirm a reduced global demand for Certified Emission Reductions and the European Environmental Agency (2011) recorded a sharp decrease in carbon offset prices in 2008-2009. Those prices did not recover until 2011.

Nationally, the coup d'état of March 2009 was a major event that stalled investment in jatropha. The Daewoo-Logistics investment on 1.3 million ha of land contributed to the downfall of the Ravalomanana government and was immediately halted by transitional authorities. This made jatropha companies cautious about making requests for land (Üllenberg 2009). According to two government officials (#1, #6) and one corporate manager (#20), leases granted by transitional authorities may not have been validated by a successive government, which meant that only those companies that received a fully consolidated land lease and initiated an Environmental Impact Assessment before the crisis could continue to operate. Similarly to one academic (#4) and two NGO representatives (#1, #7), they argued that there was no support for jatropha after foreign aid to the country stopped and transitional authorities shifted development priorities from agriculture to mining.

Companies had problems in dealing with Madagascar government departments even before the coup d'état. Several interviewees blamed the weak institutional capacity of the Madagascar government for the failure of the industry (NGO representative #8; Government official #9; corporate manager #20). Corporate managers reported that the agenda of development institutions, which was based on the Millennium Development Goals (MDGs), created conflicts between the objectives of the government and firms' operations. The MDGs influenced the decisions that government officials made, with companies often required to invest in social responsibility initiatives if they wished to access land (Corporate manager #2, #8). Officials at different government levels used their bargaining power to induce companies to invest in the creation or maintenance of roadways, sanitation and education facilities (Andrianirina-Ratsialonana et al. 2011). Companies would have preferred to see their project prosper before creating such infrastructure, but they undertook the investment in order to access land and establish plantations (Corporate manager #2, #4, #18; Neimark 2013). They welcomed requests to build social infrastructure that provided indirect benefits to their operations, such as sanitation that improved workers' health (Corporate manager #2, #4, #18). Education was not seen as a particularly useful investment by firms because it required a substantial financial outlay that did not create shared benefits for workers, their communities, and companies (Academic #1; Corporate manager #2, #4).

Corporate managers also complained that politicians were slow to act and overarching legislation to address the industry did not exist prior to the coup d'état. Üllenberg (2008b) and ACI (2008a) point out that the development of legislation, especially taxation policies, was crucial to determine the economic viability of industrial jatropha activities. When the creation of an industry won the interest of foreign investors, in 2007, the government asked the Ministry of Environment and Forests and the World Wildlife Fund (WWF) to form a biodiesel committee, explore the viability of biofuels and propose legislative developments (Üllenberg 2008b). In 2008 the two organisations proposed a bill that, however, was not brought in front of the parliament. The government believed there were more benefits in addressing the entire production process from downstream (the

cultivation of jatropha) to upstream activities such as seedcake utilisations and fuel refining (Üllenberg 2008b). One government official extrapolated:

The official text was delayed because jatropha touches on many different dimensions and Ministries, that is, Energy, Agriculture and Environment. Moreover, jatropha is meant to reduce imports of petrol. There would be fewer duties paid for gasoline and this would come at the detriment of the government's budget. (Government official #4)

This response suggests that companies and the government were stalled in a paradoxical and difficult situation. On the one hand, firms needed to know how much tax would have been imposed on their products so they could adjust their financial calculations. On the other hand, there was a delay in developing a biofuel legislative framework due to the unclear and conflict-ridden role of different Ministries regulating the industry (Government official #3, #4, #11), and jatropha's direct relationship with the substitution of fossil fuels imports. Since firms did not know the overall costs that they would have faced and the actual market applications for the plant in the first place (Corporate manager #4), the government's decision was equivalent to leaving the maximum freedom for the establishment of the industry to its participants and supporting organisations.

8.1.2 The 'civil war' over land

Most problems that companies faced revolved around the climate and soil conditions of the *tanety* around Marovoay, which created unexpected costs and disruptions during the trials for the cultivation of the crop, and the pre-existing claims of local communities for its cultivation. Üllenberg (2008a) and ACI (2008a) point out that land tenure security was a crucial problem for peasants and companies alike. Since there were multiple formal and informal procedures to access land, conflicts at the local level posed tangible risks for corporate operations (Üllenberg 2008b). One government official stated:

There is a civil war over land. The Ministries, the regional government, the land department and so on often overlap in each other's competencies and give land to whoever comes, even when that means assigning double titles on the same parcels. Beside the formal land law, there is the customary law that is also reflected in the *dina*, and the 'do whatever you want' law. (Government official #14)

The response takes dramatic tones in its description of a 'civil war' over the control of land in Boeny. The interviewee indicates problems caused by overlapping powers between ministries and government departments, the creation of double titles, and competition between various forms of land access regulation.

As an example of overlapping powers, Ecosolutions was assigned land that was titled in the name of the Ministry of Forests at the discretion of the regional government. As long as reforestation and the cultivation of *jatropha* were involved in the project, the Ministry of the Environment allowed the company to operate (Government official #8). However, when it found out that the firm intended to cultivate food crops and engage in livestock activities, the Ministry staked its claim to the regulation of the land use against the regional government (Ecosolutions 2012).

The creation of 'double land titles' assigned to firms and farmers depended on the limited financial resources of the government to support the Land Services despite donors' agencies financial contribution. The Land Services are described as understaffed (Andrianirina-Ratsialonana et al. 2011) and the cadastre system as dysfunctional (Üllenberg 2008b). As a result, "when companies went to the Land Services, officers told them that a certain piece of land was free, but it could have been occupied if a *dina* or customary claim was not recorded appropriately" (Corporate manager #2). This is how the design of the government's land reform contributed to a 'civil war over land' featuring formal land legislation, the *dina*, customary tenure mechanisms, and a 'do whatever you want law'.

Land conflicts at the local level were created by an unclear legal ground between the definitions of State-owned land and untitled private property (Neimark 2013; Andrianirina-Ratsialonana et al. 2011). The latter included both communal village land and individual households' plots; it was distinguished from 'State-Owned' land only when the occupants claimed its customary tenure to the local administration (Andrianirina-Ratsialonana et al. 2011). They could only do so by proving individual or collective possession before obtaining a certificate with similar validity as a

title. In turn, the certificate was created by the regional State-Owned Land and Topographic Services (SOLTS) after a long and complicated process that involved field visits to verify the state of land development and create a map (Andrianirina-Ratsialonana et al. 2011). According to a corporate manager (#2), the procedure “could take years, and a lot of bureaucracy and expenditures; since farmers are poor and mostly illiterate, they risk not receiving anything even after that period” (see Neimark 2013). To complicate matters further, the SOLTS did not deal with all types of land deployed by local communities (Andrianirina-Ratsialonana et al. 2011). Franchi et al. (2013) explain that the definition of untitled private property did not include grazing land, which is most spatially extensive on *tanety*. The resource on which herders depended to make a livelihood existed in a legal vacuum open to interpretation by the technical services, which could infer that it was disposable State land (Franchi et al. 2013). The title ‘State-Owned’ in the SOLTS’ name suggests a presumption of land vacancy unless proven otherwise.

Between formal and customary land law, a grey area created by the *Gestion Locale Sécurisée* (GELOSE) legislation in the 1990s created additional conflict. The *dina* was a means of land use regulation and was linked to a contract, which related to local resource management, created between villages’ traditional authorities and government institutions (Henkels 1999). While much of it empowered local users (Marcus & Kull 1999), the *dina* added complexity to land-use and land-access possibilities by firms on the ground. One corporate manager described the conflict experienced by his company. He said:

While we were accessing land, a certain Mr Solomon came up with a *dina* on 900ha. He lodged a claim for reforestation and trees plantation purposes in the 1990s. There were barely 12 eucalyptus trees growing there. He lodged the claim but did not have the money to develop the land (#2)

Eucalyptus, pine and acacia are common species that have been used for reforestation purposes in Boeny since colonial times. In the example of the manager, the farmer’s official reason for lodging the *dina* may have been to create a eucalyptus plantation. When I saw a parcel of land that was part of those 900 ha that the manager indicated, there were plants other than *jatropha* in

the peripheral areas towards the villages and some mango trees. There was also evidence of cattle passing through the land. Assuming that a eucalyptus plantation was the rationale for developing the land, it is possible that trees were already sold to receive income from timber products when the company inspected the land. The manager described a situation in which a local owner did not have sufficient funds to develop the land according to the firm's and the technical services' interpretation. The background of the actual land-use was obscured by the necessity to proceed with an agribusiness project and the difficulty of lodging untitled private property claims by local communities.

From a customary perspective, the 'civil war over land' takes practical and emotional tones. Land, especially *tanety*, has a great cultural and socio-economic value for Malagasy farmers and herders, who interpret it as a direct connection to their ancestors (Neimark 2013): family tombs, pastures and rice fields are used to justify this. It is not only that "land is local communities' richness and heritage" (Corporate manager #1), but it also provides supplementary income and nutrition before the rice harvest (Randrianjafy 2001). In a socio-cultural perspective, the *zebu* are considered as a symbol of wealth, a herder's "bank account", and a means to "communicate with the ancestors" (Randrianjafy 2001, p. 129).

According to Rivoarivelo (2012), peasant farmers in Boeny access land through purchases, legacy, renting and sharecropping. Legacy refers to inheritance of ancestral lands or, in the case of immigrants from another region, their acquisition through marriages with autochthones. The village authorities, which comprise the *Chef du Linéage* (Head of the Clan), local notables including large cattle herders, and the *Chef du Fokotany* (Head of the Village), assign land to newcomers. Renting and sharecropping are similar concepts that involve a landlord or second party accessing land in exchange for, respectively, a royalty or a portion of the produce (Rivoarivelo 2012). These land access strategies by local communities create the untitled private property that created local

conflicts over cultivated areas. Herders have traditionally had access to almost all *tanety* land that is not utilised by farmers or other local owners (Randrianjafy 2001).

What is the ‘do whatever you want law’? The government official that raised the term portrayed it as land being used in a different manner from formal legislation requirements, *dina* or customary mechanisms. When I asked interviewees about how local communities access land, they mentioned the practice of “squatting” on public or private land (Academic #3). A government official said:

Squatters are everywhere in Madagascar. It is an itinerant agriculture based on burning, growing, and moving the fields somewhere else. If you see some abandoned jatropha fence growing in the middle of nowhere, it means that somebody brought it there as boundary marker for his house. (#15)

Similarly to herding practices that let cattle roam with minimal supervision (Corporate manager #2; Randrianjafy 2001), the regional agriculture appears to possess a nomadic component in opening fields with fire, cultivating them, and leaving them fallow. Some observers may consider the practice to be illegal (i.e., squatting) and add to the idea that peasants do ‘whatever’ they want by disregarding formal or traditional tenure systems. Similarly to the dominant conservation narratives that picture farming and herding practices as ‘irresponsible’, such assertions point to an antagonism between the agendas of companies, authorities and local communities.

