

Emergence of a biofuel economy in Tanzania : local developments and global connections from an institutional perspective

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**Emergence of a biofuel economy in Tanzania:
Local developments and global connections from an
institutional perspective**

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Emergence of a biofuel economy in Tanzania: Local developments and global connections from an institutional perspective

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Abstract

Jatropha is emerging as an important biofuel crop throughout developing countries in the tropics. Initially lauded as an environmentally-benign ‘wonder crop’ suitable for arid wasteland cultivation that would avoid competition with scarce livelihood resources, it has recently begun to attract mounting criticisms related to competition with food production, biodiversity impacts, insecurity of land access by local populations, exploitative employment conditions, and disappointing effects on greenhouse gas emission reduction. In this paper we analyse the nature of the local developments that have given rise to these criticisms, and the underlying innovation processes and global forces that are driving the sector in the direction of these contested outcomes. We focus on Tanzania, an important forerunner in *Jatropha* biofuels production whose experiences have informed the international biofuel debate more broadly. Two surveys among biofuel actors in Tanzania held in 2005 and 2008/9 are the primary data sources. An extended innovation systems perspective is adopted, which is instrumental in studying patterns of global and local institutional embeddedness from a long-term perspective. These patterns are found to be key drivers behind the emergence and evolution of three distinct organizational models in the sector: local energy production and use for rural communities; decentralised subcontracting for centralised oil processors; and large centralised plantations. Socio-economic interactions in these models seem to be regulated by institutions put in place by colonial and early post-colonial governance of agri-commodity production and exchange. Each is also closely associated with different social (network) relations, organizational choices, economic viability, and environmental sustainability effects.

(249 words)

Keywords: Sustainable development, Globalization, Institutions, Energy, Biofuels, *Jatropha*

Introduction

Jatropha is emerging as an important biofuel crop throughout developing countries in the tropics. Initially seen as a wonder crop, but like other biofuels (e.g. palm oil), the emergence of this innovation has not been without contention. An increasing number of criticisms have been voiced, for example in relation to food versus fuel, biodiversity impacts, insecurity of land access of local populations, and exploitative conditions of employment (Whiteman, 2008; Achten et al., 2007; Luoma, 2009). The objective of this paper is to analyse the nature of the local impacts that gave rise to these criticisms, and the underlying innovation processes and forces that are driving the development of the sector in the direction of these outcomes. We focus on the case of Tanzania – a country which has been an important forerunner in Jatropha biofuels production, and whose experiences with Jatropha have therefore informed the international biofuel debate to a considerable extent.

We use a modified sectoral innovation systems framework to analyse these issues. The innovation systems literature conceives of sectors as composed of actors and their relationships, whose activities are governed by institutions of various kinds. The main idea is that actor diversity, tight-knit relationships and innovation-conducive institutions such as policy incentives and trust will give rise to economic growth, technological dynamism and competitiveness (Freeman, 1987; Metcalfe, 1995; Malerba, 2002). However, conventional sectoral innovation systems frameworks tend to focus predominantly on national processes and actors, whereas the phenomenon to be studied in this paper has to encompass dynamics of global connections along with local processes. As in many other developing countries, Tanzania's biofuels sector is characterised by an extensive involvement of non-local players who are engaged in policy-making, trade, investment and development aid. We therefore develop an extended concept of sectoral innovation systems, which is capable of explicitly addressing issues deriving from such global embeddedness.

The paper draws on two surveys among biofuel actors in Tanzania held in 2005 and 2008/9. The paper is structured as follows. Section 2 lays out the theoretical framework, which enriches innovation systems theory with a more explicit institutionalist perspective, and brings in the notion of organisational models as an organising concept. Section 3 outlines the data collection methodology. Sections 4 through 6 contain the analysis, organised into three distinct periods. Section 7 contains conclusions.

1. Innovation systems: towards a dynamic and global-local perspective

The evolutionary innovation systems approach is a commonly used conceptual framework for analysing the emergence and development of new sectors (such as biofuels). However, this framework focuses predominantly on national processes and actors, whereas we must consider the dynamics of global connections along with local activities and processes. Although the importance of innovation system openness has been recognised (e.g. Lundvall, 1992; Foray, 1997; Bell and Albu, 1999), only a few studies actually address relevant aspects such as trade flows (e.g. Balzat and Pyka, 2005; Carlsson, 2006). Overall, we still lack an understanding of the impact of global influences (e.g. international institutional frameworks, external sources of knowledge, etc) that are exogenous to the political and geographical boundaries by which the system itself is conventionally defined and how the system interacts with the outside world.

In this era of globalization, like many developing countries, Tanzania is characterised by extensive involvement of international players in trade, investment and aid activities. To a greater or lesser extent, the patterns of their involvement, the local impacts which their activities give rise to, and the responses to these impacts reflect historical patterns of

international relations and local/national institutions, which took shape during the colonial and early post-colonial period. These long-standing patterns of local, national and international governance are relevant to the development of *Jatropha* biofuels even though it is a newly emerging (post 2000) sector of economic activity. In other words, we argue that one cannot hope to understand a sector's current development dynamics without reverting to a substantially extended innovation systems concept that is capable of explicitly addressing patterns of global and local institutional embeddedness from a long-term perspective. Viewed through this lens, the development of a new sector is likely to be a complex mix of contradictions, contestations and non-linear learning trajectories.

One way of getting to grips with this complexity is to focus the innovation systems approach around the changing composition and activities of the emerging network of actors in a sector, including their local and non-local ties. In particular, we trace how the *Jatropha* biofuel network in Tanzania evolved between 2000 and 2009, focusing especially on the evolution of the prominent *organisational models* adopted by its key players. Our concept of 'organizational model' refers to the way in which production, innovation and use of *Jatropha* biofuels is conducted in the value chain, spanning from cultivation to end-use. The concept is related to the better known term of 'business model' which has become common currency in recent strategic management literature. A business model describes "... the rationale of how an organization creates, delivers, and captures economic, social, or other forms of value" (Osterwalder and Pigneur, 2009 as quoted on: http://en.wikipedia.org/wiki/Business_model). This may be interpreted as a firm's strategic orientation in relation to the different key dimensions of sustainability, the commercial/financial concept, the product and/or service offerings, the organisation of cultivation, production, distribution and (envisaged) end use, the chosen technologies, social relations of production, marketing concept and supplier relationships. In this paper, however, we prefer to speak of 'organizational models' to take more explicit cognizance of technological innovations than commonly captured in management-focused 'business model' concepts and to provide a broader meso-level perspective. Our focus is less exclusively centred on the motivations and actions of the individual dominant firm(s) in value chains and how these give rise to a certain way of organising business activities. Rather, we aim to explain how value chains evolve as a result of the interactions, experiences and points of view of different actors (such as firms, farmers, NGOs, policy makers, aid organisations, the press) at different points in time. Thus, the organizational model concept includes all the aspects of business model(s), but goes further by paying explicit attention to any contradictory views on the distribution of benefits and threats across a value chain arising out of new economic activities such as the production (and use) of *Jatropha* biofuels.

The emergence and evolution of distinct organizational models in the *Jatropha* biofuels sector constitute a vital aspect of sectoral development through which institutionalised international and associated local relations find expression. Distinctly different models have come up in succession: the local rural community development model; the decentralised outgrower/subcontractor model; and the (large) plantation-based model. In principle, these forms of business organisation constitute more or less generic models that are recognisable across countries and sectors, as is the trend over time from small community development projects towards large-scale commercial investments (Thurmond, 2007). These models often bear some resemblance to colonial (and early post-colonial) models of organizing production and processing of agri-commodities. Each of these is also closely associated with different social (network) relations, organizational choices, economic viability results, and environmental sustainability effects. Furthermore, a variety of formal and informal institutions mediate between different actors' choices in the organizational models and the outcomes that these models give rise to. However, as it is still too early to analyse the

definitive outcomes of the organizational models along socio-economic and environmental sustainability dimensions, we mainly focus on how choices and actions of key actors are *governed* (or shaped) by relevant institutional contexts and policy frameworks. Following Casson et al. (2009), we take an institutional context to include local ‘customs’, laws, and social norms, as well as broader sectoral, national and global institutions, for example the political climate and practices of government, international trade regulations, and fashionable international aid approaches and practices. ‘Governance’ then in this research is performed by historically-constituted formal and informal institutions and policies that guide investment, production and innovation activities in the sector.

British colonial governance (and domination) in East Africa was characterized by the “looseness of its decentralized control.” (Elkins, 2005: 7). Mamdani (1996) uses the term “decentralized despotism” to refer to the exploitation of authoritarian elements in African indigenous culture by the British to secure their rule (also see Cooper, 1994: 1531). “The colonial state was a two-tiered structure: peasants were governed by a constellation of ethnically defined Native Authorities in the local state and these authorities were in turn supervised by white officials deployed from a racial pinnacle at the center.” (Mamdani, 1996: 287). In this way, the British colonial government also acted as a custodian of an all-encompassing tribal customary law, often expanding its meaning and scope, which was used to exercise force on uncooperative peasantry, including the governance of local land and labour transactions.¹ These transactions then took place in a gray area between coercive force and the market. In other words, “market relations were enmeshed with extra-economic coercion.” (Mamdani, 1996: 287). In the postcolonial era, this enmeshing of force and market, the customary and the economic, continued to flourish.

