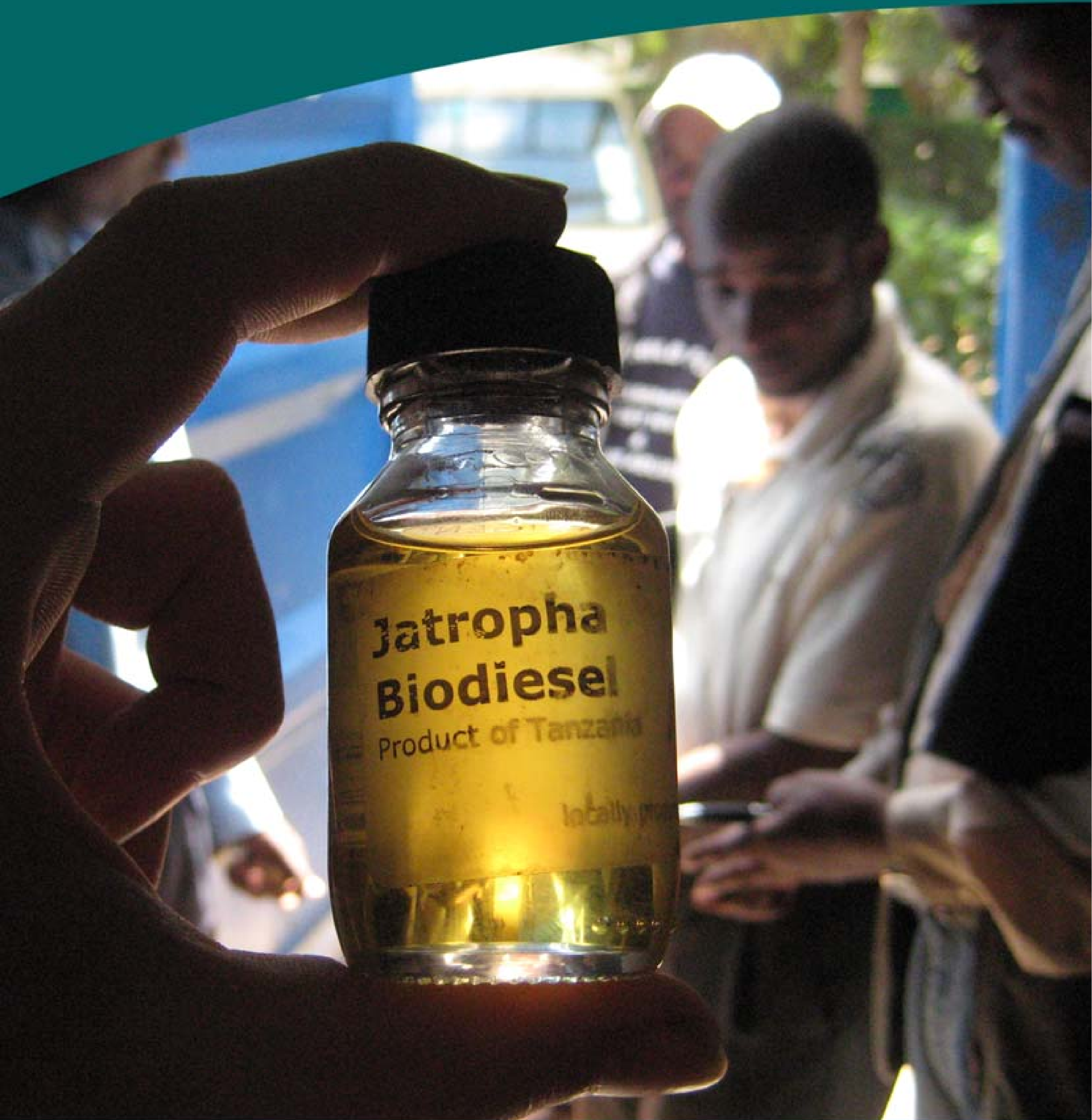
The Green Myth?

Assessment of the Jatropha value chain and its potential for pro-poor biofuel development in Northern Tanzania



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Assessment of the Jatropha value chain and its potential for pro-poor biofuel development in Northern Tanzania

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This thesis is part of the requirements to complete the MSc program International Development Studies (IDS) at the Faculty of Geosciences, Utrecht University, The Netherlands.

ABSTRACT
Currently there is a global debate on the possible positive and negative impacts of biofuels. Jatropha *curcas L.* is frequently mentioned as a promising first generation biofuel crop. Based on claims that it can grow on marginal land, requiring little water, nutrients and farm management, the assumption is often made that it does not compete with food crops. Based on fieldwork, this thesis assesses the Jatropha value chain and its potential for pro-poor biofuel development in Northern Tanzania. After exploring the entire value chain and its end markets, a stakeholder analysis is conducted. Performance along the chain is determined by analyzing its three key determinants: competitiveness, governance and the enabling environment. Gross margin calculations and a SWOT analysis are provided for all relevant value chain activities. To conclude, the potential for pro-poor development is assessed.

KEYWORDS
Value chain; pro-poor development; renewable energy; biofuel; Jatropha; Tanzania.

Cover photograph: biodiesel sample at Diligent Energy Systems Tanzania Ltd.

For Evelien

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List of abbreviations

ARI	Alternative Resource for Income Generation
CAMARTEC	Centre for Agricultural Mechanization and Rural Technology
CORDAID	Catholic Organization for Relief and Development Aid
Diligent	Diligent Energy Systems Tanzania Limited
DOSI	Dutch Orkonerei Social Investments Limited
ELCT	Evangelical Lutheran Church Tanzania
ESDT	Energy for Sustainable Development Tanzania
ETC	Educational Training Consultants
EU	European Union
EUEI	European Union Energy Initiative
Faida MaLi	Faida Market Link
FAKT	German non-profit development consultancy firm
FAME	Fatty Acid Methyl Esters
GBS	General Budget Support
GGWG	Green Garden Women Group
GTZ	German Technical Cooperation
HDI	Human Development Index
InfEnergy	InfEnergy Tanzania Limited
Jatropha	Jatropha *curcas L.*
JME	Jatropha Methyl Ester
IMF	International Monetary Fund
JPTL	Jatropha Products Tanzania Limited
HIVOS	Humanist Institute for Cooperation with Developing Countries
KAKUTE	Kampuni ya Kusambaza Teknolojia Limited
KAMA	KAMA Herbal Products Limited
KBC	Kilimanjaro Biofuels Corporation
Kikuletwa	Kikuletwa Farm Moshi
MFP	Multifunctional Platform
MMA	Match Maker Associates Limited
MEM	Ministry of Energy and Minerals
NBTF	National Biofuels Task Force
NGO	Non-governmental organization
OECD	Organisation for Economic Co-operation and Development
PRSP	Poverty Reduction Strategy Paper
REA	Rural Energy Agency
REF	Rural Energy Fund
SAP	Structural Adjustment Program
SARI	Seliani Agriculture Research Institute
Sida	Swedish Agency for International Development Cooperation
SJO	Straight Jatropha Oil
SNV	Netherlands Development Organization
SUA	Sokoine University of Agriculture
SVO	Straight vegetable oil
TANESCO	Tanzania Electric Supply Company Limited

TaTEDO	Tanzania Traditional Energy Development and Environment Organization
TBS	Tanzania Bureau of Standards
TIRDO	Tanzania Industrial Research and Development Organization
TZS	Tanzanian Shilling
UNDP GVEP	United Nations Development Program Global Village Energy Partnership
UNGANO	UNGANO Development Communication Limited
UDSM	University of Dar es Salaam
USD	United States Dollar
WWF	World Wide Fund For Nature / World Wildlife Fund

List of units

1 TZS	0.00083 USD (average January - August 2008; source: OANDA, 2008)
1 USD	1,200 TZS (average January - August 2008; ibid.)
1 acre	0.40 ha
1 ha	2.47 acre
1 bag	60 kg of Jatropha seeds

Executive summary

This thesis assesses the Jatropha value chain and its potential for pro-poor biofuel development in Northern Tanzania. In chapter 2, pro-poor development is defined as increased income and equitable distribution thereof, i.e. increased absolute and relative income of the poor. Then the value chain is defined, including its three key determinants of total value chain performance: competitiveness, governance and the enabling environment. These determinants, in turn, are influenced by other concepts such as upgrading, inter-firm cooperation, barriers to entry, policies and regulations. Subsequently, Jatropha is introduced as a promising first generation biofuel crop. Based on claims that it can grow on marginal land, requiring little water, nutrients and farm management, the assumption is often made that it does not compete with other crops, such as food or cash crops.

Illustration 1: Jatropha seeds drying outside KAKUTE's office in Arusha.

The main research question and seven research sub questions are presented in chapter 3. In order to assess the Jatropha value chain, a stakeholder database is constructed and semi-structured and in-depth interviews are conducted during a three month fieldwork in Northern Tanzania. The results are analyzed in order to assess the entire value chain and its end markets. By conducting a stakeholder analysis, the focus shifts to the level of individual stakeholders, assessing inter-firm cooperation. Subsequently, performance along the chain is determined by analyzing its three key determinants: competitiveness, governance and the enabling environment. Finally, the potential for pro-poor biofuel development is assessed. The main conclusions and recommendations, structured according to the research sub questions, are as follows.

Which links and linkages constitute the Jatropha value chain?

The links and linkages that constitute the Jatropha value chain are presented in chapter 4. It is concluded that the chain lacks a global scope and exists mainly on a national and regional level. Furthermore, links consist mainly of production activities and less of support services such as packaging and distribution. This can be explained by the early stage of the value chain, which means that most stakeholders still undertake these activities themselves.

What are the characteristics of current markets for Jatropha value chain products?

The markets for the four different value chain products are identified and analyzed in chapter 4. Firstly, the market for Jatropha seeds is unstable. Demand is higher than supply and prices are fluctuating substantially between locations due to lack of information sharing. The second market is that of straight Jatropha oil (SJO), which is relatively stable in terms of demand and prices. However, uncertainties regarding future blending policies and taxes cause doubt amongst stakeholders and impose risks. Thirdly, the national and regional market for Jatropha soap is limited. The medicinal characteristics are largely unknown amongst consumers, the price is more than six times higher than regular soap and quality control is lacking. Nevertheless, there is a potential to engage in the international medicinal soap market. Finally, there is no market for Jatropha biodiesel. Because of the current high seed price, biodiesel is more expensive than traditional energy sources such as diesel and kerosene. Hence, apart from test samples, no biodiesel is currently being produced in the research area.

Which individual actors undertake the activities at each link, what are their characteristics and which linkages can be identified?

As part of the stakeholder analysis, as presented in chapter 5, an actor constellation is drafted, including all relevant stakeholders and their linkages. From the analysis it is concluded that several potential linkages between stakeholders are absent. For example, lack of information sharing between actors is observed due to missing horizontal as well as vertical linkages. Farmers and collectors, for example, are unaware of market developments and prices in other regions. Horizontal linkages in the form of information sharing could benefit farmers and collectors in responding to the market. Vertical information sharing between suppliers and buyers could be used to improve products and services in the chain.

Recommendations

- Provide market accessibility training to farmers and other stakeholders involved
- Foster collaborative research between research institutes and stakeholders
- Create a forum to share knowledge

To what extent are activities at each link within the value chain competitive?

Illustration 2: A small-scale farmer in Engaruka intercrops Jatropha with beans.

The competitiveness of all value chain activities is determined in chapter 6. Gross margin calculations show that, in relative terms, nursing activities are most competitive, followed by oil extraction and seed collection. The competitiveness of gathering, small-scale farming and soap production is limited. These activities are only feasible under certain conditions, such as limited availability of alternative labor opportunities, crop yields and seed prices. Both large-scale farming and biodiesel production are concluded to be uncompetitive. Large-scale farming is unfeasible due to low yields and continuous flowering which requires labor intensive manual harvesting. Biodiesel production is not viable because the production costs are high and there is currently little or no market.

To what extent are governance in the chain and the environment in the research area influencing Jatropha value chain development?

In section 6.2 it becomes clear that some stakeholders have taken steps towards acquiring governance in the chain, but in practice have little power over other actors. For example, contracts are not enforced, side selling is observed and few price or quality standards are set. Regarding the enabling environment, international biofuel policies are under debate, no national blending policies exist in Tanzania and it is thus far unclear if biofuels will be taxed in the near future. Furthermore, the role of district and village governments is unclear. Interviewed stakeholders blame the absence of government policies for creating uncertainties and impeding biofuel related developments. Furthermore, high transaction and transportation costs negatively impact value chain development.

Recommendations

- Start roundtable discussions to identify joint stakeholder ideas in which to address the National Biofuels Task Force (NBTF)
- Define the role of district and village government with all stakeholders involved

What is the existing knowledge and experience regarding Jatropha?

It is concluded that there is a lack of knowledge on the characteristics of Jatropha, farm management practices and the effects of different inputs on productivity and oil contents of seeds. Furthermore, most farmers are unaware of their production costs and have limited information on the market and its buyers. Moreover, the feasibility of Jatropha compared to other biofuel crops is currently unknown. Even at large-scale farms, this lack of knowledge is apparent. Actors that are promoting Jatropha are providing their target groups with limited information regarding production costs, market developments and risks involved. In general there is a lack of information sharing between actors, which makes it harder to bridge the observed gaps regarding knowledge and experience.

Illustration 3: Even at large-scale farms there is a lack of knowledge on Jatropha *curcas L.*

Recommendations

- Actors promoting Jatropha need to help farmers calculate the costs and benefits compared to other crops and make their target groups aware of the risks involved

To what extent can the Jatropha value chain contribute to pro-poor biofuel development?

Despite uncertainties and risks involved, several Jatropha activities, such as nursing, gathering and manual oil extraction, provide alternative sources of income to the poor. At the household level, SJO is not used in oil lamps or cook stoves because these are not working properly. SJO and biodiesel are not competitive with conventional household energy sources such as firewood, charcoal and kerosene, but Jatropha can be used in other applications. Planting as hedges, for example, can protect land against cattle and erosion. Furthermore, in remote rural areas, Multifunctional Platforms (MFPs) could run on SJO in order to provide off-grid rural electrification and related services (see annex 5), which could contribute to development.

Illustration 4: SJO is not competitive with traditional energy sources such as firewood.

Recommendations

- Enhance functionality and efficiency of Jatropha oil lamps and cook stoves
- Improve management and clarify ownership of Multifunctional Platforms
- Run Multifunctional Platforms on Jatropha when feasible compared to diesel

Conclusion

Illustration 5: Jatropha requires common inputs and is not immune to pests and fungi.

All in all, it is concluded that there is little knowledge on important issues such as production costs and feasibility compared to other crops. In general, Jatropha requires common inputs such as nutrients, water and farm management, thereby competing with food and other crops. Furthermore, Jatropha is not immune to pests and fungi. Hence, it is not the promising biofuel crop it is said to be. Under certain conditions, the Jatropha value chain could contribute to pro-poor biofuel development in Northern Tanzania. But for now it is still in an incipient stage.

Preface

Although placed fairly at the beginning, this section is actually the last I write in order to complete this master thesis. Now that another study adventure is at a near end, and so many hours are devoted to the product that lies before you, it is an honor to dedicate this section to the people who supported me in so many ways. To them I owe my gratitude, for without them this thesis would not have seen the daylight. It is my privilege therefore to sit down once more, at the end of this concluding night, while the first sunrays are lingering around the corner to announce a new day, pushing my devoted coffee machine to its limits once more, to produce these very final keystrokes, with pleasure, in order to express my appreciation.

Gratitude goes to all the respondents and stakeholders who contributed their valuable time, effort and expertise to the research that was conducted in Tanzania. Their contributions provided the very foundation of this thesis. I am aware that, under certain conditions, asking respondents to sacrifice their time can impact their ability to meet their daily needs. I am therefore grateful to those who did and sympathetic to those who did not.

Special thanks go to Albert Mshanga from JPTL, who not only arranged field visits but also took the greatly appreciated effort of chairing our Jatropha stakeholder workshop in Arusha. Big thanks also deserve Edith Mtenga from JPTL and Janske van Eijck from Diligent, for arranging field visits and contributing to the research in various other ways.

The internship and fieldwork in Tanzania were made possible thanks to the support of SNV Northern Portfolio in Arusha, who generously provided their facilities as well as a research budget. In particular, I would like to thank Peter Bos, biogas advisor at SNV and my supervisor during the internship, for his support, practical and useful suggestions and hospitality upon arrival in Arusha. Thanks deserve all other SNV colleagues as well, for tolerating us while we took over the previously so quiet lunch room in the garden and brutally converted it into our temporary office. Furthermore, I would like to thank Lauren, Lieke, Karine and Jan for the productive fieldwork and for the great time we had in Arusha.

I am especially grateful to dr. Henk Huisman, coordinator of Utrecht University's International Development Studies master program, who offered me the project and was willing to supervise me from the start. His supervision included an appreciated visit to assess the fieldwork in Tanzania. During all our meetings his constructive feedback and continuous enthusiasm on the project motivated me to a great extent. Furthermore, the inspiring discussions and countless vivid narratives made it a pleasant and unforgettable experience. I would also like to thank dr. Paul van Lindert for acting as the second reader. The effort is sincerely appreciated.

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newsletters and pictures that she could get a hold on, but also for literally typing out a Dutch radio interview related to Jatropha while I was conducting the fieldwork in Tanzania.

To conclude, I would like to thank a few people that contributed to this thesis in a more indirect way. My thanks go to: Ombeni and my other valuable friends in Tanzania, for allowing me to experience so many aspects of Tanzanian culture. I had a great time and am convinced our friendship will last for long to come; Alphons, for some exciting and adventurous days in Holland during my thesis writing and for buying me expensive lunches to keep me motivated; Marleen, for her nightly phone calls checking if I was still alive, discussing development theories and elaborating on the meaning of life. It seems we both survived; Jan-Willem, for promising to send me 10 bucks of his well deserved salary every month as my scholarship ran out. I actually did receive them once; Tom, for keeping our back garden constantly dotted with colorful flowers. The view significantly eased the burden of being locked inside my room during the sunny summer days; Lies and Rick, for supporting me in countless ways and for their continuous and unreserved faith. Last but not least I would like to thank Evelien for her unconditional support, patience and understanding, and for walking the dog.

1 Introduction

Since fossil fuels are due to run out in the near future, alternative sources of energy are increasingly gaining interest. Currently, a global debate exists on the possible positive and negative impacts of biofuels. This is not only a debate between experts, but also between people involved in related subjects. The public media, newspapers and television also play an important role in the debate and at the moment biofuels can be considered a hype. Often mentioned positive effects include diminishing green house gas emission, while skeptics point at the undecided environmental impact and food security issues when biofuel crops are grown at the expense of food crops. In this respect, Jatropha *curcas L.*, a non-edible oilseed crop, is often mentioned as a promising plant. Certain assumed characteristics, such as its ability to survive on marginal lands, not requiring additional inputs such as irrigation or fertilizers and without the need for intensive farm management, fuel the assumption that Jatropha biofuels provide an alternative to fossil fuels without the aforementioned negative environmental impact and food security issues.

Illustration 1.1: Planting Jatropha using direct seeding at Diligent's test plot in Arusha.

In Northern Tanzania, several initiatives have been undertaken to promote Jatropha related activities. Such activities include Jatropha farming, seed collection, oil extraction, soap making, biodiesel production and domestic use of straight Jatropha oil for cooking and lighting. NGOs involved claim that these activities lead not only to development of sustainable alternative energy sources but also to development of the poor. However, currently little literature is available regarding contemporary Jatropha related activities in Northern Tanzania and their impact on pro-poor development. This thesis aims to fill that gap.

Illustration 1.2: Manual oil extraction results in unfiltered straight Jatropha oil (SJO).

As part of Utrecht University's MSc program International Development Studies, a study was conducted with the objective to assess the Jatropha value chain and its potential for pro-poor biofuel development in Northern Tanzania. Fieldwork was carried out in Northern Tanzania as part of a three-month internship hosted by SNV (Netherlands Development Organization). The value chain was selected as the main analytical framework, because it not

Illustration 1.3: Different Jatropha products, including soap, SJO, oil lamps and seedcake.

only provides for the means to assess a complicated set of related activities, but moreover is in accordance with SNV's private sector development focus. Furthermore, value chain selection, analysis and development currently are key tools of various development organizations. In contemporary development thinking, it is widely believed that by linking to global networks of firms, private sector development can be fostered.

This thesis is an academic study that places the results from the fieldwork in their appropriate context. Chapter 2 focuses on the relevant thematic-theoretical context, exploring and defining pro-poor development, value chain concepts and agricultural small holder production of biofuels using Jatropha. The last section of chapter 2 assesses various geographic characteristics at a global, national and regional level, such as rising fossil fuel prices, domestic energy use and agricultural land use in the research area. Subsequently, the research questions, conceptual model and used methods are explained in chapter 3. The succeeding three chapters present the results and analysis. Chapter 4 assesses the characteristics of the entire value chain, including its end markets. A stakeholder analysis, zooming in further to the level of individual stakeholders, is provided in chapter 5. In the sixth chapter, the scope of analysis is shifted to the level of individual links within the value chain, considering for example their technical and economic feasibility as well as the impact of governance and the enabling environment. At the end of chapter 6, the potential for pro-poor development is assessed, after which the general conclusions and recommendations are presented in chapter 7.

Illustration 1.4: Geographical characteristics influence agricultural land use in the area.

2 Value chains and pro-poor biofuel development

In the first sections of this chapter, the relevant thematic-theoretical viewpoints are presented, i.e. pro-poor development, the value chain and biofuels. Subsequently, the final section of this chapter focuses on the geographical context at different scale levels, describing national and regional characteristics such as domestic energy use, environmental conditions, economic development and government policies.

2.1 From globalization to pro-poor development

2.1.1 Globalization and the role of private sector development

Globalization has become a modern catchword referring to the world economy in the late twentieth century (Dicken, 1998). Opposed to the much older trend of economic internationalization, which depicts the spread of economic activities across international boundaries, globalization is a more recent phenomenon that implies functional integration between internationally dispersed activities (Gereffi et al., 2001). Hence, globalization not only refers to the international scope of economic activities, such as the international division of labor, but moreover to the global organization of economic activities. For enterprises, whether in developed or developing countries, globalization means that economic growth to a lesser extent is achieved by developing new products and to a greater extent depends on gaining access to existing chains that consist of many different firms. In other words, *"participation in global value chains and production networks is the key to economic growth"* (ibid., p. 5).