8.1.3 Food comes first: the agrarian economy of Boeny

The regional *tanety* was imbued with trade-offs between the cultivation of food by local communities, herding practices, and the imperatives of the large, export-oriented agribusiness projects undertaken by jatropha companies (ACI 2008a). According to a corporate manager, “the approach of companies was wrong from the very beginning because to invest in jatropha in Madagascar the reality of small farmers must be taken into account” (#1). Given that jatropha was promoted as a pro-poor, specialised energy crop whose cultivation avoided competition with food production, firms should not have encountered obstacles in their relations with local communities. An academic made the following assertion about plantation workers:

Peasant farmers are interested in cultivating their own plot before they contribute to the cultivation required by companies. This gives rise to behaviours detrimental for the development of plantations, such as employees working for fewer hours than expected by firms. (#1)

The respondent hinted at differing goals between plantation workers and companies when it came to the cultivation of food. This was perhaps to be expected because jatropha is toxic. Rice, cattle and food crops such as cassava have made up most of the production of the region since pre-colonial times. However, it would be quite simplistic to say that the conflict of interest arises because farmers are selfish. Statements such as “people prefer to grow edible species on *tanety* because Marovoay and the region of Boeny have a food and rice agricultural vocation” (NGO representative #6) are unhelpful in understanding why there is a conflict of interest between companies and local communities, including plantation workers, in regard to the cultivation of food crops.

On a social and cultural level, peasants consider rice as the most important agricultural crop that they can grow on their land. They prioritise its cultivation because it is the key staple of their diet. The labour shortage that companies faced due to the competition between the agricultural calendars for jatropha and rice is a tempting evidence to support the idea that plantation workers are simply interested in cultivating their own paddies. However, farmers are unlikely to have made choices based solely on cultural factors. The response of a corporate manager provides a more precise account of ‘the reality of small farmers’. He said:

Jatropha is not a food: it is toxic. Since during the food prices increase of 2007-2008 farmers were getting poorer and faced food shortages, they prioritised the cultivation of food on their land. Jatropha indirectly competed with food: it was grown on *tanety* land where rainfed rice and cassava are cultivated and herding is widely practiced. (#2)

The response contextualises the food agricultural vocation of the region in the light of the spike in international food prices of the years 2007-2008. The competition between jatropha and food production stands in sharp contrast to the financialisation motives that viewed the plant as a specialised energy crop that would be unaffected by swings in food prices or competition with food production. The manager’s observation is further elaborated by Medernach, Burnod and

Rakotomalala (2011), who show that plantation workers in Boeny considered that cultivating their own plots was more economically valuable than the income they received from plantations.

Plantation workers considered the wage that they received as a side income to their main livelihood activities, which revolved around the production of food crops and, in their communities, herding practices.

The relationship between companies and outgrowers was even more complicated than the one they had with plantation workers. Contract farmers decided to cultivate the seedlings and cuttings given to them “to create fences around their food plots rather than creating mono-crop plantations” (Corporate manager #1). It is tempting to explain this behaviour by stating that they resorted to their “traditional knowledge about the crop” (NGO representative #13), but their choice was determined by other factors at play.

Beyond the ordinary climatic and crop failure hazards intrinsic to every outgrower scheme, jatropha companies were “outsourcing to farmers the risk of not knowing how the crop works” (Corporate manager #2). The financing and price arrangements in their contract did not outweigh the risks of cultivating jatropha as a mono-crop against the benefit that alternative land-uses would have provided them, especially in a context of increasing food prices (Farmer #3, #4).

An example of this is D1-Oils. Outgrowers did not receive the expected financial support from the company and development aid to establish the plantation and purchase oil presses (USAID 2009). The domestic banking sector was also unfavourable to them because interest rates attached to loans were very high and they could not provide sufficient collateral (Üllenberg 2008b). Two government officials provided answers that further contextualised farmers’ disinclination to follow corporate directions. They said:

People in Boeny were interested in eating and accessing food. Cassava is grown but little cared about, and it is of the same plant family of jatropha. Peasants would not put much effort in the cultivation of cassava because it is not a good source of income, but they cultivate it because they can eat it: jatropha is something that the engine eats. (Government official #12)

Peasants would prefer crops that provide quick returns, best if annual. Jatropha did not interest them out of living fences because it did not improve their quality of life, and therefore it was particularly difficult to attract their interest for a non-edible, long term crop. (Government official #14)

Two important factors shaped outgrowers' attitude towards jatropha. First, they did not believe that the crop would have improved the quality of their lives. It is something that "the engine eats", as an additional respondent mentioned (NGO representative #4). They would not derive benefits from jatropha's cultivation other than an income after several years and, perhaps, some seedcake to be used as fertiliser. Second, they considered that jatropha was less valuable than the cassava that provided for their subsistence and annual incomes, and that they cultivated on tenacity.

The highest price offered for the purchase of jatropha seeds by D1 and JSL-Biofuels was about 600-700 AR (i.e. 0.08 USD) per kg in 2008-2009 (Corporate manager #1; Heijnen 2010). A NGO representative considered that, in hindsight, the price was still "too low to stimulate farmers' interest in cultivating the plant" (#7). In 2012, after the food prices spike, I observed that cassava sold, as a Farmer mentioned to me, "for about AR 600-700 per kg at the market and at a lower price in the streets of Mahajanga" (#5). Everything else equal, in a context of high food prices in 2008-2009, farmers would have preferred to cultivate the edible cassava to selling jatropha seeds.

In an attempt to overcome this problem, as part of its production model, D1-Oils provided contract farmers with Bielenberg oil presses and allowed them to keep the seedcake and sell the oil back to the company for a higher profit (Corporate manager #1; Chemonics 2009). However, as Üllenberg (2008b) explains, very few people in the region had experience in operating the presses, which were not provided to most outgrowers' communities due to funding problems. Value addition from the extraction of jatropha oil by contract farmers did not unfold into a viable commercial strategy in rural Boeny (NGO representative #5).

Against the corporate newcomers, traders have been the key actors organising outgrower schemes in rural Boeny since pre-colonial times. They have been playing the role of intermediaries within the agricultural commodity chains of the region, and they mediate access to land for renting and sharecropping purposes (Farmer #1). One corporate manager stated that “traders were not interested in organising the collection of seeds for the jatropha industry because it would have diminished their revenue over established commodity chains such as rice” (#1). ACI (2008a) substantiates that claim. The consultancy reports that a 50kg bag of rice could only fit 22kg of jatropha seeds. Oilseeds were bulky and did not provide sufficient income to stimulate traders’ interest because, at the peak of the price offered by firms, they were worth as much as cassava.

Rice and cassava are important crops cultivated by farming communities in Boeny, but the livelihood of the Sakalava has revolved around the herding of cattle since the time of the Merina Empire. Herders often leave cattle roaming in semi-freedom on *tanety* and their land-use exists within a legal vacuum. While cattle do not eat jatropha, the use of fire by herders could damage plantations (Üllenberg 2008a; corporate manager #4). Since cattle could also step on young plants and create considerable damage (Henning & Ramorafeno 2005), companies needed to reach agreement with herders in relation to land-use other than for livestock (Üllenberg 2008b).

The context in which respondents mentioned the use of fire by local communities points to a sharp antagonism between companies and local herders. I present the perceptions of interviewees in Table 8.1. I categorised the entries of the Table from the discussion of Kull (2004, p. 82, Table 3.1 and p. 83, Table 3.3) about Madagascan uses of fire and some causes of wildfires recorded by government agencies. Üllenberg (2008a) and ACI (2008a) recognise the risk that fire poses to the industry, but they propose a more balanced view on the issue than interviewees. They include natural causes and suggest creating a dialogue with local communities about wildfire prevention.

Table 8.1: Perceptions about the use of fire by local communities in Boeny across government officials, corporate managers, and NGO representatives

Utilization	Explanation	Number of respondents
Celebrations	Entertainment	1
Clearing grounds	Increase visibility of wild tubers for harvest	1
Travelling	Clear trails and roadsides	1
Pest control	Control locusts, rats, mosquitoes and ticks	1
Ecological clearing	Open irrigation canals and purge pests such as rats	1
Cattle control	Improve the visibility of cattle	1
Downhill fertilisation	Exploit erosion on <i>tanety</i> to fertilise lower lying areas	3
Field preparation	Open and fertilise field before cultivating it	3
Wood fuel management	Charcoal production	5
Criminal	Arson or symbolic protest	7
Grazing land maintenance	Rejuvenate Savannahs and avoid bush encroachment	8

(Source: compiled from field interviews)

Cattle are a symbol of wealth, power and status in Madagascar (Marshall 2008). Herders form part of the group of notables within traditional village authorities (Randrianjafy 2001; Rivoarivelo 2012). In the absence of a dialogue with local communities, the corporate top-down approach to land access may not have accounted for their authority and necessity to use *tanety*. It is reported that, in fact, local conflicts relating to the approach taken by firms escalated to the deliberate starting of fire and the freeing of cattle on plantation grounds (Rivoarivelo 2012; Medernach, Burnod & Rakotomalala 2011; Heijnen 2010; Üllenberg 2008b; ACI 2008a).

Most responses about the uses of fire by herders and local communities resonate well with dynamics that Kull (2004, p. 179-203) discusses in depth about the criminalisation of fire-use by the government and the resulting local resistance to such imposition. The creation of export-oriented plantations on *tanety* entered the dialectic power contestation between the elites of Antananarivo and local communities to control resource access and use (Neimark 2013; Kull 2004). In the case of the jatropha industry in Boeny, the power struggle regarded the critical livelihood role of *tanety* within the agrarian economy, a typology of land otherwise interpreted 'marginal' by managers and government officials.