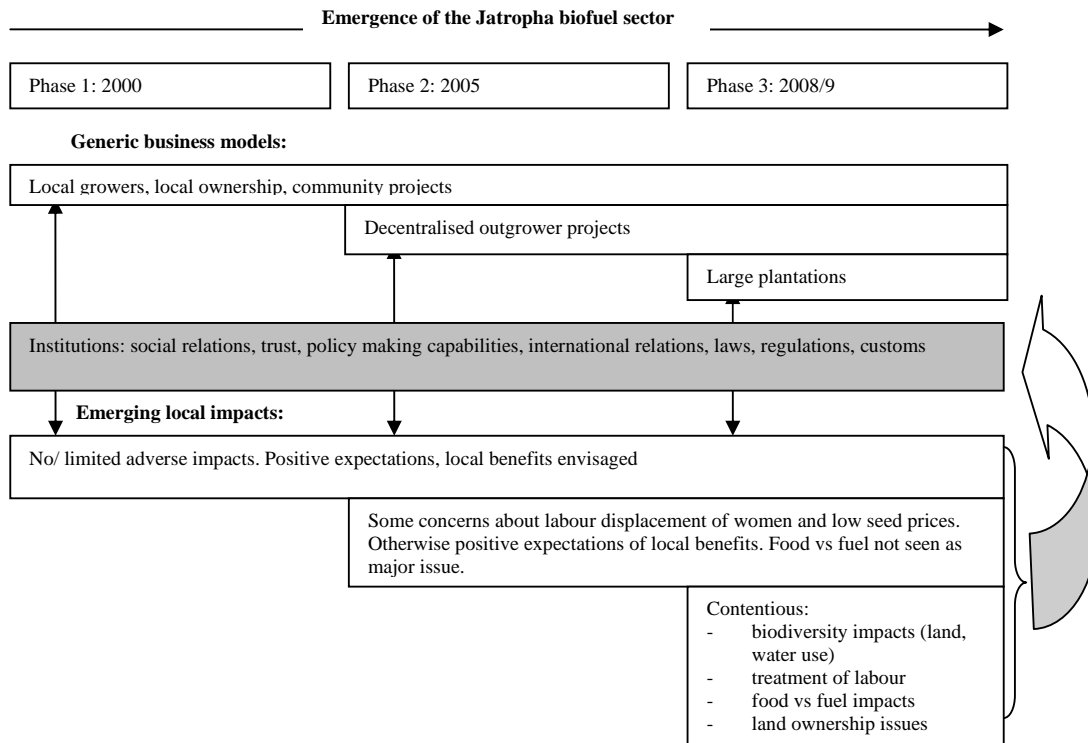
The bifurcated nature, or the two-tiered structure noted above, of colonial governance was not successfully dismantled or reorganized in postcolonial times. It resulted in an ever-widening gulf between the worlds of peasants in the rural areas and the national ruling elites. In fact, the ruling elites revived colonial forms of governance by promoting the “twin processes of bureaucratization and technicalization” (Corbridge, 2007: 194, citing Chatterjee, 2004). A natural outcome of this bureaucratic revival was top-down administration of development programs that were driven by strict national planning, such as the Nyerere government’s compulsory resettlement of nomads and peasants into Ujamaa villages to promote ‘modern scientific agriculture’ (Scott, 1998). In addition, the ruling elites who earlier had led the struggle for independence carried their own past experience and dispositions, of mistrusting popular forms of politics and by extension other bottom-up initiatives, from the colonial into the postcolonial era. The scope of this mistrust was extended beyond the national ruling elites to encompass local political leaders in postcolonial governance, who acted without conducting democratic consultation with rural civil society, and thus installed a new extended form of ‘decentralized despotism’. In Tanzania, this mistrust was enshrined in the Arusha declaration to build an African socialism under which “all the major means of production and exchange in the nation are controlled and owned by peasants *through the machinery of their government and their cooperatives.*” (Nyerere, 1968: 16, our emphasis). In this paper, using the above insights on colonial and postcolonial governance, we attempt to show how recent forms of bureaucratic (and investor-driven) technicalisation, and mistrust of local agency among public and private elites, are becoming manifest in the development of the *Jatropha* biofuel sector in Tanzania and its relations with other parts of the world.

We combine this institutional approach with tools from Social Network Analysis (SNA). The literature on social networks has shown that the way in which a network is structured and the strength of its ties play a crucial role in stimulating innovation and learning (Borgatti and Foster, 2003; Granovetter, 1983). We use aspects of SNA to analyse how and to what extent the different actors in the sector are linked to each other, especially how particular

constellations of actor linkages come together in the form of organisational models. We carry out a dynamic analysis by comparing the sectoral network in terms of emerging organizational models and associated outcomes at three different points in time, namely in 2000, 2005 and 2008/9 (see Figure 1). Throughout this analysis we show how different institutions mediate between the choices made by different actors and the wider network development processes and the emerging outcomes to which they give rise. In the first instance, institutions are treated as exogenous influences on the development of organizational models and the *Jatropha* sector.

We then analyse how these models and their institutional governance are beginning to give rise to initial social, economic and environmental outcomes through actor choices. Achieving sustainability along these three key dimensions is crucial in biofuels. The *Jatropha* sector emerged and has been being widely pushed precisely because of its alleged potential to contribute to climate change mitigation and restoration of degraded tropical ecosystems, while avoiding competition with food crop production and creating reliable and easy opportunities for boosting local livelihoods, alongside promising sound economic viability of investments (e.g., Francis et al., 2005). If, however, the system turns out to fall short of expectations in some of these respects in due course, these problems are likely to give rise to various local and non-local actions that can induce reflexive learning in the sector. Such practices of reflexive learning by relevant actors in the present can even create new institutions and transform old ones while simultaneously being governed by an older set of norms. Mamdani (1996) and Appadurai (1981) have argued that in order to understand processes of governance through long-standing institutions, we must be careful not to reduce multiple, and often contested, pasts to a one-dimensional reality that fully determines present-day developments. Therefore, when emerging lessons about economic, social and environmental sustainability outcomes begin to inform frameworks for policymaking and business choices, we map different dimensions of this fledgling institutional endogenisation process. However, since this process has started only recently, we are unable to give a comprehensive account of this phenomenon at this point in time. In general, institutional endogenisation in systems research is still a relatively underdeveloped area due to the inadequate operationalisation of temporal dynamics of these systems. Even the most dynamic versions of innovation systems research such as Strategic Niche Management (e.g., Raven, 2005; Kemp et al., 1998 and 2002) and Functional Systems Approaches (e.g., Hekkert et al., 2007; Jacobsson and Johnson, 2000) to the emergence of sustainable socio-technological systems have still paid only relatively little attention to how institutions – especially informal ones – co-evolve with technologies and organisational practices.

Figure 1



2. Methodology

In two surveys in early 2005 and late 2008, we tried to identify all significant projects and business activities with Jatropha in Tanzania by talking to local people who were knowledgeable about the budding sector, primarily officials from the Ministries of Agriculture and Minerals and the National Biofuels Taskforce (started in 2006), NGO representatives, academics and private entrepreneurs. For identifying these key informants we relied on the snowball method, starting with a few known experts, and identifying others through these people. A project or business activity in this context should be understood as an activity undertaken by an individual or a group aimed at growing Jatropha, seed pressing, or developing one or more end-use applications for the oil or the seedcake. Most of the initial activities took the form of development projects led by local NGOs and governmental agencies, but there were also a few for-profit ventures run by commercial companies. Some had foreign connections involving financial support or knowledge transfer, while others were purely local affairs. In the first survey, 17 experimental projects were found, and the second survey uncovered close to 40. In the first survey, we were also able to reconstruct the earliest beginnings of the sector, which go back to 2000.

The great majority of the activities were visited and a few were contacted by e-mail. Most early experiments were situated in the Arusha and Kilimanjaro regions in the northeast. Others were situated in Morogoro, Dar es Salaam, Kilwa and in Tunduru in the south. Later activities were also found in western Tanzania. The interviews with the representatives of these Jatropha experiments were held face to face, with the help of a detailed standard checklist of open-ended questions. Each interview covered information about the goal, history and nature of the Jatropha activities undertaken. In order to get a sense of the evolution of the

sector, the respondents were requested to provide considerable details about the development trajectory of their *Jatropha* activities over time. We also probed how these activities are embedded into larger business networks. For the pivotal actors in these business networks, we investigated what these networks looked like in terms of the adopted organisational models, covering aspects such as strategic goal orientation (in relation to the three key sustainability dimensions), organisation of cultivation and processing, technology and associated learning processes, labour relations and linkages with other actors in the sector. We also inquired about people's expectations about future developments, since expectations can be important drivers of people's actions. Considering the complexity of the processes, the experimental nature of the research, and the low level of literacy of some respondents, we confined ourselves to gathering mostly qualitative information through informal discussions, loosely guided by our checklist. We did not ask respondents to rate issues on qualitative scales. We did, however, try to collect quantitative estimates from them about the costs and benefits of each major *Jatropha*-based activity. In addition, government representatives were interviewed. These were free-flowing interviews, predominantly focused on contextual information about Tanzania's energy bottlenecks and strategy, and the government's views on the role of biofuels. Participants located outside Tanzania (such as international donors and car manufacturers) were not interviewed.

