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**Governed by history: Institutional analysis of a contested biofuel
innovation system in Tanzania**

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Abstract

Initially hailed as a miracle crop for biofuel production, *Jatropha* has recently attracted criticism for competing with food production, causing adverse biodiversity impacts, and jeopardizing land access by rural populations in tropical countries. This paper analyzes the contested development of *Jatropha* biofuel sector in Tanzania by anchoring two new concepts of ‘organizational models’ and ‘institutional arrangements’ to the sectoral systems of innovation perspective. The notion of ‘organizational models’ brings into relief the heterogeneity of actors in an innovation system and the ways in which the actors form networks, within and across national borders, to organize innovative activities. The concept of ‘institutional arrangements’ refers to the ensemble of formal and informal institutions assembled during Tanzania’s colonial and post-colonial eras, which directly govern innovative activities in specific organizational models. Based on a location-specific and historically-grounded institutional analysis within the innovation system framework, implications are drawn for the future development of Tanzania’s *Jatropha* sector including its links with European markets and for the regulation of ‘next-generation’ biofuels.

(164 words)

1. Introduction

In the early years of the new millennium, *Jatropha* emerged as an important biofuel crop in many tropical countries. Initially hailed as a wonder crop (e.g., Francis et al., 2005), it soon became subject to severe criticism, along with many other biofuel crops, for competing with food production, causing adverse biodiversity impacts, jeopardizing land access by local populations, and fostering exploitative conditions of employment on large plantations (Achten et al., 2007; Friends of the Earth, 2010). In less than a decade, the development of *Jatropha* biofuels had turned into a highly chaotic mix of contestations and complex non-linear learning trajectories, replete with contradictions between global, national and local developments, as well as confrontations between elites and the rural poor.

In this paper we examine how this process has played out in the incipient sectoral system of innovation (SSI) developing in Tanzania, an important forerunner in *Jatropha* biofuel production, whose experiences have informed the international debate to a considerable extent. Our main objective is to perform an historical-institutional analysis of emergent organizational dynamics underlying the turbulent development of a sector around this controversial new technology. While recent studies have explored the development of contestations and conflict around *biofuel sustainability* in Tanzania and beyond (see for example, McCarthy et al., 2012; Montefrio, 2012; Romijn and Caniëls, 2011; Levidow and Paul, 2010), they have not studied how the *emergence of biofuel sectors* is shaped by long-standing historical institutions that are updated to present times in a co-evolutionary process of simultaneous mutual shaping of the old and the new. Such an analysis of emergence of new sector emergence is perhaps best carried out using the sectoral systems of innovation framework. However, in order to provide historical-institutional depth to the analysis of the emergence and early development of the complex and contested *Jatropha* biofuel sector in Tanzania, we have augmented the conventional SSI with two new concepts.

Using middle-range theorizing that starts from a specific empirical and historical situation, we develop the concepts of ‘institutional arrangements’ and ‘organizational models’. These concepts allow us to historicize institutions such as rules, beliefs and durable relations of power, which shape the activities of and the interactions between different actors in a sectoral system of innovation. Moreover, by including actors such as non-governmental development organizations and mass media outlets in our analysis, we are able to broaden the range of actors, their networks and interactive learning processes, which are normally considered as constituent elements of an innovation system. As we will show in this article, historically-constituted institutional arrangements directly govern the emergence of different organizational models and shape the interactions between (for- and non-profit) organizations, peasants and the state in these models, which form the core of Tanzania’s *Jatropha* biofuels sector. Paying attention to governance by institutions that are specific to Tanzania allows us to reveal how ostensibly global developments, such as the demand for biofuels induced by the climate change imperative and its European subsidies/targets, are ‘localized’ in different organizational models. Such location-specific and historically-grounded explanations of sectoral development processes are difficult to arrive through analyses that *apply* a ‘universal’ conceptual framework, such as the conventional SSI, in a particular part of the world.

Through this augmented SSI analysis, we aim to accomplish two things. First, we aim to trigger further conceptual development within the domain of innovation system studies. This conceptual development, as we illustrate below, should be driven by specific local histories rather than by treating prevailing institutions in a region or sector as local manifestations of generalist institutional elements of a SSI. Second, our historical-institutional and organizational analysis permits the drawing of policy implications for benefits (if any) and risks associated with *Jatropha* biofuel development in Tanzania (and its role as a supplier of biofuel feedstock for European consumption) and so-called ‘next-generation’ biofuels.

Policies to adequately regulate biofuel innovation and production have become particularly urgent in developing country contexts, particularly those in sub-Saharan Africa, where many biofuel investments have unleashed a large-scale grab of natural resources out of the hands of the rural poor in the hallowed name of global environmental sustainability

This article draws on two surveys conducted among biofuel actors in Tanzania in 2005 and 2008/9. More recent material collected during 2011-2 was used to update some of the arguments. In section 2, we introduce the SSI framework and then augment it by developing the two key theoretical concepts of organizational models and institutional arrangements. Section 3 outlines the data collection methodology. Section 4 contains the empirical analysis, organised into three distinct periods. Section 5 presents summary and conclusions.

2. Governance of organizational models in sectoral systems of innovation

The sectoral systems of innovation (SSI) literature conceives of sectors as composed of actors and their networks, which are governed by a variety of formal and informal institutions (Malerba and Mani, 2009a). The central idea is that actor diversity, cooperative as well as competitive relationships between them, and innovation-conducive institutions such as policy incentives and trust promotes economic growth, technological dynamism and competitiveness (Metcalf, 1995).

The sectoral innovation systems framework has been commonly used to analyse the emergence and development of new sectors as a process in which firms attempt to create and exploit the economic potential of technological innovations by meeting an emerging demand for new and established products (Malerba, 2002). In carrying out their sector-building activities, firms interact with a heterogeneous group of other actors (suppliers, users, universities, government organizations etc.) to form networks and learn technologically to develop not only new (or improved) products but also more suitable production technologies.

The effectiveness of this learning by interacting is shaped, and the different network relationships are governed, by national as well as sector-specific institutions. The governing institutions include ‘formal’ laws (e.g. intellectual property rights, environmental regulations) and standards (on industrial safety, quality etc.) as well as ‘informal’ beliefs, routines and social norms in specific regions and communities (Malerba and Mani, 2009a). Such a sectoral system is however not static but rather its different elements, ranging from new technologies to networked organizations and governing institutions, co-evolve with each other (Malerba, 2002).

In recent years, the sectoral systems of innovation (SSI) framework has been used to study innovation processes and emergence of new sectors in developing economies (see e.g. Chaturvedi, 2007; Kristinsson and Rao, 2008; Kim and Lee, 2008; Malerba and Mani, 2009b; Cusmano et al., 2010). This literature has provided rich insights into the acquisition of innovation capabilities among developing country firms in sectors ranging from wine in Chile to wind energy in India and capital goods in Korea. The process of technological ‘catch-up’ has been shown to be driven not only through learning linkages with advanced economy sources of knowledge but also through firms’ networking with domestic organizations such as research institutes and universities. Despite its rich insights however, this literature has tended to focus on ‘mainstream’ innovation actors (firms, scientific institutions, R&D labs, public policy makers), leading to a relative neglect of ‘fringe’ actors such as non-governmental organizations (NGOs), citizens’ pressure groups, mass media and resource-poor peasants (cf. Hart and Sharma, 2004). These ‘fringe’ actors may play a crucial role in the evolution of a new sector, particularly under the aegis of international development.