8.2 Regional development outcomes and industry remnants

8.2.1 Production, marketing and development outcomes

According to interviewees, the convergence of the factors described in the previous section, especially wildfires, disrupted the creation of the regional biofuel industrial complex. The comments of two NGO representatives encapsulate the views of regional stakeholders about the results achieved by firms. They said:

Jatropha projects were grandiose. I do not know if companies managed to do something, but I do not perceive any sort of change as compared to the past decades. (NGO representative #9)

There has been a lot of talk about creating an industry. If only 5% of what was said was done, it would have changed the face of the region forever. (NGO representative #2)

Companies failed the expectations that they raised for the crop. The impressions of the respondents are substantiated by the information that I collected during my field research. Out of 100,050 ha of land targeted for the creation of plantations, I estimate that jatropha businesses developed approximately 1100 ha. This estimate is based on the values provided by the WWF (2011), Andrianirina-Ratsialonana et al. (2011), and the specific information provided by several corporate managers (#2, #6, #8, #20) and government officials (#6, #8, #10). In the best case scenario, companies would have expanded contract farming schemes over 51,000 ha. However, D1-Oils established contract farming arrangements covering approximately 500 ha of land (ACI 2008a), while JSL-Biofuels did not succeed in securing significant contracts (Heijnen 2010). Firms cultivated jatropha on about 1% of the land that they originally intended to develop.

There was no export of jatropha from the region (Government official #14). Seed production remained small. D1-Oils and Redsols produced small quantities of oil utilising their own presses and employed it to fuel their tractors (Corporate manager #4, #14, #18). Energyplus created a contract with a soap producer to extract oil from jatropha seeds and venture the production of soap on a small scale (Corporate manager #10, #13). The company also supplied the oil to two fishing boats, the engines of which it modified by importing *ad-hoc* equipment, and used it to fuel its tractors (Energyplus 2012). The seedcake obtained after oil extraction was used as fertiliser on plantations' and contract farmers' fields (Corporate manager #1, #2, #4, #18).

The region did not experience economic upgrading processes such as the creation of specialised jatropha refineries (i.e., oil extraction, biodiesel transesterification) or the re-skilling of the labour force, for example, to specialise in analysing soil composition (Corporate manager #2, #4; Government official #5). But a limited number of farmers increased their expertise with the use of tractors (Corporate manager #2; NGO representative #10). Soavadia decided to use the semi-industrial press that it purchased to produce edible vegetable oil (Corporate manager #19).

Farming communities did not use the plant in traditional ways because they did not know how to and cheaper substitutes were available in rural areas (Üllenberg 2008b; Corporate manager #12; Government official #12; NGO representative #14). USAID (2006) indicates that, in retrospect to its demonstration of the product, the transformation of jatropha seedcake into briquettes for cooking was not a viable option for the utilisation of the plant's products.

While the small size of plantation activities did not change the composition of regional production, it had an influence on local communities. Rivoarivelo (2012) states that several farmers lost land to plantations and relocated their activities. Corporate managers shared that view but added that not all plantation land was "suitable for the cultivation of jatropha due to, for example, limited accessibility, slope or soil reasons: in some areas farmers could grow any crop that they wished" (#16). One NGO representative held that "people would not lose land to companies: they would squat or move a little more far away" (#2). In light of the challenges created by the 'civil war over land' and the context of local communities, these replies are unable to justify the fact that companies caused losses of critical agricultural and grazing land to an impoverished population.

The question then becomes whether those losses were outweighed by the development benefits provided by companies to local communities. I asked government officials to share their thoughts about the regional development outcomes of the industry. They mentioned the wages paid to local communities and the taxes raised by the government from land leases. One in particular answered:

Given the state of investments, you can say that regional development has been minimal. If there was some positive impact, it would be in terms of the employment created and of the payment of taxes to the government. (Government official #9)

It is possible to estimate the corporate expenditures in the region, including the labour solicited, although companies were secretive about the terms of land lease and the cost of their operations (Andrianirina-Ratsialonana et al. 2011). Averaging estimates from ACI (2008a) and three corporate managers (#6, #8, #20) for the cost of establishing plantations – assuming

Energyplus land lease expenditure of 1 USD/ha/year as indicative of that of other companies' (Andrianirina-Ratsialonana & Teyssier 2010), and excluding additional expenditures such as the creation of schools – the cost of establishing and maintaining 1,100 ha of land with jatropha from 2005 until 2009 would have been about USD 2-4 million. This expenditure includes information provided by several other corporate managers (#2, #8, #18), Rivoarivelo (2012), Medernach, Burnod and Rakotomalala (2011), Heijnen (2010) and ACI (2008a) about plantation employment, which consisted of 500-600 rural farmers paid AR 3,000-4,000 per day (about USD 1), for the same period. The estimate of USD 2-4 million of expenditure assumes that investments already created 1,100 ha of plantations in 2005 and maintained them with the amount of labour indicated until 2009. This is an important sum in the context of an impoverished region such as Boeny, but it is relatively small divided across nine agribusiness operations and their financiers.

One NGO representative commented that “plantations created a distortion in the local economy by offering a wage” (#3). Regional rural households' income is mostly derived from agriculture and livestock, which provide up to AR 20,000 (i.e., USD 9) per week for about 70% of the population (Heijnen 2010). There is an argument that the provision of plantation work represented an important contribution to the welfare of rural communities (Heijnen 2010). This is countered by Medernach et al. (2011), who contend that the additional income offered by jatropha companies contributed to the commodification of labour in the rice sector. The presence of wage labour interfered with the traditional mutual aid system of local communities and reduced the profits to large peasants. The latter had to offer a wage similar to the one of jatropha plantations in order to attract employment during the rainy season (Medernach et al. 2011), and plantation workers were willing to pay more than half of their salary to maintain their rice paddies. A corporate manager observed that his “workers paid even AR 2,000 per day for another local farmer to work in their rice fields” (#2). This shift in the local agrarian economy translated to a greater reliance on wage labour in the rice industry. The problem derives from the fact that, as

Navalona (2012) indicates, local farmers were sometimes put in a position of reliance on plantation work to support their livelihood, and most plantations in the region stopped operating.

The creation of sanitation, education and physical infrastructure had some positive development outcome, but firms created local rivalries by focussing on the construction of facilities in the villages from which they sourced most labour (Rivoarivelo 2012; Medernach et al. 2011). Infirmaries and wells contributed to sanitation and improved health in those workers' communities (Academic #1; Corporate manager #2; Rivoarivelo 2012; Medernach et al. 2011). One manager believed that "schools are a very long term plan and do not produce immediate benefits at the level of the household; one thing is to create or repair the building of a school, another thing is to provide teachers that are going to be there and, since rural farmers would not have enough, pay their salary" (#2). Other interviewees proposed the same view (Academic #1; Corporate manager #11). The creation of dirt roads to access plantation grounds, conversely, created benefits such as easier paths to support local mobility. I observed that communities preferred the tracks created by companies to the ones that they utilised before a firm's arrival.

8.2.2 The survivors

The development benefits of the industry may have been limited, and the conflict solicited great. However, two companies were operative in 2012 despite all of the challenges that the industry was facing. Redsols and Energyplus shared various characteristics that enabled their continued cultivation of the crop in the region. The two firms received stable financing through the financial centre of Mauritius, and they both created consortia (i.e., a group of companies) that leveraged their bargaining position vis-à-vis government officials (Corporate manager #2, #8, #18). They created large plantations that produced both jatropha and food crops directed to the consumption of the workforce, local sales (e.g., rice, papaya, and maize) and export (e.g., cashew, dwarf chillies, black-eyed beans).

The diversification of production had two positive outcomes. Firstly, it overcame cash flow bottlenecks related to the uncertainty around *jatropha*'s maturity, yields, and the responses of the crop to the regional environment, including soil, climate, wildfires and pests. The firms could amortise the fixed costs of creating plantations – “break-even” (Corporate manager #2) – within relatively short time-frames by spreading the expenditures of creating plantations on more than one crop that provided annual income, thus reaping the benefits of economies of scale and of scope in their agricultural activities. The diversification of production also aligned companies' production objectives with workers' preference for the cultivation of food crops (Corporate manager #18).

The survivors were also distinguished from other companies by their land access and management of the relationships with local communities. The land that Redsols cultivated with *jatropha* was located on the soil of an ex-cashew plantation and had been owned by the firm since the 1990s (Redsols 2012). The company's plantation was not established on *tanety*. The firm avoided land tenure insecurity problems and conflicts with local farmers and herders (Redsols 2012). Energyplus, conversely, received a long-term lease from the central government in 2008. Its plantation was located on *tanety* near the commune of Ankarazomborona in the development zone of Marovoay. The company had to learn how to manage land assigned to it and create local social arrangements that would have minimised local conflict. During the early years of operations the company deployed a top-down approach to access land (Rivoarivelo 2012). It went on to modify its approach to harmonise land-use claims across the levels of the region, district, commune and village. The village level was “critical to identify land not overlapping with traditional uses, especially herding, and create access agreements” (Corporate manager #2).

Redsols built housing for the vast majority of its workers near plantation grounds and cultivated rice and food crops for local subsistence, sales and exports. This aligned the objectives of the firm and the workforce, especially in relation to the rice agricultural calendar. Energyplus purchased rice at wholesale prices to distribute it to the workforce on a monthly basis. It

distributed the product at non-profit rates to provide workers' households with better prices for the staple (Corporate manager #2). During the critical moment of transplant of jatropha seedlings, which competed with the transplant of rice, the company was willing to provide housing, higher wages, and food – thus decreasing its profit margins – to those workers' participating to plantation activities (Corporate manager #2). The company harvested jatropha seeds before mid-May and after the beginning of June to reduce overlap with rice activities (Corporate manager #2).

While Redsols avoided difficulties with cattle herders by virtue of its location and long-term land ownership, Energyplus found a solution to address their necessities. Drawing from the experience of JSL-Biofuels (see Heijnen 2010), the firm decided to intercrop jatropha plots with *Estilosantes* and *Brachiaria*, which are forage and nitrogen fixating plants (Fernandes et al. 2005). It then created agreements to allow herders to enter plantation grounds after the first two years of the plants' establishment (Corporate manager #2).

Only these two firms – Redsols and Energyplus – anchored themselves to the Boeny region despite prevailing winds of adverse agroecological, political and economic conditions. Within two years of their arrival, the remaining seven jatropha pioneers had sailed away due to a perfect storm that was unfolding at the international, national, regional and local levels. Falling global petroleum and carbon offset prices, the international financial crisis and the food riots all contributed to the failure of their business plans. In conjunction with shakily established biofuel policies, the overthrow of the national government confounded the support of regional institutions and reduced the security of land rights for establishing jatropha plantations. Everything else equal, local communities appeared more interested in securing their livelihood than assisting corporate business plans, and this further sank their profitability prospects.