4. The situation in 2000: The proto stage

Context

The emergence of the first *Jatropha* activities in Tanzania has to be seen against a wider background. The country has a very high import-dependence on fossil fuels and an underdeveloped energy supply system. The electricity grid reaches just 11 % of the total population (EWURA, 2007), and frequent blackouts and power drops occur. Rural electricity coverage is estimated to be no more than 4%. Traditional sources of biomass fuel – charcoal and firewood – are becoming increasingly scarce and expensive. There is increasing concern over deforestation and biodiversity loss due to land clearing for fuel and agriculture for an expanding poor population (ref). Tanzania's rural sector is dominated by vast numbers of smallholders. These are poor marginal farmers, who have long been suffering from structurally low prices of staples such as maize and cassava, underdeveloped infrastructure and lack of services of various kinds (Wahl et al., 2009).

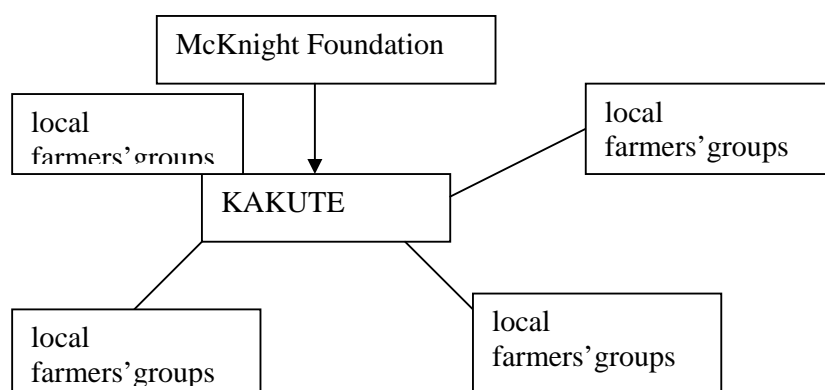
Actors and network

Against this setting, a private non-profit organisation called KAKUTE started local experiments with *Jatropha* in 1992. *Jatropha* had been grown in the country for generations as a fencing material and a grave marker, so people were familiar with the shrub, but the seeds did not have any commercial value for them (Wahl et al., 2009; van Eijck and Romijn, 2008). KAKUTE's first activity was to collect 200 kg of seeds for some local experiments, having discovered the plant in the Sengela region. They started research on cultivation and seed processing and helped small scale farmers to cultivate the plant, and provided assistance with local manual processing of the seeds and use of the oil for lighting and soap making. Simple ram presses were introduced, and oil lamps designed – made from Africafé tins – that could utilize *Jatropha* oil. Knowledge was basically accumulated through practical experimentation, the running of test plots, and from talking with local women's groups who were beginning to engage in *Jatropha* cultivation and processing. KAKUTE was the first to set up a network of local collection centres in rural areas around Arusha, where seeds could be brought by local farmers, and from where they were collected periodically, to be processed in the city in the organisation's own oil pressing and soap-making facilities. Initially, KAKUTE also played a

significant role in the establishment of other players in the sector by freely sharing its knowledge. However, after 2005, when a number of large actors arrived who had set their sights on supplying global markets – as opposed to fostering local markets for rural development –, KAKUTE began to charge for its information.

We take the year 2000 as the starting point for our analysis because that was the year in which KAKUTE obtained finance from a US-based NGO, the McKnight Foundation, to expand *Jatropha* activities. To our knowledge, this year heralded the start of international financial involvement in the budding sector. Since then, KAKUTE has diversified its funding to several different donors based in various western countries. The incipient *Jatropha* network in 2000 is pictured in fig 2.

Figure 2



Institutional setting

One can say much more about what is absent in this network than what is present. The knowledge generation function is incipient, without involvement of specialised knowledge institutions; and there is only one organisation that takes it upon itself to collect and disseminate information within the network. The government is completely absent, either as a regulator, a network actor, or a financier. This is not an entirely coincidental pattern which could be considered normal in any new industry. Rather it should be seen from the perspective of the general long-term underdevelopment and neglect of the agricultural smallholder sector, which has been a major institutional feature of Tanzania's socio-economic situation since colonial times. No policy support for smallholders has existed. There have been no micro-credit programmes, or well-running agricultural extension services. The government does employ agricultural extension officers, but these have been underpaid and have had inadequate transport facilities to be able to reach out effectively to the remote rural areas. In addition, due to disastrous experiences with government-sponsored 'scientific agriculture' in the past, such as that promoted in Ujamaa villages under Nyerere (Scott 1998), local farmers have had low faith in experimenting with new crops introduced through government initiatives. More recent experiences such as with the Moringe tree – promoted by the government some years ago – were also disappointing as farmers were let down for lack of a profitable market (Roks and van Vlimmeren, 2009). The wavering political commitment has engendered a structural lack of trust in government among the peasants, which may be viewed as the response of the rural population to the governing elite's mistrust of peasant initiative and politics witnessed in the early postcolonial period. Combined with an inadequate government capacity to mobilise consistent, well-coordinated and pro-active support, this lack

of trust has plagued the development of the *Jatropha* sector from the very beginning, in particular the activities based on organizational models aiming for local rural development and small-scale outgrowing such as those undertaken by KAKUTE which are focused on emancipation of poor (women) farmers.

At this early stage of its development, however, these issues were not yet major concerns, since there were no actors with competing objectives on the scene. As we will see, a few years later competing claims on the same resources by stakeholders with fundamentally different interests and concerns would begin to call for more active regulatory intervention by the state, including its ability to drive a process of strategic priority setting and weighing of concerns by different agents.

However, Tanzania also suffered, and continues to suffer, from all kinds of infrastructural and capacity-building problems stemming from historical institutional issues, which impede the establishment of new economic activities more generally. Its degree of industrialization is low, and its infrastructure is inadequate. Policy-making and implementation capacity is limited. Road transport is time-consuming, difficult and costly. Local knowledge about oil pressing is limited. Although basic technological knowledge exists due to widespread use of vegetable oil presses for crops such as sunflower and castor, there is no advanced knowledge about efficient high-capacity presses in the country itself (van Eijck and Romijn, 2008).

5. The situation in 2005: Early growth and high expectations

Context

Among the factors underlying the early growth of the *jatropha* sector in Tanzania we again have to point to increasing concerns about global warming. The Kyoto Protocol came into force on 16 Feb 2005. Other important pressures from the international environment include an increasing awareness of the finiteness of fossil fuels, fast rising energy demand from emerging Asian economies, and structural unreliability of middle eastern oil supplies due to geopolitical problems. Steadily rising prices of fossil fuels, which reached almost \$ 70 per barrel (Brent Crude) in the course of that year, were an important manifestation of these emerging pressures. Meanwhile, potential investors in biofuels began to perceive the attractiveness of vast areas of uncultivated land in Africa that could possibly be exploited for biofuel cultivation for western markets (Mercer, 2003). Among different biofuel crops, *Jatropha* was quickly singled out as particularly promising, because early publications noted its potential for degraded land regeneration and erosion prevention alongside energy provision (Henning, 2004; Heller, 1996; Jones and Miller, 1993; Openshaw, 2000).

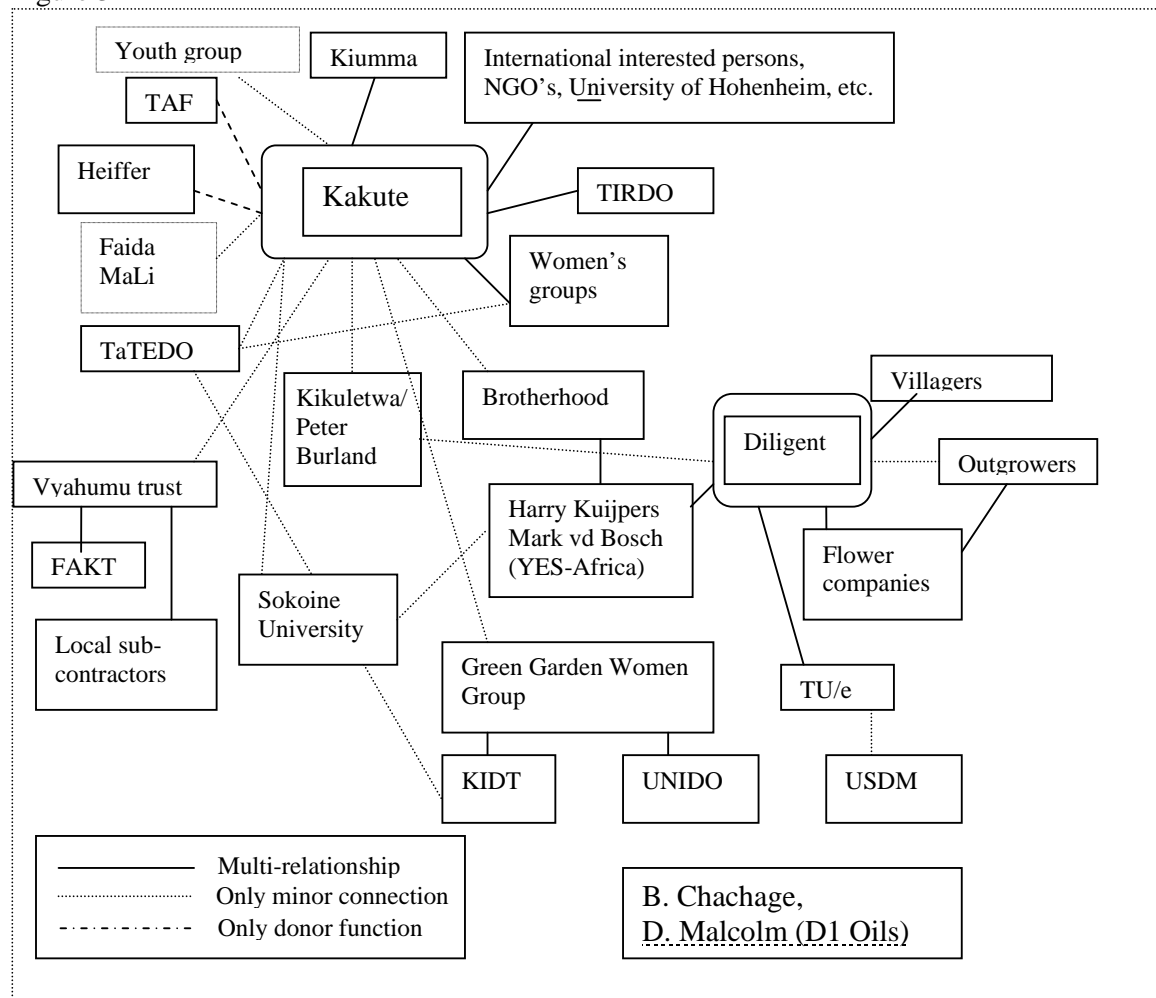
Tanzania began to attract foreign investor attention in an early stage for several reasons that have to do with various national characteristics. Foreign investors generally find it an attractive country because of its political stability, democracy, relatively low violent crime, treaties to protect foreign investment and recent economic liberalisation. Foreign investment is actively facilitated by the Tanzanian Investment Center (TIC). There is also a large workforce which is relatively highly trained due to prioritization of education during the past decades. Likewise, many western aid organisations find Tanzania a good place to execute projects and programmes despite the problems with Tanzanian infrastructure discussed in section 4.