Within the aforementioned globalized context it can be expected that private sector development plays an important role for economic growth, and therefore for development. In order to understand the role of the private sector within contemporary development thinking, the evolution of development thinking is now briefly discussed. Initially, after the Second World War, development thinking was based on Keynesian principles and focused on economic growth in terms of income (Jolly, 2005). Post-war consensus dictated Import Substitution Industrialization (ISI) as the rightful path to development, with a key role for the interventionist state (Ranis, 2004). The focus was still predominantly on income growth and not so much on equitable distribution thereof, which would follow later. Subsequently, while the basic needs approach centered around the provision of basic commodities, thereby circumventing income (ibid.), the emerging neoliberal approach advocated privatization and liberalization of capital markets (Simon, 1997). This so-called Washington consensus was a result of rising influence within the development debate of the Bretton Woods institutions, i.e. the International Monetary Fund (IMF) and The World Bank. As a result, Structural Adjustment Programs (SAPs) were implemented in developing countries as part of aid conditionalities in order to acquire loans from the IMF or The World Bank (Ranis, 2004). SAPs generally advocated privatization and deregulation, thereby promoting free market policies (Cypher & Dietz, 2004). Hence, opposed to the post-war consensus, SAPs involved diminishing the role of the state.

One of the criticisms on SAPs is this very neglect of the role of the state and institutions (InWEnt, 2004). Many development countries are characterized by market failure and government failure, and without a functioning political and institutional environment, privatization and liberalization will not lead to the intended result of high economic growth. Another criticism on SAPs is that issues related to equitable distribution of income were still largely neglected. Furthermore, SAPs were criticized for the lack of involvement of the loan recipient, suggesting that SAPs were merely a way of imposing predominantly neoliberal ideas on the receiving country by the international financial institutions and their donor countries. The perception that the core concepts and policies of the Washington Consensus were outdated, combined with the growing notion of conventional development failure, amongst other factors, led to an impasse in development thinking in the mid 1980s (Cypher & Dietz, 2004). This impasse demanded for new views on development. In 1990, the first United Nations Human Development Report was drafted, focusing on the human aspect of development (United Nations, 1990). Human development is defined as the process of enlarging people's choices and strengthening human capabilities. This human aspect includes globalization, consumption, economic growth and poverty reduction. Hence, human development entails, but is not limited to, private sector development. Recently, more attention is also paid to micro economics and market failures that influence development (Ranis, 2004).

Returning to the concept of globalization, as introduced at the start of this section, Kaplinsky and Morris argue that contemporary development thinking is dominated by the belief that increasing integration into the global economy is the key to long term growth (Kaplinsky & Morris, 2007). Businesses in developing countries therefore have to take globalization into account. However, the question can be asked as to who exactly gain from globalization. According to Kaplinsky, globalization has particularly bypassed people living in developing countries and has led to rising income inequality between and within countries (Kaplinsky, 2007; M4P, 2007). Or, as Gereffi et al. put it, *"the gains from globalisation are very unevenly distributed within, as well as between, societies"* (Gereffi et al., 2001, p. 1). While mainstream economics centered around the idea that comparative advantage and thus specialization and trade-openness per definition would benefit countries, it is now clear that within the current global context the assumptions that led to these beliefs are no longer valid (ibid.). Developing countries will not necessarily benefit from an open playing-field in global trade or from trade negotiations (Kaplinsky & Morris, 2007). Furthermore, according to the latter author, the perceived potential of export-oriented industrialization can only be realized in a restricted trade environment. From the above it can be concluded that new initiatives in developing countries have to be embedded in global networks, an aspect which will be discussed in this thesis.

2.1.2 Towards pro-poor development

As became clear in the previous section, not everybody profits from globalization. Thus, the question can be asked how private sector development in a globalized world can benefit the poor. Rather than questioning whether to participate in the global economy at all, a more interesting question instead is how to participate in a way that ensures equitable income growth and distribution (Kaplinsky, 2007). Economic growth with poverty reduction, i.e.

economic growth that benefits the poor, generally is referred to as pro-poor development (USAID, 2006). Other definitions of pro-poor development exist, such as the broad definition of an increase in GDP that reduces poverty, development that reduces poverty and decreases inequality or development that benefits the poor proportionally more than the non-poor (ibid.). Hence, two important aims of pro-poor development are to increase the absolute income of the poor on the one hand, and to increase their share or relative income on the other (M4P, 2007). Most development agencies currently have specific policies regarding pro-poor development (see for example DFID, 2000; OECD, 2006; USAID, 2006; The World Bank, 2008). Pro-poor growth can for example be achieved by targeting industries where the poor are concentrated, such as agriculture, and by supporting equity with competitiveness (USAID, 2007).

Summarizing, it can be stated that globalization, with an increased income gap between and within countries, has significantly influenced development thinking and the role of the private sector therein. Businesses in developing countries have to take globalization into account. Since markets in industrialized countries are to a great extent accessed through value chains, economic growth depends on gaining access to these large international networks of firms. The characteristics of these chains are important because they have a direct impact on pro-poor development. Hence, value chain analysis can assist in explaining the dynamic processes of functional integration by bringing together stakeholders from different production stages and by focusing on organizational aspects of these chains (Gereffi et al., 2001). The value chain therefore is discussed in the next section.

2.2 The value chain concept

The value chain is a broad and flexible framework, involving many different but interrelated concepts. Within a development perspective, the value chain framework can be used to analyze value chains and identify constraints and opportunities for development. Although there is currently some consensus on what is generally meant by a value chain, many names and definitions are used within value chain studies (Gereffi et al., 2001). Moreover, there is no consistent terminology to refer to important concepts related to value chains. In this section therefore, a selection of views on the value chain concept is presented and the definition for use in this thesis is provided. Subsequently, important determinants and related concepts within the value chain are defined and explained.

2.2.1 Evolution of the concept

Various publications provide useful overviews of important value chain authors and definitions over time (cf. Kaplinsky & Morris, 2001; Gereffi et al., 2001). The origin of the concept lies in 1985 when Michael Porter publishes his work *Competitive Advantage: Creating and Sustaining Superior Performance*. Porter defines the value chain as follows:

> *"The value chain disaggregates a firm into its strategically relevant activities in order to understand the behavior of costs and the existing and potential sources of differentiation. A firm gains competitive advantage by performing these strategically important activities more cheaply or better than its competitors." (Porter, 1985, p. 33)*

Porter focuses on the activities that are performed at different links within the chain. He makes an important distinction between different types of activities, i.e. activities related to supply, processing and support services. He thereby extends the definition of activities beyond the actual physical transformation that takes place at each link (Kaplinsky & Morris, 2001).

Porter defines the value chain as all the activities that take place within a single firm. By focusing on the different types of functions or activities that are performed within a single firm, Porter's value chain essentially consists of intra-link activities. An interconnected set of links, thereby connecting different value chains to each other, is defined as a *value system*. Hence, Porter's value system encompasses what in modern value chain thinking is referred to as the value chain. The basic concepts however are still the same; it is mainly a difference in nomenclature (Kaplinsky & Morris, 2001).

A similar difference in terminology, while referring to the same concept, is the term *value stream* used by Womack and Jones (1996). The French term *filière* (translating to "thread" or "chain") originated during French colonial times and is defined as "the flow of physical inputs and services in the production of a final product" (Kaplinsky & Morris, 2001, p. 7). The filière is similar to a value chain, especially the modern version which encompasses the role of public institutions. However, the filière differs from the modern value chain in that it implies a static character, not so much taking into account dynamic relationships that change over time, and because it is limited to physical and technical aspects (M4P, 2007).

An important addition to the classic value chains and value systems comes from different authors, who link the value chain to globalization processes. Gereffi for example introduces the concept of *global commodity chains* (Kaplinsky & Morris, 2001). By focusing on power relations within globally linked production systems, Gereffi shows that most value chains are coordinated by a dominant party. In this respect a distinction can be made between buyer-driven commodity chains and producer-driven commodity chains, depending on which party plays the most dominant role (ibid.). Within value chain analysis, organization and management of chains is called governance (Gereffi et al., 2001), a concept which is discussed in more detail in section 2.2.4.

Another addition to Porter's value chain framework is the change of the unit of analysis from the individual firm to the chain as a whole (Gereffi et al., 2001). While Porter defines the value system as a set of inter-linked 'complete' firms, this new value chain perspective allows for the inclusion of 'incomplete' firms. These incomplete firms perform only a specific type out of the different activities that are defined by Porter. An example of an incomplete firm is a company that specializes in marketing, therefore not dealing with activities such as input supply and production.

2.2.2 Towards an operationalized definition

As already indicated, various overlapping definitions of value chains are currently being used. Gereffi et al. recognize the problems that result from inconsistent terminology and state that "the lack of a well-defined theoretical framework limits both the generalisations that can be derived from diverse case studies and comparisons of different value chains" (Gereffi et al., 2001, p. 3). Efforts have been made to come up with a consistent definition and terminology. In September 2000 a conference was organized in Italy to address this issue. Fourteen researchers dealing with value chains came together to develop a common framework for value chain research. Results were published in different articles (ibid.) and on a website (Duke University, 2008) in order to share value chain research findings and develop a collective position on concepts, methodology and strategy. Since the initiative, more articles have been published on the topics of the conference. The definition of a value chain as formulated in one of the first of these publications is used in this thesis. Hence the value chain is defined as follows:

> *"The value chain describes the full range of activities which are required to bring a product or service from conception, through the different phases of production (involving a combination of physical transformation and the input of various producer services), delivery to final consumers, and final disposal after use" (Kaplinsky & Morris, 2001, p. 4).*

Different links can be identified that are connected by linkages. Links are activities or functions that actors can perform as part of the value chain. This embraces activities such as design, production, distribution and marketing (Johnston, 2007). A single firm can perform several activities within the same value chain. A single activity in turn can be carried out by multiple firms (Downing, 2008). Additionally, value chain links can be concentrated on a single geographical location or spread over wider areas (Weitzenegger, 2008).

Linkages are relationships or interactions between links in the value chain. These relationships can have different forms, such as capital, products, information and power (Downing, 2008). A main characteristic of a value chain is that each link adds value to the product or service. It is important to distinguish between links and linkages, the latter referring to relations *between* different links within the value chain. Economic concepts such as vertical and horizontal linkages therefore don't denote links in the value chain, but instead refer to interactions between those links.

Value chains exist on different scale levels. Local value chains have no links outside their regional or national scope, while global value chains span across multiple countries and continents (ILO, 2006). Furthermore, where traditional sectoral economic analysis ends, value chain analysis extends its range to different economic sectors (Kaplinsky & Morris, 2001). Producers within a particular value chain can feed their products into other value chains. A saw mill for example can sell its outputs to construction firms as well as furniture producers. To distinguish such a sub-chain within the value chain, the term market channel is used to denote one single branch from raw material to final output (USAID, 2005).

Within value chain analysis, three key concepts are important determinants of total value chain performance, namely 1) competitiveness, 2) governance and 3) enabling environment. These determinants are important for this thesis since they guide the methodology of the research, the data that is collected and subsequently the analysis thereof. The aforementioned key determinants, including their related concepts, are discussed in the following sections.

2.2.3 Competitiveness as an engine for growth

Competitiveness, as the first determinant of total value chain performance, is a broad concept, which applies to the value chain from its entirety up to individual links and activities (Downing, 2008; M4P, 2007). The notion traces back to Porter's competitive advantage and can be defined as "how [a firm can] provide to customers a certain good (or service) of equivalent value compared to competitors but at lower cost" (M4P, 2007, p. 13). In Porter's framework the goal is to identify competitive advantage for a firm by looking at one of the many activities that take place within that firm. It has therefore mainly a business application, assisting managers with decisions and strategies to increase enterprise competitiveness.

Within contemporary value chain approaches, the idea of competitiveness is applied with a broader scope. It is acknowledged that competitiveness of firms not only depends on their own activities and direct relationships with suppliers and buyers, but to a large extent is also determined by competitiveness of the entire chain at a national or global level (USAID, 2006a). In other words, industry-level competitiveness is as important as firm-level competitiveness.

Several factors can be distinguished that influence the competitiveness of a value chain (Downing, 2008). First of all, end markets determine the characteristics of a successful product or service, such as price, quality, quantity and timing (USAID, 2006a). End markets for Jatropha products are discussed in chapter 4. Furthermore, competitiveness is influenced by the enabling environment, which is discussed in section 2.2.5. Thirdly, firm-level upgrading strategies, such as improving products and production processes, positively impact competitiveness. Finally, inter-firm cooperation influences the effectiveness of firms within the chain, since linkages can lead to innovation, to name an example. The concepts of upgrading and inter-firm cooperation are briefly discussed in the following sections.

Upgrading

Upgrading refers to the process of innovating, i.e. continuously improving products and processes (Kaplinsky & Morris, 2001). Hence, the ability to learn is an important factor for successful upgrading. However, upgrading is only profitable when it occurs at a higher rate than competitors, thereby maintaining a competitive advantage. Apart from increasing economic competitiveness, upgrading can also refer to occupying new positions in a value chain or delivering to new markets (ILO, 2006). Kaplinsky distinguishes four types of value chain upgrading (Kaplinsky & Readman, 2001). First of all, process upgrading refers to improving the efficiency of internal processes to make them more price efficient than those of competitors. In this respect, one can speak of price based competition (Downing, 2008). As a second type of upgrading, Kaplinsky defines product upgrading as developing new products or improving existing products faster than rivals. Increased quality or product differentiation results in competition based on quality and uniqueness (ibid.). In this respect, inter-firm cooperation is important, since it fosters innovation (Diyamett, 2004). Thirdly, according to Kaplinsky, functional upgrading involves changing a firm's activities within the value chain, for example by outsourcing certain functions. The fourth form of upgrading is referred to as chain upgrading and encompasses moving to a different value chain, i.e. producing different end products. All in all, upgrading, in whichever form, is an important factor in achieving and sustaining competitiveness (Parsons, 2006).

Inter-firm cooperation

The USAID value chain lexicon defines inter-firm cooperation as "joint action between two or more firms in a value chain" (USAID, 2005, p. 4). There is a tension between inter-firm cooperation and competition, i.e. between cooperating to eliminate common constraints and competing to capture as much benefits as possible (USAID, 2006a). Despite the perceived risk of cooperating with competing firms however, inter-firm cooperation is fundamental to growth (Downing, 2008). For example, cooperation between firms is important for innovations, which in turn fuel upgrading and thereby the competitiveness of individual firms as well as the entire chain (Diyamett, 2004). As USAID states, by bringing actors together to identify common constraints and opportunities, they can be motivated to collaborate despite the prevailing tension between inter-firm cooperation and competition (USAID, 2006a).

Inter-firm cooperation is a broad concept which encompasses all possible linkages in the value chain, hence numerous classifications exist to distinguish between different types of linkages. Kaplinsky differentiates between relations based on mass production and those based on the Japanese business model (Kaplinsky 1989). The author states that mass production relations are usually arm length, whereas in the Japanese business model firms in general have fewer and longer lasting relationships, making mutual investments between buyers and suppliers more common. Greek et al. categorize linkages on the basis of the different actors involved, e.g. between firms, public sector, government and academics. Goodman makes a distinction founded on the nature of the linkages, e.g. between technological, organizational and social linkages. Diyamett focuses on the degree of interdependency, e.g. highly interdependent versus loosely coupled linkages (Diyamett, 2004). The most common distinction that is made is the one between horizontal and vertical linkages (USAID, 2005; USAID, 2006a).

Vertical linkages, sometimes referred to as market linkages, are mainly buying and selling transactions between firms that undertake different activities in the chain (Diyamett, 2004). Within the concept of vertical linkages, a further distinction can be made between backward and forward linkages (ibid.). Backward linkages, or input linkages, denote relations with input suppliers. An example of a backward linkage is a farmer acquiring fertilizers. Forward linkages, or output linkages, constitute relations to buyers who purchase a product of a firm. An example of a forward linkage is a farmer selling his product to the food-processing industry (Diyamett, 2004).

Horizontal linkages are defined as interactions and relations between firms performing the same function in the value chain (USAID, 2005). Essentially this means that horizontal linkages are linkages between competitors (Diyamett, 2004). By cooperating through horizontal linkages, firms can create economies of scale, e.g. bargaining power and bulk sales

(Downing, 2008). Furthermore, sharing of information on market prices and quality can have mutual benefits for horizontally linked firms (M4P, 2007).

2.2.4 Governance and the role of power

Governance is the second determinant within value chain analysis and refers to the organization and management of the chain. Firms with power over others generally receive the greatest benefit within the value chain (USAID, 2006a). Gereffi et al. define governance as "the ability of one firm in the chain to influence or determine the activities of other firms in the chain" (Gereffi et al., 2001, p. 5). This influence can take different forms, such as defining the products to be produced, setting standards to be used and providing technical support to suppliers. The power to do so is a direct result of existing barriers to entry, which provide market power and high returns.

The need for governance structures arises when a value chain consists of many firms, thus requiring supply coordination. Furthermore, higher risks on the supply side encourage more coordination within the chain. USAID's Value Chains Lexicon distinguishes between four types of governance (USAID, 2005). First of all, a market relationship is characterized by many buyers and many suppliers, with limited information exchange and little interactions. Secondly, a balanced relationship is typified by a few buyers and suppliers who are dependant on each other, resulting in extensive information exchange. A third type of relationship is a directed relationship, whereby the main buyer is in control and defines the product, offering technical assistance to the supplier. The last relationship is hierarchical, characterized by vertical integration of activities within a single firm.

Barriers to entry and rent

As was stated before, the highest profits within the value chain go to those firms who have power over others. This is also true for firms that manage to protect themselves from competition (Kaplinsky & Morris, 2001). Control over scarce resources generates economic rent, thereby constructing barriers to entry for other firms. Hence a barrier to entry is a scarcity that prevents another firm from being more competitive. The resources that are controlled can be of any type, e.g. capital, land, innovation and information. Some types of economic rent are constructed by firms or groups of firms (e.g. technology rents, organizational rents and relational rents), while others are of a more external nature (e.g. resource rents) (Kaplinsky & Morris, 2001). In addition, possible barriers to entry include the cost of infrastructure and seasonality of products (USAID, 2006a).

Quality and price control

The governance or power firms have within a value chain can be used to determine quality and price standards. In doing so, firms can convince other firms either into process upgrading, resulting in more efficient production and thus a lower production price, or into product upgrading, resulting in higher quality or diversified products that meet the demands of the governing firm. Quality and price control thereby usually influences the competitiveness of several firms in the chain. Furthermore, quality and price control is a form of inter-firm cooperation, requiring exchange of information and knowledge in order to achieve new standards.

2.2.5 Enabling environment: defining the boundaries of opportunities

The third and last key determinant within value chain analysis is the enabling environment. It exists at different scale levels, i.e. global, national and regional, and consists of policies, international trade agreements, laws, regulations and public infrastructure such as roads, and electricity (USAID, 2006a). In a more 'soft' interpretation, factors such as culture and norms constitute the enabling environment as well. The key notion of an enabling environment is that it facilitates (or hinders) the movement of a product or service along the chain. Or, as Downing states, the enabling environment defines the boundaries of opportunities (Downing, 2008).

National policies and regulations play a significant role in ensuring a favorable enabling environment (USAID, 2006a) and ensuring a level playing field for all actors involved (SDC, 2005). Small-scale farmers, for example, generally have difficulties with contract negotiations and meeting contractual requirements (Baker, 2007). When local or national government is functioning deficiently or legal frameworks are not enforced, transaction costs rise. Higher transaction costs and risks of doing business, in turn, discourage investment in upgrading and inter-firm cooperation. As Douglass North states it, economic history is the development of institutions to mitigate the risks of exchange. Governments therefore have the task of lowering the transaction and information costs for entrepreneurs, including small-scale farmers. Furthermore, governments can ensure fair governance and promote investment in incipient domestic value chains that don't not necessarily attract private investment (Baker, 2007). Since local policies and regulations can more easily be changed than those at a national level, opportunities exist for local governments to positively impact enterprise and value chain development.

Apart from policies and regulations, infrastructure is an important determinant for the enabling environment as well. This includes roads, power grids and communication technology such as mobile phones and internet. In a broad sense, infrastructure also encompasses development policies. Summarizing, it can be stated that "in an enabling environment, government would encourage local self-organisation, maintain an active dialogue with stakeholders, and ensure that local needs are addressed" (SDC, 2005).

2.3 Renewable energy

Increasing awareness of the consequences of green house gas emissions, depleting fossil fuel reserves and rising demand for and prices of conventional fuels all contribute to a growing interest in alternative sources of energy. One such alternative is renewable energy. The term *renewable* in this respect refers to the sustainability of the production, i.e. the energy is generated from natural resources which are naturally replenished. Therefore, supply of the energy source will not decrease in the predictable future. Contemporary types of renewable energy include solar power, wind energy, hydroelectricity and biofuel. The focus in this thesis is on the latter category.

2.3.1 Biofuels

Biofuel refers to renewable energy produced from biomass, i.e. organic material such as plants, fruits or seeds (Shell, 2007). A distinction can be made between first generation and second generation biofuels. Generally, first generation biofuels, sometimes referred to as conventional biofuels, are derived from crops that are grown for biofuel production purposes. These crops include mainly food crops. The most widespread first generation biofuel is ethanol, which is produced from sugary plants such as sugar cane, corn and wheat. The second biggest first generation biofuel is called FAME (fatty acid methyl esters). Because it is a diesel type of fuel, FAME is often referred to as biodiesel. Possible crops to produce biodiesel include rapeseed, palm oil and Jatropha. The straight vegetable oil (SVO) that is gained from these plants is converted into biodiesel through a process called transesterification. In this thesis, straight vegetable oil derived from Jatropha seeds is referred to as straight Jatropha oil (SJO). The FAME type of Jatropha biofuel is referred to as Jatropha biodiesel.

One of the disadvantages of first generation biofuels is that they are mainly produced from food crops (The World Bank, 2008a). Hence, scaling up first generation biofuel production to meet the rising global demand for fuel has a direct impact on food availability. Furthermore, large-scale cultivation of biofuel crops in some cases leads to land clearing and related environmental impacts. Although biofuels emit roughly the same amount of CO2 as fossil fuels, in the former case the emitted carbon dioxide has been absorbed from the air during the lifetime of the plant (Shell, 2007). This renders the carbon dioxide balance essentially neutral. However, this equation does not take into account additional CO2 emissions during the production process from raw material to distribution of the biofuel. All in all, the total impact of first generation biofuels to date remains unclear. Hence, it is not surprising that currently a global debate takes place on issues related to biofuels, including energy demands, food security and environmental impact. An in-depth analysis of this ongoing debate is not within the goal of this thesis, neither is taking a standpoint on the matter, but the mere existence of the debate is relevant when first generation biofuels are discussed. Relevant in this respect is also the development of second generation biofuels, which are produced from plant waste and therefore are supposed to impose a smaller burden on available agricultural lands and food security. When second generation biofuels will be developed and ready for use exactly is unknown, estimations differ from 10 to 20 years.