9 The ebb and flow of green desires

Like modern Argonauts looking for the Golden Fleece, companies reached Madagascar under the great promise of cultivating the undomesticated *jatropha* in large plantations so they might, within the timeframe of five to seven years, reap high profits. In the climate of general euphoria about biofuels, firms came to see themselves as pioneers in a 'green gold' bonanza in which stakeholders were persuaded on the miraculous potential of the plant. They found fertile ground of support among a variety of organisations that also saw *jatropha* as a promising investment opportunity for the country. The various levels of government in Madagascar, bilateral and multilateral development aid agencies, international environmental organisations, and local NGOs helped the biofuel companies with their business plans and establish plantations in Boeny. The companies, in turn, began with great expectations to forge a new biofuel value chain linking farmers, processors and biofuel buyers. But the *jatropha* value chain did not go very far. After limited prospecting and experimenting on plots, it was apparent that there were no quick fortunes to be made. Most of the *jatropha* pioneers set sail for new ventures.

This chapter presents the conclusions of my study. The first three sections benefit from references related to *jatropha* that were introduced within the literature on Foreign Direct Investment (FDI) in biofuels. The first section presents the findings of this thesis regarding the creation, development and impacts of the *jatropha* industry in Boeny. The second section provides insight into wider themes characterising the literature on biofuels. Following on, the third section reflects on the benefits of the multidisciplinary analytical framework of this study. As compared to the conventional literature on biofuels, the framework is shown to introduce a new perspective on the *jatropha* industry, biofuels and market-based mechanisms linked to sustainable development. This establishes the ground of the research significance and applied

aspects for academic scholarship and policy. In the final section I propose a departing point for future research directions linked to regional development and the carbon economy.

9.1 Research findings

Chapters four to eight of this thesis provided historical- and contemporary-based insight into three research objectives: the configuration of policies and institutions that facilitated the emergence of FDI in jatropha in Madagascar and the creation of a related industry in the Boeny region; the financial background, business model, and plantation operations of companies; and the development outcomes accomplished by the economic activities of firms, vis-à-vis all of the participants to the regional 'biofuel industrial complex'. In what follows, I review the findings of this research project in relation to these objectives on the basis of the information provided by the literature on jatropha.

9.1.1 Objective One: the creation of the jatropha industry in Madagascar and Boeny

The literature suggests that national governments were the main promoters for the creation of jatropha complexes in South and Southeast Asia – especially within Malaysia, Indonesia and India – through policies and subsidies facilitating contract farming arrangements (Habib-Mintz 2013; Fatimah 2011; Ariza-Montobbio et al. 2010). Within Sub-Saharan Africa, especially in Tanzania, Mozambique and Kenya, additionally to the pro-FDI policies of the national governments, the establishment of jatropha plantations was promoted by development aid agencies (e.g., Swedish aid, GIZ), local NGOs, and leading domestic and foreign companies (e.g., KAKUTE, D1-Oils) (see Habib-Mintz 2014; Caniëls & Romijn 2011; Hunsberger 2010; Schut, Slingerland and Locke 2010; Messemaker 2008). Together, these parties translated jatropha from a relatively unknown shrub to, as a participant to the study of Hunsberger (2010, p. 366) remarked, the “brand of biodiesel”.

In Madagascar, the pro-biofuel policies and narratives about jatropha's prospects reinforced well-established discourses on the importance of foreign investment for the cultivation of export-oriented cash crops, agricultural modernisation, conservation and various national development goals such as rural electrification and energy security. The non-government organisations that facilitated the emergence of the jatropha industry were historically linked to the environmental and economic policies characterising Madagascar from the 1980s.

Bilateral donors, development consultancies and NGOs played a central role in supporting every step of the creation of the proposed jatropha value chain in Madagascar. Through the development consultancy Chemonics, USAID championed the cause for cultivating the plant to produce biodiesel. This occurred at the time when international biofuel mandates were being established and the shrub was targeted for biodiesel production by the Indian government. USAID acted in collaboration with D1-Oils, the largest international company in the jatropha industry, as well as the World Wildlife Fund (WWF), the *Deutsche Gesellschaft für Internationale Zusammenarbeit* (GIZ) and the Millennium Challenge Account (MCA). USAID and the WWF – an authority on conservation activities and a representative of the global governance of the plant – were critical in legitimising the sustainability of investments at the national level. They also played a major role in the promotion of the crop towards national and regional governments. Alongside the MCA, they created the pre-conditions for FDI in jatropha to take place (e.g., the land reform of the government).

The discourse on jatropha by governmental and non-governmental organisations, including companies, was based on several observations: the Madagascan population had known about the plant since pre-colonial times; its low input requirements were suitable for poor, small farmers; it could be cropped on land that 'irresponsible' farming and herding practices had degraded, help this land recover, and produce high yields for supplying foreign and domestic markets.

National level assessments for jatropha cultivation were based on considerations such as favourable climate, land availability, low population density, and the presence of supportive, value-added industries (e.g., the vegetable oil industry). The Boeny region was identified as the growth pole for the jatropha industry in Madagascar. The development zone of Marovoay was selected as the pilot site for launching production. With the collaboration of foreign aid agencies and NGOs, the goal of the regional government was to provide four types of support for setting up the industry: the identification of potential plantation areas, the promotion of nurseries' establishment, the founding of organisations to connect farmers with firms, and the incentivisation of creating processing units.

Since jatropha was a new industry for Madagascar, the national government provided the necessary preliminary conditions for companies to establish their production units and marketing avenues without imposing new fiscal rules or regulatory compliance measures. These initiatives followed market-friendly principles advocated by donors and allowed companies to access cheap land, plentiful low-wage rural labour, and the potential to expand production through contractual arrangements with farmers. The World Bank's endorsement of the Madagascar Action Plan (MAP) in 2007 legitimised the groundwork on jatropha done by bilateral donors, NGOs and companies. Following on from the government's discourse on conservation and economic development, the MAP sanctioned the convergence of the government's energy security, and "pro-wastelands" and "pro-poor" discourses embodied by jatropha (Ariza-Montobbio et al. 2010, p. 878).

9.1.2 Objective Two: corporate activities on the ground

The multipolar governance of the jatropha value chain in Boeny was underwritten by a range of private sector organisations (e.g. British Petroleum, Daimler Chrysler, French European distributors), NGOs (e.g. the World Wildlife Fund, the Global Exchange for Social Investment), aid agencies (e.g. USAID, GIZ), industry organisations (the Roundtable on Sustainable Biofuels, the Jatropha Sustainable Biofuels Alliance), supranational and international institutions (i.e., the

European Union, the World Trade Organisation) and the Madagascan government. However, this elaborate network of investments' governance had very little impact in regulating trade, production or firm-to-firm transactions because the industry hardly produced biofuels. Sustainability standards were at their inception and could not regulate production activities. All that this complex governance did was to provide legitimacy for foreign investors to obtain leases for setting up *jatropha* plantations.

Most companies arrived in the Boeny region and established plantations in 2007-2008. Their headquarters were, for the most part, set up in Europe and Mauritius, from where they managed their finances. The investors in their operations included hedge funds and wealthy entrepreneurs, European petrol retailers, shipment companies and reforestation NGOs. One domestic firm invested its internal corporate funds to seek energy independence from the national utility provider. Among foreign companies, pioneering the commercial viability of *jatropha* was a key investment motive and an end in itself. In 2006-2008, food prices were rising and the food-versus-fuel dispute gained steam in international debates. The cultivation of *jatropha* – a non-food crop – on cheap, marginal *tanety* land (hills in Malagasy) offered firms a winning ticket for reaping windfall profits from the EU biofuel market. Additional investment motives included the framing of biodiesel as a chemical by the World Trade Organisation; the satisfaction of EU quality standards for biofuel consumption; and, in case of local sales, the possibility of receiving Certified Emission Reductions from the Clean Development Mechanism of the Kyoto protocol. Other economic factors also mentioned in the literature include bilateral trade agreements, land reforms, tax exemptions and rural development incentives (see Habib-Mintz 2014, 2013; Caniëls & Romijn 2011; Hunsberger et al. 2014; Schut, Slingerland & Locke 2010; Fatimah 2011; Ariza-Montobbio et al. 2010; Messmaker 2008; Chachage 2003), but they were not considered very important by these firms.

Companies in Boeny employed either a large plantation or a nucleus estate production model with the expectation of harvesting commercial yields within five years on average. These

production models focussed on either mono-crop cultivation techniques by firms and contract farmers, or diversified production with other agro-forestry species and food crops. Jatropha companies had the vision of tripling the regional area dedicated to the cultivation of cash crops, establishing refineries and connections with processors, and supplying domestic and foreign markets with biofuel. Schut, Slingerland and Locke (2010) report similar grandiose plans in the case of Mozambique. In India, Indonesia and Malaysia, such a vision was linked to government-led initiatives (Habib-Mintz 2013; Fatimah 2011; Ariza-Montobbio et al. 2010).

Bilateral aid agencies supported corporate operations through their hosting NGOs and provided assistance to farmers' organisations participating in nucleus estates models. The 'pioneering' of commercial jatropha cultivation included: the selection of starting materials to create plantations; methods of propagation of the plant; the identification of optimum plantation areas to cultivate the crop; studies of the subsoil structure in connection to root development and plantation spacing; and evaluations of the influence of the seasonal rains on crop management. Companies discovered that the commercial production of jatropha was far from being the smooth sailing that they expected.

Value chains characterising the local agrarian economy had a major influence on corporate operations. During the rainy season, the rice agricultural calendar impinged on the availability of labour for transplant and harvest operations. During the dry season, due to the fire-prone ecology of *tanety*, the wildfires ignited by herders to feed their *zebu* (cattle) demonstrated that jatropha was not fire-proof. The plant did not cooperate as expected in the climate and soil conditions of Boeny. High rainfall during the wet season did not help the development of the crop, and low rainfall during the dry season required irrigation and fertiliser to aid the plant's growth. Pest outbreaks showed that the shrub was not as hardy and resistant to insects as its promoters had claimed. Firms had to find non-degraded *tanety* or farming areas where jatropha could be cultivated, clear them of savannah grasses, fence them from cattle, and establish large firebreaks to prevent damage from wildfires.