Actors and network

It is against this background that the first activities towards the development of a *Jatropha* sector in Tanzania began to take shape. In 2005, we can begin to speak of a small innovation system, consisting of a few loosely connected single experiments involving no more than around 30 different actors in total (see figure 3). Network density is low, and the government

is still notably absent from the network. There is no regulation, and no stimulation (van Eijck, 2007: 87).

Figure 3



There are still just two key players. Aside from KAKUTE, a subsidiary of a small Dutch TNC (Diligent Energy Systems) has just started up. Their organisational models are not yet clearly articulated. Kakute is still pursuing an informal outgrower model, collecting seeds from farmers on an irregular basis, including seeds from wild *Jatropha* plants already growing in the region. These are pressed manually with ram presses. The oil is used as lamp oil and as the key ingredient in medicinal *Jatropha* soap. Production takes place on a small scale. Diligent's efforts revolved around contracting small farmers to supply its prospective oil pressing facility in Arusha with seeds from seedling plants that the company supplies, and that the farmers plant around their small plots as hedges. No large plantation cultivation was noted.

Institutional influences on sectoral development

Diligent's choice for a business model organised around small-scale outgrower farmers is not coincidental. One reason has to do with generating cash flow in the early years of business operations. *Jatropha* takes about 3-4 years to bear fruit after planting, and if one has to start from scratch with young saplings one cannot generate cash inflow for several years. Diligent

opted to settle in an area where much wild mature *Jatropha* already exist, which can be collected by local people and sold to Diligent right from the start. But there are various wider reasons why Diligent opted for a small-scale outgrowing model. It pursues a “triple bottom line” business philosophy, which, in addition to having ideological motives, is inspired by the conviction that this is a requirement for healthy business development in the present day and age. Contract-based outgrowing could be a way in which the poor farming community in Tanzania could supplement their earnings without undermining their normal activities revolving around food production. Moreover, the small scale of the operations and hedge-planting practices would avoid substantial negative ecological impacts. Interestingly, this idea is now supported by several institutional investment agencies and foundations in the Netherlands, that are seeking to promote development precisely through such business initiatives. One could say that the international financial institutional environment has a niche which enables societally responsible business operations to come off the ground in poor developing countries like Tanzania.

In addition, there are local institutional reasons why Diligent chose this model. Procedures for land acquisition in Tanzania are cumbersome, and such processes can be fraught with difficulties and contestations due to the complexities of traditional informal land rights regulation in the rural areas. There are also long standing gripes by the local population arising from past bad experiences with foreign parties who occupied prime lands for purposes which did not benefit the locals (Odgaard, 2006; Laltaika, 2008; Sulle and Nelson, 2009).

From the early stages, Diligent experienced severe institutional difficulties with gaining farmers’ trust. Farmers are happy to sign a contract, but often default on it as soon as another seed buyer (such as KAKUTE or its representatives) comes along who offers them a higher price than what Diligent is willing to pay on a structural basis, even though the company guarantees a 10 year sales agreement and a fixed (albeit low) minimum price. Its spokespersons note that trust is something that can only be built over a longer period, in which the company consistently has to prove its reliability, integrity and honesty, and farmers will have begun to experience the benefits of being associated with the firm on a longer-term basis. In general, the lack of trust between the farming communities and *Jatropha* buyers are preventing the building of stable long term relations that are required for establishing reliable outgrower-based supply chains that can upscale.

Another institutional problem that Diligent pointed to, concerns the lack of a clear government policy on renewable energy development. This created uncertainties over the future market prospects of the sector, especially concerning the economic attractiveness of the national transport market. The main issue concerns uncertainties over the granting of biodiesel tax exemptions, which is crucial for market development because biodiesel could not yet compete with fossil diesel on price. However, since Tanzania's government budget is highly dependent on import duties from fossil fuels, any exemptions for biodiesel would cut into its own revenues. The dependence of government income on import taxes is a structural institutional feature of economic organisation in many poor countries. Not surprisingly, by 2005 there had been no substantial progress with the development of a renewable energy policy that could assist in an orderly market development of biofuels, set strategic priorities, and reduce policy uncertainties for investors.

This caused Diligent to explore international markets in addition to local markets. In the local market, they had to search out niches where parties would be prepared to pay a premium price for boosting their ‘green’ image, such as eco-safari companies in Arusha. In addition, underdeveloped institutions in the Tanzanian system of innovation created more direct marketing problems of various kinds. For instance, *Jatropha* oil being a new commodity, there were no product standards and that meant that the product could not be officially traded or exported. The development of these standards proved beyond the technological capacity of

the Tanzanian Bureau of Standards. In the event, Diligent set up its own local laboratory facilities and assisted the Bureau with the development of national *Jatropha* standards for both PPO and biodiesel.

A variety of formal and informal institutional and infrastructural conditions have affected the development of Diligent's organisational model: The way in which Diligent's outgrower model took shape derived from the need to control all stages of the production chain, even involvement in activities that would normally be carried out by other specialised actors in the innovation system (such as standards development). Due to the underdeveloped knowledge base, power facilities and oil storage possibilities in the rural areas, it was effectively impossible to opt for a decentralised oil processing model, in which the seeds would be pressed locally in the rural areas and the bulky seed cake easily returned to the farmers as fertilizer. The company opted for a centralised oil processing facility in Arusha. The policy-induced uncertainties over the economic prospects for biofuels in the national market forced the firm to go for special local niche markets and to explore western export markets. And competitive behaviour on the part of outgrowers forced the firm to develop its main sourcing into outlying areas where there would be less competition from seed buyers.

Going back to the sectoral composition in 2005, we note a diversity of actors in the *Jatropha* cultivation stage. However, the oil pressing stage was still incipient and the end-use stage almost non-existent. This makes sense, since a full value chain can only be built up once sufficient oilseeds are available, and it takes 3-4 years for new plants to start bearing fruit. In the cultivation stage, the actor network was found to be expanding quickly and becoming more diverse, with research institutes (including a few foreign ones) beginning to be involved. Several agronomic learning processes had already occurred, for example concerning different ways of propagation of plants, irrigation, and planting distances. However, these learning processes had not yet been synthesized or shared among all the relevant actors. People's expectations about *Jatropha*'s viability are generally highly positive. On hindsight (from the perspective of 2010) people's yield estimates of 5 to 10 t/ha/yr in our 2005 survey have proved to be completely unrealistic, a clear sign of the underdevelopment of the sector.

In oil pressing, we see a small but diverse actor network, mostly linked through KAKUTE. Early technical learning by Diligent and KAKUTE was based on basic mechanized Sayari oil expellers made in Tanzania by the Vyahumu Trust, a German aid-supported NGO in Morogoro, and on manual ram presses. There were no lessons about efficiency and profitability of different press techniques yet, although the women associated with KAKUTE observed that the ram press is definitely unwieldy for processing larger quantities. There were no ideas either about what press capacity would ultimately be used, because of complete lack of information about market acceptability and suitability of the oil. There were also no lessons yet about the infrastructure and storage requirements of seeds and oil, and the behaviour of the oil under different climatic conditions, although this aspect was expected to be important because seeds and oil are natural products. Transport difficulties due to poor roads, and unreliability and inefficiency of equipment are seen by our respondents as major institutional barriers to the development of the industry.