2.3.2 Jatropha as a biofuel crop

Jatropha *curcas L.*, in this thesis simply referred to as Jatropha, is a wild plant that can grow up to seven meters high. The plant produces seeds which contain oil. If the seeds are pressed, straight Jatropha oil (SJO), a type of straight vegetable oil (SVO) can be extracted. There is not much knowledge available on the genetics of the plant and there is little experience with breeding programs (Jongschaap et al., 2007). However, due to several claims regarding its special characteristics, Jatropha is seen as a promising biofuel crop (van Eijck, 2007).

On of the claims is that Jatropha can grow on marginal lands, requiring little water, nutrients and farm management (Jongschapp et al., 2007). This would mean that Jatropha can be grown in areas where other crops cannot be successfully cultivated, therefore to a lesser extent competing with food or other crops. Additionally, Jatropha is seen as a promising biofuel plant because the plant itself and the oil are non-edible. This means that Jatropha plants are less likely to be eaten by animals such as grazing cattle. The third reason why Jatropha is seen as promising is because it has many rural applications (Henning, 2002). SJO can be used in lamps and cook stoves or as a substitute fuel in modified diesel engines. When blending SJO with regular diesel up to 10 – 20 %, the mixture can be used as fuel in unmodified engines. When SJO is converted into biodiesel, the resulting fuel can also directly be used in unmodified diesel engines. Furthermore, soap can be produced from SJO, which has medicinal characteristics (Wiskerke, 2008). When pressing the seeds for oil, the seedcake that remains as a byproduct can be used as briquette, fertilizer or input in a biogas plant (Heller, 1996).

All the attention for the assumed characteristics of the plant has lead to a hype around Jatropha, although the presumed yields, for example, have not been validated by facts (Jongschaap et al., 2007). Currently, these presumed characteristics are mostly still under debate. In 2007, a report was published titled *"Claims and Facts on Jatropha curcas L."* (ibid.). In this thesis, some of these claims are verified in the context of Northern Tanzania.

2.4 Global, national and regional environment

2.4.1 Global

In the global context, rising fossil fuel prices are an important factor influencing potential biofuel developments. World energy demand is rising every year and with the depletion of fossil fuel reserves in the foreseeable future, alternative sources of energy are gaining interest (The World Bank, 2008a). However, the European Union recently announced that due to undetermined environmental impact of biofuel production and possible related food security issues, 10% blending policies for 2020 within the EU were under debate again.

In the United States of America and Brazil ethanol is the biggest biofuel that is currently being produced (ibid.). However, a recent World Bank report indicating that rising biofuel production is the main cause of food shortages and rising food prices (ibid.), fuels the debate on food versus fuel. Regarding food security, developing countries are widely expected to be hit hardest.

2.4.2 National

Tanzania lists among the poorest countries in the world. With a human development index (HDI) of 0.467 it ranks 159th out of the 175 countries on UNDP's HDI list. In other words, Tanzania belongs to the bottom 10% of the list. In the national context, the political economic background of Tanzania is important. When the first democratic elections were held in 1995, it brought an end to socialism in Tanzania. Through SAPs, the state interventions that were common during socialism diminished and differentiated relations emerged, whereby some benefited and others were forced into subsistence agriculture or secondary and tertiary activities (Simon, 1997). Many small holders were left exposed to high transaction costs and market failures (The World Bank, 2008). In general, economic reforms benefited urban households and farmers with market access over others (Minot, 2005).

In Tanzania, the majority of the rural poor are active in agriculture, mainly as producers with little value addition and often with limited access to markets. Agriculture is the most important economic sector in terms of GDP and employment. Agriculture accounts for more than 40% of total GDP and for 80% of employment (National Bureau of Statistics, 2002). The main crops that are grown are maize and cassava and 90% of the agricultural producers are small holders with 1 ha of land or less. Agricultural productivity is generally low, as can be observed in other parts of Sub Saharan Africa, and Tanzania clearly missed the green revolution.

2.4.3 Regional

Northern Tanzania, specifically the Arusha region, is one of the dryer regions in Tanzania, with an average annual rainfall of 875 mm in 2002 (National Bureau of Statistics, 2002). Two rainy seasons are observed, one around April and one around November. Average annual temperatures range between 12.0 and 28.7 degrees centigrade. The main crops grown in the region are maize and beans.

2.4.4 Host organization

Started as a voluntary organization, SNV evolved into an professional development organization with capacity building as the main goal. SNV currently has two focus areas, namely BASE and PIE. BASE focuses on improving access to basic services, while PIE focuses on production, income and employment. Within SNV's PIE focus, value chain analysis is an important tool related to private sector development. Within SNV Northern Portfolio in Arusha, Tanzania, currently no Jatropha related initiatives exist. Most related to Jatropha is probably the biogas initiative which runs under Peter Bos. No Jatropha projects are planned by SNV Northern Portfolio in the foreseeable future.

3 Methodology

3.1 Research questions

The research objectives in the introduction are still in general terms. The main objective of this thesis is to explore the characteristics of the Jatropha value chain in Northern Tanzania. Furthermore, it aims to link the results to pro-poor development by identifying the constraints and opportunities for development. In order to reach these objectives, a central research question and several sub questions are defined. The main research question is formulated as follows:

What are the characteristics of the Jatropha value chain in Northern Tanzania?

From this central research question the following sub questions are derived. These sub questions are formulated in such a way as to gradually zoom in on the subject, covering the entire value chain and its end markets, the role of individual stakeholders and performance of individual links along the chain.

1. *Which links and linkages constitute the Jatropha value chain?*
2. *What are the characteristics of current markets for Jatropha value chain products?*
3. *Which individual actors undertake the activities at each link, what are their characteristics and which linkages can be identified?*
4. *To what extent are activities at each link within the value chain competitive?*
5. *To what extent are governance in the chain and the environment in the research area influencing Jatropha value chain development?*
6. *What is the existing knowledge and experience regarding Jatropha?*
7. *To what extent can the Jatropha value chain contribute to pro-poor biofuel development?*

Now that the questions that direct the argumentation in this thesis are clear, the issue remains how these questions are translated into research practice. The next sections address this matter.

3.2 Conceptual model

In order to illustrate how concepts that were discussed so far relate to each other, a conceptual model has been constructed in figure 3.1. First of all, the markets for products or services determine the potential maximum performance of the value chain. Without one or more sufficiently large end markets, any value chain will result in a failure in terms of performance. The total performance of a value chain in turn is determined by its three key determinants as discussed in sections 2.2.3 to 2.2.5, namely competitiveness, governance and enabling environment. End markets and value chain performance, based on these three determinants, are discussed in chapter 4.

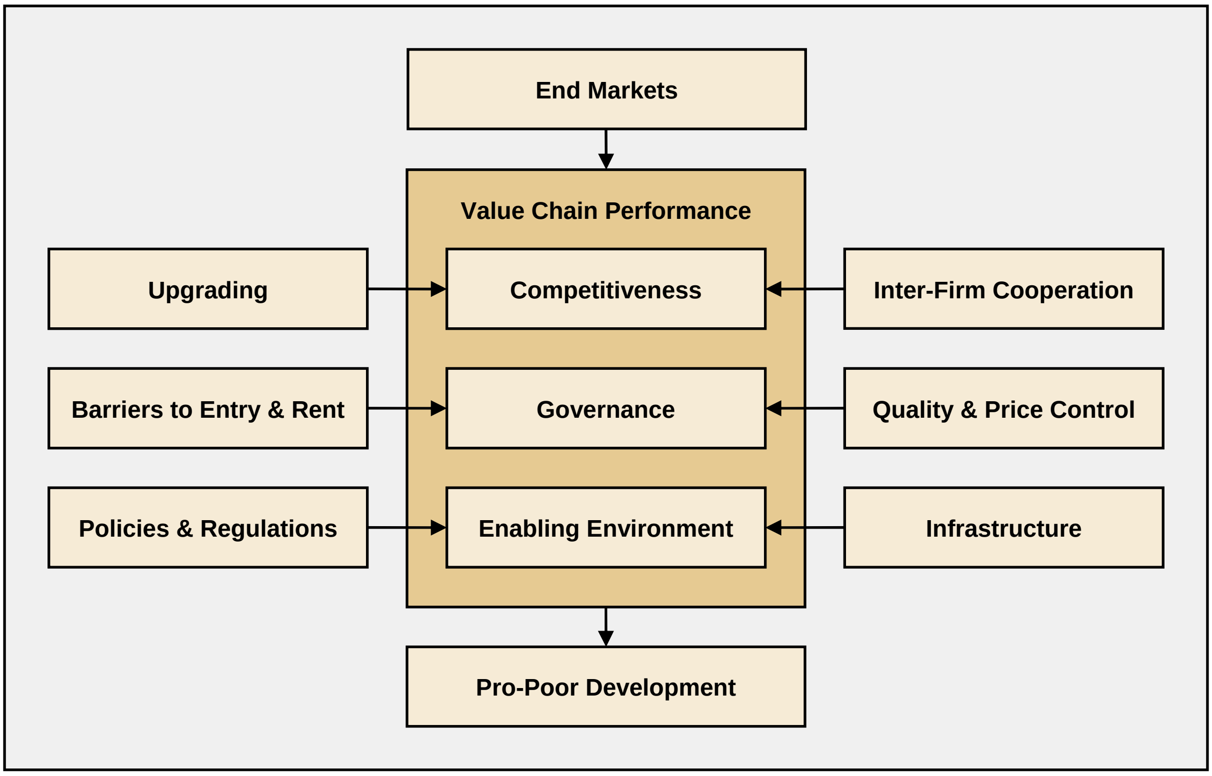

Figure 3.1: Conceptual model

The three key determinants are influenced by other concepts, which to a large extent operate at the level of links in the chain. Competitiveness is influenced by upgrading (which encompasses knowledge sharing and innovation) and inter-firm linkages (which entail vertical and horizontal linkages as well as backward and forward linkages). Stakeholders and inter-firm linkages are discussed in chapter 5. Governance is influenced by barriers to entry (including different types of rents) and quality and price control. Finally, the enabling environment is determined by policies and regulations on different scale levels and infrastructure in a broad sense of the definition. These concepts and their influence on the Jatropha value chain are discussed in chapter 6. Finally, the over-all contribution to pro-poor development is discussed in section 6.4.

3.3 Methods used

It is clear by now that not much existing research is readily available on the contemporary Jatropha value chain in Northern Tanzania. Following the research objective and questions, the study carried out for this thesis primarily has an exploratory character. Within the limited timeframe of the fieldwork, part of the time is directed towards acquiring an overview of the activities and actors currently involved. Furthermore, through more research, different characteristics of the Jatropha value chain are evaluated. Last but not least, individual stakeholders and their relations are analyzed. The different research methods that are used to gather the required data are discussed in the following sections.

3.3.1 Stakeholder database

First of all, using the available knowledge on value chains, renewable energy and Jatropha as laid out in the previous chapters, a possible Jatropha value chain is drafted, listing potential activities or functions. In order to get a first impression of the actual value chain in Northern Tanzania, the relevant stakeholders in the research area and their activities need to be identified. Hence, before commencing with the fieldwork in Tanzania, a free internet search was conducted, collecting as many stakeholders as possible using available secondary data sources.

The results were collected in a stakeholder database. Within this database, stakeholders were categorized based on their location and activities. These activities correspond to the different links in the Jatropha value chain. Within the database, the relationship between stakeholders and activities was defined as a *many-to-many* relationship, denoting that any stakeholder can fit in multiple categories and any category can contain multiple stakeholders. Some stakeholders did not directly participate in the value chain but were linked to stakeholders in the chain, for example through funding relationships. These stakeholders were included in a secondary database with special annotation. The stakeholder database served as the starting point for research during the fieldwork.

During the fieldwork, stakeholders were continuously added, moved between categories or removed, based on the results from interviews and observations. The use of interviews and observations is discussed in more detail in the next section.

3.3.2 Value chain analysis

Based on the aforementioned stakeholder database, value chain links and relationships were identified. For each link the main characteristics needed to be determined, hence after the abovementioned use of secondary sources, stakeholders were visited and interviewed to assess their individual characteristics. Due to the level of detail, a distinction is made between methodology and operationalization.

Value chain methodology

The research methods used for the value chain analysis included conducting semi-structured interviews with stakeholders and carrying out in-depth interviews with key informants. Opposed to structured interviews, semi-structured interviews permit a mix of quantitative and qualitative information, as well as leaving out certain questions and adding others when required during the interview (Laws, 2006). Structured interviews can therefore be characterized as relatively fixed, while semi-structured interviews are more flexible, giving the researcher more freedom to adapt to the situation. The researcher is granted even more freedom when using in-depth interviews, this freedom comes at a price however, since data becomes hard to compare and analyze. Where possible, semi-structured interviews were preferred over in-depth interviews, because comparable gross margin data was required. In some cases however, such as interviews with national government representatives, in-depth interviews were necessary to acquire the needed information.

Interviews were chosen over alternatives, such as surveys, due to the fact that Jatropha value chain in Northern Tanzania is relatively small and immature. Apart from farming related activities, which are the primary research focus of Lauren Parker's parallel livelihoods study, each link in the value chain currently consists of no more than a few stakeholders. Hence, separate surveys would result in too little respondents to draw significant conclusions. Since the nature of activities per definition varies between different links in the value chain, one single survey for all stakeholders is not seen as a viable option either. Each group of stakeholders requires their own questions, focusing on issues that are relevant to that group.

Furthermore, the very nature of the research questions requires the use of semi-structured interviews. Exploring the value chain and identifying stakeholders demands continuous checking of the stakeholder database. Existing records in the database, that are derived from secondary sources, need to be verified and new stakeholders can be discovered by asking respondents which other players they know of. In some cases, the initial answer lacks stakeholders the respondent simply does not think of at the time the question is asked. By adapting to the situation and imagining possible relationships with other actors, such as funding organizations, specific follow-up questions can be asked to probe for more ample results. This requires an interview structure that permits adding new questions on the fly, based on the respondent's answers. In a survey or structured interview, doing so would not be permitted. In some cases, follow up interviews were conducted as the need arose for more information to confront stakeholders with the views of others.Apart from the aforementioned use of secondary sources and interviews, systematic observation is used as a third research method for value chain analysis.

Value chain operationalization

During the interviews, information had to be collected on different characteristics of the value chain. These included existing linkages with suppliers and buyers, primary activities, prices of inputs and outputs and gross processed volumes. For the individual value chain links, as well as for the value chain as a whole, the three most important value chain determinants that were identified in the thematic theoretical context were operationalized during the research.

The first key value chain determinant of competitiveness, regarding the entire chain as well as individual links, was operationalized by measuring the feasibility of activities. Amanor-Boadu distinguishes between two types of feasibility, namely technical and economic feasibility (Amanor-Boadu, 2004). Technical feasibility refers to the operational and technological functioning, whereby questions are asked such as if a project can be built and if it will technically work. Furthermore, it takes into account if a certain technology is suitable for the desired production quality and quantity, including scalability, what knowledge is required and the availability of alternative technologies.

Economic feasibility refers to the financial business aspects, asking the question if it makes economic sense to invest in the project or activity (ibid.). Because economic viability is at the core of businesses, a project which is deemed technically feasible but economically unfeasible is not worth pursuing. Within this thesis, gross margins are calculated to provide an indication of economic feasibility. In order to do so, data was collected in the field regarding, for example, prices and use of inputs, gross output volumes and prices and the cost of labor and equipment. The purpose of these calculations is not to come up with outcomes that entail an accuracy required for decision making such as investment plans. This notion is amplified by the fact that, as per definition, in gross administrative and sales costs are left out in gross margin calculations (ibid.).

In analyzing the research results, it has to be acknowledged that the obtained data can, and most certainly will, entail inaccuracies. For example, when a small-scale farmer is interviewed on his plot, asking questions on the trend of gross output volumes over the past years, it is unlikely that the respondent can accurately provide these figures on the spot, especially given the lack of account keeping that was generally observed in these situations. Furthermore, yields can differ per individual plant, prices of inputs and outputs can fluctuate according to time and location and efficiency varies depending on equipment and inputs used. Hence, the presented gross margins are simplified for the scope of this thesis.

To operationalize upgrading, as part of competitive strategies, respondents were asked what products they produced, how they produced them and what activities they undertook in the past. Questions were asked such as "what did you sell in the past?", "what are you selling currently?" and "what activities are you planning to undertake in the future?". Inter-firm cooperation, another concept related to competitiveness, was operationalized by mapping horizontal and vertical linkages, which are used not only for the value chain analysis but also for the stakeholder analysis later on.

Governance, the second key determinant of value chain performance, was operationalized using the concepts of barriers to entry and rents on the one hand and quality and price determination on the other. Barriers to entry were measured by asking questions such as "can anybody become a Jatropha seeds collector?", "have you signed a contract with your buyer and/or supplier?" and "what conditions are required to enter a contract with supplier x or buyer y?". Price and quality determination was measured by asking questions such as "do you accept all products from your suppliers, regardless of quality?" and "who determines the price you get for you products?".

The role of the enabling environment, as the last key determinant of value chain performance, was operationalized by investigating the role of government policies and regulations as well as infrastructure. To assess the impact of contemporary policies and regulations, value chain respondents were asked if they could identify policies or regulations that were either limiting or supporting their activities. Furthermore, in-depth interviews were conducted with several key-informants at relevant national government institutions and international donors, in order to identify their standpoints on various issues relating to the Jatropha value chain, e.g. renewable energy commitment, blending policies, tax exemptions and land use policies.

The impact of infrastructure on value chain performance was measured by comparing farm gate prices with factory gate prices and asking respondents about the costs of transportation. Furthermore, the use of communication technologies such as mobile telephones and internet was assessed.

3.3.3 Actor constellation

As part of the internship, SNV requested for an actor constellation to be constructed. An actor constellation is a visual representation of all individual actors, including relevant linkages. A distinction can be made between actors that operate at different scale levels, i.e. regional, meso and national level. If applicable, an international level can be included as well. Through its visual representation, an actor constellation allows for missing linkages to be easily identified. Furthermore, it provides for a structured way to discuss each actor and its linkages, with reference to their operation level.

An actor constellation is one of the many tools available for stakeholder analysis. Other tools include the influence/importance matrix, which focuses on the role of actors within a specific project or intervention (Laws, 2006). An advantage of an actor constellation over an influence/importance matrix is that links between actors are included, that possible absence of links can be recognized and that different levels of operation are included. An advantage of the influence/importance matrix compared to an actor constellation, on the other hand, is that an influence/importance matrix defines to what extent actors can influence or are influenced by a certain intervention. Because of the explicit request of SNV to draft an actor constellation and because of the absence of a planned Jatropha related intervention to define the influence and importance determinants, it was decided to use the actor constellation as the tool for stakeholder analysis. Other SNV advisors use comparable actor constellations as well, hence the choice expectantly adds to the compatibility of the results.

Concerning the methodology of the stakeholder analysis, the same research methods were used as for the value chain analysis. Compared to the value chain analysis however, more actors were identified and involved which were linked to value chain actors but were outside the scope of the value chain mapping. Hence, during the interviews questions were added to grasp these relationships, e.g. questions on donor funding and indirect NGO involvement.

3.3.4 Stakeholder workshop

As part of the research, on the 7th of May 2008, a stakeholder workshop was organized in Arusha, Tanzania. Excluding the organizers, fourteen stakeholders participated. The complete list of participants is included in annex 2. The four main goals of the workshop were to bring together different stakeholders, share the preliminary research findings, jointly identify important issues and discuss the way forward.

By facilitating a meeting to bring together different stakeholders, the research can move beyond acquiring results and analyzing data to actually contributing to value chain development. This contribution can take various forms. For example, exchange of knowledge and experience can help identify common interests and benefit such things as the competitiveness of various stakeholders within the value chain.

By sharing the preliminary research findings, the workshop gives participants the opportunity to comment on the results, analysis and conclusions of the feasibility study. It is an important feedback mechanism for researchers, because it tests if the conclusions are shared by the research population. This obviously benefits the study itself. Furthermore, sharing the results is another way of letting participants profit from the research. The respondents and other people that contributed to the research obtain the findings of the study, e.g. information regarding market developments and roles of other stakeholders, which can potentially benefit their own development and that of the chain as a whole.

The third goal of the stakeholder workshop, i.e. to identify important issues, is a means to test whether, for example, constraints and opportunities that result from the value chain analysis are perceived as important by the stakeholders themselves. It is also an opportunity for other issues to arise, that are not identified by the research. For example, by choosing the value chain analysis as the main research method, issues relating to environmental impact are less likely to be identified. During the stakeholder workshop, a substantial part of the agenda was reserved for discussions (see annex 3). All issues that arose during presentations and discussions were collected on small cards and attached to the wall.

For the fourth and last goal of the workshop, namely to discuss the way forward, the collected issues were used. The participants were divided into working groups, based on clusters of related issues. The specific task of each working group was not only to discuss how the respective issues could be resolved, but also to come up with a time path and explicitly identify who needed to be involved.

4 Characteristics of the value chain and its end markets

4.1 Mapping the value chain

Figure 4.1 shows a model of the different links and linkages within the Jatropha value chain as observed in the research area. The diagram has been simplified to include only those links and linkages relevant within the scope of this thesis. For example, farmers have possible linkages with fertilizer suppliers, soap production uses more than straight Jatropha oil alone and biodiesel production requires linkages with methanol suppliers. Furthermore, some secondary activities such as packaging and marketing take place. However, since these activities are mainly undertaken by the same actors that carry out primary activities, the secondary activities are not included separately in the diagram. All individual links and linkages that are depicted in figure 4.1 are discussed in more detail in chapters 5 and 6.