Companies realised that they were off the mark in their expectations about jatropha yields, their cost and timing. Establishing plantations appeared to be the main end of corporate activities because there was a lack of agronomic practices addressing the cultivation of the crop. Even outside of Madagascar, although firms intended to scale up operations, small pilot plantations and in-company research and development activities dominated the industry (Hawkins & Chen 2012; Hawkins & Chen 2011).

The findings about the jatropha industry in Boeny resemble the case of Kenya evidenced by Hunsberger (2010). She notes that the market cycle for jatropha considered seeds as a planting stock rather than a raw material for oil extraction. This created a scenario where the establishment of plantations became an end in itself, which is a “highly unusual” situation as compared to established cash crops (Hunsberger 2010, p. 950). She states that jatropha activities could continue because they were not entirely dominated by the private sector: so-called market-based approaches were subsidised in a variety of ways by bilateral aid agencies and other organisations.

9.1.3 Objective Three: development outcomes

By the end of the first decade of the new millennium, most companies that were to form the jatropha biofuel industrial complex of Boeny had left. Similar to the experience of firms investing in jatropha plantations elsewhere in the world (see ILC 2012; GEXSI 2008), the companies in Boeny developed about 1% of the land that they expected to farm (i.e., a total of 1600 ha as against the proposed 150,000 ha under the crop). The large failure of jatropha value chain activities left Boeny with several economic, social and environmental development impacts. These impacts define the group of winners and losers from the establishment of plantation activities.

Regional economic development outcomes are mainly linked to economic upgrading and trade. Processes such as the creation of ad-hoc oil-extraction facilities and transesterification plants remained at the planning stage. There was no re-skilling of the regional labour force, but a

limited number of farmers increased their expertise with the use of tractors. Technological transfers such as the production of soap from jatropha oil remained limited to the area of Marovoay, but they were left unexploited by local communities. Other utilisations of the plant were limited because the market provided cheaper substitutes for them (e.g., candles, firewood). There was no export of jatropha oil from the region. The jatropha industry was unable to link Boeny with global networks of biofuel production.

According to respondents, the rush to establish the jatropha industry generated a kind of 'civil war' over land which featured the competing interests of companies, the state, and local farmers and herders. Herders were resentful of the companies taking up their pastures and were often accused by company managers of setting fires that spread into the plantations. These complaints and accusations reflected the enduring tensions centred on the institutional control over resources, and local resistance, between the government of Madagascar and rural communities. Most companies employed a top-down approach to land access that did not account for the role of 'traditional' village authorities in regulating land-access and land-use. They contributed to old and new social inequalities by marginalising some communities that were deprived of common village land and grazing areas during local consultations. The communities living closest to plantation grounds benefited the most from employment opportunities and received almost the entirety of social infrastructure created by firms. The others found limited opportunities for seasonal wage work and access to improved dirt roads in the proximity of plantation areas.

The environmental outcomes of jatropha activities in Boeny concern the clearing of vegetation, land-use changes, and input to the cultivation of the plant. Companies removed savannah grasses to create fire-cut corridors around plantations, utilised tractors to till the land, employed pesticides, and sometimes chemical fertilisers, as part of their crop-management strategies. In the short-lived existence of most projects, the ecological outcomes linked to the cultivation of jatropha were negligible.

Corporate activities created a set of winners and losers that range from the state to local communities. The Madagascar government and its agencies, bilateral donors and supportive local NGOs, and corporate employees emerge as winners from Jatropha ventures. First, the Madagascar government succeeded in attracting foreign capital for jatropha cultivation. The FDI projects that received land leases from the government's departments consolidated claims of state ownership on land. To a lesser extent, investments in Boeny contributed to state objectives of transitioning the peasantry towards a market-based economy. However, the government did not generate much revenue from the jatropha industry in Boeny. Regional government and Ministry offices justified their budget by adding jatropha to their portfolio, but were conflicted in their regulatory and governance roles due to the different sectoral dimensions (i.e., energy, environment, agriculture) associated with the crop. Local government *communes* benefitted to some extent from fees paid for access to land, and from a few sanitation projects and school buildings that were provided in some villages. Second, bilateral aid agencies such as USAID and GIZ expanded their portfolios to support market-oriented strategies for agribusiness development, providing aid funding to consultancies such as Chemonics for implementation of jatropha cultivation. Despite the failure to effectively establish a jatropha industry in Boeny, the consultancy was awarded another contract by USAID to implement jatropha cultivation for biofuel production and soil conservation in Haiti from 2009 until 2011 (Chemonics 2009). Similar to Hunsberger's findings in Kenya, the NGOs that were funded to support jatropha cultivation appear to have gained the most from the ventures. Finally, the directors, managers and other workers employed by jatropha companies in Boeny received higher wages than what the contract farmers earned from cultivating and selling jatropha.

Financers of jatropha companies and local communities appear to have lost out on the jatropha experiment in Boeny. Financers suffered from the absence of profits and may have lost the funds that they invested. In the case of hedge funds, such losses could be considered small as compared to disposable capital. Investments in crops other than jatropha, such as soy or

sugarcane, could have awarded them with some returns. Despite the low financial outlay, pioneering the crop had a large opportunity cost. Local communities suffered from some losses of agricultural and grazing land. The competition between rice and jatropha resulted in higher wages being required for the harvest of the staple by workers on large fields owned by peasant farmers. Some communities entered in conflict due to the inequality of the distribution of benefits (e.g. infrastructure, labour opportunities) that came about from the presence of plantations.

9.2 Insights into the literature on foreign direct investment in biofuels

The literature on biofuels converges around two discourses in relation to foreign investments: one in favour and one against. These discourses focus on six interlinked themes. The dimensions of the pro-biofuel discourse included the contribution of investments to reducing the risks of 'fossil fuel crises', implementing 'climate change mitigation' strategies, and promoting 'sustainable agro-industrial development' in poor countries. Referring back to these dimensions, critics questioned the sustainable development potential of FDI in biofuels. They reported adverse impacts linked to themes of 'food security', economic, social and environmental outcomes ('triple bottom line assessment'), and the 'global resource enclosure' that they induced. The research findings of this thesis offer limited ground to support pro-biofuel claims. From the departing point of the 'fossil fuel crises', and taking advantage of references from the literature on jatropha, the discussion below provides insight vis-à-vis the six dimensions characterising biofuels debates.

9.2.1 Fossil fuel crises

The case of the jatropha industry in Boeny questions the contribution of biofuels to energy security. Promises of rural electrification, export or domestic consumption, and alternative energy utilisation remained unfulfilled. Companies undertook isolated, local experiments with straight vegetable oil deriving from jatropha seeds. The competition between biofuel and fossil fuel value chains appeared self-defeating for regional, national and international energy security purposes.

As chapters six and eight outline, the promotion of national energy security was a key reason for the Madagascar state to facilitate FDI in jatropha. But the conflict of interest between collecting petrol import duties, which formed part of the thin government budget, and the local production of biofuels delayed the establishment of a related fiscal policy. This was also due to the unclear structure of the emerging jatropha value chain and corporate production costs in the ecological and economic context of Boeny. After several years of dissatisfactory results, from 2005 until early 2009, transitional government authorities changed their industrial development priorities. The withdrawal of support from the biofuel industrial complex also took place at a time of falling global petroleum prices. In conjunction with larger uses of natural gas in the transport and energy sectors internationally, lower petroleum prices undermined the interest in pursuing biofuel alternatives.

9.2.2 Climate change mitigation

Although they are inextricably linked to the energy industry, biofuels were mainly proposed as a sustainable solution to problems of climate change mitigation. Market-based mechanisms to avoid GHG emissions boosted the economic appeal of the cultivation of energy crops. The Emission Trading Scheme (ETS) and the Clean Development Mechanism (CDM) of the Kyoto Protocol were seen as the means to increase the profitability of biofuel production in developing countries. The United Nations Framework Convention on Climate Change (UNFCCC) ensured the contribution of financial and technical assistance to these projects from parties to the Organisation for Economic Cooperation and Development (OECD). FDI in biofuels gained traction due to the indirect subsidies provided by the consumption mandates of EU member states.

These market-oriented mechanisms were undoubtedly successful in stimulating investments in biofuel production in the global South. However, the extent to which they achieved their aim of mitigating the risks of climate change by availing the production of clean fuels is questionable. The climate change mitigation discourse overlooked several factors

influencing these green investments. These aspects included the complex interaction between financial markets, fossil fuel prices, the government policies of developing countries, the investment motives of firms, and the local context of production. The companies that invested in jatropha in Boeny aimed to profit from biofuel mandates and high petroleum prices, and hardly regarded the receipt of Certified Emission Reductions (CERs) from the CDM as a relevant investment motive. Firms mentioned that a fall in the value of CERs harmed their profitability only when decreasing petroleum prices, national political constraints, and local contestation processes ruined their business plans.

9.2.3 Sustainable agro-industrial development

FDI in biofuels was promoted as an integrated mechanism to attain energy security, climate change mitigation and, critically, sustainable development in poor countries. The prospects for such sustainable agro-industrial development were reinforced by making reference to energy and climate change discourses, and by suggesting that biofuels should be cultivated on unutilised, marginal land. The task of foreign firms was to implement a business plan that, through a large plantation or contract farming scheme, would have promoted economic growth, exports, employment generation, the modernisation of the agricultural sector (e.g., via technology transfers), and the reclamation of degraded land.

Jatropha found a potent ally in discourses identifying various ‘miracle’ crops that provide these multiple development and environmental benefits (Von Maltitz, Gasparatos & Fabricius 2014; Kant and Wu 2011; Booth & Low 2007). The plant was promoted as a low-input crop that could grow on marginal land, provide a multitude of benefits to rural communities, and steadily attend energy security and climate change mitigation strategies. For a short timeframe, plantations in Boeny created employment, but they provided little to no stimulus for economic growth and the reclamation of marginal land.

9.2.4 Food security

The food versus fuel dispute held that biofuels were responsible for the hike in food prices of 2007-2008 and the related riots around the globe, and hence undermined the food security of developing countries. Against this backdrop, jatropha was promoted as a crop that did not compete with food production and ensured a stable supply of raw material for biofuel refineries in the global North. Case study research highlights that FDI in the cultivation of the shrub had a mixed impact on food security (Van Eijck et al. 2014). Among negative impacts, some corporate plantations induced a switch of land-use from food production to the cultivation of toxic jatropha. In Asia, some contract farmers switched to the cultivation of the plant due to the grants, subsidies or tenure security benefits provided by their governments (Habib-Mintz 2013; Ariza-Montobbio et al. 2010). The case of Boeny confirms that plantations diverted some local communities' land away from the production of food. Plantations competed with food production because their land could be used for more profitable livestock activities or the cultivation of other crops such as cassava.