Additionally, the literature has generally under-appreciated the importance of specificity and the complexity of new sector emergence in developing country contexts. Far from being a teleological process, the development of new sectors in most settings is likely to be a

disorderly mix of local-global contradictions, contestations and non-linear learning trajectories.¹

Controversies around new technologies and the contested sectoral development process triggered by them thus necessitates us to move beyond a conventional systems of innovation approach as frequently employed by SSI scholars. In order to study the organizational and institutional emergence of a rather controversial new sector (biofuels) in Tanzania's globalized yet specific postcolonial context, we augment the SSI framework with two new concepts. First, to account for the full diversity of actors and the ways in which they form relationships with other actors and organize innovative activities, we develop the notion of *organizational models*. Focussing on organisational models draws attention to actors hitherto not considered as part of the SSI. These 'fringe' actors do not only shape learning by firms, research institutes and government, they may also learn themselves about the underlying knowledge bases and wider socio-economic consequences of new technologies. Additionally, studying the emergence of organizational models foregrounds how different actors become organisationally bound together in complete value chains. Second, in order to carry out a more explicit historical-institutional analysis of the governance of (the emergence and evolution of) different organizational models, we introduce the concept of *institutional arrangement* composed of multiple formal and informal institutions formed during successive

¹ Such an under-appreciation of contestations is perhaps due to the SSI framework's underlying theoretical view on how learning networks emerge. Differences in competences among the actors making up a SSI are argued to underlie network emergence which allows firms to "integrate complementarities in knowledge, capabilities and specialization" (Malerba, 2002: 256). While we agree with the SSI's thrust on heterogeneity of actors in terms of their competence and objectives, harnessing this difference solely for integrative complementary learning forecloses possibilities of observing and analyzing contestations between actors. Actors may arrive at divergent understandings of an innovation based on their different knowledge bases, competence and objectives. In fact, whether differences between actors will converge toward complementarity or diverge toward contestation can only be known ex-post and fruitfully analyzed as a process that is shaped by historically-constituted institutions.

eras of Tanzania's colonial and post-colonial history. In this conceptualization, Tanzanian institutional factors are not treated as local manifestations of generalist national or sectoral institutional elements of an innovation system which can be found anywhere in the world. Rather we attempt what may be called middle-range theorizing (Boudon, 1991; Geels, 2007), driven by a specific empirical situation and history, in order to embed the emergence of Tanzania's biofuel sector explicitly within its postcolonial context. However this does not imply that we treat the Tanzanian SSI as self-contained, lacking any connections to the outside world.

Organizational models

In the current era of globalization, few if any sectors are developed within the confines of national borders. This is particularly true for countries where international development funds flow in at the same time as foreign direct investments by transnational corporations. Therefore, to study sectoral emergence and development, we must consider the dynamics of global connections alongside local activities and processes. This implies going beyond accounting for trade and investment flows by studying how actors in particular socio-economic settings assimilate and adapt global developments such as changes in international regulatory frameworks and the advent of new external sources of knowledge or grassroots initiatives by non-governmental organizations (NGOs) in response to calls for bottom-up development from international aid agencies. To study the changing (heterogeneous) composition and activities of an emerging network of actors in a sector, including their local and non-local ties, we propose the notion of organizational models. An organisational model refers to the way in which production, innovation and use of a particular product or technology is carried out in the emerging sector. The concept combines and connects two of three building blocks of a sectoral system of innovation, knowledge/technology and

actors/networks.² It brings into focus the formation of networks and value chains (including the content of flows between actors in the networks or chains), which may be required to create, produce and use a technology in a sectoral system of innovation. These networks and value chains may be composed of profit-making entities such as firms and/or non-profit organizations, which may collectively organize and perform the entire range of activities from cultivation to end-use (in our case, of *Jatropha* biofuels).

Our concept of organizational model is related to the better known term of ‘business model’ which has become common currency in recent strategic management literature (see for example, Amit and Zott, 2001; Chesbrough and Rosenbloom, 2002; Teece, 2010). A large number of definitions of the business model concept are now available. Based on a survey of the literature, Zott et al. (2011a) argue that ‘business model’ is not one, but rather many concepts. The dominant conceptualisation views a business model as the logic of how a business creates value while meeting its customers’ needs and “the architecture of revenues, costs, and profits associated with the business enterprise delivering that value [to its customers].” (Teece, 2010: 173; see also Chesbrough and Rosenbloom, 2002). Studies adopting such a definition of business model generally analyse how a focal firm exploits technological or organizational innovations (Zott et al., 2011a). Even though it is noted that a focal firm cannot create or exploit value without its suppliers and buyers, the business model concept remains centred on the firm and its revenue flows. Such a conceptualization is inadequate for appreciating the heterogeneity of actors and networks operating in Tanzania’s emerging *Jatropha* sector.

A more promising conceptualization for our purposes is provided by studies on business strategy which lay emphasis on activities that cross a firm’s boundaries. Here, a business

² The third building block, institutions, is elaborated by the concept of institutional arrangement discussed later.

model is treated as an activity system.³ It is a “system that is made up of components, linkages and dynamics” (Afuah & Tucci, 2001: 4, in Zott et al., 2011a: 19). An activity system then tells us how a set of interdependent activities are organized by a network of actors. It includes the commercial/financial concepts used by the actors, their product and/or service offerings, the organisation of cultivation, production, distribution and (envisaged) end-use, development of new technologies, marketing concepts and buyer-supplier relationships. However, the activity systems (and the wider business model) literature has little to say about *how* a diverse group of actors form and modify relationships with each other in a network, governed by a set of relevant institutions in a sectoral system of innovation (SSI).

In the *Jatropha* biofuels SSI of Tanzania, different organizational models have appeared in succession: the local rural community development model; the decentralised outgrower/subcontractor model; and the (large) plantation-based model. Ostensibly, 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). However, a closer examination reveals how their development is guided by historical institutions that are specific to Tanzania’s postcolonial context and bear some resemblance to late colonial models of organising production and processing of agri-commodities (Havinden and Meredith, 1993). Each organizational model is also closely associated with different actors, network relations, organisational strategies, and different views on the importance of economic viability as compared to environmental and social sustainability. In this sense then, the concept of

³ The original concept of, and the early literature, on activity systems focussed on the set of interdependent and complementary activities performed by a single firm (see Zott et al., 2011b for an overview). In the present article however, we view it as the system of interlinked activities that span a firm’s boundaries and must be performed by a network of actors.

organizational models directs our attention not only to the heterogeneity of actors in a SSI, but also to the multiple modalities of their networks, their collective strategies and the socio-economic and environmental consequences of their innovative activities.

Furthermore, a variety of formal and informal institutions mediate between different actors' activities in the organisational models and the socio-economic and environmental sustainability performance that the models give rise to. However, as it is still too early to analyse the definitive outcomes of the organisational models, we focus on the *process dynamics*: how key actors' innovation and production activities, and the nature of relationships between them, are governed and influenced by relevant institutional arrangements.

The institutional arrangement

Following Casson et al. (2009), we use the term institutions to refer to local customs, beliefs, and social norms, as well as broader sectoral, national and global institutions such as the political climate and routines of government organizations, international trade regulations and development aid regimes. This emphasis on a wide range of institutions shaping actors' innovative activities and interactions runs through much of the literature on systems of innovation (see for example, Carlsson and Stankiewicz, 1991; Lundvall et al., 2002; Parto et al., 2005; Malerba and Mani, 2009a).⁴ In the present article, we view the set of formal and informal institutions, which guide the development of an organizational model, as an institutional arrangement. 'Governance', then, is performed by a historically-constituted

⁴ However, it must be noted that the concept of institutions has taken different meanings in different strands of the systems of innovation literature (see Gronning, 2008 for a review). Some scholars have also treated organizations, including large firms and their sub-units, as institutions (e.g. Carlsson and Stankiewicz, 1991; Nelson and Rosenberg, 1993; Niosi, 2002).

institutional arrangement that includes relevant formal and informal institutions and policies which together guide investment, production and innovation activities in the sector. An institutional arrangement, after it has been gradually assembled and stabilized through a historical process, may be location-specific but its constituent elements often have their roots in national/global regulations *and* local ‘traditions’. For instance, the Tanzanian institutional arrangement of interest to us has its roots in pre-colonial ‘traditions’ (adapted to ‘modern’ times) and colonial as well as post-colonial modernity. Thus, in this arrangement that governs present-day biofuel activities in Tanzania, (updated) ‘traditional’ institutions *co-exist* with other newer institutions put in place during colonial and post-colonial eras.