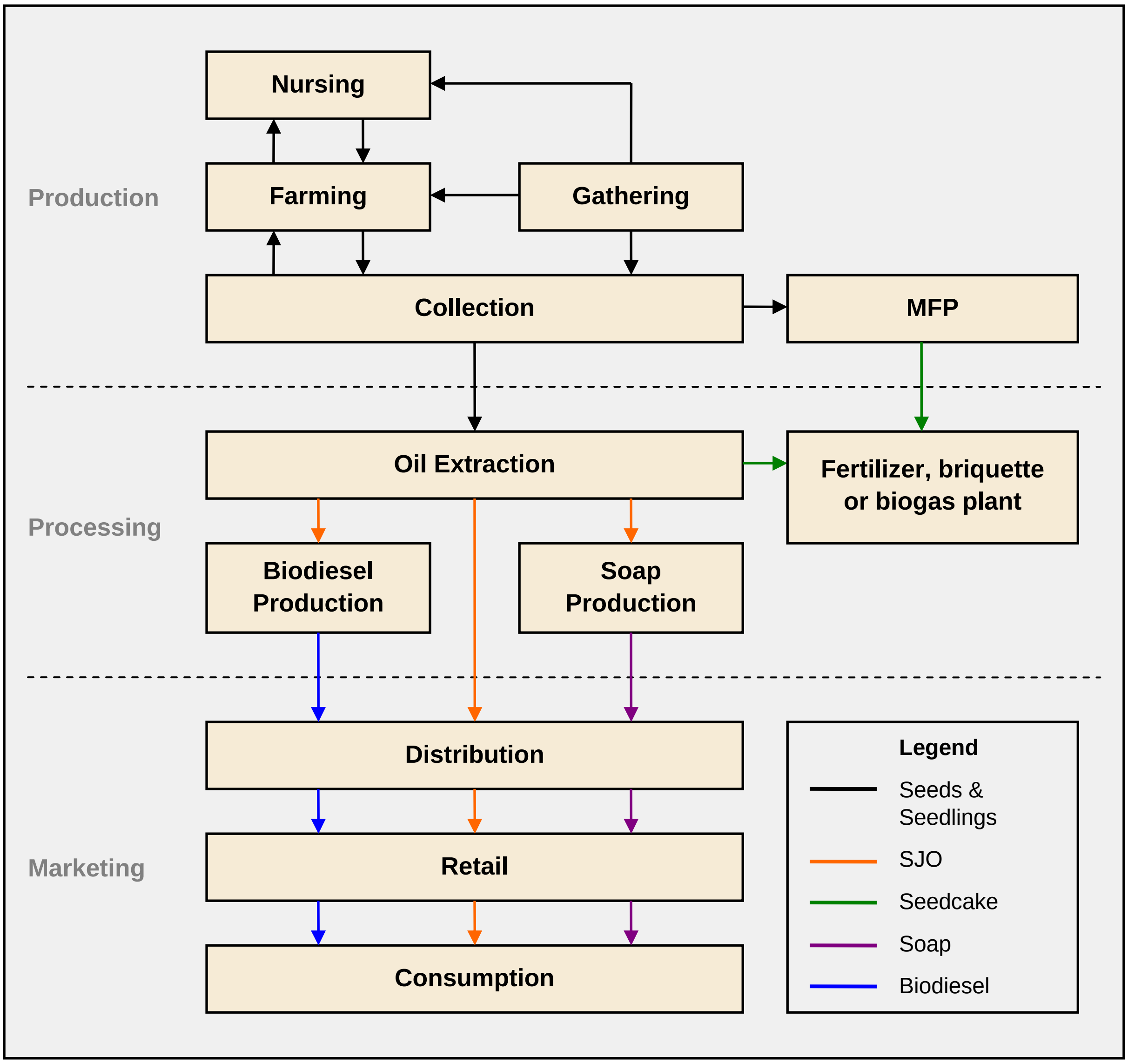

Figure 4.1: Jatropha value chain in Northern Tanzania
Source: fieldwork, 2008.

The value chain diagram is a result of interviews and field visits. After more explorative field visits during the first weeks of the research period, subsequently more semi-structured and in-depth interviews were conducted based on the acquired knowledge. In total 43 interviews were conducted, covering all links within the value chain (see annex 1 for a list of interviews). Some general observations will now be discussed, based on a general division that can be made between the three stages related to production, processing and marketing. This general division reflects different types of activities within value chains that were mentioned in section 2.2.2.

Illustration 4.1: Some farmers plant Jatropha by nursing cuttings from existing plants.

In the production stage of the chain all activities focus around farming. Farmers start to grow Jatropha plants either by direct seeding, using cuttings from other plants or planting seedlings that are produced in a nursery. Seeds for planting are acquired by gathering from existing hedges or bought directly from other farmers or collectors. Nurseries grow seedlings from seeds and sell them to farmers who want to plant, ideally at the start of the rainy season. Gatherers are people that collect from existing Jatropha hedges, either on their property or on public grounds. The gathered seeds were usually sold to collectors, but were occasionally also observed to be sold to nurseries or farmers. One respondent went to gather seeds and cuttings from existing public hedges for his initial planting. If absolute harvest quantities are low and distance to the market is big, as observed on field visits, collectors are an essential middleman between the farmers and gatherers on the one hand, and buyers of seeds on the other. A special case is the Multifunctional Platform (MFP), which is discussed in annex 5.

In the processing stage of the chain, three activities can be identified. Oil extraction, to start with, involves pressing of Jatropha seeds to gain straight Jatropha oil (SJO), a form of straight vegetable oil (SVO). Oil extraction was either done manually, using for example the ram press, or mechanically, using for example the Sayari oil expeller. Secondly, although on a small scale, straight Jatropha was processed into biodiesel through a process called transesterification. The biodiesel can then be sold for direct use in regular, i.e. unmodified, diesel engines. Thirdly, straight Jatropha was used to produce soap by adding soda, amongst other ingredients. Straight Jatropha oil was also sold directly, e.g. for use in modified diesel engines, for blending purposes or for use in lamps and cook stoves. After extracting the oil from the seeds, the seedcake that remained was observed to be used as input in a biogas plant or as briquette. The supposed use of the seedcake as fertilizer, either in a production or testing environment, was not observed in the research area.

In the final stage of the Jatropha value chain, the end products are marketed. In general, a distinction can be made between distribution, retail and consumption by the end users. During the research it was observed however, that distribution and retail links were bypassed in some cases, selling the end products directly to consumers at the factory gate. This issue is touched upon in the next section and is analyzed in more detail when the individual value chain links are discussed in sections 6.1.6 to 6.1.8.

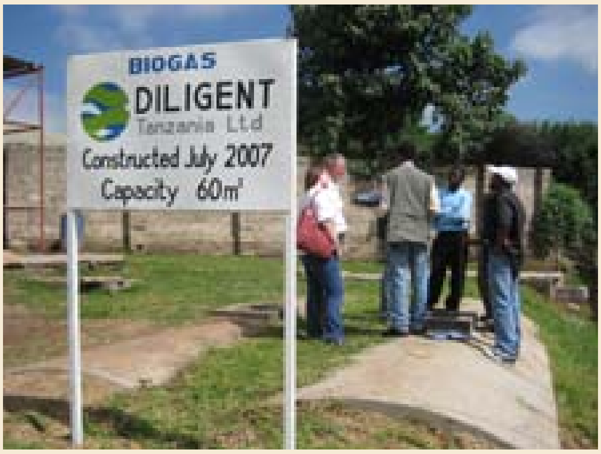

Illustration 4.2: Diligent tests the use of Jatropha seedcake in their biogas plant.

4.2 A tense market for Jatropha seeds

Although strictly not defined as an end market, or as a market channel, a tense market for harvested seeds was observed in the research area, which to a large extent influences the end markets and competitiveness of the other value chain products that are discussed further on. Because planted seeds take around three years to produce a considerable harvest, there are not that many farmers with substantial Jatropha plots in the area and due to seasonality harvests are limited to two rainy seasons, absolute seed supply from existing plots is low compared to the demand. Since actors such as KAKUTE, Diligent and JPTL have been convincing farmers to grow Jatropha for several years, and due attention is paid to the potential of Jatropha in various media and at government level, demand for seeds for planting purposes is currently high and still rising. In Engaruka it is for example observed that people with access to land are planning on planting Jatropha this year.

The rising demand, combined with the lagging increase of supply, is reflected in rising seed prices over the past 4 years. An illustrative example was encountered in the village of Engaruka, where factory gate prices, i.e. prices farmers were paid to deliver seeds to collectors, rose from TZS 100 per kg in 2005 to TZS 300 per kg in 2008. Although no reliable quantitative data on the development of Jatropha seed prices over the past years is available, the general rise of prices is confirmed by other actors not involved in Engaruka.

Actors that required seeds for planting purposes were willing to pay even more for the seeds than the market price at that time. One respondent buying seeds to start a nursery indicated buying seeds at TZS 5,000 per kg from Diligent, which is 30 times higher than the market price. Apart from the fact that the seeds were selected for planting quality and therefore could have a higher value, a potential explanation is the low share that seed prices have in determining the total startup costs for planting Jatropha (see section 6.1.1). Furthermore, respondents indicated that occasionally buyers from Kenya had bought seeds at higher prices than the market price. When asked for the reason, respondents indicated that interest for Jatropha is growing in Kenya, while presently little domestic seeds are available. However, during the research no data was gathered to neither confirm nor deny this claim.

However, in this respect it can be questioned what the exact market price is, since different buyers pay such different prices. Within the research context, the choice was made to ask the respondents to indicate their average prices, as well as their minimum and maximum prices. Obviously, because account registers were absent in all cases, the interpretation of 'average' might differ from one respondent to another, as might be the case with remembering the actual minimum and maximum prices over a year. Nevertheless, since all respondents that were involved in either selling or buying seeds were asked about their seed prices, a general picture arose, with average seed prices in 2008 varying between TZS 180 and 500 per kg. Prices above TZS 300 per kg were only observed in cases where the distance to the market was more than average. Comparison of interviews and prices indicated that average market prices differed between locations. It also stood out that respondents were unaware of different prices in other regions, which is an indication that the actors involved are uninformed about the market.

High seed prices are currently favorable to farmers, but the question remains how prices will develop in the future, when changes in supply and demand occur. In general, high prices of Jatropha seeds have a negative influence on other Jatropha value chain products, and thereby on the entire value chain, as is demonstrated in the following sections.

4.3 A substantial end market for straight Jatropha oil

Three market channels can be identified within the value chain, each producing different end products. Up to and including the oil extraction link, the market channels share the same links. After the oil is extracted the channels split. In the first channel, straight Jatropha oil is sold directly as an end product, either with or without filtering the oil before sale. Distributors and retailers are bypassed in all observed cases by selling the oil directly to consumers or producers who require it as another input (i.e. soap and biodiesel production). In the research area, apart from the producers selling their products themselves, not one distributor or retailer of SJO was discovered. Furthermore, no households were encountered that applied straight Jatropha oil successfully for domestic use, neither in an oil lamp nor in a cook stove. The main reason was that the devices were not working properly.

Illustration 4.3: Jatropha oil lamps are not used because they are not working properly.

Another potential market for straight Jatropha oil can emerge as a result of a national blending policy for biofuels with conventional diesel. As seen in section 2.4, there is currently no such policy present in Tanzania. Interviews with key-informants at selected national government institutions don't reveal if such a policy is to be expected in the near future. As one respondent puts it, "we are working on renewable energy policies, but it is a delicate subject with many issues, and the draft guidelines have not passed parliament". The draft guidelines themselves were not public yet. Furthermore, the respondent indicated that one such delicate subject was the issue of land use and food security. Another issue that remains in debate, also within the national government, is whether Tanzania should permit foreign companies, such as European energy firms, to produce biofuels in Tanzania and export them to Europe.

Competitiveness of SJO is partly determined by its price compared to competing products. As a result of high seed prices, at the time of the research SJO sold at a price of TZS 2,000 per liter, which was more than conventional diesel that sold for TZS 1,600 at the gas station. Given the required engine modification and lack of policies regarding biofuels, straight Jatropha oil can only be competitive as a fuel when the price is lower than that of existing fossil fuels. With the current global trend of rising energy prices, it is not unlikely that the diesel price will exceed TZS 2,000 at some point in the near future. Within the current research context however, it can be concluded that the market for straight Jatropha oil is limited.

4.4 A limited end market for Jatropha soap

In the second market channel, straight Jatropha oil is used to produce soap. With a relatively simple process that does not require high technology equipment and involves only a few ingredients, soap can be produced from the oil. The soap was observed to be made in different moulds, resulting in different bars between producers in terms of shape and weight. The most encountered pieces weighed 90 gram each. The pieces were therefore small compared to the regular 200 gram soap bars on the market.

In section 2.3.2 it already became clear that Jatropha soap is said to have medicinal characteristics and is therefore used by people with various skin diseases and sensitivity to regular soap. That is precisely the market Jatropha soap producers aim for. However, with SJO being the main ingredient that determines the price of the soap (see section 6.1.7), and SJO currently selling at high prices, Jatropha soap is substantially more expensive than regular soap. Regular soap was sold at TZS 200 per 100 gram, while Jatropha soap was sold at TZS 600 per 90 gram. This calculates to Jatropha soap being over 3 times more expensive.

The special characteristics of the soap could justify the higher price customers would have to pay. In this respect, KAMA aimed to enter the international market for medicinal or herbal soap. In order to do so, KAMA was in the process of registering Tanzania's first medicinal soap certificate at the Tanzania Bureau of Standards (TBS). However, during the fieldwork it became clear that all former soap producing women groups had quit making soap. The reason given was that they had trouble selling the soap, which could have several causes. According to JPTL, an NGO supporting various soap making groups in Northern Tanzania, the reason for suspending soap producing activities was that Jatropha oil became too costly. This is supported by the responses from members of former soap making groups, who indicated that the oil turned too expensive and hence it made more sense to start pressing seeds and sell straight Jatropha oil instead. Thus it can be concluded that, within the current market, soap production is not competitive.

4.5 No end market for Jatropha biodiesel

In the third market channel, straight Jatropha oil is processed into biodiesel. The advantage of biodiesel is that it can be used straight in existing diesel engines, thereby not requiring engine modification. Although the process of transforming SJO into biodiesel by itself is relatively simple, without the need for high technology refineries, international standards for biofuels are strict, requiring continuous and precise laboratory measurements. Adhering to these international standards is essential if Jatropha biofuel is to be exported, one of Diligent's main goals.

Since biodiesel has to compete with regular diesel, and SJO was already more expensive than diesel, at the time the research took place biodiesel production was not competitive. This was acknowledged by Diligent and InfEnergy, the two only firms with biofuel production capacity in Northern Tanzania. One of the respondents even stated that "you would have to pay someone TZS 30 – 40 per kg [of seeds] to make it viable" (fieldwork, 2008). As mentioned earlier, during the fieldwork the average seed price was between TZS 180 and TZS 300 per kg. Without substantially lower seed prices and/or higher fossil fuel prices, biodiesel production is not competitive.

5 Stakeholders and inter-firm cooperation

5.1 Actor constellation

The actor constellation in figure 5.1 includes all relevant stakeholders that were encountered in the research area or linked to other stakeholders in the research area (see the last page of this document for a larger version). Each light brown box depicts a stakeholder or group of stakeholders and each arrow indicates a linkage between stakeholders. Different colors correspond to different types of relationships. A black line indicates a product linkage such as supplies, blue depicts a service relationship such as training or research and green signifies a funding linkage. Furthermore, a dotted line indicates a proposed linkage, as is explained in the next section. On the vertical axis a distinction is made between different scale levels at which stakeholders operate. In the dark brown boxes, directly related international donors and funding organizations are included.

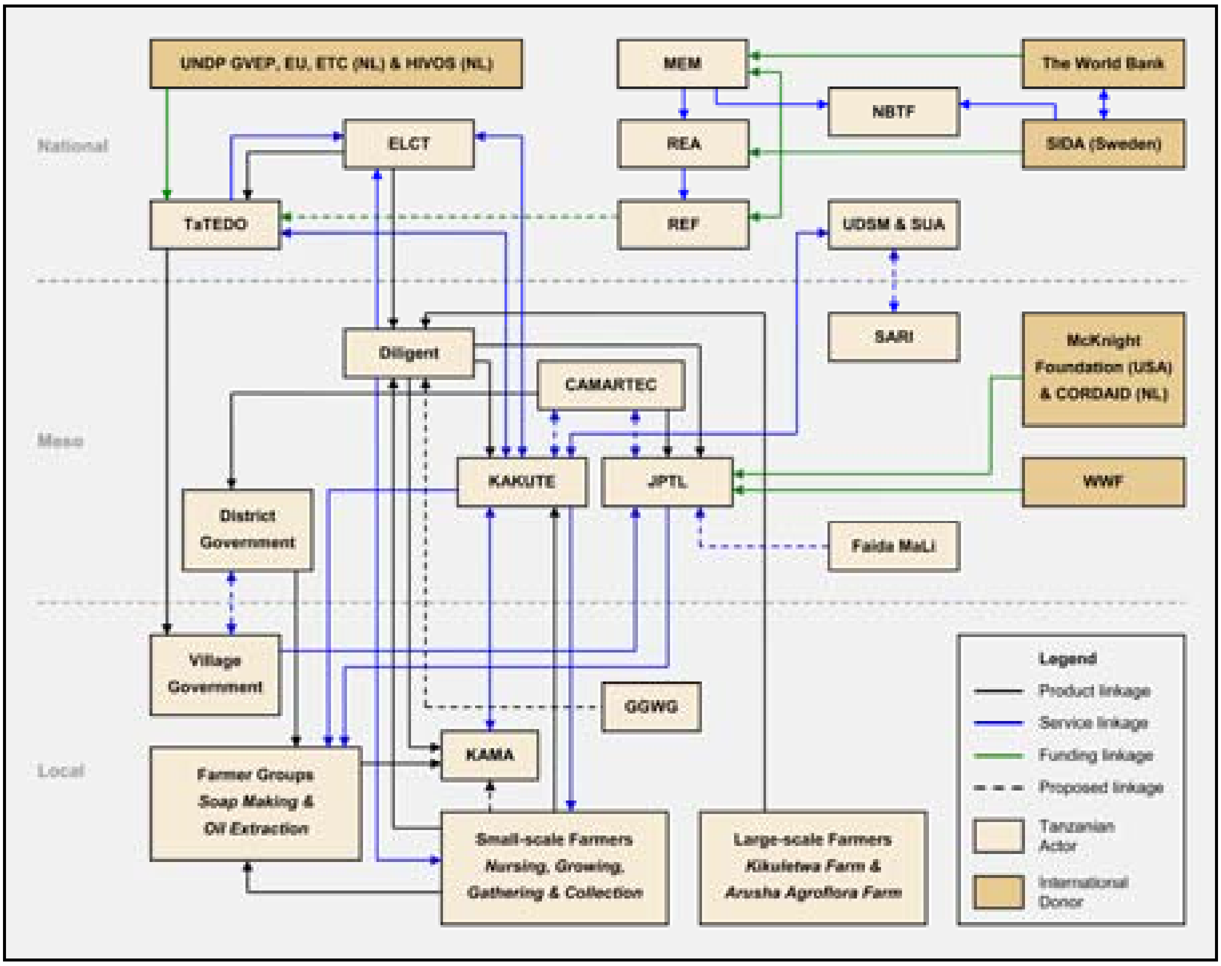

Figure 5.1: Actor constellation

Source: fieldwork, 2008.

5.2 Stakeholders, linkages and issues raised

CAMARTEC

The Centre for Agricultural Mechanisation and Rural Technology (CAMARTEC) is based in Tengeru. It is a meso level government institute that developed the ram press, which can be used to manually extract oil from different types of seeds, including Jatropha. The cost of one ram press is USD 100, which amounts to TZS 120,000. CAMARTEC is distributing the presses through district governments and through direct selling to buyers such as JPTL. Because the existing Jatropha oil lamps and cook stoves are not functioning properly, opportunities exist for CAMARTEC to get involved and improve the equipment. Because JPTL and KAKUTE developed the oil lamps and cook stoves, CAMARTEC would need to be linked to JPTL and KAKUTE.

Diligent

Diligent Energy Systems Tanzania Limited is a branch of Diligent Energy Systems Netherlands. Diligent was established in 2005 as a commercial company and is based in Arusha. For biodiesel and SJO production, Diligent promotes Jatropha cultivation to small-scale farmers by means of intercropping and hedges. They use out-grower and collection schemes in which they provide support to small- and large-scale farmers from whom they buy seeds. 2006 resulted in 70 ha of out-growers and by 2007 this figure had risen to 1,500 hectares. They currently have 1,000 out-growers and their target is to work with 30,000.

Although Diligent's core business initially was producing Jatropha Methyl Ester (JME), better known as Jatropha biodiesel, they are currently mainly extracting straight Jatropha oil (SJO) from Jatropha seeds. In 2007 Diligent processed 40 tons of seeds and produced 10,000 liters of SJO. Diligent sells SJO to KAMA, KAKUTE, JPTL, two local safari companies and individuals with modified engines in their vehicles. Furthermore, Diligent sells selected seeds for planting purposes to national and international buyers and experiments with different mechanical oil expellers. ELCT provided the Sayari oil expeller to Diligent and in turn Diligent is providing feedback to ELCT on its performance. This is an example of a vertical linkage leading to the exchange of knowledge and subsequent improvement of value chain products and processes, with mutual benefits. Diligent is presently experimenting with the use of the seedcake in their biogas plant.

District Government

The district governments purchase ram presses from CAMARTEC and distribute them to farmer groups, providing the groups with long-term loans to pay for the press. In one occasion a farmer group was observed that had bought a second press on itself without taking a loan. Two other groups were mentioned that had bought their own press directly without support from the district government.

ELCT

The aim of the Evangelical Lutheran Church in Tanzania (ELCT) is to enable people to know Jesus Christ and gain eternal life. The ELCT, together with the German FAKT foundation and with funding of the Vyahumu Trust, developed the mechanical Sayari oil expeller. In first instance the expeller was developed to press sunflower seeds. Up to today, 150 Sayari oil expellers have been sold, of which 5 are being used for pressing Jatropha seeds. Two have been delivered to TaTEDO, of which one is located in Engaruka and the other in a test Multifunctional Platform (MFP) in Dar es Salaam. One expeller has been sold to Diligent, one to an unnamed sister company of Diligent in Uganda and the fifth one to the German energy company Prokon in Mpanda. The ELCT is working together with TaTEDO and Diligent to improve the press based upon their feedback. Although requested by the ELCT, Prokon is not providing feedback on the performance of the press. In 2001 the ELCT started an NGO for Sustainable Development through Renewable Energies in Tanzania (SUDERETA), which is promoting Jatropha together with Diligent outside the research area of this study.