Forming the bulk of neutral food security impacts from jatropha cultivation, some researchers pointed out that households losing agricultural land to plantations sometimes had to relocate their cultivations (Van Eijck et al. 2014). Plantation wages compensated for the loss of agricultural land only when food was available for purchase in local markets. Some contract farmers practised intercropping. In Boeny, workers and contract farmers prioritised the cultivation of food crops and, including the various communities affected by plantations, they did not appear to have lost substantial land or labour resources to jatropha cultivation. Water is a scarce resource during the dry season of Boeny, but companies created wells or artificial lakes independent of community group access to this resource for their own agricultural necessities and hence this did not result in water shortages.

9.2.5 Triple bottom line assessment

The jatropha industry in Boeny was negatively influenced by the overlapping of institutional responsibilities between Madagascan government agencies and departments regulating access to land and investments. This context is linked to the apparent lack of clear biofuel policies, legal frameworks and institutional capacity to regulate jatropha industries in Sub-Saharan Africa (Von Maltitz et al. 2014). Unlike other case studies mentioned in the biofuel literature, the case of Madagascar suggests that bilateral aid agencies played a critical role alongside the government in welcoming investments. The tax concessions offered to the jatropha industry in Boeny incentivised corporate investments but, since plantations were not profitable, limited government income to the fees paid by companies to set up operations. Similar to other studies on these green investments, corporate managers complained about government officers' latency (red tape) in facilitating the development of their business plans.

Biofuel critics mention that development programmes in Sub-Saharan Africa were unhelpful in contributing specific know-how and institutional capacity because they were created in the early 2000s (Jumbe et al. 2009). The case of Boeny questions this claim. The Madagascar Action Plan (MAP) was the Poverty Reduction Strategy Paper approved by the World Bank for the country in 2007. It featured the contribution of jatropha to Madagascar's 'quantum leap' in development. The Madagascan network of bilateral donors and NGOs facilitating investments since their inception in 2003 overlooked the importance of establishing national regulations, transfer know-how and stimulate institutional capacity to manage the industry.

The findings of this thesis reinforce the notion that the cultivation of jatropha is not commercially viable under outgrowers' models or large plantation schemes at every step of the value chain due to a poorly established agronomy (Van Eijck et al. 2014). Similar to the general literature on biofuels, the recurrent problems encountered by companies in Boeny included conflicts between customary and legal land rights, and disputes over compensation and local employment availability. Jatropha plantations contributed to poverty alleviation by providing the

minimum agricultural wage in rural areas (Van Eijck et al. 2014), but rural economies in Boeny were adversely impacted by loss of agricultural land, competition for employment across different agricultural value chains and interference with livelihood activities. As reported by other studies, some farmers became more vulnerable to economic and environmental shocks due to their dependence on the continuity of plantation activities to support their livelihoods.

As argued in the biofuel literature, jatropha investments unquestionably intended to take advantage of cheap land and labour. Some scholars also argued that these were speculative investments related to four scenarios: “subsidized project development and the speculative selling of Certified Emission Reductions for potential carbon sequestration trading payments” (USAID 2006, p. 11); overly optimistic (speculative) assumptions about the agronomy of the crop (Hunsberger 2014); the establishment of “ready-to-start” biofuel farms to profit from higher land values and future demand from third parties interested to acquire plantations (Boche & Anseeuw 2013, p. 10); and financially speculative ventures for the “production of bio-diesel” (Cadmus Group 2014, p. 44). These assessments are reflected in the different aspects of jatropha cultivation explored by my study such as the commodification of land and CO₂ emissions, and corporate intentions to pioneer the cultivation of the plant without properly establishing the agronomic conditions prior to doing so. My findings support the arguments that jatropha investments took advantage of subsidies for project development based on speculative assumptions on the agronomy of the crop, but also show that these aspects do not represent ‘financial speculation’ in any clear analytical and empirical sense of the term.

Although FDI in biofuels is seen as a driver of deforestation (Van Eijck et al. 2014), the global environmental impact of jatropha plantations has generally been regarded as positive in terms of the life-cycle of the oil and its by-products (Bailis & McCarthy 2011; Finco & Doppler 2010). The special report of the Intergovernmental Panel on Climate Change (IPCC 2012) illustrates that GHG emissions from the cultivation of jatropha fall within the range of palm oil plantations. The small size reached by plantations in Boeny, their short period of operations, and

their inability to produce biofuel for exports point to negligible benefits or negative impacts to the environment and GHG reductions.

9.2.6 Global resource enclosure

The findings of this research confirm the arguments for a 'global resource enclosure' linked to biofuel investments, land allocation to foreign companies and their impacts on rural economies. Similarly to the case studies of the biofuel literature, local communities in Boeny were often marginalised in the process of land allocation and local consultations regarding the prospects of investments. The creation of infrastructure, especially wells and clinics, were positive aspects of jatropha investments, but their unequal distribution underscored that they were inadequate compensation for the loss of agricultural land, especially by herders. Jatropha plantations had adverse impacts on tenure security and land conflicts (Van Eijck et al. 2014), but their influence over the access of water resources appears neutral in the case of Boeny.

My study adds further evidence to criticisms which argue that jatropha investments have been an ineffective solution to energy security, climate change and rural development problems worldwide. They have had mixed impacts on food security, negligible economic and environmental benefits, and contributed to conflicts over land.

9.3 Reflection on the analytical framework

The framework of this thesis was structured by political ecology and global value chain analysis. The two analytical approaches enriched one another vis-à-vis dimensions of scale, productive activities, institutions, power, economic and environmental impacts, and the role of human and natural resources in mediating them. The framework highlights the inter-scalar connections between institutional and productive activities and their outcomes. Chapters four to eight progressively contextualise the three research objectives of this thesis across international, national, regional and local scales. This was a narrative choice to simplify the discussion of the

dynamics characterising the creation, development and impact of the jatropha industry in Boeny. A more flexible political ecology understanding of the relations between production, governance and regional resources also enriches the global value chain approach by directing attention to the spatial and political configurations framing productive activities and their impacts.

The study of production networks and financialisation provided important insight into the creation of the jatropha industry and its activities. With input from global value chain analysis, the political ecology approach considered firms as producers of landscape changes and gained awareness of the political economy linking government agencies, bilateral aid, firms and, in particular, NGOs. At the same time, global value chain analysis accounted for corporate productive activities on the ground within their ecological and social contexts. Its understanding of the organisations participating in the biofuel industrial complex was enriched with historical analysis.

Corporate, institutional and collective power categories were useful in understanding the dynamics of value creation (e.g., establishment of corporate plantations and harvest of oilseeds), enhancement (e.g., valorisation of jatropha products and collaboration with processing firms) and capture (e.g., the creation of local infrastructures, fees, financial transfers from Mauritius) through the lens of political ecology. The global value chain analysis derived insight from considerations about processes of discourse and contestation underpinning such power configurations and their outcomes.

The study of industrial development outcomes included livelihood, social and environmental impacts. I also considered possibilities for regional economic upgrading – a non-traditional category within political ecology – under the stimuli of the jatropha industry. As chapter two explains, the global value chain literature – specifically, the Global Production Network framework – highlights two processes that link the exploitation of regional assets with development outcomes: the strategic coupling by firms and the dependable transformations

originating from 'regional' institutions. They can be empirically re-interpreted as processes of institutional control from political ecology. In the perspective of political ecology, contestation against them reshape biogeography, economic activity, institutional practices, and the networks underlying spatial and political configurations.

The ecosystem and local communities, which frame the context of the primary productive activities considered by value chain research, were active agents rather than passive subjects. Their actions were independent of the claims and expectations with which they were invested by a variety of organisations in Boeny. This is evident in the way soil, climatic conditions, jatropha, plantation workers, contract farmers and herders were misaligned with the objectives of the other participants to the biofuel industrial complex. The contestation that ensued had implications for development outcomes and reshaped the biofuel industrial complex: most firms fled, the survivors implemented new production practices, and institutions changed their development priorities.

9.3.1 Jatropha, biofuels and market-based sustainability mechanisms

The findings of my research provide new insights about the fortune of the global jatropha industry and the ability of market-based mechanisms to solve sustainable development problems. Kant and Wu's (2011) article 'The extraordinary collapse of jatropha as a global biofuel' argues that the cultivation of the plant was a case of well-intentioned, top-down approach to climate change mitigation that brought misery to millions among the poorest farmers worldwide. They posit that governments overlooked the application of the principle of "due diligence" and the "conflict of interest of research organisations", which were engaged in a cutthroat competition to attract financing and contributed to the misrepresentation of the crop's potential for biodiesel production (p. 7115).

Along these lines, von Maltitz et al. (2014, p. 3633) suggest that the failure of the value chain was due to a jatropha narrative "based on unproven claims and selective use of available

data". When most international investments in jatropha cultivation took place, research was still informing the crop's cultivation, processing and marketing techniques (see Nazir et al. 2009; Akbar et al. 2009; Atchen et al. 2008; Santoso & Purwoko 2007). The plant requirements for labour, water, fertilisers and pesticides were underestimated and yields proved dissatisfactory (Habib-Mintz 2013; Fatimah 2011; Ariza-Montobbio & Lele 2010; Wahl et al. 2009). Similarly, corporate managers in Boeny pointed out that cultivation of the plant was established on very shaky foundations. They had to spend a substantial amount of time experimenting with different methods of plant cultivation *in situ*. However, all parties that facilitated FDI in jatropha were aware, to some extent, that not much was known about the agronomic conditions for cultivating the crop in Boeny. The most important reason for investing in the cultivation of the plant was to demonstrate the commercial viability of the crop.

Although the wisdom of that cultivating marginal land leads to marginal crop yields may be true (USAID 2006), poor soil quality was recognised at the outset of choosing jatropha as a biofuel crop. Since the plant was seen to thrive in areas of poor soil quality, most firms located their plantations on 'wastelands' that had not been previously used for agriculture. Dry savannahs and other 'marginal' soils were constantly promoted as the ideal settings for jatropha investments, but were not capable of sustaining commercial yields (Van Eijck et al. 2014; Andrianirina-Ratsialonana & Teyssier 2010). In Boeny, even though Redsols cultivated jatropha on agricultural land that had previously been a cashew plantation and applied organic fertilisers, the company was still unable to obtain sufficient oilseed yields. The lands targeted by companies were in excellent locations for the development of export-oriented activities with proximity to major cities and roadways.