At the usage-stage of the production chain, the network is embryonic because a commercial market for *Jatropha* oil and its by-products does not yet exist, while there is also no developed seed and oil supply system. However, actors had by then identified several different possible uses for *Jatropha* and were just beginning to engage in learning. First, local and western NGOs were beginning to perceive *Jatropha* oil as a potentially good diesel substitute in remote locations within Tanzania. Others, such as Diligent, were noting potential for export and – subject to government tax policy – for the national and regional diesel market. Diligent was also exploring the behaviour of the pure plant oil (PPO) in car engines by converting one car engine to enable it to run on pure *Jatropha* oil. Diligent's experiments

were to some extent supported by research at Eindhoven University of Technology (TUE) in the Netherlands, where an MSc project had started about the behaviour of Jatropha oil in diesel engines (Rabé, 2004). However, since Jatropha had never been used as a diesel substitute, lessons on acceptance by users and the world's leading car manufacturers were still lacking.

Again, the shaping of the linkages in this part of the chain is heavily influenced by local institutional factors. Domestic universities proved to have inadequate laboratory facilities for conducting substantial engine and oil tests, and this necessitated the building of foreign research linkages such as those with the TUE. Institutional constraints also show through in the disappointing results from local experiments that were carried out without such external inputs. KAKUTE's experiment with Jatropha seedcake for biogas production, involving a small biogas plant, yielded mixed results because of unreliable gas pressure. KAKUTE was also pursuing another possible application, namely the use of the PPO in oil lamps and cooking stoves. Kerosene lamps are widely used in the villages, but using Jatropha oil is expensive because a separate lamp with a thicker wick is required than what is normally used. KAKUTE has a small Jatropha-oil lamp factory, but no widespread market for this new lamp was found. It has also experimented with a cooking stove prototype, but there has been no sharing of lessons and no continuous learning due to shortage of Jatropha oil. The stove prototype was not functioning properly and there were many complaints about fumes and suspicions about their possible toxicity. Clearly, much technical (and societal) learning was still required here.

The research in 2005 showed that seed cake and PPO applications had been explored only very marginally. This was then identified as a major weakness for the development of the Jatropha innovation system. Firstly, because it was becoming evident that productive use of the seedcake (which still contains about 50% of the oil) is crucial for making Jatropha biofuels profitable, and secondly because finding suitable uses for PPO could make Jatropha particularly attractive as an energy source in rural areas.

In sum, people's expectations about possible end-uses varied widely in the absence of developed end-markets and supporting institutions of various kinds. There was no communication with potentially interested users who could provide useful information about their preferences and needs. This state of affairs is reflected in all the different potential Jatropha applications. This stage in the industry's development is still driven by beliefs and expectations, rather than facts, experiences and effective support structures. This stage is characterised by what Kempf (2007) has called 'limited first order learning' which is basically learning about only the key technical processes in the value chain. There are no wider lessons yet about the impact of the processes: about user acceptance, competition with food production, effects on land and water use, biodiversity impacts, logistics requirements, possible dangers associated with toxicity, and so on. We still see a reasonably harmonious process led by few individual actors with plenty of space in this vast country to pursue their own interests without having major effects on each other. At this early stage there is no large influx of big investors whose activities could potentially have major effects on the rural ecological and social-economic scene. The public at large – both within Tanzania and abroad – is still hardly aware of Jatropha's emergence. To the extent that people are aware of it, there is just a vague sense, mostly based on hearsay, that social and environmental impacts will be positive.

6. The situation in 2008/9: explosive growth and emerging contestations

Context

The hyped expectations generated in the early years of the development of the *Jatropha* sector in Tanzania - as well as in other tropical countries including such giants as Brazil and India - fostered an international climate of great optimism regarding investment possibilities (Carels, 2009; GEXSI, 2008). This was simultaneously being stimulated by developments elsewhere: the IPCC published a report stating that it is 90% certain that the increase of CO₂ in the atmosphere over time is induced by human activity. It also stated that if the combustion of fossil fuels would not be reduced significantly within the next decades, a temperature increase of over 2 degrees Celsius will cause climate change with catastrophic consequences (IPCC, 2007). The film 'An Inconvenient Truth' produced by Al Gore also did much to enhance public awareness of the dangers of human-induced climate change.

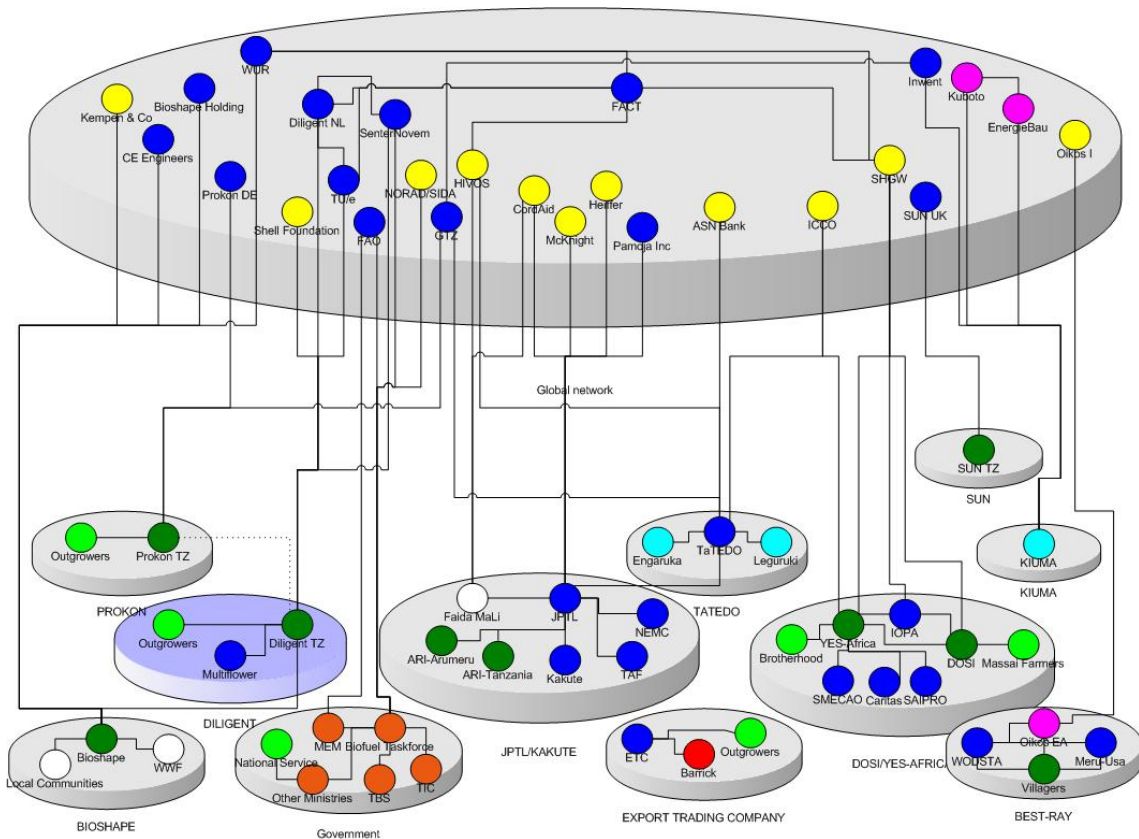
The positive expectations about *Jatropha* were accompanied by a growing interest in western developed countries to utilise biofuels to combat climate change and enhance energy security. The EU adopted Directive 2003/30, in which it set indicative targets for biofuel consumption as road transport fuel of 5.75% by 2010, and 10% by 2020. In the US, a target was set of 7.5 billion gallons by 2012. According to the OECD, the annual support given by the US, EU and Canada to stimulate the supply and use of biofuels had risen to US\$ 11 billion in 2006 and was expected to rise further to approximately US\$ 25 billion by 2015 (Hauwermeiren, 2008).

The combined occurrence of these trends heralded a major new phase in the industry's development, causing a large-scale influx by western transnational corporations (TNCs) into tropical countries in Asia, Africa and Latin America which are intent on the large-scale commercial cultivation of *Jatropha* predominantly for western markets of transport fuel and electricity-generation feedstocks (e.g., ABN, 2007; Beattie, 2008; Knaup, 2008; FAO, 2008; GEXSI, 2008). Within just a few years, the stream of these investments had grown to such an extent that it began to attract considerable attention in the press in developed and developing countries alike. One CNN report estimated that more than 720,000 ha had been planted by spring 2008, expected to rise to over 21 million ha in 2014 (Whiteman, 2008), out of an achievable total potential of around 30 million ha (Wille, 2008).

Actors and network

In Tanzania, the combination of these various global pressures and positive expectations gave rise to a virtual deluge of foreign investments into the fledgling *Jatropha* sector. A survey undertaken in the spring of 2008 identified a whole range of different initiatives and scales of production, varying from very small-scale production activities to extremely large plantations (or sets of plantations) exceeding 50,000 ha (Martin et al., 2009). In our own second survey in late 2008, all these initiatives were found to be linked to foreign investors or aid donors. The international linkages for some key projects are illustrated in Figure 4 (Roks and van Vlimmeren, 2009). See figure 4.