Faida MaLi

Faida MaLi is an NGO specialized in market access, with a focus on market linkages for small-scale farmers. Faida MaLi has a formal agreement with JPTL to train their soap making groups on market access when needed. However, this has still to be translated into practice since JPTL has not yet identified the villages where training is required. Previously, Faida MaLi was part of the ARI-Monduli project started by KAKUTE to promote Jatropha soap making as alternative resources for income (ARI) to women groups in the Monduli district. Within the project, Faida MaLi was responsible for the market study supervision and market linkage activities.

Farmer Groups

Farmer groups are mainly soap making groups promoted and supported by JPTL or KAKUTE. Other possible activities include nursing, farming, collection, oil extraction and soap making. Due to limited local and national markets, currently no groups are making soap. Most groups are extracting SJO from seeds instead, in order to sell it to KAMA, JPTL or other SJO buyers.

GGWG

The Green Garden Women Group (GGWG) is an NGO located in Moshi. It was established in 1998 with the aim to promote and empower women to engage in economic activities and environmental management. Furthermore, the goal was to eradicated extreme poverty and hunger at the household level. The GGWG is growing Jatropha and has recently started a new plot on the slopes of Mount Kilimanjaro. Contacts between the GGWG and Diligent were established at the Jatropha Stakeholder Workshop, which could possibly result in a future linkage between the two stakeholders.

JPTL

Jatropha Products Tanzania Limited (JPTL) is an Arusha based NGO that supports soap making groups through training and the promotion of Jatropha. It was formed out of KAKUTE, a commercial company, because donor regulations required a non-commercial company to manage the funds for supported projects. JPTL incorporated two existing projects of KAKUTE, but the donor requirement of an exclusive focus on women led to problems because men traditionally own the land. New projects of JPTL are open to both men and women. They promote Jatropha farming, oil extraction, oil filtering and soap production in their current project. JPTL does not form groups but rather approaches village governments to locate existing groups to work with.

Due to market accessibility problems of their soap making groups, JPTL currently buys their soap and sells it to retailers in Arusha. Furthermore, JPTL sells Jatropha oil lamps and is currently producing soap, despite the danger of competing with their own soap making groups. Furthermore, because they are an externally funded NOG, by engaging in production activities they commit market interference, making it impossible for commercial companies to compete.

JPTL provides training, demonstrations, seeds and training materials to farmer groups for free as part of their strategy to interest farmers in Jatropha. They also provide soap packaging to their soap making groups. JPTL has a formal agreement with Faida MaLi to train their soap making groups on market access, but they have yet to identify the villages where training is required. Financially, JPTL is supported by Cordaid and the McKnight Foundation and recently received funds from WWF.

KAKUTE

Kampuni ya Kusambaza Teknolojia Limited (KAKUTE) is a commercial company established in 1995. KAKUTE helped initiate the first Jatropha activities in the region. Despite KAKUTE no longer being actively involved in Jatropha production activities, they still buy and sell Jatropha seeds and SJO when requested for research purposes. KAKUTE also buys SJO from Diligent. There is uncertainty regarding the exact nature of KAKUTE’s income generating activities and the role of Jatropha activities therein.

KAKUTE embarked on a partnership with Match Maker Associates to form KAMA Herbal Soaps Ltd. for soap production purposes. KAKUTE is also working together with ELCT on soap production training. In the past KAKUTE has cooperated with the University of Dar es Salaam (UDSA) in order to research issues regarding SJO as a renewable energy source. It is however unclear if this partnership still exists.

KAMA

KAMA Herbal Products Limited (KAMA) is a soap production company located in Arusha. The company was formed out of a partnership between KAKUTE and MMA. KAMA’s goal is to buy the SJO for soap production directly from rural farmers. KAMA is currently buying oil from previous soap making groups, which are currently extracting oil instead of producing soap, and from other oil extraction actors such as Diligent. KAMA is in the process of obtaining the first TBS certificate for medicinal soap in Tanzania.

Large-scale farmers

Large-scale farmers are defined as farmers cultivating 10 or more acres of Jatropha. Kikuletwa farm is a 20 acre farm south of Moshi that has Jatropha plants up to 6 years old. Kikuletwa obtained their first seeds from KAKUTE. Because of low yields and high costs of Jatropha cultivation, a shift was made to other crops such as aloe vera and various flowers. The existing Jatropha plantation is still being maintained and is currently being leased to infEnergy, a company specialized in biodiesel production. Because of the disappointing yields on the Kikuletwa farm, infEnergy is currently looking into other oil crops to produce biodiesel. Kikuletwa farm sold seeds to Diligent once, but the oil content of the seeds turned out to be so low that Diligent does not buy seeds at Kikuletwa for now.

Arusha Agroflora Farm has an 80 acre Jatropha plot close to Arusha. Plants are 3 years old and have produced no harvest yet, mainly because seeds were used for planting and the farm is in a relatively dry area. They expect to sell their first seeds to Diligent. The main issue raised by large-scale farmers during interviews is that there is not enough knowledge on inputs, outputs and management of the plant. High yields are not yet observed at any farm, making alternative oil crops more interesting to farmers. The instability of the seed market is also mentioned as an issue concerning farmers.

MEM

The Ministry of Energy and Minerals (MEM) in Dar es Salaam has a Department of Energy with a Section Renewable Energy under the Assistant Commissioner Renewable Energy. The MEM acts as the secretariat for the National Biofuels Task Force (NBTF). The MEM commissioned the Rural Energy Agency (REA) and receives financial support from both Sida and The World Bank. 46% percent of the budget of the MEM consists of revenues from taxes on fossil fuels. The MEM is supported by different international donors through General Budget Support (GBS). Within the donor community, Sida and The World Bank are focusing on energy and therefore are the most important donors linked to the MEM. The main issues brought forward by the MEM during the interview are a slowly developing national market, the balance that has to be sought between producing for the national versus the export market and the inability to completely avoid environmental impact. Part of the action plan of the MEM is to introduce zoning to dedicate certain areas for either food or biofuel crops.

NBTF

The National Biofuels Task Force (NBTF) was established in April 2006 in Dar es Salaam because biofuel issues concern many different ministries. It is financially supported by Sida, chaired by the Ministry of Planning, Economy and Empowerment and the secretariat is at the Ministry of Energy and Minerals (MEM). Members of the NBTF include different ministries and representatives from the private sector. Biofuel issues that the NBTF is currently talking about include land use, environmental impact, socio-economic impact, legal framework, blending policies, bio-ethanol and large-scale investors.

REA

The Rural Energy Agency (REA) was commissioned by the Ministry of Energy and Minerals as part of the National Energy Policy 2003. It is still under construction in Dar es Salaam. The board was formed in October 2007 and as of April 2008 the first 17 staff members were contracted. The REA is supported by Sida and GTZ has shown interest as well. Since there is no Rural Energy Policy yet, one of the future tasks of the REA is to formulate such a policy. The REA manages the Rural Energy Fund.

REF

The Rural Energy Fund (REF) is managed by the Rural Energy Agency in Dar es Salaam. Its goal is to support, but not fully finance, rural energy projects in order to reduce initial capital investment. There is currently USD 10 million (corresponding to TZS 10.2 billion) residing in the fund, but the only projects supported so far are from TANESCO, the Tanzanian national energy company. Sida is providing direct financial support to both the REA and the REF. The REF is still working on draft guidelines. As soon as these are ready, proposals for funding can be submitted. The REA is in contact with TaTEDO, who provided some consultancy services to the Ministry of Energy and Minerals, but TaTEDO hasn't applied for any REF funding for their MFP projects so far. This is an opportunity for a future financial link, where the REF could support the installation of Multifunctional Platforms (MFPs) because without subsidized installation costs the fees for connected households would be too high (see annex 5).

SARI

Based in Arusha, Seliani Research Institute (SARI) is one of the Tanzanian government research institutes with more than five years experience in conducting field research on the impact of conservation tillage and cover crops on soil fertility and crop production in Northern Tanzania. SARI is conducting research on application of the Jatropha seedcake as a fertilizer. While SARI is conducting research on application of the Jatropha seedcake as a fertilizer, a direct link between SARI and any Jatropha actor at the micro, meso or national level is currently missing.

Small-scale farmers

Small-scale farmers are those farmers that have a plot dedicated to the cultivation of Jatropha, independent of crop system and formation used. For readability considerations, in the actor constellation small-scale farmers include nurseries, gatherers and collectors. Nurseries plant Jatropha seeds to produce seedlings. Gatherers are those harvesting Jatropha seeds from existing hedges. Collectors are those actors that buy Jatropha seeds from local farmers and gatherers in order to sell the seeds in larger volumes to bigger buyers in the market. In the next chapters, nurseries, gatherers, farmers and collectors are discussed separately. Small-scale farmers are selling seeds to KAKUTE, Diligent and farmer groups. KAMA aims to buy SJO directly from small-scale farmers in the future. The most frequently expressed concern by small-scale farmers was the insecurity of the market.

TaTEDO

Tanzania Traditional Energy Development and Environment Organisation (TaTEDO) is an organization in Dar es Salaam. Within their renewable energy department, in cooperation with KAKUTE TaTEDO distributed 100 Jatropha oil lamps to women. In 2006 TaTEDO implemented two pilot Multifunctional Platforms (MFPs) in Engaruka and Leguruki, consisting of an engine, alternator, dehusker, milling machine and mechanical oil expeller. The pilot MFPs were financed by UNDP GVEP and ETC and supplied directly to the village governments. The MFPs were providing electricity to connected households during the evening for a monthly flat fee. Other services like milling were provided at daytime. In Engaruka the MFP was not running at the time of the fieldwork. In Leguruki the MFP was functioning, albeit without a mechanical oil press. TaTEDO acknowledged some problems with financing, ownership, management and seed supply in the two pilot projects. TaTEDO recently received funding from the EU and Hivos to scale up the project to 100 villages, installing 50 MFPs in 11 districts during the coming 5 years. According to TaTEDO, the setup will be roughly the same, but services will be expanded with water pumping and electricity supply to social centers like schools. Additionally more attention will be paid to business development and involvement of the private sector.

UDSM and SUA

Both the University of Dar es Salaam (UDSM) and the Sokoine University of Agriculture (SUA) have conducted research on Jatropha. Formerly a research partnership existed between UDSM and KAKUTE, however it is unclear if this partnership still exists. No present linkage between either one of the universities and other Jatropha stakeholders was identified during the fieldwork. No present linkage between either one of the universities and current Jatropha stakeholders was identified during the fieldwork. Overall, there is a large gap in partnerships between national research institutions and micro, meso and national level Jatropha stakeholders. This is an area where collaboration may take place and could offer much needed dialogue and forum for future discussions and topics as illustrated by their isolation in the actor constellation.

Village Government

Some village governments received Multifunctional Platforms from TaTEDO. Upon request, village governments linked JPTL to existing farmer groups for their Jatropha promotion activities and soap making projects. However, some cases were mentioned by respondents where village government interfered with projects and limited private sector development. However, due to lack of verifiable information on these cases, they are not discussed any further in this thesis.

6 Performance along the chain

In the following sections, each link is analyzed in more detail, with a focus on assessing its competitiveness. As indicated in section 3.3.2, competitiveness of value chain links is operationalized in three ways. Firstly, for each link the feasibility is determined, both technical and economic. In order to determine the economic feasibility, gross margin calculations are performed with the data gathered in the field. Secondly, past and present upgrading strategies are identified. The third concept that is discussed is that of inter-firm cooperation, constituting vertical and horizontal linkages. Concluding each section the findings related to the respective value chain link are merged into a SWOT table. Unless indicated otherwise, the source for all data in this chapter is fieldwork, 2008.

6.1 Competitiveness of each link

6.1.1 Nursing

Observed nurseries within the value chain are small-scale (i.e. not bigger than 0.1 acre), mainly as a side activity of farmers or farmer groups, using them for their own planting as well as selling them to other farmers. Actors involved in nursing activities included Diligent, KAKUTE and Agroflora in Arusha, DOSI in Northern Tanzania, the Menzini Women Group in Leguruki, the Green Garden Women Group in Moshi and individual farmers.

Illustration 6.1: Seedlings being nursed at KAKUTE's demonstration plot in Arusha.

Nurseries require little technology and there are no barriers to entry. Apart from labor and a small area of land, seeds for planting, plastic bags, soil and water are the only inputs required. Storage of seeds can be required, when seeds are bought in the harvesting season and need to be planted before the next rainy season. Because of the low quantity of seeds required for the observed nurseries, storage availability was not considered an influential factor. Because planting of seedlings on farmland ideally takes place at the beginning of a rainy season, nurseries are a seasonal activity. This is one of the reasons why nursing activities were only encountered as a small-scale side activity of stakeholders with other primary activities, such as farming or soap making. Seedlings are ready for planting after 3 months, but can be nursed for a longer period. Scaling up to meet higher demands is easy, because seedlings can be produced within 3 months, provided that the seed supply on the market is sufficient, and only a small area of land is required. This was for example observed in a case where a nursery was producing on request of a farmer, raising the production volume for that year.

Compared to alternative technologies, i.e. direct planting from seeds or cuttings, nurseries provide several benefits. First of all, it is easier to take care of the plants when they are placed together in nurseries. Secondly, planting the seedlings at the start of the rainy season gives the plants a head start of 3 months or more, making them more mature and thus stronger at the end of the first rainy season. This means the plants will more quickly produce higher yields. Thirdly, nurseries provide opportunities for the plants to get strong before transplanting them to marginal soils, hence increasing the survival rate. Therefore, based on the low technology requirements, the scalability and the preference over alternative technologies, nursing activities are concluded to be technically feasible.

The current market for seedlings is favorable, because more farmers are in the process of planting Jatropha compared to previous years. Future demand for seedlings depends on activities further along the chain, which is a risk for nurseries. Net benefits and gross margins are calculated in table 6.1. As stated in section 3.3, the calculations are simplified for the purpose of determining economic feasibility. When applicable, the gross margin calculations in this chapter include three seed price scenarios. The low scenario corresponds to a seed price of TZS 100 per kg, medium to TZS 200 per kg and high to TZS 300 per kg. In all three scenarios the other costs and benefits remain the same. Although the plastic bags were provided for free by JPTL to their women groups, they are included in the calculation here. Seedlings were observed to be sold at TZS 150 each. From the resulting gross margin percentages in table 6.1, ranging from 54% to 55% in the three seed price scenarios, it follows that the net benefit constitutes more than half of the total revenue. In other words, more than half of the total revenue is profit. From the calculations it can be concluded that nurseries are economically feasible. Furthermore, it becomes clear how small the influence of the different seed price scenarios is on the net benefits and gross margins. This explains why stakeholders that buy seeds for planting purposes are willing to pay high prices for the seeds, as already observed in section 4.2.

Table 6.1: Gross margins of nursing 20,000 seedlings during 3 months

	Low (100/kg)	Medium (200/kg)	High (300/kg)
Cost			
Seeds	10,000	20,000	30,000
Polyethylene tube	421,200	421,200	421,200
Polyethylene sheet	89,300	89,300	89,300
Labor	765,000	765,000	765,000
Depreciation of equipment	50,000	50,000	50,000
Total cost	1,335,500	1,345,500	1,355,500
Revenue			
Produced seedlings	3,000,000	3,000,000	3,000,000
Net benefit	**1,664,500**	**1,654,500**	**1,644,500**
Gross margin	**55 %**	**55 %**	**54 %**

All prices are in TZS.
Source: fieldwork, 2008.

Several types of upgrading were observed during the fieldwork. First of all, a case of process upgrading was observed at DOSI's nursery, where a shallow hill was constructed, covered with plastic and seedlings placed on top of it. This innovation made irrigation more efficient because water, which was supplied only at the top of the hill, flowed down by itself, thereby requiring less water and less labor. This innovation was not observed at other nurseries. Secondly, functional upgrading took place in cases where farmers or soap making groups expanded their activities by starting a nursery. In the case of farmers, the nursery mainly served their own planting purposes, while soap producers mainly produced Jatropha seedlings in order to sell them to farmers. Apart from the aforementioned cases of process and functional upgrading, no other forms of upgrading were observed. For example, no use of improved seeds was observed, neither was the use of inputs such as fertilizers or pesticides for improved yields and product quality. Furthermore, some partially destroyed nurseries were observed, possibly as a consequence of cattle or people walking over the seedlings. In this case, process upgrading is required to improve the performance of nursing activities. In order to conclude this section, the findings are summarized in the SWOT table below (see table 6.2).

Illustration 6.2: Partially destroyed nursery at the Menzini Women Group in Leguruki.

Table 6.2: SWOT analysis of nursing

Strengths	**Weaknesses**
Capital extensive	Labor extensive
Low technology requirement	Small scale
Higher survival rate for planting	No use of improved seeds
Quicker and higher yields for planting	No use of fertilizers or pesticides
Scalability	
Opportunities	**Threats**
Rising demand for seedlings	

Source: fieldwork, 2008.

6.1.2 Gathering

Gatherers consist of individuals that harvest seeds from existing hedges and therefore operate at a small scale. Seeds are transported to collectors where they are sold. Actors involved included individual gatherers visited in Engaruka and Leguruki.

For gathering activities, no machinery or other technology is required. For transportation of the collected seeds to the collection centers, plastic bags are used. Because collection is done from existing hedges, it is hard to scale up the activity when the demand rises. Only by planting new hedges, which take several years to produce their first harvest, production can be increased. Alternative technologies include planting on a farm using either intercropping or mono cropping. Therefore, these alternatives are only available to gatherers that have access to the required land, capital, etc. Storage is possible and has low technology requirement, but in most cases not necessary because seeds can be sold directly to collectors (see section 6.1.5). Hence, gathering is considered to be technically feasible.

Illustration 6.3: Due to competition between gatherers, seeds are picked when still green.

Due to competition between gatherers that collect from the same public hedges, the risk of others picking the seeds leads to collecting as soon as possible, resulting in only green seeds being collected. The quality of these seeds is low in terms of oil and water contents and they require more time to shell and dry. Hence the competition between gatherers lowers the quality of the end product.

Apart from labor, no other inputs are required. According to a respondent, it used to be possible and free of charge to collect seeds from any hedge in the past. However, since the economic value of the seeds is more widely known and competition between gatherers has grown, on the observed locations gatherers were only allowed to harvest from their own hedges. In some cases gatherers paid owners of hedges an unspecified fee to allow them to pick the seeds. Seeds were sold to collectors in Leguruki at a factory gate price of TZS 150 per kg, but depending on the location the price was observed to rise up to TZS 300 per kg in Engaruka. In table 6.3 these prices are translated into gross margin calculations. To quantify the labor required to gather the seeds, the opportunity costs of labor haven been used, i.e. the income a gatherer would earn as a wage worker. In the harvesting season, the labor cost of one man day was observed to fluctuate around 2,500 TZS.

Table 6.3: Gross margins of gathering 10 kg of seeds during 1 day

	Low	**Medium**	**High**
Cost			
Labor	2,500	2,500	2,500
Revenue			
Harvested seeds	1,000	2,000	3,000
Net benefit	**- 1,500**	**- 500**	**500**
Gross margin	**- 150 %**	**- 25 %**	**17 %**

All prices are in TZS.
Source: fieldwork, 2008.

The resulting gross margins indicate that gathering is economically feasible only in the high seed price scenario when seeds are sold at TZS 300 per kg. It must be noted however, that in the observed cases the availability of alternative labor was limited. Encountered gatherers were relatively poor families with little or no farmland or job opportunities. The calculated opportunity costs are therefore rather fictive and collecting activities did indeed provide a valuable source of income for these families. However, due to the limited availability of hedges and rising competition between gatherers, gross produced volumes are low and not sufficient for making a living. It is concluded that gathering activities, by generating income with only labor investment, can be feasible in selected cases where hedges are available and alternative sources of income are absent or insufficient.

Table 6.4: SWOT analysis of gathering

Strengths	**Weaknesses**
Labor intensive	Small scale
Capital extensive	Lack of scalability
	Early picking results in low seed quality
Opportunities	**Threats**
	Diminishing availability of public hedges

Source: fieldwork, 2008.

The main findings of this section are summarized in SWOT table 6.4. In this case, a labor intensive characteristic is considered a strength in the context of pro-poor development. Labor intensive activities generate employment which leads to rising income and development. Labor extensive activities, on the contrary, generally benefit fewer stakeholders directly, which is therefore considered a weakness. The same argumentation is applied to capital extensive versus capital intensive activities. Capital intensive activities are only available to stakeholders with access to sufficient financial means, who are not considered to be the poorest. Hence, capital extensive properties are categorized as strengths, whereas capital intensive characteristics are considered to be a weakness.

6.1.3 Small-scale intercropping farming

All visited and interviewed small-scale farmers, with plot sizes ranging from 0.5 to 2.5 acres, were intercropping Jatropha with food or cash crops. They produced larger annual quantities of seeds than gatherers, but because of intercropping practices the yields per acre were still lower than farmers that applied mono cropping (see next section). Actors involved included Hortanzia in Arusha, farmers in Engaruka and Leguruki and individual out-growers of Diligent.

The technology applied at small-scale Jatropha farms was observed to be relatively basic. On not one single small-scale farm the use of either organic or inorganic fertilizers was observed, neither was the use of pesticides, fungicides or herbicides. Little or no weeding was observed. In the limited cases where irrigation was applied, it was a basic form of flood irrigation by diverting a nearby river to temporarily flood the land, usually twice a year. Although the exact effect of these various factors on Jatropha plants were largely unknown, initial trials with Jatropha and experiences with comparable crops suggested that application of fertilizers, pesticides, fungicides, weeding and improved irrigation would positively impact Jatropha farm productivity. One case of more advanced drip irrigation was observed at a Diligent demonstration plot for an agricultural fair in Arusha. However, due to the


Illustration 6.4: Expensive irrigation system at Diligent's demonstration plot in Arusha.

discouraging effect it had on potential future out-growers, who were worried that the expensive irrigation system was necessary to grow Jatropha, Diligent is currently in the process of removing the drip irrigation system from their demonstration plot.

Jatropha cultivation is hardly scalable, because the first substantial harvest from directly planted seeds takes between 2 and 3 years from the planting date. Furthermore, the observed small-scale farmers possessed only a few acres of land, parts of which were needed to grow foodcrops. Alternatives to small-scale farming are gathering from existing hedges (see previous section) and large-scale farming (see next section). Small-scale farming has a higher annual yield compared to collecting, but a lower yield than large-scale mono cropping farming. However, an advantage for small-scale farmers is that intercropping involves less risk than mono cropping when it comes to dependence on yields and future market developments, because risks are spread over different crops.