In the making of an institutional arrangement, older institutions condition the emergence of newer ones, even if the latter may eventually displace the former. In this way, older and newer institutions are transformed in interaction, or co-evolve, with each other as elements of a dynamic system of innovation. The past (in terms of older institutions) is not simply forgotten and relegated to history but remains active and relevant in guiding human behaviour in the present (Shortland, 1998). In general, institutional change may be viewed as the production of more and more entanglements between old and new institutional elements, rather than a progressive and complete replacement of the old by the new (cf. Latour, 2000). In the following, we delve into East African colonial and post-colonial history to delineate the formation of an institutional arrangement that is directly relevant for our present purposes of analysing the evolution of Tanzania’s *Jatropha* biofuels SSI.

In colonial times, Mamdani (1996: 287) has famously argued that the “state [in Sub-Saharan Africa] 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.” Under this *indirect governance*, peasants did not possess the rights of a citizen but rather remained

subjects of the colonial state. The colonial government also acted as a custodian of an all-encompassing ‘tribal customary’ law, often expanding and distorting its meaning and scope, which was used to exercise force on uncooperative peasantry as well as govern local land and labour transactions. These transactions took place in a grey area between coercive force and the market. In the post-colonial era, according to Mamdani, this enmeshment of force and market, of customary authority and economic logics, continued to flourish as colonial legacies.

Recent studies have argued that Mamdani’s idea of the bifurcated state, in which colonial authorities used the power of customary chiefs to ‘indirectly govern’ their subjects, is an accurate description of the colonial situation during the 1920s and 30s only (see for example, Cooper, 2005; Schneider, 2006, Burton and Jennings, 2007). During the late colonial era of the 1940s and 50s, the decades directly preceding decolonization, the colonial state made concerted attempts to discontinue its ‘indirect governance’. In order to develop the colonies, the state had replaced most ‘traditional’ local chiefs with ‘modern and progressive’ Tanzanians. The latter, as members of village and district development councils, acted under direct orders from the central colonial government. Local governance through village and district development councils was thus progressively fused with the central government since the 1940s.⁵ The local councils received development plans and orders from the central government on whom they were financially dependent (Pallotti, 2008). The post-colonial state inherited this scheme of *developmentalist governance* in which state officials attempted to sideline ‘traditional’ authority. Similar marginalization of traditional chiefs continued in the

⁵ This fusion however does not imply that postcolonial governance completely replaced ‘traditional’ social relations. Governance through networks of informal patron-client relationships were materialized, by patrons and clients both, throughout the post-colonial era (Young, 2004).

first two decades (1960s and 70s) of the post-colonial era, particularly in Nyerere's socialist Tanzania.

Developmentalism, embedded in shared visions (of progress) and routines of state officials at all levels,⁶ is believed to be the basis of authoritarian rule by late colonial and post-colonial governments (see e.g. Scott's 1998 analysis of Nyerere government's large-scale compulsory villagization programme aimed at the modernization of Tanzanian agriculture). Developmentalism was sustained by specific representations of development's 'beneficiaries' as 'backward', 'traditional', 'conservative' and 'lazy' (Schneider, 2006). Due to these undesirable attributes, development's beneficiaries were viewed as producers of their own poverty and disease (Marsland, 2006). Such representations facilitated not only the administration and financing of top-down modernization programmes (often supported by international development aid in postcolonial times), but also fostered a mistrust of poor people's agency among state elites. As a result, state officials actively marginalized the agency and initiative of the poor, sustaining developmental paternalism. Overall, five features of late colonial and 'socialist' postcolonial developmentalist governance can be identified (Burton and Jennings, 2007): (a) state officials' faith in modernist top-down planning; (b) promotion of and confidence in developmental solutions provided by Western technoscience; (c) paternalism of the state toward its citizens and subjects; (d) concomitant suspicion toward the citizens' agency, particularly those that were uneducated and poor; (e) increasing economic and socio-cultural differentiation in the population.⁷ As we show below, most of

⁶ Schneider (2006) has convincingly argued that even when local officials did not literally follow the central government's orders, their own personal adherence to developmentalism guided their actions.

⁷ During the colonial era, in East Africa, this differentiation was promoted by the state in the first place by granting preferential access to land and other resources to white settlers and through handsome remuneration packages for state employees (Burton and Jennings, 2007). In postcolonial times, the high salaries (and other opportunities that

these features, modulated by the arrival of new institutions, have been carried over to the present.

In addition, roots of authoritarian and paternalistic governance by postcolonial elites are argued to lay in their “singular adaptation of ‘traditional’ African forms of social and political relations to the modern world.” (Chabal, 2009: 15). Here, paternalistic governance is said to be anchored in pre-colonial patrimonial ‘traditions’ in which leaders were respected as teachers and family heads. These leaders possessed the right to correct, dismiss and even punish non-elites if their initiatives were deemed inappropriate. This is certainly true for Nyerere in Tanzania, who was widely respected as a teacher and father (of the nation). Under this *patrimonial governance*, Nyerere often voiced and exercised his right to discipline and punish protesting students and peasants (Schneider, 2006; Eckert, 2011; Saul, 2012).

Since the mid 1980s, Nyerere’s socialist developmentalism has been complemented, overlaid and partly displaced by neoliberalism. Advised and coerced by the World Bank and the IMF, the Tanzanian state has gradually withdrawn from the economy to ‘free’ the markets.⁸ Poor peasants in the neoliberal discourse have been reframed as rational agents, adding a new twist to the distrust and marginalization of peasants’ agency by state elites. Under *neoliberal governance*, peasants’ agency as individualized maximizing agents of neoclassical economics is to be promoted (Harrison, 2005; Pallotti, 2008). Yet beyond the promotion of peasants’ agency in this rather narrow economic sense, public and now private

can be accessed as a result of proximity to state bodies) continued not only for government employees but also for those employed by parastatals and quangos (quasi-autonomous non-governmental organizations).

⁸ Neoliberalism has ushered in privatized governance led by non-governmental organizations (NGOs). Additionally, since the 1990s, most Tanzanian parastatals have been privatized, often with foreign direct investment promoted by the state (Schroeder, 2008). Foreign private corporations (including those from the historical rival South Africa) are now depicted by Tanzanian political elites as friends and partners in development. In terms of governance, the recent developmental partnerships of the state (with NGOs and corporations) have produced a new regime that is part public and part privatized.

elites have continued to pursue developmentalist, modernization-inspired strategies, while marginalizing and distrusting broader socio-political agency and initiative of common Tanzanians (for examples, see Walley, 2002, for disregard of local peoples' knowledge by governmental and non-governmental officials in a marine park; Marsland, 2006, on the organization of a participatory community-based public health project by the Tanzanian state in a style not very different from the old developmental paternalism; and Schroeder, 2008, for South African firms' distrust of Tanzanian farmers' capabilities).

In general, the style of neoliberalism that has emerged and developed in Tanzania over the last three decades has been shaped by developmentalist and other institutions nurtured and created during the late colonial and early postcolonial periods. While playing an active role in rolling out the neoliberal reform process, the Tanzanian state has continued to "favour the *dirigiste* model of state-society relations of the socialist era" (Pallotti, 2008: 232). Far from being consigned to the dustbins of history, governmental paternalism continues to flourish in a country where 'all land is public land vested in the President as trustee on behalf of all citizens' (URT, 1993: 3.1.b, in Pallotti, 2008: 228). Even the state itself, particularly since the early 1990s, has not been simply weakened or rolled back but rather re-formed into a specific kind of a strong state that operates according to neoliberal principles. Inside its own organizations, the state has introduced numerous incentive-based mechanisms such as "results-oriented management and output-oriented budgeting" (Harrison, 2005: 1309).

In the foregoing, we have attempted to illustrate how newer institutions of governance in Tanzania did not simply replace their older counterparts, but rather the old and the new, the formal and the informal, became entangled with each other. Such institutions included 'customary' norms, shared developmentalist visions of political elites, governmental regulations to promote free markets and constitutional decrees that vest all land in the office of the country's president. These and other historically-constituted institutions form a

contemporary institutional arrangement assembled during colonial and postcolonial eras under indirect, developmentalist, patrimonial ('traditionalist') and neoliberal governance. Together the elements of this institutional arrangement guide but do not determine the behaviour of different actors (including those whose agency the same arrangement attempts to marginalize), and the nature of their interactions with each other, in a SSI. In some circumstances that are deemed unjust or undesirable, these actors may, collectively and individually, confront, subvert, adapt, or evade institutional governance.