Figure 4



At this stage we can also begin to differentiate between more or less distinct organisational models with distinctive technologies and business organisation (Martin et al., 2009; Roks and van Vlimmeren, 2009). First, several local *Jatropha*-energy projects are established in rural areas, motivated by the potential for improving livelihoods through collective utilisation of local resources (Appropriate Technology, 2007). There is considerable financial support for these kinds of ventures because it fits well with the current emphasis on achieving ‘pro-poor growth’ through decentralized efforts and reaching the Millennium Development Goals in the international aid community. One of the MDGs is concerned with local energy security; another with environmental sustainability. Borrowing from a concept initially piloted in Mali (Togola, 2008), two so-called ‘Local Multifunctional Platforms’ (LFP) were set up in the remote Maasai villages of Engaruka and Leguruki by a local NGO called Tatedo. Designed to promote local economic development through self-sufficiency, LMPs consist of a set of three basic interlinked machines placed behind one another: a small oil expeller, a generator set, and a maize mill. The idea is that local farmers will cultivate the plant as hedges round their fields and/or intercropped with food crops, and that the oilseed harvest would be sufficient in due course to substitute for fossil diesel as a feedstock for locally generated electricity (Wijgerse, 2007). The LMP should stimulate activities such as maize milling, lighting, radio services and mobile phone charging. In 2008, the EU financed a large-scale expansion of the LMP concept to 120 other locations through NGOs in EU member countries such as the Dutch HIVOS (Roks and van Vlimmeren, 2009). Several other NGOs have also started developing *Jatropha* projects for local development, such as DOSI’s scheme to make dairy products in collaboration with local Maasai groups, with funding from a Dutch foundation Het Groene Woudt; and Kiumma’s German-funded project for local electricity generation for a hospital and religious order in the South. One can conclude that the local development *Jatropha* model in Tanzania – as elsewhere in the developing world – is

fuelled by considerable western institutional support which has not been accompanied by adequate critical self-reflection concerning its socio-economic sustainability by the donors, or by the Tanzanian government, or by the receiving NGOs, which are obviously very donor-dependent – an institutional feature of Tanzanian ‘civil society’ which has also been noted by others (Ndegwa, 1996; Gould, 2005). As argued by Mercer (2003: 749) “The Tanzanian state, or certain elite groups within it ... are keen to maintain good relations with donors and the international financial organisations because they enable access to international credit and foreign investment”. It is likely that the lack of critical debate in this *Jatropha* sub-sector as a major issue that will come to visit the aid community in the near future. As we will see below, for now the controversies have focused almost entirely on the other side of the organisational model spectrum – the large plantations.

This large plantation (LP) part of the *Jatropha* sector consists of a number of western investors, mostly from EU countries, who were attracted by the Tanzanian government's welcoming attitude to large scale initiatives that promise to improve Tanzania's balance of payments situation, whether through import substitution of diesel oil or through direct exports. It should be noted that Tanzania is so impoverished that it has been part of the World Bank and IMF's HIPC initiative. Since large plantation investment projects are required to go through lengthy land acquisition procedures, they were still in their infancy during this stage, but their plans were grandiose (not unlike their precursors during the colonial era). In one case, a company wanted to lease 80,000 ha of village land for conversion into *Jatropha* monocultures, in the form 200 ha estate plots of “mosaic plantations”. It planned to remove existing vegetation using heavy duty imported machinery. It was also planning to conduct systematic agronomic experiments in collaboration with local and foreign universities to optimise *Jatropha* yields by means of pruning, mulching, and introducing pest and disease controls, and it wanted to use mechanical harvesting, never tried before with *Jatropha* at that stage (Romijn, 2008). Many of the large plantation schemes were being established in Tanzania's coastal zone, in view of their ambitions to export (Martin et al., 2009), in many cases through shipping out the raw agricultural product (Romijn, 2008).

The middle range in the business spectrum is occupied by a few schemes – among which Diligent still occupies a prominent place – that try to use a decentralised outgrower model (OM) with small-scale farmers, combined with centralised oil pressing. These projects do not acquire (large parcels of) land and are thus much less “invasive” than the plantations (Sulle and Nelson, 2009), but the flipside of this is that the benefits for the rural outgrowers are likely to remain limited since the market does not support remunerative seed prices. The OM affords a more gradual growth trajectory, enabling firms to start experimenting with oil pressing on a small scale, growing gradually by extending their contract farmer network over time. They also utilise well-established *Jatropha* plants that are already growing wild in some areas, such as Shinyanga and Singida. These companies were not established with a definite plan where their main market should be. Exports as well as domestic and even local sales were being considered, depending on the economic viability. In any case they plan to utilise the *Jatropha* by-products (hulls and seedcake) locally, so their market strategy is more mixed than that of the local multifunctional platform projects and the large plantation schemes (Roks and van Vlimmeren, 2009).

Start of reflexive learning

The first half of 2008 is marked by major instabilities in the global and local levels, which have had dramatic effects on the development of the Tanzanian biofuels innovation system. These developments coincided with the accumulation of experiences from the cultivation of *Jatropha* as a managed agricultural crop. Since *Jatropha* takes about 3 years to start yielding its first seeds, the earliest *Jatropha* projects in Tanzania and in other countries such as India

were beginning to get their first results around this time. From these results, it was becoming increasingly clear that although *Jatropha* is indeed able to survive under hostile environmental conditions, it will not do much more than that; its seed and oil yields are much higher in conditions where the plant has adequate access to soil nutrients and water (FAO, 2008; Achten et al., 2007, 2008, Luoma, 2009).

At around the same time, global food prices began to climb to the highest levels since the 1970s. The FAO (2008) gave warning about serious implications for food security among poor populations around the world. It forecasted global food-import expenditures to reach US\$ 1035 billion in 2008, 26 percent higher than the previous peak in 2007. These emerging facts intensified and expanded a debate, until then limited to the USA and Brazil, about competition between food and fuels (Rathmann, et al., 2009). The World Bank (Mitchell, 2008) and the OECD (2008) came out with reports claiming that biofuel production, spurred by attractive subsidies, minimum blending requirements, and skyrocketing fossil fuel prices in an overheating global economy, had been one of the main reasons for the increasing food prices.

This, coinciding with a drought in Eastern Africa, caused great concern in the region, where periodic food shortages have been an issue for a long time (The Citizen, 23 July 2008; Wahl et al., 2009). It began to spur major controversies over the large scale biofuel plantations that had recently been established in the country. NGOs have played a prominent role in setting off the debate (prominent early reports include: Land Rights Research and Resources Institute and Joint Oxfam Livelihood Initiative for Tanzania, 2008; WWF, 2008). While plantation investors often claimed land abundance, they began to point out that land that might seem unused at first sight can yet be valuable for its provision of durable ecosystem services, as a resource of various forest products, as spiritual places, and as roaming places for nomadic people and cattle. A World Bank report estimated that informal uses of local forests account for US\$ 35-50 in generally unaccounted-for per capita income in Tanzania (Sulle and Nelson, 2009, p. 4). Also, the argument was surfacing that future land requirements for food crop cultivation restrict its availability for biofuel production, for example in traditional rotational agricultural schemes that are still widely practiced in Tanzania. In 2007 the African Biodiversity Network (ABN) noted that "... the Tanzanian government is evidently committed to fast-tracking agrofuel initiatives, and switching over vast areas of land to sugar cane, palm oil and *Jatropha*. The most fertile lands, with best access to water are being targeted, even though these lands are already used for food production by small-scale farmers. Any talk of biofuel production for local energy consumption is undermined by the obvious intent of international investors to target foreign markets ... Also, there are no plans to invest in infrastructure in Tanzania to process agrofuels for local use" (p. 12).

Several international actors meanwhile began to question whether biofuels were really as GHG-friendly or -neutral as they were initially claimed to be. In January 2008, two articles in *Science* caused a worldwide stir, pointing out that biofuel energy life cycle studies so far had neglected greenhouse gas emissions due to land conversion prior to start of cultivation. Palm oil plantations established on former tropical forest lands in Malaysia and Indonesia would need to run for over 300 years for the initial carbon debt to be repaid (Fargione et al., 2008). It did not take long for these concerns to be reinforced by others who were conducting research specifically on *Jatropha* (Achten et al., 2008; Romijn, 2010). Other studies flagged environmentally unsustainable practices by large foreign investors in Tanzania (WWF, 2009). Together, these sustainability studies undertaken by local and global actors raised worldwide doubts about the desirability to promote biofuel investments of any sort.