A weakness of Jatropha intercropping is that it is only technically possible during the first 2 to 3 years, when the Jatropha plants are still small. When the plants grow bigger and develop a large canopy, they block most of the light for other crops, assuming that spacing between plants is 2 by 3 meters, as was observed in practice during the fieldwork. For maximum yields per plant a big canopy is needed however, because the flowers develop mainly in the canopy. Therefore, the bigger the canopy is, the more seeds a plant will produce. After a few years, enough sunlight for the other intercropped plants will only remain when Jatropha is planted further apart than was observed, resulting in lower intercrop yields per acre. Trials at Kikuletwa farm (see next section) confirmed that 3 year old plants developed canopies with diameters ranging from 3 to 5 meters. However, during the fieldwork neither small-scale farmers, nor stakeholders promoting Jatropha cultivation, indicated that larger intercropping distances were considered for future planting.

Small-scale intercropping Jatropha farming was promoted by several organizations to their target groups. As illustrated by the aforementioned drip irrigation example, the promoted farm practices were basic, i.e. without the use of fertilizers, pesticides or advanced irrigation. Regarding knowledge on farm management, during the stakeholder workshop it was confirmed that most farmers were unaware of their production costs. Organizations promoting Jatropha cultivation were not able to provide these calculations either. In this section basic production cost, net benefit and gross margin calculations are provided as a starting point. Apart from the production costs, existing pests and fungi were largely unknown to farmers. On one occasion during a field visit, an extension officer of a Jatropha promoting organization failed to recognize clearly visible pests on Jatropha plants. Furthermore, their damage to crops, as observed on all field visits, was denied, stating instead that no pests or fungi were harmful to Jatropha plants. However, visited large-scale farms (see section 6.1.4) indicated that pests and fungi were one of the most important cost factors that were influencing economic feasibility.

The costs involved in small-scale intercropping of Jatropha are mainly related to planting, cultivation and harvesting. No storage costs are required since seeds can be directly sold to collectors. When stored however, seeds can be sold at higher prices outside of the harvesting seasons. There are no high inputs involved in storage, since seeds can be stored without technological requirements such as cooling equipment. Since the gestation period was observed to be around 3 years, i.e. it took 3 years from the planting date until the first harvest, the opportunity costs were high. The resources used during those three years, such as land, capital and labor, could have been used to generate profit with other activities instead. An example of such an alternative is planting maize, which can be harvested after 3 to 6 months. This amounts to at least 6 harvests of maize before Jatropha yields its first harvest. These lost profits need to be taken into account when determining the feasibility of Jatropha farming activities. Furthermore, the long gestation period acts as a financial barrier to entry, because not all farmers are capable of making such long term investments.

Illustration 6.5: Spraying is required when fungi attack Jatropha seeds.

At the time of the fieldwork there was a high demand for seeds, resulting in high prices. Farm gate prices of seeds ranged from TZS 100 to TZS 300 per kg, depending on the location. In Engaruka farmers sold their seeds to collectors for a factory gate price of TZS 300 per kg. Farm gate prices of up to TZS 500 per kg were incidentally reported by small-farmers but could not be verified through other sources. Future market developments are uncertain and depend for example on national demands, blending policies and export possibilities of SJO and Jatropha biodiesel.

In table 6.5 gross margins are calculated based on the observed farming practices. Labor costs for simple irrigation and weeding is included. Consistent with the observed lack of fertilizer and pesticide application, costs thereof are excluded. The calculations are based on a one acre plot, in the third year after planting, which implies that the plants are relatively mature and are producing an actual harvest. During the fieldwork, most small-scale farmers had planted recently and therefore had not harvested thus far. It must therefore be noted that the harvest data in table 6.5 is based upon the average yields of the two encountered small-scale farms that were actually harvesting, combined with average plant yields gathered at large-scale farms (see next section). For a detailed list of assumptions, which are based upon the fieldwork and are used in the gross margin calculations, see annex 4.

Table 6.5: Gross margins of small-scale farming during 1 year

	Low	Medium	High
Cost			
Irrigation	5,000	5,000	5,000
Weeding	10,000	10,000	10,000
Harvesting	140,000	140,000	140,000
Total cost	155,000	155,000	155,000
Revenue			
Harvest (kg)	675	675	675
Price per kg	100	200	300
Total revenue	67,500	135,000	202,500
Net benefit	**-87,500**	**-20,000**	**47,500**
Gross margin	**-130 %**	**-15 %**	**23 %**

All prices are in TZS per acre, during the third year after planting and based on 2 x 3 m spacing.
Source: fieldwork, 2008.

From the net benefit and gross margin data in table 6.5. it becomes clear that small-scale intercropping farming is only feasible at the high seed price scenario. However, since these calculations are based on the third year after planting, the costs of the first two years without harvest are not taken into account. Therefore, in table 6.6 the same calculations are provided for a five year period. The five year period is chosen because it is more realistic to spread the initial clearing, planting and pruning costs over five years, rather than three. The same applies to the irrigation and weeding costs during the first years without harvest. The results show that small-scale intercropping farming is feasible over a five year period, even when initial planting costs are taken into account, but only when seed prices are high. From tables 6.5 and 6.6 it becomes clear however, that as soon as the seed price drops to the medium scenario of TZS 200 per kg, small-scale farming is no longer economically feasible. In addition, the calculations show that harvesting costs are by far the most important determinant of the total costs. The high harvesting costs are due to the fact that Jatropha plants produce seeds all year long, which requires near continuous harvesting of small quantities. Furthermore, manual picking is required because green, yellow and brown seeds are grouped together, whereas usually the latter type is harvested. Observed average annual yields per plant ranged between 0.5 kg and 2 kg. Several interviewees suggested that these absolute yields as well as net benefits of Jatropha were low compared to other crops. However, in order to verify this claim, further research would need to be conducted on productivity and net benefits of alternative crops under comparable conditions.

Illustration 6.6: Green, yellow and brown seeds together require manual harvesting.

Table 6.6: Gross margins of small-scale farming during 5 years

	Low	Medium	High
Cost			
Land preparation	2,500	2,500	2,500
Planting	2,600	2,700	2,800
Pruning	2,500	2,500	2,500
Irrigation	25,000	25,000	25,000
Weeding	50,000	50,000	50,000
Harvesting	420,000	420,000	420,000
Total cost	502,600	502,700	502,800
Revenue			
Harvest (kg)	2025	2025	2025
Price per kg	100	200	300
Total revenue	202,500	405,000	607,500
Net benefit	**-300,100**	**-97,700**	**104,700**
Gross margin	**-148 %**	**-24 %**	**17 %**

All prices are in TZS per acre, during the initial five years after planting and based on 2 x 3 m spacing. Source: fieldwork, 2008.

Illustration 6.7: Jatropha trees planted with 2.5 m spacing at Kikuletwa farm in Moshi.

As mentioned before, small-scale farmers only applied intercropping. Due to the observed small intercropping distance of 2 by 3 meters, which is close to observed large-scale mono cropping distance of 2.5 by 2.5 or 3 by 3 meters, these calculations would generally also apply to small-scale mono cropping farming. The economic feasibility of either type of small-scale farming largely depends on yields and seed prices. An opportunity for functional upgrading, especially when seed prices drop, is to include into oil extraction activities at the farm. Oil extraction adds more value and prices of SJO were observed to be more stable than those of seeds. However, there is a high barrier to entry for this type of upgrading, because biofuel producers, as potential large-scale SJO processors, require high quality SJO for biodiesel production (see section 6.1.6). These stakeholders thereby exercise quality control, the demands of which small-farmers are not able to meet when applying mechanical oil extraction.

The main findings of this section are summarized in table 6.7. Although productivity is relatively low and knowledge on farm management issues such as planting distance, fertilizers, pesticides, weeding, pruning and irrigation is limited, small-scale intercropping farming is technically feasible. However, because of the low productivity, small-scale farming is currently only economically feasible in the high seed price scenario. Furthermore, since economic feasibility largely depends on seed prices and because future market developments are uncertain, the risks are deemed high.

Table 6.7: SWOT analysis of small-scale farming

Strengths	**Weaknesses**
Spread of risks	Lack of knowledge on farm management issues
Low technology requirement	Lack of knowledge on production costs
Sharing inputs with other crops	High opportunity costs
	Low productivity
	Intercropping only during the first 2 - 3 years
	Lack of scalability
Opportunities	**Threats**
Oil extraction at farm	Only feasible at high seed price scenario
	Uncertain future market developments

Source: fieldwork, 2008.

6.1.4 Large-scale mono cropping farming

Mono cropping was observed at two relatively large-scale farms of 20 and 80 acres respectively. The two stakeholders involved were Kikuletwa in Moshi and Agroflora in Arusha. Both large-scale farms recently changed from mono cropping to intercropping by granting small-scale farmers access to the land, who were allowed to plant crops between the existing Jatropha plants and in return maintained part of the Jatropha plantation. Both large-scale farms halted their commercial Jatropha cultivation because the activity was not deemed feasible. Kikuletwa changed into aloe vera cultivation, which is a clear example of chain upgrading, by using its experience to undertake an activity in a another value chain.

Illustration 6.8: Chain upgrading from Jatropha to aloe vera cultivation.

The observed large-scale commercial farms had more access to land and capital than their small-scale counterparts. The availability of these production factors made farming activities more scalable, although the germination rate of Jatropha plants still had to be taken into account, since responding to rising demands nonetheless would take at least three years. At the observed large-scale farms, more inputs could be applied at a larger scale, generating economies of scale. For example, fertilizers were used to improve growth rates and yields. Furthermore, spraying was used against pests and diseases, which were more likely to develop and spread because of mono cropping. Irrigation practices were roughly the same as the small-scale farms, with the difference that a pump was used to make river water flood the land at more frequent intervals than small-scale farmers. By testing these different inputs, large-scale farmers gained more knowledge on farm management than small-scale farmers. For example, trials with various planting methods and pruning heights at Kikuletwa demonstrated the different effects on branches and canopies. At the same farm, which was initially planted with 2.5 m spacing between plants, it was learned that, due to the large canopy required for higher yields, spacing of 3 m was preferable. Results from these trials furthermore showed that the plant could indeed survive on marginal lands with little inputs, but would not produce any seeds under those conditions. These results render the claim that Jatropha would not compete with food crops, because it could be cultivated on marginal lands, obsolete. In that respect, Jatropha behaved like any other plant and required the usual inputs such as water and nutrients.

Illustration 6.9: Trials with various planting methods and pruning heights at Kikuletwa.

Despite this growing knowledge and experience however, according to the large-scale farmers themselves, much knowledge was still absent and exact impacts were largely unknown. To maximize yields, more precise knowledge is required on the effects of different types of pruning, irrigation, fertilizers, weeding and cleaning, to name just a few. The observed yields at Kikuletwa were low, with an average yield of 0.5 kg of seeds per plant per annum. For Agroflora no data on yields was available, because harvesting was stopped. The reason was that continuous flowering throughout the year resulted in labor intensive harvesting of small quantities. In the case of Agroflora, harvesting on itself was not feasible, let alone if other production costs were taken into account. Kikuletwa confirmed this statement and at the time of the research was only selling seeds to buyers who were willing to pay TZS 6,000 per kg, which is 20 times more than the high seed price scenario used in the gross margin calculations in this chapter.

Because of the varying yields observed, not only between locations but also between individual plants on the same farm, combined with the aforementioned lack of knowledge on the effects of different inputs, gross margin calculations for large-scale mono cropping farms are highly case specific. Since Agroflora was not harvesting and could not provide data on annual yields, the gross margin calculations in table 6.8 are solely based on data from Kikuletwa. Due to extensive account keeping at Kikuletwa, by registering all costs and benefits on a daily basis from the start, the data used was relatively detailed. For the gross margin calculations the same assumptions apply that were mentioned already with respect to small-scale farming in the previous section.

The results in table 6.8 clearly show that large-scale Jatropha farming in this case is not feasible by any means, regardless of the seed price scenario. Despite the application of fertilizers, pesticides and frequent irrigation (included in the permanent worker cost), average annual yields were as low as 0.5 kg per plant. The cause of this low productivity was unknown. Speculations were made by respondents about bad soil quality, although aloe vera crops were growing well on the same grounds. Low yields could also be a consequence of plant genetics, since Jatropha is still considered a wild plant. However, Kikuletwa planted different seeds from different parts of the world, which would suggest at least some plants should be genetically favorable. Another respondent indicated that Jatropha plants need to be stressed at certain times in order to stimulate flowering. This claim could however not be verified at either one of the large-scale farms.

Table 6.8: Gross margins of large-scale farming during 5 years

	Low	Medium	High
Cost			
Land preparation	3,750	3,750	3,750
Planting	74,863	74,863	74,863
Pruning	28,075	28,075	28,075
Fertilizer	11,850	11,850	11,850
Pesticides & herbicides	115,738	115,738	115,738
Harvesting & drying	160,300	160,300	160,300
Permanent worker	450,000	450,000	450,000
Total cost	844,576	844,576	844,576
Revenue			
Harvest (kg)	573	573	573
Price per kg	100	200	300
Total revenue	57,300	114,600	171,900
Net benefit	**-787,276**	**-729,976**	**-672,676**
Gross margin	**-1374 %**	**-637 %**	**-391 %**

All prices are in TZS per acre, during the initial five years after planting and based on 2.5 x 2.5 m spacing.
Source: fieldwork, 2008.

Illustration 6.10: Labor intensive manual harvesting results in high production costs.

Despite such negative net benefit and gross margin figures, a break-even point can be reached by changing certain variables. Hence, the question can be asked at which seed price large-scale Jatropha farming becomes economically feasible, provided that all other costs remain the same. Figure 6.1 depicts the net benefit as a function of the seed price received at the farm gate. From the graph it becomes clear that the break-even point is reached at a seed price of around TZS 1,500 per kg. At that price the gross margin equals 0%. In order to acquire a gross margin of 20%, the seed price needs to be around TZS 1,850 per kg. Because of the observed shortage of seeds and because people who needed to plant were able to pay a higher price for the seeds, buyers could still be found

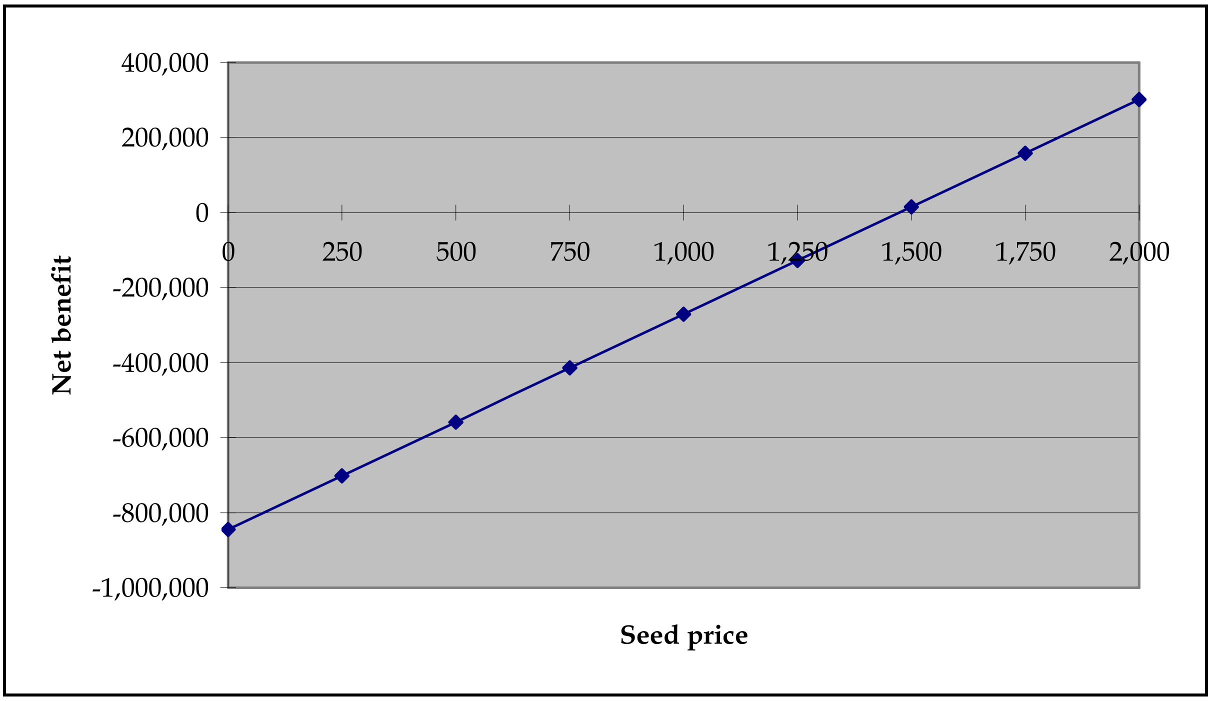

Figure 6.1: Net benefits of large-scale farming at different seed prices
All prices are in TZS per acre and are based on the data presented in table 6.8.
Source: fieldwork, 2008.

at both seed prices. However, if total seed production in the research area increases in the future and seed scarcity is less, it is unlikely that seeds can still be sold at such high prices. The main finding of this section are summarized in table 6.9. Taking into account the mentioned low and fluctuating yields, together with the costs of different inputs and the lack of knowledge on the effects thereof, currently large-scale Jatropha farming is considered not feasible. In case large-scale farming becomes feasible in the future, upgrading opportunities include oil extraction at the farm. The barriers to entry in terms of quality standards can more easily be overcome compared to small-scale farmers, due to higher processing volumes and mechanical oil extraction possibilities (see section 6.1.6).

Table 6.9: SWOT analysis of large-scale farming

Strengths	**Weaknesses**
Farm management experience	Lack of knowledge
Economies of scale	High opportunity costs
Some scalability	Low yields
Labor intensive manual harvesting	
Opportunities	**Threats**
Oil extraction at farm	Unknown pests and fungi
Possible higher yields	

Source: fieldwork, 2008.

6.1.5 Collection

Collectors are individuals that collect seeds from different sources, e.g. from gatherers and farmers. They store the seeds until the volume is high enough to either sell the seeds to a buyer that visits their collection point (i.e. sell at farm gate) or to transport them to a buyer, usually in the city (i.e. sell at factory gate). In most cases collectors were also Jatropha farmers or gatherers themselves. Actors involved included individuals visited in Engaruka and Leguruki. Diligent could also be considered a collector when they sent their truck into the field to act as a mobile collection point, while in fact they were merely a buyer of seeds that bypassed intermediaries and was buying more or less at the farm gate.

Illustration 6.11: Jatropha seeds for sale at a collection point in Engaruka.

The main input requirement is storage of the collected seeds. Since dry seeds can be stored for one year without substantial loss of oil content, storing the seeds is not limiting the technical feasibility. Because collectors are dependent on farmers and gatherers bringing their seeds, the activity is hardly scalable when demand of buyers increases or decreases. Visited collectors indicated that knowing the buyer was important to becoming a collector. Collectors in Engaruka for example all had connections with Diligent, or knew someone who had connections with Diligent. Knowing the buyers is therefore considered a barrier to entry to becoming a collector, and in that respect a form of chain governance. Various gatherers and farmers indicated that they would like to become a collector, but existing collectors and buyers had the power to keep them out.

Table 6.10: Gross margins of collecting 1,000 kg of seeds between 2006 and 2008

	2006	2007	2008
Cost			
Seeds (kg)	1,000	1,000	1,000
Price (farm gate, per kg)	120	200	300
Total seed cost	120,000	200,000	300,000
Transport	50,000	50,000	50,000
Total cost	171,120	251,200	351,300
Revenue			
Seeds (kg)	1,000	1,000	1,000
Price (factory gate, per kg)	180	300	500
Total revenue	180,000	300,000	500,000
Net benefit	**8,880**	**48,800**	**148,700**
Gross margin	**5 %**	**16 %**	**30 %**

All prices are in TZS.
Source: fieldwork, 2008.

Apart from the storage space, no financial inputs are necessary. Gatherers and farmers bring their seeds to the collector. Since most collectors own a shop or other business, storage space is shared with other activities. When selling the seeds in the city, only transportation costs have to be added and collectors get a higher price for their seeds. Gross margin calculations are presented in table 6.10. Instead of the seed price scenarios of TZS 100, TZS 200 and TZS 300 respectively, the real prices during the past three years are used as observed in Engaruka. The results show rising net benefits and gross margins per ton of seeds over the past three years. In 2007, a collector in Engaruka collected and sold 150 bags of seeds, corresponding to 9,000 kg of seeds. Using the calculations provided in table 6.10, the total profit for that particular collector in Engaruka amounted to TZS 439,200 in 2007. It can therefore be concluded that collecting is technically and economically feasible.

Illustration 6.12: Bags with seeds stored in an abandoned lavatory.

In Engaruka no price competition was observed between individual collectors, because they set a fixed price together. Big farmers that produced high volumes were observed to sell their seeds directly to buyers, thereby bypassing collectors and generating more income. Stakeholders that were buying for planting purposes were also observed to bypass collectors, since they bought their seeds directly at farms. An exception was DOSI, which bought seeds from Diligent because they were especially selected for planting purposes. The findings related to collection are summarized in the SWOT analysis in table 6.11.

Table 6.11: SWOT analysis of collecting

Strengths	**Weaknesses**
Little inputs	Connection with buyer
	Lack of scalability
Opportunities	**Threats**
	Farmers selling directly to buyers

Source: fieldwork, 2008.

6.1.6 Oil extraction

Extracting oil from Jatropha seeds can be done either with a manual press, such as the ram press, or with a mechanical press, such as the Sayari oil expeller. Actors involved in manual oil extraction include farmers and soap making groups and the Multifunctional Platform (MFP) in Leguruki, actors involved in mechanical oil extraction include Diligent and the MFP in Engaruka.

Manual oil extraction requires the manual ram press and is relatively labor intensive. A good pressing technique is required, because factors like the speed of pressing, which differs per seed type, influence the oil yield. At best 1 liter of oil can be extracted out of 5 kg of seeds. However, depending on the operating technique and quality of seeds, this ratio was observed to degrade down to 8 kg of seeds per liter of oil.

Mechanical oil extraction was more efficient but required more advanced equipment that needed to be connected to either a mechanical or electrical power source, i.e. an engine or a power grid. The only encountered type of mechanical oil expeller was the Sayari oil expeller, which, according to co-producer ELCT, was owned by just three Jatropha related actors in Tanzania. Diligent, as the largest oil extractor in the research area, was one of them, together with the observed MFP in Engaruka, which was not using the expeller to extract SJO, and Prokon in Mpanda, situated a few hundred kilometers south of the research area. Since the Sayari oil expeller was still in development, technical aspects like maintenance requirements and long-term performance remained unclear. At best 1 liter of oil could be extracted out of 3,5 kg of seeds. However, depending on the quality of seeds, the average extraction ratio was around 4 kg of seeds for 1 liter of oil.