In the remainder of this paper, we use the two concepts of institutional arrangement and organizational model to analyse how particular constellations of actors come together in the form of distinct organisational models as the SSI evolves. We carry out a dynamic analysis by comparing emerging organisational models and their institutional governance in Tanzania's Jatropha biofuels SSI for three different years: 2000, 2005 and 2008/9. We also attempt to show how learning by firm and non-firm actors in the respective organisational models shapes subsequent actions and choices, once again in an intimate interplay with the institutional arrangement. Since the kind of reflexive learning processes that can give rise to new strategic decisions and re-orientation have gotten underway only recently, we are unable to give a comprehensive account of this learning dynamic at this point in time. The focus in the following is thus squarely on the unfolding *processes* (as opposed to definitive outcomes or impacts) of sectoral development observed as the emergence of different organizational models governed by the prevailing institutional arrangement. Thus, our analysis built on the two concepts we have developed above encapsulates and links up the three building blocks of SSI (namely, technologies, actors with their networks, and institutions). However, it also permits us to add historical depth to, and broaden the heterogeneity of actors and their networks and learning processes beyond conventional SSI analyses.

3. Methodology

In two surveys in early 2005 and late 2008, we attempted to trace all significant *Jatropha* activities in Tanzania by talking to people who were knowledgeable about the fledgling sector: officials from the Ministry of Agriculture and Minerals and the National Biofuels Taskforce (established in 2006), NGO representatives, academics and private entrepreneurs. *Jatropha* activities include nursery preparation, cultivation of the plant, seed pressing, and developing end-use applications for the oil or the residual seedcake. We used the snowball method to identify key informants, starting with a few known actors and identifying others through them. Most early activities were development projects led by local NGOs and governmental agencies, but there were also a few for-profit ventures run by local companies. All had one or more foreign connections for accessing financial support or techno-scientific knowledge. The first survey found 17 experimental projects and the second identified close to 40.

Most of the activities were visited and a few contacted by e-mail. Many early experiments were in the Arusha and Kilimanjaro regions in the northeast. Others were in Morogoro, Dar es Salaam, Kilwa, and in Tunduru in the south. Later on, activities were also found in western and northwestern Tanzania. Face-to-face interviews, guided by a detailed standard checklist of open-ended questions, were held with representatives of these *Jatropha* activities. Each interview covered 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 inquired how these activities were embedded in larger business networks. For the pivotal SSI actors out of these, we investigated what the networks looked like in terms of the adopted organisational models, covering aspects such as strategic goal orientation (in relation to environmental, social and economic sustainability), organisation of cultivation and

processing, technology and associated learning processes, labour relations and linkages with other actors in the sector. We inquired about people's expectations about future developments, since expectations can be an important driver of people's actions. Considering the complexity of the processes and the experimental nature of the research, we focussed on gathering qualitative information through the interviews.

In addition, government representatives were interviewed, predominantly for contextual information about Tanzania's energy bottlenecks and strategy and the government's perspective on the role of biofuels. Actors located outside Tanzania (such as international donors, car manufacturers, seed growers and airlines) were not interviewed.

4. Emergence of a *Jatropha* biofuels sector in Tanzania: institutional and organizational considerations

In the development of Tanzania's *Jatropha* biofuels sector, three different organizational models have appeared in succession since the year 2000. We analyse the institutional emergence of these organizational models, starting with the nascent situation of the sector in the year 2000 with the local rural development model, followed by the emergence of the smallholder outgrower and plantation models in 2005 and 2008/9. Over time, the heterogeneity of actors and their networks in the SSI thus became greater. This growth in actor heterogeneity, and of the size of the sector, was accompanied by increasing contestations and controversies about the sector's operations as well as about its environmental and developmental consequences.

4.1 The fledgling situation in 2000

The emergence of the first *Jatropha* activities in Tanzania has to be seen against a wider background. Tanzania is heavily dependent on fossil fuel imports to meet its energy needs.

The electricity grid reaches only 11% of the total population (EWURA, 2007) and blackouts and power drops occur frequently. 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 as the country's population continues to expand.

Tanzania's agricultural sector is dominated by vast numbers of small and marginal farmers who have long been adversely affected by structurally low prices of staples such as maize and cassava, underdeveloped infrastructure, and lack of services (Wahl et al., 2009). Due to their faith in developmentalist modernization, Tanzanian politicians since the colonial days have aimed to develop a 'modern' agricultural sector based on large-scale farming. Additionally, since the onset of IMF-induced neoliberal strategy of Structural Adjustment in 1985, resources for agricultural research and extension work and subsidies on mineral fertilisers for the bulk of Tanzania's small farmers have all but dried up.

The first organizational model

Jatropha has been grown in the country for generations as fencing and grave marking, but it had no recognized commercial value until 1992, when a small company with a rural development mission called KAKUTE started local experiments with it. KAKUTE first collected 200 kg of seeds in the Sengela region for research, on the basis of which it started helping smallholder farmers to cultivate the plant. Simple ram presses and Jatropha oil lamps made from instant coffee tins were introduced. Knowledge was basically accumulated through practical experimentation, test plots, and discussions with local women's groups. KAKUTE was the first to set up a network of local collection centres in rural areas, from where seeds were collected periodically to be processed in the organisation's small oil-pressing and soap-making facilities in Arusha. Initially, KAKUTE also played a significant role in the establishment of other players in the fledgling SSI 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.

This grassroots-based organizational model is in line with a fast growing strand in the literature on technology and development, which studies how new technologies can enhance social inclusion and reduce poverty (e.g. Arond et al., 2011). Many of these studies observe that new technologies can address specific social needs, especially when they are developed through networking and collaboration with local communities (e.g. Sutz and Arocena, 2006; Richter, 2004; Douthwaite et al., 2001), as KAKUTE attempted to do. Elements of the literature also argue that even though such initiatives hold out the promise for poverty alleviation, some of them may eventually lead to disappointing results and create situations where the poor may be further subordinated (see e.g. Nygaard, 2010; Romijn et al., 2010; cf. Mosse, 2001; Cleaver 1999).

The institutional arrangement

In the year 2000 KAKUTE obtained its first international funding from the US-based McKnight Foundation to expand its *Jatropha* activities. Development funding of KAKUTE's *Jatropha* activities is symptomatic of Tanzania's heavy reliance on international aid in all spheres of life. Under this developmentalist cum neoliberal institutional governance, even private businesses (such as KAKUTE) have been able to access government and foreign resources for development purposes. In fact, thousands of NGOs and private social entrepreneurial ventures have proliferated in Tanzania since the mid-1980s. The more prominent of these are organizations that tap into the foreign aid stream, which have, in this process, honed their resource acquisition skills and nurtured their contacts with funding agencies. However, such a focus on the development of funding acquisition skills does not

directly translate into effectiveness in achieving grassroots-based development interventions where the poor beneficiaries' needs and agency must be made central. Achieving such effectiveness becomes particularly problematic in the Tanzanian institutional context where the same beneficiaries' agency has been marginalized and distrusted for decades under regimes of developmentalist, indirect, and patrimonial governance (as outlined in section 2).

In this broad institutional context, KAKUTE turned out to be a highly capable player, riding on a wave of international popularity of *Jatropha* as an instrument that promised to deliver poverty alleviation and rural development. It dominated the small *Jatropha* network in the years following 2000. The learning processes in the sector were incipient (based on KAKUTE's efforts), without involvement of specialised knowledge institutions such as universities and committed R&D laboratories. The government did not play a direct role in promoting learning, as a regulator, network actor, or financier in the sectoral system. As we already noted, however, the government has played an important role in the background to usher in neoliberal governance (of Tanzanian agriculture and international development aid) while sticking close to its developmentalist ideals.