Some studies have argued that companies' ability to establish plantations and harvest jatropha were constrained by labour shortages (Burger & Peters 2010; Schut et al. 2010). However, most jatropha projects used criteria such as low population density, availability of large tracts of land and labour supply for cultivation. Labour intensity was expected to be high because

there was no jatropha-specialised agricultural machinery to manage plantations. In Boeny, despite the availability of a large pool of labour, there was a shortage because the plantation activities and jatropha crop cycle overlapped and competed with the demand for labour in rice production. In the case of nucleus estates, the price offered for the purchase of jatropha seeds was insufficient to stimulate contract farmers' interest in mono-crop cultivation and traders' contribution to the logistics of oilseed collection.

Many of my respondents expressed the view that the lack of legal frameworks and weak national governance institutions in Madagascar contributed to the collapse of jatropha projects and failure of the industry. This view has also been expressed in the literature. While this may be partially true for some other countries in Sub-Saharan Africa, it does not hold up to the evidence of substantial promotion and support provided to companies investing in jatropha production in Boeny. It fails to acknowledge the substantial effort invested by national and regional governments, international development programmes and NGOs in Madagascar to create FDI-based biofuel industries as a win-win solution for energy security, climate change mitigation, and sustainable rural development. All of these institutional actors created a biofuel policy discourse and governance complex that demonstrated substantial coherence and institutional capacity. Even emerging economies with 'greater' institutional capacity, such as India and Malaysia, were unable to bring their national jatropha programmes to success (Habib-Mintz 2013; Ariza-Montobbio et al. 2010).

Some scholars have argued that the final nail in the coffin for most jatropha projects around the world was the perfect storm of falling international petroleum prices, the global financial crisis and critiques of biofuels. In 2008 oil prices dropped and reduced the potential profitability of jatropha investments (Caniëls & Romijn 2011; Habib-Mintz 2010, 2014). During the concomitant financial crisis, investors withdrew their support because the standing of biofuels as sustainable investments was compromised due to evidence of deforestation and diversion of land-use from food to fuel production (Slingerland & Schut 2014; Boche & Anseeuw 2013).

However, this argument does not explain why and how some companies have survived in the face of widespread collapse of the jatropha biofuel industry. As it was in the 1990s, there is a growing consensus that the industry can be viable if smallholders cultivate the plant as a living fence in areas where jatropha utilisations are economically competitive against market substitutes (Van Eijck et al. 2014; Openshaw 2000). Similar to my findings in Boeny, a few studies show that some jatropha plantations remained operative because they expected modest yields and partitioned cultivated areas with the involvement of local communities (Von Maltitz et al. 2014). A handful of jatropha companies in Mozambique survived by incorporating the cultivation of food crops in their business model (Slingerland & Schut 2014).

The explanations for the collapse of the global jatropha experiment are inadequate in understanding the fortune of the industry and the attempt to create a new global value chain. Jatropha companies were start-ups that aimed to produce jatropha biofuel as an innovative alternative in the context of energy security, climate change mitigation efforts, and sustainable development discourses. In her analysis of the jatropha industry in Kenya, Hunsberger (2014, p. 227) applies the concept of the “economy of appearances”, which describes how start-ups exaggerate their business plans and bias investment prospects to attract funding, to the modality through which NGOs promoting the cultivation of the shrub attracted donors’ financing. Von Maltitz et al. (2014, p. 3616-3617) talk of a “jatropha hype” in which the plant was promoted as a “miracle crop” among various “potent rural development strategies” to industrialise Sub-Saharan Africa.

These statements reflect the ‘buzz’ surrounding concepts such as innovations, alternative energy sources and carbon trading that would generate significant profits in the developing world and attracted the interest of governments, bilateral donors and NGOs (Hunsberger 2014, p. 225). My findings echo these arguments and show that, besides NGOs, most jatropha promoters across local, regional, national and international scales reinforced the expectations attributed to jatropha. In Boeny, some of these organisations (e.g., the Millennium Challenge Account, the

Programme de Lutte Anti-Erosive) provided some cautionary advice about the experimental nature of investments (ACI 2008a; Henning & Ramorafeno 2005), which they still facilitated.

The claims and arguments presented about the global collapse of the industry blame its failure on someone or something else. They deflect attention from the group of winners and losers created by the rise and fall of the jatropha industry. All participants, except local communities and perhaps a few investors, gained advantages from the cultivation of the plant. There was widespread financial opportunism by companies and convenience for a variety of other organisations that surrounded the promotion and facilitation of investments across international, national, regional and local scales. Governments, development agencies and consultancies and NGOs neglected the principle of 'due diligence' and largely emerged as winners from extending their support to the industry. This facilitated the emergence of international investments that formerly targeted 11 million ha of land worldwide, cultivated 1 million ha, and considered developing countries as laboratories providing the optimal conditions to test the potential of the plant to suffice their profit motives.

These processes are reflected in the jatropha experiment of Boeny. It appears that, even in the 2000s, the dilemma of Madagascan agricultural and rural development policies was in their execution by and for almost everyone but the peasantry. Jatropha was promoted as the latest champion for sustainable development agendas but it was, for the most part, a risky venture that lacked a careful analysis of its commercial potential for establishing a value chain. The jatropha industry was largely a bubble that neither yielded massive short-term profits for investors nor created a biofuel industrial complex. All parties – research institutions, NGOs, development and aid organisations, governments and biofuel certification organisations – played a direct or indirect role in facilitating or legitimising investments based on their respective agendas.

The United Nations Framework Convention on Climate Change was a milestone for the emergence of international action to address global environmental problems. The initiatives

implemented by the Convention facilitated the emergence of promising market mechanisms to address interconnected issues of climate change mitigation, adaptation, and sustainable development in the global South. These initiatives created a role for the private sector in tackling global sustainability issues and encouraged investments to seek profits where it was least costly, such as Madagascar and other tropical and subtropical countries. The global experiment with the jatropha value chain entered this context alongside other biofuel raw materials. Jatropha was a large driver of the biofuel boom in the 2000s and provided scarce results on all fronts of the global problems that it was supposed to address. The industry destroyed financial value and interfered with the livelihood of the world's poor. The discussion of these findings within the wider literature about jatropha and biofuels reveal a widespread convenience – financial or political – underlying the uptake of the cultivation of the crop.

Sustainability is the capacity to continue certain human activities indefinitely by satisfying the needs of current generations without compromising the ability of future ones to meet their own necessities. The involvement of the private sector in sustainable development is, by all means, indisputably important. Innovation is crucial to the swift international progress to a low-carbon economy, and start-up ventures like jatropha companies – with their 'economy of appearances' – have traditionally been its carriers in the private sector. Despite considerable progress in tackling investment impacts, the institutions and governance mechanisms in place to ensure their sustainability appear ill-equipped to engage with underlying financialisation mechanisms. Before it went bust, the large-scale cultivation of jatropha was supported by the sustainability desires and agendas of stakeholders dispersed across international, national, regional and local levels. The lack of application of clear governance principles, or 'due diligence', to separate expectations from the reality of *in-situ* operations can lead to such undesirable global scenarios. Current market-based approaches to tackle global problems open a window of opportunity for a well-intended support to industrial initiatives that, without the necessary

preparation, take bold steps forward under the great promise to change the world. The outcomes of such process are uncertain, unintended, contingent and, in principle, unsustainable.

9.4 Research significance

The insights of this thesis affirm and extend the findings from the critical literature on jatropha to issues of FDI in biofuels and wider sustainable development mechanisms. Beyond the case study object of this research, the academic scholarship, policy-makers and development practitioners can draw important theoretical, methodological, and practical insights.

The theoretical contribution of this research mainly unfolds through the novel combination of political ecology with the global value chains approach. The multidisciplinary integration of the two approaches brought to light unexpected complementarities and tensions between their theoretical propositions. The empirical analysis shows that value creation and reproduction processes affect and are influenced by the biophysical, social, and economic assets and institutions that influence the trajectory of value creation within production networks. The horizontal conditions considered by GVC, the constraints imposed by the social context of the labour environment and the political ecology of contestation combined to determine contingent, and sometimes counterproductive, regional development outcomes.

This study also operationalises the theorisation of regions as socially and politically constructed spaces and units of strategic economic organisation. It furthers the political ecology scholarship by grappling with network-based approaches and the role of firms as producers of social and environmental change (see Robbins 2004, pp. 208-215). This thesis advances global value chains approaches by re-engaging with the original research agenda of articulating the geography of value added activities, their governance structures and the institutional frameworks that determine their shifting fortunes.

The mixed methodology of this thesis invites a dialogue between critical social and political sciences and the managerial literature to identify viable value propositions in the context of sustainable development initiatives. It uses a wide range of qualitative data sources, from semi-structured interviews to direct observations, and links them to quantitative evidence gathered from various documents and archival records. The synthesis of the two categories of data and their triangulation via software provided the foundations for successive analyses. The approach has gained importance in recent years across the academic, private and public sectors. Especially in remote areas of developing countries, it has the potential to bring together various expert groups to examine complex phenomena from a multiplicity of angles and improve projects' design.

Policy-makers, officers and corporate managers operating across international, national and regional environments (e.g., bilateral aid institutions, international companies and NGOs) can draw important insights. Similarly to the theoretical and empirical studies of Ponte (2014b), Bumpus and Liverman (2009), and Sutter and Parreño (2007), this thesis questions the effectiveness of current market-based mechanisms and international roundtable governmentalities in stimulating sustainable development outcomes in poor countries. Public and private initiatives that aim to stimulate monetary exchange, social resilience and grassroots environmental restoration could fail to consider crucial biophysical, economic and regional social constraints. Observers contend that this situation primarily arises from counterproductive incentives in the political agenda of national and transnational institutions and the lack of thorough local consultations (see Horning 2008; Duffy 2006; Kull 2004).

This study shows the critical importance of considering the a-priori viability and desirability of projects based on local markets, legal, extra-legal and customary social practices, and the dynamic influence that increasing international cultural exchanges and trade exercise on them. The case of the jatropha industry in Boeny shows the importance of accommodating these factors into the design of pilot projects. Strengthening the governance of public and private

initiatives requires policy-makers and project managers to cope thoroughly with their peculiar logistic, productive and financial challenges before their implementation into international, national and regional development schemes.