In early 2008 the biofuel sector in Tanzania had grown large enough (approximately 38 leading actors) and its effects proportionately contentious that it began to draw the attention of

another prominent institution: the national, regional and international press. In May 2008, the Financial Times reported that the food versus fuel debate and associated turmoil had led to disarray in the Tanzanian government about how to proceed, "blowing hot and cold" depending on who's asking, and dithering over the introduction of effective regulation. A national biofuels policy was called for by concerned donors and investors who dearly desire more clarity about future prospects and land acquisition procedures, but so far divided politicians and the 'creaky government machinery' had not made much progress (Beattie, 2008). The East African regional newspaper adds further inflammatory details about one 8000 ha plantation scheme close to Dar es Salaam implemented by Sun Biofuels (UK), especially about its lack of prior consultation with local affected villagers, the low wages on the plantation (\$3), the long land lease (99 years), and the danger that Tanzania might soon be overrun by similar investments, which would cause a major threat to its already precarious food security situation (Redfern, 2008). A few weeks later, the East African hones in on a highly critical new report by Oxfam International (2008) claiming that the EU biofuel target could actually increase carbon emissions by 70 times by 2020, because of the required changes in land use (Oxfam International, 2008). The same article also reports on a Tanzanian Member of Parliament (MP) cum environmentalist who takes the government to task over its rush to embrace biofuels without proper consideration. In reply, the Prime Minister announces that the Ministry of Energy and Minerals and the Ministry of Agriculture, Food and Cooperatives have been tasked to come up with policy regulations, but that investments that are already underway in the country cannot be halted (Afandi, 22 July 2008). Just two days later, a local paper adds to the heat with an editorial stating that another concerned MP spoke in parliament about a Dutch investor acquiring long leases over very large tracts of fertile land directly from villagers in the Kilwa area, which it is not allowed to get without prior government permission under the 1999 Village land Act. The journalist laments that the government has remained silent, in spite of more and more reports and statements from local watchdogs, NGOs, university researchers and MPs expressing great concerns over the large-scale allocation of fertile land (estimated by the Land Research and Resources Institute to amount to 641,170 ha by then) and the uncertainties hanging over the supposed benefits of biofuels like *Jatropha*. It is urged to act immediately to put regulatory and legislative mechanisms in place (The Citizen, 24 July 2008). It is probably fair to conclude from this review that the press, aside from having its own voice, has also been mobilised by various other stakeholders to give voice to their concerns and put pressure on the government to act and to some extent abandon its unquestioning support to large biofuel investors. Either way, the press – including various internet sitesⁱⁱ that post relevant press articles – has been a prominent institutional medium for shaping the development of the sector at this stage in its growth.

Another type of institutional influence concerns the academia. A multidisciplinary study group from Tanzania's three best known universities was formed. The group noticed that the country's coastal regions top the investment list because of port facilities, a factor indicating that the biofuel business is mainly for export. This, they say, raises concern about benefit sharing with smallholders and farm-workers for improving local livelihoods. Long term attractiveness of the current crops is also no certainty, in view of intensive ongoing research for more efficient biofuel crops. Will the costs of the loss in biodiversity and land degradation caused by these developments not outweigh short term financial gains? And finally, they draw attention to the need to build better national capabilities, research and transport infrastructure. In the absence of these assets, foreign investors will be induced to keep relying on foreign partners for key services and collaborations, thus contributing to exclusion of national parties and lost knowledge accumulation and local development opportunities (Mwamila, 2008).

In the active role played by academia in the Tanzanian biofuels debate we can see that this community is a major repository for knowledge about earlier problematic experiences with large-scale modern colonial and early post-colonial farming programmes. One researcher from the University of Dar es Salaam (UDSM) traces the root of the food shortage problem to “imperial expansion to the peripheries”, in which Tanganyika was a peasant economy whose main role was to produce colonial cash crops for export to Europe. This model was sustained through the use of “naked force and extra-economic coercion”, leading to “the expropriation of surplus at no cost to the expropriator” (Kamata, 2009). Another UDSM article introduces the concept of ‘climate colonialism’ as a new version of an much older and strongly-institutionalised pattern of international relations (Madoffe et al., 2009). In the mere use of this terminology we see reflections of the Marxist dependency movement of the 1960s-70s, in which the UDSM took an active part. Another Tanzanian academic details the impacts of advancing *Jatropha* cultivation on Maasai pastoralists, including loss of grazing lands and spiritually significant places. It also cautions NGOs that try to involve Maasai in cultivation of *Jatropha* themselves. Many Maasai apparently experience it as upsetting their traditional ways of life and culture, though they might not say so openly (Laltaika, 2008).

The current stance taken by leading Tanzanian academics and journalists in the biofuel debate clearly constitutes a strongly historically institutionalised response that can only be fully grasped when viewed against a broad historical canvas. The structural tendencies and relationships that caused earlier modern agricultural projects to fail are now being evoked again. In a recent workshop at UDSM, there emerged general agreement that the current Tanzanian government is no less elitist than earlier colonial and early post-colonial governments in the way that it expects the solution to the problem of underdevelopment to lie in the adoption of modern, large-scale industrialised agricultural practices and in the way that it is allowing the foreign-driven biofuel sector to take shape, without learning any lessons from history. In particular, concerns were raised about the failure to learn about the severe adverse social consequences that arose from the historical alienation of land from poor small-scale farmers by the state for the facilitation of large wheat farms and for groundnut cultivation to produce oil for export to Europe. The key to the failure of these schemes, it was pointed out, lay in the neglect of the food needs of the rural poor (Kamata, 2009).

New institutional developments

Whereas in the previous sections of this paper we have seen various examples of local and global institutions influencing the manner in which the *Jatropha* sector developed in Tanzania, at this stage we also begin to observe the start of a feedback process, where reflexive learning induced by controversial impacts in Tanzania (and elsewhere!) give rise to new institutional development. First of all, several countries, regional groupings, and organisational networks begin to step up efforts to institute committees to develop social and environmental sustainability criteria that biofuels must meet to ensure responsible practices (Lerner, 2008; van Dam et al., 2010). The best-known national initiatives include: the RTFO (UK), the Cramer initiative (The Netherlands), the Social Biodiesel Schemes and Programme for Certification of Biofuels (Brazil) and the South African biofuel standard. Three international institutional initiatives were also started: The GBEP (G8+5, UN agencies), the BEFS and BIAS (FAO), and the EU Biofuels Directive. In addition we should mention a major international voluntary initiative, the Roundtable on Sustainable Biofuels (RSB), which initiated a specific working group devoted to standard setting for *Jatropha* by mid 2009.

Due to these cumulative pressures, the Tanzanian *Jatropha* sector is increasingly forced to prove its environmental and social sustainability credentials along with securing economic viability. The pressures come down mainly on those projects connected to large international investors. Restive global, Pan-African and local NGOs point to potential threats to land,

livelihoods, food security, biodiversity and water. One NGO notes that the government of Tanzania has already surveyed many fertile regions with the best access to water, which also happen to be the regions where farmers are already growing food. It warns that Tanzania's main rice areas could be given over to biofuels production and that production of maize, wheat, beans and cassava may also be affected. The NGO accuses the present government of having few qualms about evicting smallholders from their land, in ways not dissimilar to the colonial government. Perhaps worst of all, it predicts increased conflicts over already problematic water access when this resource will be diverted for biofuel irrigation (ABN, 2007).

What is particularly noteworthy about this account from the perspective of this paper is the fact that ownership rights to these resources do not provide adequate protection to local users in this new situation. Old customary common laws that were set and managed solely by the local communities, which worked fine in situations without acute resource pressures, are unable to cope with sudden demands from national and international powers (Sulle and Nelson, 2009; Odgaard, 2006), and are widely seen to result in unsatisfactory outcomes for all concerned. Also, these traditional institutions sometimes become overruled by 'modern' forms of formal property rights laws and regulations, which do not take adequate account of customary land use by multiple users of different kinds. In this way, secondary users such as nomadic people and their roaming cattle tend to lose out to primary land users (Sulle and Nelson, 2009). Another consequence of prevailing land ownership arrangements that has been noted is that once communities have signed over their land to the state for allocation to large investors, they cannot get it back even if the investor goes bankrupt and quits the country (Sulle and Nelson, 2009). In these developments we can recognise a clash between traditional customary institutions and modern economic and bureaucratic rules.

These institutional inconsistencies are putting large investors and the government under considerable pressure to provide more adequate protection to local communities and vulnerable groups. One effect of this is already emerging, in the form of proposals for less invasive innovative organisational models, in which foreign investors do not obtain ownership rights but co-develop the land together with the local farmers by means of partnerships (Sulle and Nelson, 2009; Vermeulen et al., 2009), and arrangements like 'block farming', in which several different small farmers are allocated adjacent plots by local communities so that they can easily collaborate for various purposes (Njau et al, 1999). In this recent debate one can see the early beginnings of attempts to introduce institutional adaptation and innovation, induced by reflexive learning about unsatisfactory sustainability outcomes in the industry.

In retrospect, this brief period (2005-8) was a particularly tumultuous one in the biofuel development trajectory, both in the world at large and in poor developing countries like Tanzania. There were enormous spikes in food prices, leading to social unrest in many countries. Fossil energy prices also reached an all time high, averaging US\$ 120 per barrel during the 2nd quarter of 2008 (Bloomberg, 2008). This boosted biofuel energy investments by fuelling widespread expectations of structurally high energy prices. Whether or not biofuel investments indeed played a truly dominant role in the food price rises has remained a matter of some debate. However, a more important lesson that sunk in during this episode was that some of the major drivers of the food price hike constitute major structural developments – especially the steadily rising purchasing power in large emerging economies in Asia. Hence, the world can ill afford to devote vast tracts of arable land to the cultivation of biofuels.

This realisation began to sink in just as the first results of significant progress in learning in the emerging global *Jatropha* biofuel niche began to circulate. The vital agronomic lesson emerging at this stage is that *Jatropha* is no different from any other wild crop: it can survive in drought-prone conditions and poor soil, but it cannot possibly be financially attractive and reliable under those conditions. This caused investors to scout for cultivable land, further

inflaming the food versus fuel debate in Tanzania. This dawning reality therefore marks the start of reflexive learning. The accumulation of problems with large plantations was beginning to cause disillusionments about the much hyped developmental benefits of the crop for poor developing countries like Tanzania. For many, this effectively punctured the overblown expectations that had been built up.