The government produced other indirect effects on *Jatropha* biofuels sectoral development. Many farmers have had disastrous experiences with earlier government-sponsored 'scientific agriculture' initiatives such as that promoted in socialist *Ujamaa* villages under Nyerere. Farmers have also lost faith in experimental new crops introduced through government initiatives.⁹ The lack of trust by farmers in the government and its promises to uplift them, has thus accumulated over decades of negative experiences. Since the mid-1980s, under neoliberal developmentalist governance, the failure of many NGO-led development

⁹ Recent experiences, such as that with the Moringe tree – promoted by the government a few years ago – were also disappointing as farmers were let down by the lack of a profitable market (Roks and van Vlimmeren, 2009).

projects has broadened the ambit of farmers' lack of trust (that originated in government interventions) to include private organizations. This general lack of trust has thus influenced the effectiveness of interactive learning by different actors in the *Jatropha* biofuels SSI from the very beginning.

4.2 The situation in 2005: A road paved with high expectations

The growth of the *Jatropha* sector in Tanzania (and elsewhere) was boosted by the Kyoto Protocol on measures against global warming, which came into force on 16 February 2005. Other important pressures from the international environment included increasing awareness of possible oil price peaks, fast-rising energy demand from emerging Asian economies, and structural instability of Middle Eastern oil supplies due to geopolitical problems. Steadily rising prices of fossil fuels, which reached almost US\$70 per barrel (Brent crude) that year, were an important manifestation of these emerging pressures on the sectoral system. Meanwhile, potential investors in biofuels had already perceived the attractiveness of vast areas of seemingly uncultivated land in Africa that could be exploited for biofuel cultivation for western markets (Mercer, 2003). *Jatropha* had also been singled out as a particularly promising crop after early publications noted its potential for regenerating degraded land and preventing erosion, alongside energy provision (Heller, 1996; Henning, 2004; Jones and Miller, 1993; Openshaw, 2000).

New organizational models

By 2005 a small *Jatropha* sectoral innovation system had formed in Tanzania, consisting of a few loosely connected experiments involving around 30 different actors. However, guided by neoliberal governance, the government was still not a directly involved actor in the network (van Eijck, 2007: 87), leaving the private sector to lead biofuel development initiatives.

The original key player, KAKUTE, had been joined by another core actor: Diligent Tanzania Ltd, a subsidiary of a small Dutch TNC, Diligent Energy Systems. The latter had started pursuing an informal outgrower model, collecting seeds from farmers on an irregular basis (for instance at weekly markets), including seeds collected from wild *Jatropha* plants already growing in Arusha region. As a next step, Diligent began to contract small farmers to provide seeds on a more regular basis for its prospective mechanical oil-pressing facility in Arusha, and initially distributed *Jatropha* seedlings as well. Diligent was cautious, foreseeing the competition between food and fuel crops: farmers were advised not to plant *Jatropha* as a substitute for food crops on arable plots, but only as hedges around their food plots and homesteads, where they could function as boundary markers, wind breaks, and anti-erosion devices.

A new variant of the rural-development organizational model was also getting off the ground at this time, initiated by an NGO called TaTEDO, a well-established organisation for appropriate technology development with close links to the government and major international aid donors. TaTEDO received aid money from the German GTZ (Deutsche Gesellschaft für Technische Zusammenarbeit, now GiZ) to enter into *Jatropha* activities. Borrowing from an idea initially piloted by GTZ and other western donors in Mali (Togola, 2008), TaTEDO set up two 'Local Multifunctional Platforms' (LMPs) in the remote Maasai villages of Engaruka and Leguruki. Designed to promote 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 farmers cultivate *Jatropha* as hedges around fields and/or intercropped with food crops, and that the oilseed harvest eventually substitutes for fossil diesel as feedstock for locally generated electricity (Wijgerse, 2007). The LMP was meant to stimulate activities such as maize milling, lighting, radio services and mobile phone charging. Given the low rural electrification rate and the high diesel and kerosene prices in the

country's remote rural areas, combined with the government's developmentalist visions for its millions of roaming Maasai herders to adopt a "modern" sedentary lifestyle with access to basic health and education facilities, the LMP held out promise as a significant engine of rural development.

In subsequent years, considerable financial support for additional multi-functional platforms became easily available to TaTEDO, in spite of the fact that even the original platforms in Mali were by then rumoured to be powered mainly on fossil diesel in view of the extremely arduous and unrewarding work involved in harvesting and dehulling *Jatropha* seeds. The most well-known Malian project of Garalo, which was extensively supported by the Dutch FACT Foundation and the Danish Folke Center, reportedly only worked on *Jatropha* oil in the presence of important visitors. On these occasions, local women were paid from project aid money to induce them to gather seeds, railing against the original development aid idea of financial self-sufficiency.¹⁰

The institutional arrangement: influences on sectoral development

Institutionally, the emergence and rise of TaTEDO's organizational model based on multi-functional platforms has been guided by neoliberal developmentalist governance which nurtures NGOs in their attempts to achieve 'pro-poor growth'. This form of developmentalism is fostered from within and outside Tanzania by current fashions (e.g. for 'pro-poor growth') in the international aid community led by the World Bank and the development visions generated by the Millenium Development Goals (women's empowerment and environmental sustainability). *Jatropha* LMP projects aiming at local rural development were widely embraced as a promising concept that could provide the perfect tool

¹⁰ Personal communication between Ywe Jan Franken of the FACT Foundation and one of the authors.

for realising all these variegated ambitions simultaneously (Nygaard, 2009). Thus, similar to KAKUTE, TaTEDO's activities and network interactions were institutionally shaped by prevailing international development aid fashions, modulated by Tanzania's mix of developmentalist and neoliberal governance.

Diligent's organizational model, organised around small-scale outgrower farmers, aligned well with Tanzania's private-sector development strategy to foster investment and economic growth. Outgrower models were already popular with western flower and seed firms in the area, which had settled in the Arusha and Moshi area after Tanzania adopted a foreign investor-friendly development strategy in the 1980s. Diligent basically copied the same type of arrangement. One of its investors was also the owner/entrepreneur of a flower-growing firm, which shared some of its outgrower contacts with the new company.

Diligent's choice for an organizational model that did not require own land acquisition by the firm was also governed by other institutional elements. Official procedures for land acquisition in Tanzania are cumbersome. Particularly onerous for foreign investors is a law that stipulates that 'village lands', over which communities have customary rights, cannot be leased directly to them. First, such lands have to be converted to 'general land' which is directly under jurisdiction of the state. The state then leases out the 'general land' to the investors (for a maximum of 99 years). Under this updated form of indirect governance of land transactions (as discussed in section 2), local populations have experienced many unwanted land transfers to foreign parties for purposes that often entail no benefits for the locals. Even the complexity of the procedures, involving rural communities with their customary ownership of land and many levels of Tanzanian government, can lead to different interpretations of a situation and possible conflict (HAKI ARDHI, 2010; Kashaigili and Nzunda, 2010; Odgaard, 2006; Sulle and Nelson, 2009).

Despite avoiding direct acquisition of land, Diligent experienced severe difficulties in gaining farmers' trust as a result of the prevailing institutional arrangement, with its history of developmentalist governance. Farmers were happy to sign a sales contract with the firm, but often broke it as soon as another seed buyer (such as KAKUTE) came along with a higher price, even though Diligent guaranteed purchases for 10 years at a fixed (albeit low) minimum price. This lack of trust between farming communities and firms has been a core factor in preventing the building of stable long term relations that are required for sustained interactive learning and for establishing reliable outgrower-based value chains. Diligent's management attempted to overcome these trust-related institutional constraints by investing in regular personal visits to the farmers. However, as the firm expanded its operations, the sheer number and geographical spread of outgrowers made it logistically infeasible to continue these visits. This lack of trust is not limited to the relationships between peasants and non-state organizations. The Tanzanian government is not trusted by civil society elements including environmental NGOs (such as the Tanzania Natural Resource Forum) and journalists, particularly in relation to its welcoming neoliberal attitude toward large-scale biofuel investments (which ushered in disastrous biofuel projects after 2008, as we document below). The government has taken some of the criticisms (made by NGOs and journalists) on board, insisting that controversies about biofuels' environmental and health effects must be resolved before it can commit itself to *Jatropha* promotion. This stance has led to two important interrelated elements of the *Jatropha* biofuels innovation system remaining unaddressed: a) government regulations and official product standards scripted by the Tanzanian Bureau of Standards, and b) stimulation of domestic demand which is necessary for ensuring that Tanzania's biofuel production helps address some of its energy poverty and accessibility problems.