Illustration 6.13: Demonstration of ram press operating techniques at CAMARTEC.

While storing dry seeds for a limited amount of time had no substantial influence on oil content, at some point seeds would loose oil. Storing the oil instead of the seeds was therefore preferred on the long term. This could be done in air-tight barrels. Furthermore, with the current average mechanical extraction rate only 25% of the transported seed volume was eventually gained as oil. The seedcake that remained as a byproduct could be used as fertilizer or as input for a biogas plant, which would require transporting the seedcake back to those users. Hence, transportation of the oil instead of the seeds was preferred by actors involved, requiring oil extraction at the farm.

For direct use in modified diesel engines, oil lamps or cook stoves, simple filtering of the oil is sufficient, for example by pouring it through a cloth. For other uses, such as the more critical biodiesel production, the problem of quality control arises. Strict international regulations regarding the chemical composition of biodiesel require high quality oil which could currently not be produced at any observed farm. Furthermore, although no exact figures were available, relatively high processed volumes were said to be required to make mechanical oil extraction feasible. Due to quality and volume requirements an option could be to organizing oil extraction at village level, thereby gaining economies of scale. During the fieldwork village level oil extraction activities were not observed however. Although stakeholder such as Diligent preferred oil extraction at the farm, thereby lowering transport volumes by 75%, the quality demands rendered it currently impossible. This is a form of governance, whereby through quality control barriers to entry are enforced, be it desired or not. These barriers to entry avert farmers from potential functional upgrading into oil extraction activities.

The main variable cost when extracting oil was the seed price. Although average seed prices were observed to differ between TZS 180 and TZS 500 from one location to the other, the price for one liter of Jatropha oil remained constant at TZS 2,000 per liter. This implies that oil extraction is economically more feasible in areas with lower seeds prices and becomes less feasible when seed prices rise. The main fixed cost for manual oil extraction is the cost of the ram press (TZS 120,000), which is low compared to the mechanical Sayari oil expeller (TZS 4,000,000). Because of the lower variable labor costs, mechanical oil extraction can benefit from economies of scale. However, high investment costs make mechanical oil extraction only accessible to big actors that process high volumes of seeds.

Illustration 6.14: Mechanical oil extraction using the Sayari oil expeller in Engaruka.

Currently, the possible uses of the seedcake are largely unknown in the research area, but when possible applications of the seedcake become more widely recognized, oil extraction activities can generate extra income by selling the seedcake. In table 6.12 gross margin calculations are provided for manual oil extraction, excluding possible revenues from seedcake sales. The results support the claim that, due to constant oil prices, oil extraction is more feasible when seed prices are low. Manual oil extraction is deemed economically feasible at low to medium price scenarios. As soon as seed prices reach TZS 300 per kg, feasibility becomes critical.

Table 6.12: Gross margins of manual oil extraction of 8 liters during 1 day

	Low	Medium	High
Cost			
Seeds	4,000	8,000	12,000
Labor	2,500	2,500	2,500
Depreciation of equipment	153	153	153
Total cost	6,653	10,653	14,653
Revenue			
Extracted oil	16,000	16,000	16,000
Net benefit	**9,347**	**5,347**	**1,347**
Gross margin	**58 %**	**33 %**	**8 %**

All prices are in TZS.
Source: fieldwork, 2008.

Unfortunately, data required for gross margin calculations on mechanical oil extraction could not be provided by stakeholders involved. Based on Engaruka MFP experiences and mechanical oil extraction activities at Diligent, which were both viable according to the stakeholders involved, it can be assumed that mechanical oil extraction is economically feasible. In order to summarize this section, the main findings are summarized in SWOT tables 6.13 and 6.14.

Table 6.13: SWOT analysis of manual oil extraction

Strengths	**Weaknesses**
Low investment costs	Low oil yield
Low technology requirement	Optimal operating technique not well known
Labor intensive	Lack of quality control
Some scalability	
Opportunities	**Threats**
Application of the seedcake	Uncertain seed price developments

Source: fieldwork, 2008.

Table 6.14: SWOT analysis of mechanical oil extraction

Strengths	**Weaknesses**
High oil yield	High investment costs
Quality oil	High technology requirement
High scalability	Labor extensive
	Unknown maintenance and performance data
Opportunities	**Threats**
Application of the seedcake	Uncertain seed price developments

Source: fieldwork, 2008.

6.1.7 Soap production

Jatropha soap can be produced from straight Jatropha oil. Actors involved in soap production included women groups in Engaruka and Leguruki, KAMA and JPTL itself. Soap production is a low technology process, requiring only a storage tank, moulds, packing material and three ingredients: straight Jatropha oil, Lye and Soda. However, the quality of the soap was observed to differ between manufacturers but most surprisingly also between different production batches at the same stakeholder. Actors involved were not able to explain these differences in quality yet, but suspected the quality of the supplied straight Jatropha oil to be the cause. In Leguruki for example, soap producing actors were observed returning a bottle of SJO to the supplier in order to determine why the oil quality was fluctuating. Possible causes included seed quality, pressing technique or blending with other, cheaper, vegetable oils. The fluctuating SJO quality links back to the earlier mentioned quality control that was necessary at the oil extraction stage in the value chain.

Because the soap making process only takes four days it is easily scalable. Alternatives include regular soap, which is several times cheaper than Jatropha soap but does not have the medicinal characteristics. Since fixed costs are low, the SJO price to a large extent determines the price of the end product. Jatropha soap was selling for TZS 600 per piece of 90 grams, which was expensive compared to the regular soap, which was selling for TZS 100 per piece of 100 grams on the market. In table 6.15 net benefit and gross margin calculations are provided for soap production based on SJO. In this case three price scenarios are included for SJO, ranging from TZS 1,500 per liter (low) and TZS 2,000 per liter (medium) to TZS 2,500 per liter (high). The medium price scenario corresponds to the actual SJO price observed in the research area. From the results it becomes clear that at current SJO prices, soap production is only marginally feasible. Since administration and marketing costs are not included in gross margin calculations, it is likely that net benefits drop below zero when these costs would be taken into account. In the cases of the observed women groups, however, administration and marketing services were provided free of charge by NGOs.

Illustration 6.15: Pieces of Jatropha soap produced and sold by JPTL in Arusha.

Table 6.15: Gross margins of soap production from SJO during 4 days

	Low	Medium	High
Cost			
Labor	20,000	20,000	20,000
Jatropha oil	30,000	40,000	50,000
Other ingredients	10,800	10,800	10,800
Packing materials	27,100	27,100	27,100
Storage facility rent	14,000	14,000	14,000
Depreciation of equipment	900	900	900
Total cost	102,800	112,800	122,800
Revenue			
Soap	120,000	120,000	120,000
Net benefit	**17,200**	**7,200**	**-2,800**
Gross margin	**14 %**	**6 %**	**-2 %**

All prices are in TZS, based on producing 200 pieces of 90 grams during four days when buying SJO.
Source: fieldwork, 2008.

In the previous section it already became clear that manual oil extraction is economically feasible. For soap production it is therefore possible to consider manually extracting the oil from seeds instead of buying SJO. In table 6.16 adjustments are made to reflect manual oil extraction activities. In this case, the soap price is directly linked to the seed price. As with the gross margin calculations in previous sections, the scenarios correspond to TZS 100 per kg (low), TZS 200 per kg (medium) and TZS 300 per kg (high). The resulting gross margin percentages show that by manually extracting the oil instead of buying SJO, even the highest seed price scenario becomes feasible and in all scenarios more value is added.

Table 6.16: Gross margins of soap production from seeds during 4 days

	Low	Medium	High
Cost			
Seeds	10,000	20,000	30,000
Oil extraction labor	6,250	6,250	6,250
Oil filtering labor	1,250	1,250	1,250
Depreciation of ram press	1,000	1,000	1,000
Soap production labor	20,000	20,000	20,000
Other ingredients	10,800	10,800	10,800
Packing materials	27,100	27,100	27,100
Storage facility rent	14,000	14,000	14,000
Depreciation of equipment	900	900	900
Total cost	91,300	101,300	111,300
Revenue			
Soap	120,000	120,000	120,000
Net benefit	**28,700**	**18,700**	**8,700**
Gross margin	**24 %**	**16 %**	**7 %**

All prices are in TZS, based on producing 200 pieces of 90 grams during four days when pressing Jatropha seeds for oil.
Source: fieldwork, 2008.

As already became clear in section 4.4, the high soap price combined with the lack of consumer awareness on the medicinal characteristics resulted in a very limited local and national market for Jatropha soap. As a result, while KAMA and JPTL were still buying SJO from Diligent to produce soap, the visited soap making groups were making little or no soap and were extracting and selling SJO instead. This is a form of functional upgrading, by moving to different activities in the chain that produce more added value. The observed groups that were still making soap had difficulties with accessing the market. According to JPTL, producers in remote rural areas had trouble transporting their products to the city and were not able to market their products to the shops. JPTL was therefore buying the soap from the groups and was subsequently marketing it in the shops. Faida MaLi was cooperating with JPTL to provide market accessibility training, but no target groups were identified by JPTL so far.

During the fieldwork, KAMA was in the process of acquiring a medicinal soap certificate from TBS. If successful they will be the first and only Tanzanian soap producer with an official certificate regarding the medicinal characteristics of their soap, creating a barrier to entry for other actors. It will give them not only an advantage on the national market but also possibilities to explore the international pharmaceutical market. With the current seed prices and limited national market, producing for an international pharmaceutical market seems the only viable option. These and the other findings regarding soap production are summarized in the SWOT analysis in table 6.17.

Table 6.17: SWOT analysis of soap production

Strengths	**Weaknesses**
Low technology requirement	High straight Jatropha oil price
Scalability	Small local and national market
Opportunities	**Threats**
Improved local market accessibility	Rising seed prices
International pharmaceutical market	

Source: fieldwork, 2008.

6.1.8 Biodiesel production

Straight Jatropha oil can be transformed into biodiesel, which can be used as fuel in unmodified diesel engines. The two actors involved in biodiesel production were Diligent and infEnergy, although both were not producing biodiesel at the time of the fieldwork. Producing biodiesel requires advanced technology because the end-product must meet various chemical standards set by large international energy companies. To adhere to these standards, quality control on the inputs as well as on the production process is required. For example, straight Jatropha oil had to be continuously tested in Diligent's laboratory to see if it sufficed. In order to get the right quality Jatropha oil, manual selection of seeds and mechanical oil extraction were necessary. Subsequently, methanol had to be added, and since the latter was not domestically available it had to be imported.

Illustration 6.16: Bottled biodiesel sample at Diligent in Arusha.

Although exact figures were not available, infEnergy Tanzania indicated that for feasible biodiesel production from straight Jatropha oil, Jatropha seeds should not exceed a price around TZS 30 to TZS 40 per kg. Even with the lowest observed seed price of TZS 100 per kg, biodiesel production is therefore not feasible. This coincided with Diligent, stating that they were not producing biodiesel because it was not profitable. Apart from the profitability, there was little national or international market for biodiesel. Hence, Diligent applied functional upgrading by focusing on mechanical SJO extraction and possible uses of the seedcake, while infEnergy applied chain upgrading by completely moving away from Jatropha related activities and engaging in the international flower value chain instead.

Possible future national blending policies and related subsidies could provide opportunities for future biofuel production. However, due to low yields, large-scale cultivation of Jatropha for biodiesel production did not seem viable to the stakeholders interviewed. Furthermore, according to the respondents, possible threats to Jatropha biofuel activities included the development of second generation biofuels, which could eventually render first generation biofuels obsolete. The findings of this section are summarized in table 6.18.

Table 6.18: SWOT analysis of biodiesel production

Strengths	**Weaknesses**
Scalability Application in unmodified engines	Capital intensive Labor extensive Advanced technology requirement
Opportunities	**Threats**
Blending targets Export markets	Second generation biofuels

Source: fieldwork, 2008.

6.1.9 Distribution, retail and consumption

Because the markets for most Jatropha products were small, as was illustrated in chapter 4, the section of the value chain that covers distribution, retail and consumption was not much developed yet. Diligent was selling straight Jatropha oil directly to tour companies and some international buyers for testing purposes. According to respondents, several large international energy companies indicated their intention to buy a few million liters of straight Jatropha oil per year, however these amounts could not currently be supplied. SJO was not being sold or blended at the gas stations yet, because there was no national blending policy in place. International blending targets like those of the EU, i.e. 10% biofuel blending by 2020, are currently under debate because of their potential impact on food security and environmental issues. Like straight Jatropha oil, biodiesel was not sold at gas stations either. Permission for biodiesel export was yet to be granted and international market developments were unsure, especially with forthcoming second generation biofuel developments.

Illustration 6.17: A bag of seeds waiting to be transported.

With respect to Jatropha soap, JPTL was distributing the soap for their soap making groups directly to retailers, because the soap making groups were encountering market accessibility problems. During the fieldwork, numerous brands of soap were encountered in different stores, which turned out to be distributed either by the producer of the soap or by JPTL. Although distribution, retail and consumption activities were clearly taking place, these activities were largely performed by existing stakeholders earlier in the value chain. Fore example, no stakeholders were encountered that were solely specialized in the distribution of Jatropha related products.

6.2 Governance

As already became clear in the previous section, the Jatropha value chain is in an early stage of development. In general, little governance was observed within the chain. No strong power relations between actors were detected and only a few barriers to entry were identified. However, some steps towards governance in the chain were already observed. These steps will now be discussed.

Illustration 6.18: Weighing machine at a collection point in Leguruki.

First of all, Diligent was in the process of signing contracts with out-growers and collectors from the start in 2005. These contracts contained fixed prices that would be paid for supplied seeds, which originally ranged between TZS 100 and TZS 120 per kg. Due to recent market developments, including competition between buyers and rising seed prices, side selling was observed in several cases. According to stakeholders involved, due to the lack of experience farmers have with contracts, contract requirements were generally not met. Diligent was therefore forced to raise prices, despite the signed contracts. In practice, contracts were not being enforced when side selling was observed, i.e. no sanctions were applied. As seen in section 2.2.4 however, enforcement of contracts is essential to the functioning of governance. Furthermore, during the fieldwork it was still unclear if contracts were legally binding. Diligent therefore signed all contracts in the presence of the respective village chairmen.

With respect to barriers to entry, during the fieldwork three cases were identified where barriers to entry were constructed by value chain stakeholders. First of all, Diligent controlled who could become collector. The more collectors operate in a certain area, the lower the volumes they are able to collect. By keeping the number of collectors in a certain area low, higher volumes and therefore lower transportation costs are ensured. Secondly, by quality control of SJO for biodiesel production, Diligent limits the opportunities for oil extraction at the farm. Although Diligent indicated that SJO production at the farm is preferred, manual oil extraction using the ram press can not adhere to Diligent's quality standards. Furthermore, Diligent was the only stakeholder in the research area with a working mechanical oil expeller, since the second press in Engaruka was not being operated. The third barrier to entry was the TBS medicinal soap certificate, that was in the process of being registered by KAMA. As soon as the certificate are issued, it will create advantages for KAMA products on the local, national and international market. The certificate will provide KAMA with technological rents, e.g. being able to continuously meet certain standards, as well as marketing rents, e.g. better marketing capabilities and a more valuable brand name. Soap producers that aspire to compete with KAMA will then have to register a similar certificate, which, according to KAMA, is a lengthy and costly process.

Apart from the aforementioned barriers to entry, another form of governance is the ability to control price. In this respect, the question can also be asked if the Jatropha value chain is producer driven or buyer driven. Indications of a producer driven chain lay in soap making groups producing Jatropha soap despite the limited market. Large stockpiles of soap were observed at these stakeholders, including JPTL. Furthermore, some nurseries were observed that were producing seedlings, despite the absence of a market in the area. These nurseries were mostly neglected, full of weeds and overrun by animals.

On the other hand, situations were observed where the buyer was more influential. For example, collectors set the price they paid gatherers and farmers for their seeds. The price that collectors received, in turn, was determined by Diligent. Hence, in both cases the buyer set the price. Furthermore, during the last years the price of SJO was observed to remain stable, while seed prices were fluctuating. This is an indication that the price of SJO was not determined by the production costs but by the market. The fluctuations in seed prices and observed differences between areas are an indication that the seed prices are set by the market as well. Additionally, biodiesel production activities were highly buyer driven. Quality standards were set by large international energy companies and the feasibility of the activities depended on the price consumers were willing to pay for alternative fuels. As long as conventional energy resources such fossil fuels, firewood and charcoal are cheaper than biofuels, the latter are hard to sell. This argument is particularly applicable in a poverty context, where survival usually comes before the environment.

To summarize value chain governance, it can be stated that some stakeholders have taken steps towards acquiring governance in the chain, but in practice have little power over other actors yet. In its current state, the value chain is characterized by a mix of producer driven and buyer driven activities, with various factors determining price and quality, for example.

6.3 Enabling environment

The opportunities that individual stakeholders and value chain activities get to develop are influenced by the enabling environment. At the time of the fieldwork, no national blending policies existed in Tanzania to mix SVO with fossil fuels. Furthermore, international biofuel policies, such as EU blending targets, were under debate due to the undecided environmental impact of biofuel production. Additionally, the Tanzanian government had not yet made a decision on allowing or prohibiting large exports of biofuels. Furthermore, it was not decided yet if biofuels would be taxed, and if so, to what extent. Diligent, for example, was still awaiting these decisions. Many interviewed stakeholders depicted the absence of government policies as creating uncertainties and impeding biofuel related developments. As a result, for example, consumers were reluctant to adapt their engines for SJO use, large-scale investments in biofuels remained absent and neither SJO nor biodiesel was available at gas stations. Additionally, stakeholders involved called for subsidies on Jatropha related activities, stating that without subsidies SJO or biodiesel could not compete with fossil fuels.

Another important aspect of the enabling environment are the transaction costs. Because Diligent needed SJO and not enough seeds were being produced, the company started to convince farmers to grow Jatropha. In doing so, Diligent encountered high transaction costs. Farmers had to be revisited once every few months, preferably even every few weeks, in order to remind them of their agreements and the alleged advantages of Jatropha cultivation. Combined with the aforementioned uncertainty about the legal status of out-grower contracts and the observed side selling, these factors were all contributing to high transaction costs.

Finally, infrastructure was observed to limit value chain development. As an example, in Engaruka the price of one liter of diesel reached TZS 2,000, opposed to TZS 1,600 in Arusha, due to high transportation costs. For other products and services these transportation costs are high as well, thereby limiting development. Nevertheless, the high diesel price could also create opportunities in remote rural locations, because in those cases SJO and Jatropha biofuel can become more competitive. During the fieldwork this effect was not yet observed however.

6.4 Potential for pro-poor biofuel development

Now that the value chain has been mapped, stakeholders have been discussed and Jatropha related activities have been assessed, it is time to bring all findings together and assess the potential for pro-poor biofuel development. As became clear in section 2.1.2, pro-poor development focuses on income growth and equitable distribution thereof. Hence, two determinants of pro-poor development within the Jatropha value chain can be identified. The first determinant is the increase in absolute volumes and added values of products and services that the poor sell, thereby raising absolute income. The second determinant is the increase in relative income of the poor, compared to other actors in the chain, i.e. an increasing share of the poor in the chain or increasing margins per product or service.

To start with the first determinant, it can be stated that some poor have indeed experienced an increase in income. Gatherers, who generally were the poorest of all stakeholders and consisted mainly of women and children from families without access to farmland, managed to generate income by collecting seeds from existing hedges. Although absolute volumes were low, the activity required only labor investment and therefore had a low barrier to entry. Additionally, nursing activities provided income for the poor. Profits and gross margins were favorable and investment costs were relatively low. However, demand for seedlings was limited because the amount of farmers that were planting Jatropha each year were low and many of those farmers were planting seeds or cuttings instead of seedlings. The effects of small-scale farming activities on pro-poor development were unknown. Although the poor were generally involved, productivity was low, market developments were uncertain and the feasibility of Jatropha in comparison to other crops was unknown. Finally, oil extraction seems to be the most pro-poor activity when it comes to increased added values and income. As discussed in section 6.1.6, manual oil extraction activities were feasible, labor intensive and generating a substantial income for the poor.

Not contributing to pro-poor development were activities such as collection, large-scale farming, soap making and biodiesel production. Collection was highly profitable, but was not benefiting the poor, because only a few people with access to substantial amounts of capital were able to become collector. Capital was required to bridge the time between buying large volumes of seeds and subsequently transporting and selling them. Large-scale farming was no option for pro-poor development because it was unfeasible and required large amounts of capital and land. Soap production was not contributing to pro-poor development because there were little or no markets for the products since they were too expensive. Finally, biofuel production did not play a part in pro-poor development, not only because the activities were not taking place, but also because they would be highly capital and technology intensive.

With regard to the second determinant of pro-poor development, namely increasing the share of the poor, there is some potential. This share is increased when mainly small holders are involved, such as small-scale farmers, and large companies are only undertaking the highly capital and technology intensive activities such as biodiesel production. However, in order for this to work, Jatropha farming must first become more productive by achieving higher yields per acre. Furthermore, it must be assured that large commercial companies don't absorb all activities with high added values, while the poor remain engaged in less value added activities. In order to do so, farmer cooperatives or associations could be formed in order to stand stronger in contract negotiations, to name an example.

Illustration 6.19: The MFP in Leguruki provides off-grid rural electrification.

Regarding the potential of Jatropha as an alternative energy source, it can be stated that much still remains uncertain. Yields appeared to be low compared to other biofuel crops such as sugar palm. Under the observed conditions, the lower seed prices that were required to render biodiesel production feasible were below the production costs. Furthermore, the price of SJO was higher than that of all conventional energy sources, including diesel. Hence, Jatropha was not commercially viable as a biofuel crop. Not surprisingly therefore, SJO and Jatropha biodiesel were hardly used as an alternative source of energy. Apart from occasional experiments, no considerable use in vehicles was observed. Furthermore, SJO was not used in oil lamps and cook stoves because they were not working properly.

Despite these unsatisfactory results, Jatropha can still be made to good use in other applications. Planting as hedges, for example, can protect land against cattle and combat erosion. Furthermore, in remote rural areas, MFPs could be run on SJO in order to provide off-grid rural electrification and related services (see annex 5), which can be considered as contributing to development.