9.5 Future research directions

Coe, Lai & Wójcik (2014) call for more studies that intersect the financial and economic geography literature. Financialisation dominates economic activities and plays a leading role in shaping rural livelihoods (Baka 2012). Firms increasingly exploit derivatives and pursue finance-based strategies, and banks appear to combine the extension of credit to the enterprise sector with the orchestration of financial instruments. Deregulated, fully-mobile and globally integrated finance is considered a critical determinant of the fortune of nations. The study of financialisation creates a range of research directions for the literature contributing to development studies and corporate social responsibility analyses. Within the context of market-based mechanisms to climate change mitigation, for example, is it possible that some financial investors seek to access tax benefits and spread them across multiple high- and low-risk sustainable development projects? The implications of financialisation research at the intersection between financial and economic geography, within the lens of development studies, are enormous.

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Appendix 1 Semi-structured interview questions

A1.1 Group 1: Environmental and Rural NGOs representatives

Characteristics of the NGOs

- What are their main activities? Do they operate in other parts of the country?
- How long has their organisation existed? How long have they been working in the Boeny area?
- Which are the groups they consider as their ‘target group’ or ‘clientele’? What kinds of projects or services do they provide for these groups?
- What kinds of interactions do they have with a) officials of government departments such as Agriculture, Infrastructure etc., b) local political leaders, c) other NGOs, and d) private companies?

NGO views on agriculture and Jatropha cultivation in Boeny

- What are the main commercial and subsistence (i.e., mainly for household consumption) crops that farmers have traditionally cultivated in this area?
- What are some of the main problems that farmers have faced in producing these crops (e.g., climatic factors such as cyclical drought, extreme variability in rainfall; high cost of inputs—chemical fertilisers, pesticides, herbicides; lack of financing, i.e., bank loans, credit, for commercial crop production; high costs of agricultural labour; difficulties with transporting crop to market; limited government support for crop prices, etc.)
- How long has Jatropha cultivation been taking place in this area? Have many farmers taken up cultivation on their own lands?
- Are they facing new problems since they started Jatropha cultivation on their lands?
- How does the biofuel company interact with farmers in the area?
- What are the problems that farmers talk about with regard to the biofuels company?
- From the NGO’s perspective, what are the benefits that Jatropha cultivation can provide to farmers? What other benefits can it provide for people who are not farmers, but who live in the Boeny area? What benefits does it provide for local, provincial, and national governments?
- From the NGO’s perspective, what are the disadvantages of Jatropha cultivation for farmers, the economy and environment of the Boeny region, and more broadly at the national or global level?

A1.2 Group 2: Government officials and academics

General questions

- How familiar are they with the Boeny region? How long have they lived/worked/done research in the area?
- What are some of the main characteristics or distinctive features relating to agricultural production in this region?
- What are the other major non-agricultural activities that are distinctive to this region?

Government Policy

- What are some of the key policies outlined by the national government for development of the export-oriented agriculture sector?
- What are the policies that are targeted for regional development?
- What are the differences in economic development activities promoted by the government in the highlands, the lowlands, and coastal areas?
- Where is most of the Foreign Direct Investment (FDI) taking place in the country? In which sectors?
- How is the national government's environmental policy linked to the FDI in biofuels?
- How many foreign and national firms are involved in biofuel production across the country? Are there more companies entering the market?

Views on Jatropha cultivation in the Boeny region

- What are the specific incentives or support provided by the government for companies involved in Jatropha production?
- What are the advantages of Jatropha production in this area compared to other parts of the country?
- What are some of the constraints that are faced by farmers or companies involved in export-crop production? Do these constraints also affect Jatropha production?
- What are some of the benefits that have been generated from FDI in Jatropha production for the Boeny region?
- What is the longer term perspective on the continued viability of Jatropha production in this region?
- What is the longer term perspective on FDI in the agriculture and energy sectors of the country?
- What are some of the problems that have emerged, or are likely to emerge, with expansion of FDI in the agriculture sector?

A1.3 Group 3: Biofuel corporate managers

General characteristics of the Company

- Where is the company's headquarters? How long has it operated in Madagascar?
- How long has it been involved in biofuel production?
- How many countries does it operate in? In how many countries is it involved in biofuel production?
- What other sectors (non-biofuel) is the company involved in, in terms of production?
- What are the different biofuel crops that the company is involved in producing in Madagascar? In other countries?

Views regarding Jatropha cultivation in Madagascar and the Boeny region

- What are the advantages of establishing biofuel production facilities in Madagascar?
- What kinds of benefits or incentives are offered by the Madagascan government for attracting companies to the country for biofuel production?
- What are the reasons for selecting the Boeny region for setting up Jatropha production?
- How long has the company's Jatropha production been operating in Boeny?

Organisation of Jatropha production

- Area under cultivation; how much under direct control of the company, how much through contractual arrangements with farmers?
- Describe production process on company plantation: annual cycle: time of planting, duration of crop, time for applying fertiliser, herbicide, pesticides, time for harvest; labour required for all these activities
- Describe production process through contractual arrangement with farmers. Does the company supply inputs such as seeds, fertiliser, pesticides, herbicides, etc.? Does it specify when farmers should apply these inputs? How does it set a price for farmers involved in contractual production?
- Is the harvested crop processed on site? If yes, then describe processing activities, and labour required for these activities. If not processed on site, then where is it processed?
- What are the transport and other logistics involved in taking the harvest/processed crop to exporting facilities?

Problems faced by the company with Jatropha production in Boeny

- A. What are the major problems experienced by the company in producing Jatropha (e.g., climatic vagaries that create big fluctuations in harvest, poor infrastructure, inadequate skilled labour, poor quality/quantity supplied by contract farmers, etc.)
- B. How does the company try to resolve these problems?
- C. What is the longer term prospect for the company to continue Jatropha production in Boeny?

A1.4 Group 4: Farmers

Experiences with Jatropha cultivation in the Boeny region

- What was the main commercial crop that you produced on your land before starting to grow Jatropha?
- How does jatropha cultivation compare with other commercial crops that you grow/have grown (more or less inputs, more or less labour, more or less affected by climatic variability, more or less earnings, etc.)
- Do you still produce food crops for household consumption on your land, or do you now rely on purchasing food from the market?
- Does the government agriculture department provide you with support or advice for jatropha cultivation?

Interactions with the Biofuel Company

- What kind of relationship do you have with the biofuel company (Labourer, contract farmer, independent supplier etc.)
- Which company officials do you interact with on a regular basis (field manager, extension worker, etc.)?
- What benefits do you get from your relationship with the company?
- What are some of the problems you face when you interact with the company?
- Do many other farmers face the same problems with the company, or do they face other problems?
- What other benefits does the company provide for farmers in the region?
- Is there more work available for people in Boeny since the company started functioning?

Interactions with government agencies, local political leaders, and NGOs

- Do the local leaders or local NGOs help farmers in establishing a relationship with the company?
- Do local NGOs or leaders help in resolving any problems that you and other farmers may experience with the company?
- Do you think that more companies should come to Boeny and start Jatropha production?

Appendix 2 Interview dates and locations

A2.1 Government Officials

Reference Number	Date	Location
Government official #1	13/08/2012	Antananarivo
Government official #2	13/08/2012	Antananarivo
Government official #3	20/08/2012	Antananarivo
Government official #4	20/08/2012	Antananarivo
Government official #5	20/08/2012	Antananarivo
Government official #6	27/08/2012	Mahajanga
Government official #7	03/09/2012	Mahajanga
Government official #8	04/09/2012	Mahajanga
Government official #9	11/09/2012	Mahajanga
Government official #10	11/09/2012	Mahajanga
Government official #11	17/09/2012	Mahajanga
Government official #12	18/09/2012	Mahajanga
Government official #13	19/09/2012	Mahajanga
Government official #14	28/09/2012	Mahajanga
Government official #15	30/09/2012	Mahajanga

A2.2 Corporate Managers

Reference Number	Date	Location
Corporate manager #1	16/08/2012	Antananarivo
Corporate manager #2	27/08/2012	Mahajanga
Corporate manager #3	28/08/2012	Mahajanga
Corporate manager #4	29/08/2012	Mahajanga
Corporate manager #5	11/09/2012	Mahajanga
Corporate manager #6	12/09/2012	Mahajanga
Corporate manager #7	13/09/2012	Mahajanga
Corporate manager #8	14/09/2012	Mahajanga
Corporate manager #9	15/09/2012	Mahajanga
Corporate manager #10	16/09/2012	Mahajanga
Corporate manager #11	17/09/2012	Mahajanga
Corporate manager #12	19/09/2012	Mahajanga
Corporate manager #13	21/09/2012	Mahajanga
Corporate manager #14	21/09/2012	Mahajanga
Corporate manager #15	22/09/2012	Mahajanga
Corporate manager #16	26/09/2012	Mahajanga
Corporate manager #17	26/09/2012	Mahajanga
Corporate manager #18	26/09/2012	Mahajanga
Corporate manager #19	10/09/2012	Mahajanga
Corporate manager #20	11/09/2012	Mahajanga

A2.3 NGO representatives

Reference Number	Date	Location
NGO representative #1	15/08/2012	Antananarivo
NGO representative #2	22/08/2012	Antananarivo
NGO representative #3	24/08/2012	Mahajanga
NGO representative #4	25/09/2012	Mahajanga
NGO representative #5	20/09/2012	Mahajanga
NGO representative #6	31/08/2012	Mahajanga
NGO representative #7	31/08/2012	Mahajanga
NGO representative #8	04/09/2012	Mahajanga
NGO representative #9	03/09/2012	Mahajanga
NGO representative #10	04/09/2012	Mahajanga
NGO representative #11	03/09/2012	Mahajanga
NGO representative #12	07/09/2012	Mahajanga
NGO representative #13	08/09/2012	Mahajanga
NGO representative #14	16/09/2012	Mahajanga

A2.4 Academics

Reference Number	Date	Location
Academic #1	17/08/2012	Antananarivo
Academic #2	20/09/2012	Mahajanga
Academic #3	11/09/2012	Mahajanga
Academic #4	23/09/2012	Antananarivo

A2.5 Farmers

Reference Number	Date	Location
Farmer #1	14/09/2012	Mahajanga
Farmer #2	29/08/2012	Mahajanga
Farmer #3	03/09/2012	Mahajanga
Farmer #4	04/09/2012	Mahajanga
Farmer #5	15/09/2012	Mahajanga