In the absence of official domestic blending permissions, Diligent turned to the exploration of foreign markets where mandatory mix targets and subsidies had made actors remarkably less concerned with any adverse social or environmental consequences of *Jatropha* biofuel production.¹¹ For example, Diligent attempted to supply bio-kerosene feedstock to the EU aviation sector. It was initially successful in doing so, but became dependent on one powerful international buyer, which was subsequently hit by the EU's recession in 2011-2, and broke its pledge to pay a good price for the feedstock. This turn of events would eventually lead to severe financial problems for Diligent in mid-2012.

Overall, due to the lack of trust among different actors and the absence of a coordinating government organization and policies, individual learning processes were not being synthesised or shared, despite the presence of a relatively large number of actors operating in the sectoral innovation system. Hence, expectations about *Jatropha*'s viability remained generally highly positive, leading to little reflection on any major problems that were encountered. This is symptomatic of wider future-positive orientation in international development (Edwards, 1999). TaTEDO's case provides a perfect example of this future positive orientation and the utter lack of reflection about the disappointing results with its first two projects. The Engaruka multi-function platform never made it to the operational stage, and the one at Leguruki was only functioning (at times) on fossil diesel.¹² Yet, TaTEDO's portrayal of successful projects on its website, in brochures and in its discourse was apparently not questioned by its donors. Interactive learning was also constrained for other reasons: domestic universities had inadequate laboratory facilities for conducting substantial

¹¹ Most other foreign-direct investment in Tanzania's *Jatropha* sector was geared toward catering to the lucrative European biofuel markets from the start, without having explored the domestic market.

¹² Personal communication with Sanne Heijnen and staff members of the Nelson Mandela African Institute for Science and Technology, who carried out field visits to these TATEDO projects in 2012.

engine and oil tests, which necessitated the building of foreign research linkages. However, these external links could not fully compensate for local interactive learning processes involving exploratory brainstorming and exchange of tacit knowledge, which require close interpersonal interactions (Johnson et al., 2002; Nightingale, 2003; Balconi et al., 2007). On the other hand, local learning processes that were actually initiated by organizations such as KAKUTE were institutionally constrained by the lack of interaction with partners from research establishments. For example, one of KAKUTE's experiments with *Jatropha* seedcake for biogas production yielded poor results because of unreliable gas pressure. A cooking stove prototype did not function properly and there were many complaints about fumes and fears about their possible toxicity; all problems that could have been effectively solved through interactions with university scientists and engineers.

In sum, although organizations differed about how *Jatropha* can be best exploited for end use (types of products and nature of demand), most were still optimistic about its potential in the absence of the sharing of emerging lessons. At the same time, many elements of the institutional arrangement (assembled under neoliberal, developmentalist and indirect governance) have shaped the direction of sectoral development. In particular, by facilitating and enabling certain options while constraining or foreclosing others, they conditioned the choices for specific organizational models with their different network interactions and for marketing strategies. Some of these choices also contained the ingredients for problems that would be encountered a few years down the line.

4.3 The 2008/9 survey: explosive growth and contestations

The high expectations generated internationally in the early years of the *Jatropha* sector's development fostered great optimism regarding investment possibilities (Carels, 2009; GEXSI, 2008). This was intensified by an Intergovernmental Panel on Climate Change report

expressing 90% certainty that the increase in atmospheric CO₂ had been induced by human activity and warning that if combustion of fossil fuels was not reduced significantly within decades, a temperature increase of over 2 degrees Celsius would cause catastrophic climate change (IPCC, 2007). Between 2005 and 2008, Western countries showed great interest in utilising biofuels to combat climate change and enhance their energy security. The EU's Directive 2003/30 had set indicative targets of 5.75% by 2010 and 10% by 2020 for biofuel consumption as road transport fuel. The US set a target 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 increase to approximately US\$ 25 billion by 2015 (Hauwermeiren, 2008).

These trends together heralded a major new phase in the sector's development, causing an influx of transnational corporations into tropical countries in Asia, Africa and Latin America, intent on large-scale commercial cultivation of *Jatropha* predominantly for Western transport fuel and electricity generation (e.g. ABN, 2007; Beattie, 2008; FAO, 2008; GEXSI, 2008). Within a few years, the investment stream began to attract considerable attention in the media. A CNN report estimated that more than 720,000 ha had been planted by spring 2008; this was expected to rise to over 21 million ha in 2014 (Whiteman, 2008).

At the same time, in 2007-8, the world was hit by a food crisis. Food prices reached their highest levels since the 1970s. Many parts of the world witnessed food riots (Patel and McMichael, 2009). This crisis intensified the food versus fuel debate (Rathmann et al., 2009). A World Bank publication argued that rising demand for biofuels in rich countries was the single most important reason behind increasing food prices (Mitchell, 2008, also see OECD 2008).

Organizational models

In Tanzania, the consequences of these global trends were clearly visible in a survey conducted in early 2008 that identified a range of initiatives and scales of production, varying from small-scale local activities to extremely large plantations exceeding 50,000 ha (Martin et al., 2009). In our second survey in late 2008, all these initiatives were found to be linked to foreign commercial investors or aid donors.

TaTEDO's Local Multi-function Platform (LMP) concept was expanded to 120 other locations through financial support from EU-based international development NGOs such as the Dutch HIVOS and Cordaid (Roks and van Vlimmeren, 2009). In Tanzania, several NGOs, Christian mission communities and private social entrepreneurial ventures started developing *Jatropha* projects for local development: good examples are, a) project led by DOSI (Dutch Orkonerei Social Investment) based in Arusha to make dairy products in collaboration with Maasai groups and, b) Kiumma's German-funded project for generating electricity for a hospital and religious order in Tunduru in the south.

As *Jatropha* projects for local development were growing, new projects also started emerging on the other side of the organisational model spectrum: large plantations were being established by a number of western firms, mostly from EU countries spurred by European subsidies and fuel-mix targets. Tanzania's government was initially keen to attract this type of foreign direct investment, guided by its prevailing neoliberal developmentalist governance schema. The latter itself was informed by rhetoric from leading international aid organisations which claimed that such large-scale private sector initiatives can be significant engines of growth because of their ability to bring in new technology, create substantial employment opportunities in rural areas, and improve Tanzania's balance of payments situation through import substitution of diesel oil or direct exports of feedstock.

As discussed in the previous section, land acquisition procedures in Tanzania can be cumbersome particularly for large parcels suitable for plantations. As a result, most *Jatropha*

plantation projects were still in their infancy in 2008/9. Nevertheless the plans were rather grand. One company had plans to lease over 80,000 ha of village land for conversion to *Jatropha* monoculture, after removing existing vegetation with imported heavy duty earth-moving machinery. In accordance with the innovation system perspective, it planned to collaborate with local and foreign universities to conduct interactive learning experiments geared toward maximizing yields using techniques such as pruning, mulching and pest control. It also intended to use new production technologies such as mechanical harvesting, never tried before with *Jatropha* at that stage. Many plantation projects were established in Tanzania's coastal zone, in view of their ambitions to meet demand in foreign markets (Martin et al., 2009), often involving the shipping of the raw agricultural product. In this sense, many *Jatropha* plantations were near complete copies of colonial plantation models discussed by Havinden and Meredith (1993).

In the middle range of the organisational model spectrum, projects that tried to use a for-profit decentralised outgrower model with smallholder farmers, combined with centralised oil pressing, were still central. Among these, Diligent continued to be a prominent player. While these projects were much less “invasive” than plantations (Sulle and Nelson, 2009), the benefits they entailed for the smallholders were also proven to be limited, largely because the oil market did not support remunerative seed prices. The Tanzanian government continued to refuse to allow fuel blending or grant VAT exemptions on *Jatropha* biodiesel.