7 Conclusions and recommendations

The objective of this thesis was to assess the Jatropha value chain and its potential for pro-poor biofuel development in Northern Tanzania. In order to do so, a research question and several research sub questions were formulated. In this chapter, each research sub question is answered, based on the results and analysis as presented in the previous chapters. In addition, several recommendations are provided. The conclusions and recommendations, structured according to the research sub questions, are as follows.

Which links and linkages constitute the Jatropha value chain?

The links and linkages that constitute the Jatropha value chain were presented in chapter 4. It is concluded that the chain lacks a global scope and exists mainly on a national and regional level. Furthermore, links consist mainly of production activities and less of support services such as packaging and distribution. This can be explained by the early stage of the value chain, which means that most stakeholders still undertake these activities themselves.

What are the characteristics of current markets for Jatropha value chain products?

The markets for the four different value chain products were identified and analyzed in chapter 4. Firstly, the market for Jatropha seeds is unstable. Demand is higher than supply and prices are fluctuating substantially between locations due to lack of market information sharing. The second market is that of straight Jatropha oil (SJO), which is relatively stable in terms of demand and prices. However, uncertainties regarding future blending policies and taxes cause doubt amongst stakeholders and impose risks. Thirdly, the national and regional market for Jatropha soap is limited. The medicinal characteristics are largely unknown amongst consumers, the price is more than six times higher than regular soap and quality control is lacking. Nevertheless, there is a potential to engage in the international medicinal soap market. Finally, there is no market for Jatropha biodiesel. Because of the current high seed price, biodiesel is more expensive than traditional energy sources such as diesel and kerosene. Hence, apart from test samples, no biodiesel is currently being produced in the research area.

Which individual actors undertake the activities at each link, what are their characteristics and which linkages can be identified?

As part of the stakeholder analysis, as presented in chapter 5, an actor constellation was drafted, including all relevant stakeholders and their linkages. From the analysis it is concluded that several potential linkages between stakeholders are absent. For example, lack of information sharing between actors is observed due to missing horizontal as well as vertical linkages. Farmers and collectors, for example, are unaware of market developments and prices in other regions. Horizontal linkages in the form of information sharing could benefit farmers and collectors in responding to the market. Vertical information sharing between suppliers and buyers could be used to improve products and services in the chain.

Recommendations

- Provide market accessibility training to farmers and other stakeholders involved
- Foster collaborative research between research institutes and stakeholders
- Create a forum to share knowledge

To what extent are activities at each link within the value chain competitive?

Illustration 7.1: Former soap making groups now undertake other activities.

The competitiveness of all value chain activities was determined in chapter 6. Gross margin calculations show that, in relative terms, nursing activities are most competitive, followed by oil extraction and seed collection. The competitiveness of gathering, small-scale farming and soap production is limited. These activities are only feasible under certain conditions, such as limited availability of alternative labor opportunities, crop yields and seed prices. Both large-scale farming and biodiesel production are concluded to be uncompetitive. Large-scale farming is unfeasible due to low yields and continuous flowering which requires labor intensive manual harvesting. Biodiesel production is not viable because the production costs are high and there is currently little or no market.

To what extent are governance in the chain and the environment in the research area influencing Jatropha value chain development?

In section 6.2 it became clear that some stakeholders have taken steps towards acquiring governance in the chain, but in practice have little power over other actors. For example, contracts are not enforced, side selling is observed and few price or quality standards are set. Regarding the enabling environment, international biofuel policies are under debate, no national blending policies exist in Tanzania and it is thus far unclear if biofuels will be taxed in the near future. Furthermore, the role of district and village governments is unclear. Interviewed stakeholders blame the absence of government policies for creating uncertainties and impeding biofuel related developments. Furthermore, high transaction and transportation costs negatively impact value chain development.

Recommendations

- Start roundtable discussions to identify joint stakeholder ideas in which to address the National Biofuels Task Force (NBTF)
- Define the role of district and village government with all stakeholders involved

What is the existing knowledge and experience regarding Jatropha?

Illustration 7.2: Jatropha is not a magical plant and requires farm management.

It is concluded that there is a lack of knowledge on the characteristics of Jatropha, farm management practices and the effects of different inputs on productivity and oil contents of seeds. Furthermore, most farmers are unaware of their production costs and have limited information on the market and its buyers. Moreover, the feasibility of Jatropha compared to other biofuel crops is currently unknown. Even at large-scale farms, this lack of knowledge is apparent. Actors that are promoting Jatropha are providing their target groups with limited information regarding production costs, market developments and risks involved. In general there is a lack of information sharing between actors, which makes it harder to bridge the observed gaps regarding knowledge and experience.

Recommendations

- Actors promoting Jatropha need to help farmers calculate the costs and benefits compared to other crops and make their target groups aware of the risks involved

To what extent can the Jatropha value chain contribute to pro-poor biofuel development?

Despite uncertainties and risks involved, several Jatropha activities, such as nursing, gathering and manual oil extraction, provide alternative sources of income to the poor. At the household level, SJO is not used in oil lamps or cook stoves because these are not working properly. SJO and biodiesel are not competitive with conventional household energy sources such as firewood, charcoal and kerosene, but Jatropha can be used in other applications. Planting as hedges, for example, can protect land against cattle and erosion. Furthermore, in remote rural areas, Multifunctional Platforms (MFPs) could run on SJO in order to provide off-grid rural electrification and related services (see annex 5), which could contribute to development.

Illustration 7.3: Recently planted Jatropha hedge in Leguruki.

Recommendations

- Enhance functionality and efficiency of Jatropha oil lamps and cook stoves
- Improve management and clarify ownership of Multifunctional Platforms
- Run Multifunctional Platforms on Jatropha when feasible compared to diesel

All in all, it can be concluded that there is little knowledge on important issues such as production costs and feasibility compared to other crops. In general, Jatropha requires common inputs such as nutrients, water and farm management, thereby competing with food and other crops. Hence, it is not the promising biofuel crop it is said to be. Under certain conditions, the Jatropha value chain could contribute to pro-poor biofuel development in Northern Tanzania. But for now it is still in an incipient stage.

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Annex 1: List of interviews

Organization	Name	Function	Date
Arusha Agroflora Farm	Mr. Ismael Manang	Farm Manager	07-05-2008
CAMARTEC	Mr. Kessy	Staff Member	28-02-2008
Diligent	Mr. James Michael	Chemical and Process Engineer	21-02-2008
Diligent	Ms. Enil Kiwia	Public Relations Manager	26-03-2008
Diligent	Ms. Janske van Eijck	General Manager	26-03-2008
DOSI	Mr. Herman van Slooten	General Manager	19-02-2008
ELCT	Mr. Lehada Shila	Coordinator Renewable Energy and Environment Conservation Programme	24-04-2008
Embassy of The Netherlands	Mr. Steef van den Berg	First Secretary Economy and Trade	08-04-2008
Engaruka	Mr. Israel Ole Masai	Farmer & Collector	31-03-2008
Engaruka	Mr. Solomon Simon	Collector	31-03-2008
Engaruka MFP	Mr. Hasan	Supervisor	31-03-2008
Engaruka MFP	Mr. Mathew Laiser	Former MFP Entrepreneur	31-03-2008
Faida MaLi	Mr. Leonard Mung'ong'o	Chairperson	22-04-2008
Faida MaLi	Ms. Maria Ijumba	General Manager	19-02-2008
GGWG	Ms. Glory Mamkwe	Secretary	10-03-2008
GGWG	Ms. Salama Leema	Chairperson	10-03-2008
Hortanzia	Mr. Joseph Giovianazzo	General Manager	14-05-2008
Imara Women Group	Ms. Elia	Member	16-04-2008
InfEnergy	Mr. Graham Anderson	Director	09-05-2008
JPTL	Mr. Albert Mshanga	Operation Manager	28-03-2008
JPTL	Ms. Edith Mtenga	Monitoring & Evaluation Staff Member	21-02-2008
JPTL	Ms. Magdalena	Field Officer	16-04-2008
KAKUTE	Mr. Livinus Manyanga	Managing Director	28-02-2008
KAMA	Mr. Henri van der Land	Share Holder	22-04-2008
KBC	Mr. Clive Richardson	Chief Executive Officer	14-05-2008
Kikuletwa	Mr. Peter Burland	Director	10-03-2008
Kikuletwa	Mr. Ramadhani Kidunda	Farm Manager	07-05-2008
Mianzini Women Group	Mr. Zakkarias	Husband of chairperson	16-04-2008
MEM	Mr. Jacob Mayalla	Staff Member	10-04-2008
MEM	Mr. Kiwele	Senior Forest Officer	10-04-2008
MMA	Mr. Henri van der Land	Director	22-04-2008
Monduli District Council	Mr. Jacob Akyoo	Member	07-02-2008
NBTF	Mr. Kiwele	Secretary	10-04-2008
Oikos East Africa	Mr. Bonati Giuseppe	Director (successor of Ms. Annie Francis)	19-05-2008
Oikos East Africa	Ms. Annie Francis	Director	27-02-2008
REA	Mr. George Nchwali	Director of Finance and Administration	11-04-2008
Sida	Ms. Anne-Lie Engvall	First Secretary Programme Officer Infrastructure	11-04-2008

Organization	Name	Function	Date
TaTEDO	Mr. Godfrey Sanga	Manager Sustainable Energy	10-04-2008
The World Bank	Mr. Ralph Karhammar	Senior Energy Specialist	11-04-2008
The World Bank / ESDT	Mr. Jeff Felten	Senior Consultant	20-03-2008
Trias	Mr. Tony Rottjers	Regional Coordinator	26-02-2008
Umangu Women Group	Ms. Agnesi	Member	16-04-2008
Ungano	Mr. Job de Graaf	Staff Member	19-02-2008

Annex 2: List of stakeholder workshop participants

Organization	Name	Function
Arusha Agroflora Farm	Mr. Ismael Manang	Farm Manager
CAMARTEC	Mr. Kessy	Staff Member
Diligent	Ms. Enil Kiwia	Public Relations Manager
DOSI	Mr. Herman van Slooten	General Manager
GGWG	Ms. Glory Mamkwe	Secretary
GGWG	Ms. Salama Leema	Chairperson
ICRAF	Mr. Jan Wahl	Intern
Ilaramatak	Mr. Godfrey Lelya	Programme Officer
JPTL	Mr. Albert Mshanga	Operation Manager
KAKUTE	Mr. Livinus Manyanga	Managing Director
Kikuletwa Farm	Mr. Ramadhani Kidunda	Farm Manager
SNV	Mr. John Mlay	Business Development Services Advisor
SNV	Mr. Peter Bos	Advisor
SNV / Utrecht University	Mr. Lode Messemaker	Intern / MSc Student
SNV / Utrecht University	Ms. Lauren Parker	Intern / MSc Student
Ungano	Mr. Job de Graaf	Staff Member

Annex 3: Stakeholder workshop agenda

09:00	Opening
	Mr. Peter Bos, Advisor, SNV
09:15	Round of Introductions
09:30	Stakeholder Presentations
	Ms. Enil Kiwia, Public Relations Manager, Diligent
	Mr. Livinus Manyanga, Managing Director, KAKUTE
	Mr. Ismael Manang, Farm Manager, Arusha Agroflora Farm
	Mr. Ramadhani Kidunda, Farm Manager, Kikuletwa Farm
10:30	Coffee Break
10:45	Presentation and Validation of SNV Feasibility Study
	Mr. Lode Messemaker, Intern, SNV
	Ms. Lauren Parker, Intern, SNV
11:15	Plenary Discussion
13:00	Lunch
14:00	Group Work Sessions
15:00	Group Work Presentations & Discussion
15:30	Way Forward
16:00	Closing Remarks
	Mr. Joel Kalagho, Portfolio Coordinator, SNV

Annex 4: Gross margin assumptions

In the gross margin calculations in chapter 6 several assumptions are made. These assumptions are based on data collected in the research area during the fieldwork. The following assumptions are made, unless indicated otherwise.

- The survival rate of planted seeds and cuttings is 70%.
- The survival rate of planted seedlings is 100%.
- When planting cuttings or seedlings, the germination rate is 1 year.
- When planting by means of direct seeding, the germination rate is 3 years.
- When planting mono cropped, the optimal distance between plants is 3 by 3 meters.
- When planting intercropped, the optimal distance between plants is 3 by 5 meters.
- A Jatropha plant, when 5 years old, without the use of fertilizers and pesticides, with flood irrigation, produces an average annual yield of 1 kg of seeds.
- The average oil content of seeds is 30%. The extractable oil content of seeds is 25 %.
- If stored for one year, the oil content of seeds is not significantly reduced.
- Using the manual ram press, developed by CAMARTEC, 5 kg of seeds produces 1 liter of straight Jatropha oil. Extraction capacity is 5 kg of seeds per hour, equivalent to 1 liter unfiltered oil per hour.
- Using the mechanical Sayari oil expeller, developed by ELCT and FAKT, 4 kg of seeds produces 1 liter of straight Jatropha oil. Extraction capacity is 60 kg of seeds per hour, equivalent to 15 liter unfiltered oil per hour.
- One man day is defined as 8 hours of labor with an average wage of TZS 2,500 per day during the rainy season.

Annex 5: Multifunctional Platform case study

Special cases within the value chain are the two pilot Multifunctional Platforms (MFPs) visited in Engaruka and Leguruki. An MFP typically consists of a diesel engine that is modified to run on straight vegetable oil, an alternator which generates electricity, a mini grid connecting multiple households to the electricity source, an oil expeller and one or more milling machines. Hence an MFP can provide electricity and other services at a remote location, independent of the national power grid (i.e. off-grid). Because of the possible use of straight Jatropha oil to fuel the engine, the MFP is included in the value chain.

Because of the scale and technology involved, MFPs require sufficient technical knowledge and management skills. The MFP in Engaruka is currently not running because of management and ownership problems. TaTEDO is in the process of solving these problems and will scale up the MFP project to 100 villages, installing an additional 50 MFPs with funding from the EU and HIVOS. The MFP in Leguruki is running, but because there is no mechanical press available it runs on diesel and not on straight Jatropha oil. As long as the maximum number of connections to the mini grid is not reached, an MFP is scalable because only a connection from the mini grid to the house is required, which costs around TZS 40,000. The scalability of other activities, like milling, is also high because the total capacity of the MFP is high. This means a typical MFP can serve an entire village with these services. Currently services like milling are offered at daytime, while the electricity is provided for six hours during every evening until midnight. It is important to note that services provided by the MFP are possibly competing with existing village businesses, such as dehusking and milling.

Subscribers in Engaruka needed to pay a fixed fee of TZS 3,000 per month for electricity, allowing them to connect 2 light bulbs. Calculations from the Engaruka case show that the daily operating cost in terms of diesel consumption, i.e. not taking into account labor costs for the operator, already exceeds the highest possible benefit when the maximum number of 100 households is connected (see table A5.1). In practice, only 24 households are connected in Engaruka. Calculations show that, when taking into account all running costs, including maintenance, the break even point with 100 subscribers lies at a monthly fee of TZS 5,600. When including the investment costs for the equipment, the subscriber fee would roughly double to TZS 9,950, rendering the service inaccessible to the poorest households. If possible it is therefore recommended to finance the installation costs from another source, e.g. from the Rural Energy Fund (REF). Especially in those cases where the installation costs are not covered by the users, it is essential to properly arrange ownership of the MFP.

The same calculation can also be made based on straight Jatropha oil instead of diesel. Seeds are bought as input, oil is extracted using a mechanical expeller and after filtering the oil can then be directly used in the MFP. As shown by the calculation, even with the current high seed price of TZS 300 per kg it is still feasible to run the MFP on straight Jatropha oil instead of diesel. In this case the subscriber fee would go down to TZS 5,200 per month, excluding investment costs. As already pointed out, the Engaruka MFP is not running at all because of management and ownership problems and the Leguruki MFP is not running on Jatropha oil because there is no mechanical oil expeller installed yet.

Table A5.1: Multifunctional Platform costs

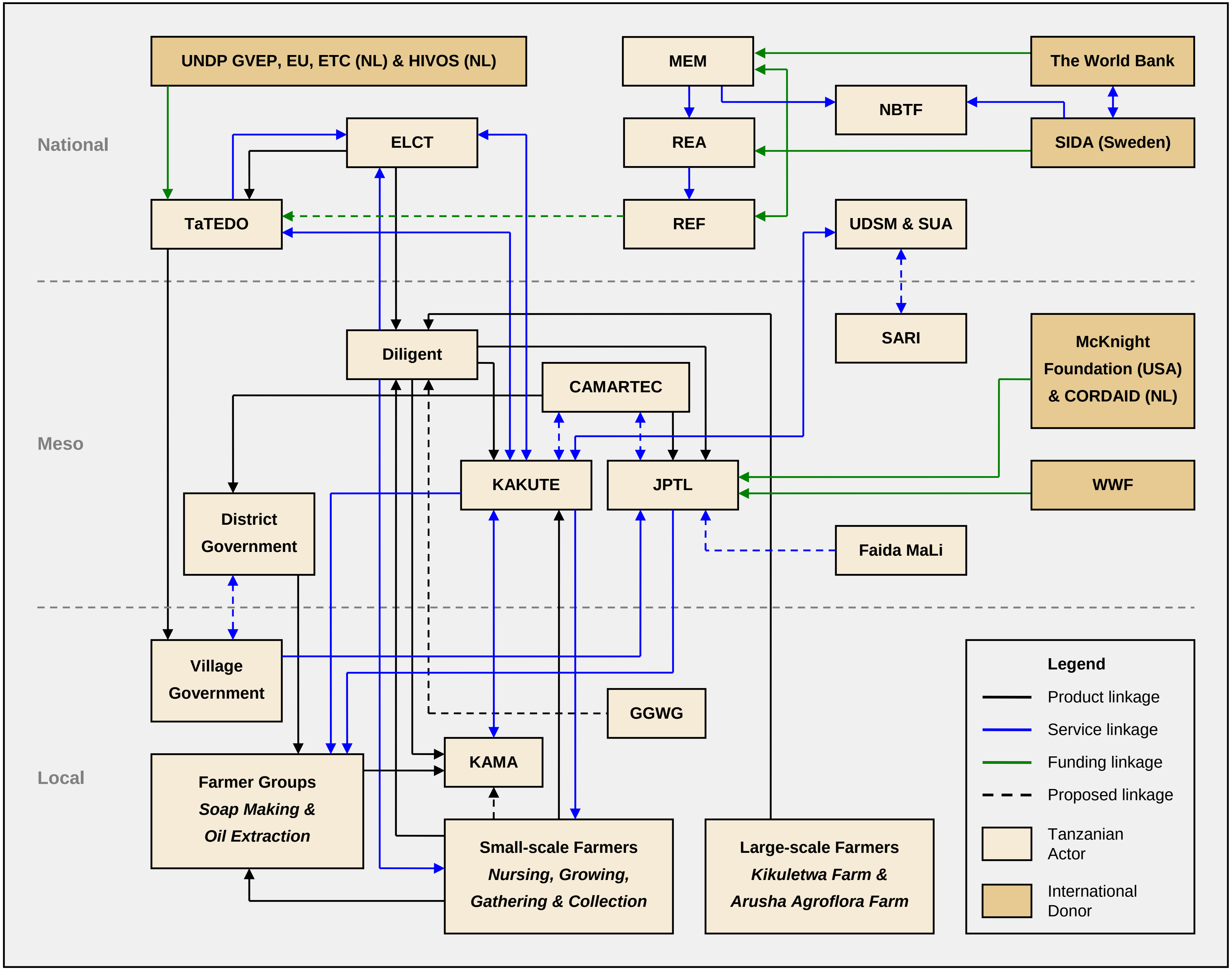
	1 day	1 month
Investment costs (installation)		
MFP	4,438	135,000
Minigrid	4,384	133,333
Prepaid meter for 100 HHs	3,288	100,000
Connection for 100 HHs	2,192	66,667
Total installation cost	14,301	435,000
Variable costs		
Maintenance (10% of installation costs)	1,430	43,500
Electricity 6 hours per day running on diesel		
Diesel (6 liter per day)	12,000	366,000
Operator + management (2 man days)	5,000	150,000
Total electricity running cost on diesel	17,000	516,000
Total costs	32,732	994,500
Per HH	327	9,945
Total costs excluding installation	18,430	559,500
Per HH	184	5,595
Electricity 6 hours per day running on SVO		
Jatropha oil (15% more than diesel) in liters	6,9	209,9
Seeds required in kg	27,6	839,5
Hours to run expeller to press 7 liters of oil	0,5	14,0
Jatropha oil in liters	0,5	16,1
Seeds required in kg	2,1	64,4
Total seeds required in kg	29,7	903,9
Cost per kg	300	300
Total seed cost	8,915	271,159
Possible 20% VAT on Jatropha oil	10,698	325,390
Operator + management (2 man days)	5,000	152,083
Total electricity running cost on SVO	15,698	477,474
Total cost SVO	31,429	955,974
Per HH	314	9,560
Total cost SVO excluding installation	17,128	520,974
Per HH	171	5,210

All prices are in TZS.
Source: fieldwork, 2008.

Calculations show that at the current diesel price of TZS 2,000 per liter in Engaruka, running on straight Jatropha oil is feasible up to a seed price of TZS 335 per kg. Looking at it from the other perspective, it is calculated that at the current seed price of TZS 300 per kg the diesel price would have to drop to TZS 1,789 per liter to make it feasible compared to running on

SJO. At a seed price of TZS 200 per kg, diesel would have to drop to TZS 1200 per liter to make it feasible again.

Because people pay a fixed monthly fee independent of their actual electricity consumption, the use of power saving equipment like efficient light bulbs is not encouraged. By installing meters, people can be charged what they actually use and thereby made aware of their power consumption. When using efficient light bulbs, total power consumption diminishes and more households can be connected to the same power supply, thereby lowering the price per household.


National
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UNDP GVEP, EU, ETC (NL) & HIVOS (NL)
MEM
The World Bank
NBTF
SIDA (Sweden)
ELCT
REA
TaTEDO
REF
UDSM & SUA
SARI
Diligent
McKnight Foundation (USA) & CORDAID (NL)
CAMARTEC
KAKUTE
JPTL
WWF
District Government
Faida MaLi
Village Government
GGWG
KAMA
Farmer Groups
Soap Making & Oil Extraction
Small-scale Farmers
Nursing, Growing, Gathering & Collection
Large-scale Farmers
Kikuletwa Farm & Arusha Agroflora Farm
Legend
Product linkage
Service linkage
Funding linkage
Proposed linkage
Tanzanian Actor
International Donor