In all this upheaval and contestation, it is hard to find evidence of additional evolutionary variation processes such as oil pressing and user applications, which along with agronomic learning had been the dominant drivers of progress in the sector until then. Undoubtedly these processes went on as before, but became eclipsed by the concerns with major unresolved issues relating to environmental and social sustainability. This is a period in which it is discovered that major institutional parameters governing the future operation of the sector need to be reset for further progress to be able to take place. We see different parties mobilising to make this happen, by doing research, writing reports, begin work on regulatory institutions, forming stakeholder forums, and striking up informal alliances (e.g., by supporting each other on blogsites and in the local press). We begin to discern the first results from these power struggles in late 2008/early 2009, to which we now turn.

Accumulation of contestation and conflict

The start of the final period in the development of the *Jatropha* sector so far is marked by the global financial crisis causing major energy regime instability. The recession is associated with dramatically plunging oil prices and falling oil demand. The oil price plunged by US\$ 115 from its peak of US\$ 147 at the end of July 2008 to its lowest point of US\$ 32 in December, the most precipitous fall the world had ever seen (The Economist, 23 May 2009, p. 69). Although long-term oil price projections point upwards, the large swing caused major problems for renewable energy programmes worldwide, including those based on *Jatropha* oil. Recently established EU biodiesel factories suddenly experienced dramatic overcapacity. By early 2009, only 60% of the German biodiesel production capacity was still in use, and several factories had closed down (MVO Magazine, May 2009). Producers of *Jatropha* feedstocks – particularly large export-oriented firms – had to revise their expectations about market prospects.

Meanwhile, the severe food shortages and high food prices that are also experienced in this period begin to fuel major concerns about the backwardness of Tanzanian domestic agricultural sector and its inability to provide food security. One finds increasingly vociferous criticisms by actors such as NGOs, academics and journalists in the press and on blogs, about the continued neglect of these issues by the government (Godoy, 2009; Kamata, 2009).

The stellar growth of the biofuel sector, combined with the adverse national and international contextual constellation and the absence of effective national regulation, conspire to feed the worries about the current and future impacts of the sector. Several leading NGOs have started investigating. One study by the WWF Tanzania chapter with support from WWF Sweden in 2008 contains damning findings regarding the location decisions, investment procedures and operations of some of the foreign plantation investors (WWF, 2009). Another study by the Tanzania National Research Forum's Forestry Working Group and the International Institute for Environment and Development, estimates that a total of 640,000 ha had been allocated for biofuel investments, with approximately 4 million ha being requested by investors. It also estimates that between 5000 and 10000 local people have been affected so far, leading to the alienation of their customary rights over land (Sulle, 2009; Sulle and Nelson, 2009).

Looking at the actual developments on the ground, the future outlook looks more mixed than the recent fast growth suggests. Despite increasing international pressures favouring renewables for environmental reasons, local fuel use preferences in Tanzania are primarily

based on price because of the poverty. Hence, the crash of the fossil fuel price in the fall and winter of 2008 was, on the whole, a bad thing for the development of an economically viable local *Jatropha* sector that would cater to local needs. This is especially true for national/local applications, such as *Jatropha* fuel for transportation or lighting. However, since the quantities of *Jatropha* oil that are actually reaching these markets are still minimal in any case, there was not much short-term negative impact there. The outlook is better for local *Jatropha* applications that do not aim for substitution of an existing fossil energy regime. For example, some projects aim for rural electrification in places that are not yet electrified. Prospects in these local sheltered spaces continue to appear to be somewhat promising, also because the desirability of local applications for *Jatropha* – as opposed to export to western markets – is increasingly being emphasized in international publications (Tilman et al., 2009, Vilt, 2009, FACT, 2010).

Further institutional developments

One aspect of sustainability-related learning that puts special pressure on the plantation investors concerns the formation and implementation of new rules, regulations and standards. Within Tanzania, this issue came to the fore after the National Biofuel Taskforce – constituted by the government in 2006, but initially not quick-acting – finally came with its first results in August 2008 in the form of a Draft National Biofuel Guideline. The task force includes a representative selection of industry stakeholders, who debated and helped to set the definition of national standards for the quality of biodiesel and bioethanol (now completed, with the help of the one firm with a laboratory), and how the government should enforce these standards (still ongoing). A need for clear rules about taxes on *Jatropha* biofuels was also voiced during the consultation process. But perhaps the most important issue tackled by the Taskforce has been the formulation of guidelines on respecting biodiversity, ensuring food security and preventing exploitation of villagers, e.g. in the form of rules on how to acquire land. A revised/improved guideline was issued in November 2008 which has been passed by parliament. However, in early 2010, the guideline had still not been approved by the Cabinet. The delay has attracted severe criticism from the local media (Mngazija, Daily News, 12 Oct 2009; Kandoya, Daily News, 4 Oct, 2009). Even villagers had become so politically aware by this time that they refused to sign a recent land lease contract with a major investor Sun Biofuels, for expanding its plantations in Kisarawe district (Lugungulo, Daily News, 12 October 2009).

More severe than the pressures from within the Tanzanian system are those emerging with respect to international norms and standards currently under development, such as the Dutch NEN norm (currently in the trial stage), the GBEP GHG guidelines (GBEP, 2009) and the EU sustainability directives (McGregor, 2008). For the actors targeting international markets, learning had to begin about how to match their practices to these new standards. The standardisation and certification efforts are linked to negotiations that are underway to create a successor treaty to Kyoto, which ends in 2012. In connection with this development, worldwide efforts to define truly sustainable biofuels are being stepped up (see, e.g., Tilman et al., 2009). The formation and introduction of trade standards and certification is widely seen as a suitable and necessary instrument for market regulation and promotion of sustainable practices by investors: the idea is that they can only earn carbon credits and market access in major western markets when they are able to prove that they meet certain social and environmental requirements.

The sector is still very much in a flux. No dominant technological design and organisational model is being foreseen (yet), although the stakeholders observe that the outgrower model has achieved the most stable situation in respect of supply and demand. That model is also expected to top the list in terms of market size and surface area in future years

(Roks and van Vlimmeren, 2009, p. 64). However, the logistics, extension, and certification requirements of this model will become highly complex and costly when such companies grow large, encompassing thousands or even tens of thousands of small contract farmers. Some outgrower-based investors are moving towards hybrid business models, comprising a core plantation supported by a sizeable outgrower system. Other ideas include hiving off all the labour-intensive training, extension, standards monitoring and seeds collection activities into a separate non-profit foundation that may qualify for carbon credit funding and can attract socially ethical investors who cannot involve themselves as co-owners in a commercial entity. This could be a way to cover the structurally high costs of working with smallholders (van Eijck, 2009; van Eck, 2009).

7. Conclusions

The evidence in this paper suggests that the emergence of the biofuel sector in Tanzania has been a troublesome process, and that the future of the sector is still highly uncertain. Aside from market bottlenecks arising from international swings in the world economy and various technical and infrastructural problems arising from newness of the activities, we can say that more profound societal obstacles to its development have also come to the fore. High promises concerning *Jatropha*'s seeming ability to thrive in poor environments and to boost livelihoods for the poor without compromising food security and local ecology could not be realised in reality. Hence, as experience began to replace hype, trade-offs between different dimensions of sustainability began to manifest themselves, and contestation and conflict have come to dominate the development of the industry as a result.

We should note that Tanzania's case is by no means an isolated case. Across Asia, Africa and Latin America more and more indications of similar trends are emerging (refs...). The analysis presented in this paper can to some extent be helpful for understanding these broader processes. However, we should warn against overgeneralisation across a highly diverse range of countries. Our analysis brought out that there are many structural institutional elements that are deeply rooted in Tanzania's past and the way in which it has been historically embedded into the world economy. These factors shape the way that the development processes in its biofuel sector are governed. We have seen this in the ways in which these factors influence perceptions, choices and actions of different parties and the feasibility and viability of different organisational models. What we can learn from this is that the way in which particular innovations work out on the ground in a given place/time configuration is always to some extent governed by highly specific factors, some of them local, some global, and some 'glocal' – deriving from the manner in which the local and the global domains are inextricably linked.

We believe that our chosen framework, which builds on innovation systems theory to encompass a more explicit and richer institutional analysis, serves as a suitable approach with which one can capture this specificity-derived complexity while not losing sight of more general patterns that can be helpful for drawing broader policy-relevant lessons for future development of the biofuels industry worldwide. Most importantly, perhaps, regulation in the sphere of international trade, aid and foreign investment need to be redesigned so as to take account of built-in biases which militate against harnessing biofuels for local and national development in poor countries. Only then can local actors in these countries be empowered to utilise these resources in a societally responsible manner.

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Notes

ⁱ However, this exertion of force and the resulting domination of the peasantry did not simply go unresisted. Struggle against coerced labour and seizure of land for large plantations is a common feature of African history (see Cooper 1994).

ⁱⁱ See, for example, <http://www.africanagricultureblog.com/search/label/jatropha>;
<http://www.tnrf.org/taxonomy/term/123>; <http://pambazuka.org/>; <http://www.theecologist.org>;
<http://allafrica.com>;