The institutional arrangement

The government continued its non-role in promoting the sharing of knowledge and lessons among different actors in the innovation system. However, unlike the situation in 2005, by 2008 other ‘fringe’ actors including non-governmental organizations and journalists had emerged as important promoters of sharing and accumulation of lessons learnt from the

cultivation of *Jatropha* as a managed agricultural crop. For many of the actors involved in the sectoral system, it was becoming increasingly clear that while *Jatropha* was able to survive on (semi) arid land, its seed and oil yields could only reach commercially viable levels with access to adequate soil-nutrients and water (Achten et al., 2007, 2008; FAO, 2008).

Some environmental and development NGOs in Tanzania played a central role in setting off the debate over large-scale biofuel plantations (see for example, Land Rights Research and Resources Institute and Joint Oxfam Livelihood Initiative for Tanzania, 2008; WWF, 2008). They highlighted the fact that it is a mistake to claim there is an abundance of unused land in Tanzania which could be converted into biofuel plantations. According to them, most lands that appear unused are in fact valuable for their role in ecosystem conservation, provision of non-timber forest products, as places of spiritual importance and as migratory routes of nomadic tribes (and for grazing of their livestock). The NGOs also argued that efforts to allocate land for biofuel production must consider the future food needs of Tanzania's growing population. In general, the NGOs adopted an oppositional stance toward biofuel plantation plans furthered by a neoliberal and developmentalist Tanzanian state, which had fast-tracked the plantation investments. This confrontation not only highlights the latest manifestation of the lack of trust between the state and civil society organizations, but also an intensification of this distrust.¹³

Additionally, Tanzania's history of authoritarian developmentalist and patrimonial governance (as outlined in section 2) has engendered a rather 'subversive' effect: an alert

¹³ NGO activists have also challenged the government on other fronts not directly associated with biofuels. For example, the government's latest agricultural development strategy launched in 2009 under the name of "Kilimo Kwanza" (Agriculture First) has drawn widespread criticism for promoting corporate interests (including those of large foreign investors) and its reliance on 'modern' agro-scientific solutions, including the use of GMOs, chemical pesticides and mineral fertilisers. Many fear that this will lead to dispossession and further marginalisation of small farmers and landless people (Qorro, 2011).

press that attempts to scrutinize state-sponsored plans for the country's development.¹⁴ This scrutiny is also founded on many journalists' lack of trust in the Tanzanian state. The relatively large size of Tanzania's biofuel sector (composed of 38 important players in 2008/9), hastily supported by the neoliberal government, and its controversial effects therefore grabbed the journalists' attention. Several of the journalists' reports, that were critical of the government's FDI-driven plantation strategy, were picked up by leading international newspapers (a nice example is Beattie, 2008, in the *Financial Times*). Reports also surfaced that a 8000 ha plantation project near Dar es Salaam, led by a British firm and initiated without the affected villagers' consent, was paying exploitatively low wages to its workers. The plantation had a long 99-year land lease. If this would be replicated in other similar investments, such plantations were argued to constitute a major threat to food security in Tanzania (Redfern, 2008). *The Citizen*, a Tanzanian newspaper, quoted an MP's statement that a Dutch investor had acquired long leases over large parcels of fertile land directly from villagers in the Kilwa area, in direct contravention of the 1999 Village Land Act (Editorial, 24 July 2008).

Other NGO and academic actors joined the journalists in building the Tanzanian debate on food security and land transfers to biofuel plantation projects. In general, these actors became increasingly critical of the government's continued neglect of food security issues (Godoy, 2009; Kamata, 2009). In 2008, the World Wildlife Fund's Tanzania chapter reported that adequate procedures had not been followed in arriving at decisions about the location of foreign-owned plantations and regarding the social and environmental consequences of these operations (WWF, 2009). A collaborative group of Tanzanian and UK-based academics

¹⁴ For instance, journalists have organised themselves in JET – Journalists Environmental Association of Tanzania (http://jettanz.com/about_us.html)

estimated that a total of 640,000 hectares had been allocated for biofuel plantations, while about 4 million hectares were requested by investors. Between 5000 and 10000 rural people had been affected by these state-sanctioned plantations, leading to alienation of their customary land rights (Sulle, 2009; Sulle and Nelson, 2009). Another multidisciplinary collaborative group from Tanzania's three best-known universities posed the question whether the loss in biodiversity and land degradation caused by the developments would not outweigh short-term financial gains. Thus interactive learning by range of innovation system actors was able to contest the government's fast-tracked decisions to usher in plantations. The latter were consistent with historically-instituted developmentalist visions to modernize the country while displaying continued disregard for socio-ecological conditions of its rural poor citizens.

In the active role played by academia in the Tanzanian biofuels debate, we can see that this community has accumulated important institutional lessons from earlier problematic experiences with large-scale colonial and early post-colonial farming programmes. One researcher from the University of Dar es Salaam (UDSM), writing about the dangers of export-oriented *Jatropha* FDI plantation schemes, reminds us that the root of the country's food shortage problem lies in the historical "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 a much older and strongly-institutionalised pattern of international relations (Madoffe et al., 2009).

Thus, Tanzanian academics (and journalists) were able to connect the current government's promotion of biofuel plantations with the state's authoritarian developmentalism in the past. In a workshop held at the UDSM, the current government was

argued to be no less elitist than colonial and early post-colonial governments (Kamata, 2009). Just as the latter, the current government's faith in modern and large-scale industrialised agriculture has guided its plans for a foreign-driven biofuel sector. Unlike the academics themselves, the government was argued to have failed to learn lessons from history, such as the historical alienation of land from small farmers by the state for facilitating large wheat farms and groundnut cultivation to produce oil for export to Europe (see Havinden and Meredith, 1993). Then as now, the government had distanced itself from meeting the food needs of the rural poor (Kamata, 2009).

Biofuel controversies in Tanzania (and elsewhere) induced some reflexive learning and opened up space for new institutional and organizational developments, pointing to an initialization of the co-evolution between different elements of the sectoral innovation system. The growing opposition to plantations put large investors and the government under considerable pressure to provide better protection to local communities and vulnerable groups. Proposals were put forward for less-invasive organisational models, in which foreign investors do not obtain ownership or long-term lease rights but co-develop the land together with the local farmers by means of partnerships (Sulle and Nelson, 2009; Vermeulen et al., 2009). The Government also produced draft National Biofuel Guidelines in August 2008 (final text in Nov 2008). The government's taskforce that prepared the Guidelines took a major step by formulating rules on respecting biodiversity, ensuring food security and preventing exploitation of villagers and their lands. Furthermore, until the Guidelines would be formally approved by the parliament, the cabinet and the president, all new biofuel investment plans involving land acquisition by foreign parties were halted. This state of affairs held till November 2012, when the government re-allowed plantation investments but imposed a land ceiling of 5000 to 10000 hectares per investor (the ceiling was different for

different crops). At this point, the government was also preparing extensive policy guidelines for biofuels, which promises to make food security concerns central (URT, 2012).

Thus, in these recent developments one can see the early beginnings of institutional endogenisation in the innovation system. The historical institutional arrangement governing the future operation of the sector needed to be reconfigured in order to co-evolve with other elements of the innovation including the organizational models in operation and their collective learning processes. Many actors both within Tanzania and elsewhere were mobilizing to make this co-evolution possible, by doing research, writing reports, beginning to work on new regulatory institutions, organizing stakeholder forums, and striking up informal alliances (e.g. by supporting each other on blogsites and in the local press). The tangible effects of this co-evolving institutional and organizational reconfiguration, however, remain to be seen.

5. Summary and conclusions

In his classic article on sectoral systems of innovation (SSI's), Malerba (2002) called for analyses of the role played by institutions in these systems. According to him, "a lot of work needs to be done in this respect, and (...) in various directions." (Malerba 2002: 257). In the ten years since, a large number of SSI studies have delved into institutional analysis using different theories and methods, in rich as well as in developing countries. We have attempted to contribute to this literature by elaborating one, hopefully fruitful, direction in which institutional analysis in SSI's can be done. The approach we have developed uses middle-range theorizing and detailed empirical analysis of the governance of actors and their interactions in emerging organizational models in Tanzania by a historically-constituted institutional arrangement. The institutional arrangement studied by us was assembled during late colonial and postcolonial eras of Tanzania's history four overlapping historical

governance schemas (see section 2): indirect, patrimonial, developmentalist and neoliberal. These schemas of governance were based on current manifestations of specific institutions including ‘customary’ norms, shared developmental visions of political elites, faith in modernization which marginalized poor peoples’ needs and agency, lack of trust between state and non-state actors, governmental regulations to promote free markets and constitutional decrees that vest all land in the office of the country’s president, together guided the composition and development of three different organizational models that constitute the core of Tanzania’s *Jatropha* biofuels sector.

The first organizational model was led by grassroots NGOs and other private organizations with a developmental mission. The stated aim of this model was often poverty reduction by building self-sufficient peasant communities that cultivate *Jatropha* for end-uses such as biodiesel for local electricity generation and soap-making. Governed by a mix of neoliberalism and developmentalism, this organizational model was characterized by a disconnect from its poor beneficiaries’ needs and practices, pecuniary alignment between funding bodies and the implementing organizations, and lack of trust between different organizations which led to fragmented learning processes without explicit coordination and interaction to synthesize results.

The second organization model entailed contract farming arrangements involving thousands of smallholder outgrowers who supplied *Jatropha* seeds to a firm owning a centralized oil processing facility. The choice of this outgrower-based model, rather than one based on ownership of a large plantation, was governed by Tanzania’s cumbersome land acquisition procedures under which rural ‘village’ land cannot be directly transferred to an investor but has to be first converted into government-owned ‘general’ land. This dual ownership of land, and the procedures for its transfer, is a clear present-day manifestation of

indirect governance. The working of the organizational model was also characterized by the lack of trust between the outgrowers and the firm.

The third type of organizational model was structured around large plantations set up by transnational corporations, often to ship unprocessed *Jatropha* seeds to the West. Many of these plantation investments were fast-tracked by the Tanzanian government, ostentatiously to generate employment opportunities for the rural poor, under the influence of neoliberal governance. Beyond the fast-tracking of investments, there was little involvement by the state to promote the development of domestic end-uses of *Jatropha* or to ensure that the plantations were not exploitative toward its workers and the local environment. For instance, there is no governmental monitoring of ongoing plantation schemes: once their application has been approved by the Tanzanian Investment Centre, they are “in”.¹⁵ Civil society groups (environmental/developmental NGOs, academics and journalists) in Tanzania did, however, highlight these problems and their parallels with plantations promoted by the colonial state for shipping primary commodities to Europe. Thus, in the specific case of large plantations, the civil society groups’ distrust of the state manifested as an open challenge to the latter’s plans guided by the dominant institutions of (neoliberal and developmentalist) governance. This confrontation triggered some reflexive learning by the state which decided to halt all applications for new biofuel plantations involving foreign investors until a national zoning plan would be officially agreed upon. It also sowed the seeds for experimentation with new institutions to deal with social and environmental problems engendered by the biofuel sector, thereby initiating a reconfiguration of the current institutional arrangement.

¹⁵ Personal communication between a spokesperson from the Land Rights Research and Resources Institute (HAKI ARDHI) and the second author, August 2012.

Overall, our theoretical approach based on the concepts of organizational models and institutional arrangements has allowed us to make two contributions to the literature on sectoral innovation systems in development. First, it has allowed us to foreground the central role played by ‘fringe’ actors such as NGOs, journalists, academics and smallholder farmers who are generally left out of the picture in sectoral innovation system studies. Second, by historically grounding Tanzania’s institutions, we are able to show how specific ways of organizing the sector and learning processes within it are governed not only by institutions that are currently dominant (such as those associated with neoliberalism), but also those put in place in the past and updated to the present (e.g. authoritarian developmentalism, patrimonial ‘traditions’, and indirect governance of land/labour transactions). Additionally, the older institutions conditioned the emergence of new ones while getting modified themselves, as witnessed in the mix of neoliberalism and developmentalism in Tanzania.

The institutions we studied are products of *Tanzania’s* transnational history. As a result, the institutions and their influences on the development of the *Jatropha* biofuels sector are surely specific to Tanzania. However, neither the institutions themselves nor the guiding influences they yielded would have been possible without connections to actors, discourses and developments outside Tanzania (a prime example is the neoliberal discourse globalized by the World Bank and the IMF). Many of these actors and discourses may have achieved a ‘global’ presence but their manifestation in a specific setting is shaped by local socio-political and ecological history. Despite these localizations, however, global actors and discourses end up producing many similarities across regions and countries, as amply demonstrated by the similar effects of biofuels in worsening food security and ecological degradation in parts of Asia, Africa and Latin America (Smith, 2010; Kant and Wu, 2011). An historical-institutional analysis of the kind we conducted in this paper affords the possibility to understand how any similar outcomes may be *differently produced* through institutional processes that are specific

to one country or region and rooted in local/national historical trajectories which nevertheless possessed non-local (international) connections.

Using the two concepts of institutional arrangements and organizational models, we are able to explain the emergence of reasonably successful reflexive learning processes in Tanzania *Jatropha* biofuels sector. These processes were undergirded by institutionalized activities carried out by a plurality of actors, including strong environmental-developmental non-firm and non-governmental organizations, societally-embedded academic institutions with neo-Marxist roots, and a critical press with a long tradition of civic engagement. Similar outcomes in *Jatropha* biofuels sectors of other Sub-Saharan African countries, such as Mozambique, Kenya, Ghana or Ethiopia, are difficult to imagine. However, as we noted above, even if they do arise, such outcomes can only be adequately understood by studying specific political-economic histories of these countries as they localize (adapt) ‘global’ discourses of neoliberalism and developmentalism, while being driven by their pre-colonial and colonial institutional legacies that have been updated to the present times.

Our work has important implications for future ‘next-generation’ cellulosic and algal biofuels. The promise of these new biofuels is based on the claim that they do not compete with food production and can be grown on marginal lands. Some strains of algae can thrive on wastewater or saline water, avoiding competition with food for freshwater sources (ETC Group, 2010). Early growth of and hype around *Jatropha* was based on similar claims regarding its ability to grow on degraded land without irrigation or fertilization. Widespread experience with *Jatropha*, in Tanzania and elsewhere, has now punctured this hype due to dismal seed yields from *Jatropha* grown on degraded lands, the insufficiently-remunerative work involved in cultivating and harvesting (or collecting) the seeds, and the difficulty of extracting at least half the oil content of the seeds. However, this puncturing of the *Jatropha*-hype is rather recent. As our analysis has shown, despite many unfavourable experiences in

the field, much of the hype around *Jatropha* continued to thrive for some time (in some circles, *Jatropha* is still argued to be a promising biofuel feedstock if it meets certain conditions, see for example, van Eijck et al., 2012; Pandey et al., 2012). To confront these hypes based on an in-depth evaluation of actual experiences with feedstock such as *Jatropha*, (international) civil society organizations need to team up with scientists (and journalists) in different parts of the world to set up biofuel monitoring organizations. In our case, a start in this direction was already made by the informal coalition between Tanzanian academics, NGOs and journalists in their attempts to oppose the state's fast-tracking of biofuel plantations. Similar monitoring work is being done by Biofuel Watch (<http://www.biofuelwatch.org.uk/>) based in the UK and the US, in cooperation with their international partners. Most importantly, such watchdog organizations need to be based in tropical countries that will provide a bulk of the feedstock for 'next-generation' biofuels.

Finally, many adverse impacts of land-use change entailed in cultivating biofuels can be 'irreversible'. For example, a woodland that is deforested to make way for a biofuel plantation, aside from producing a negative carbon balance (Romijn, 2011), can take decades to regenerate (and only if concerted efforts are made to do so). This can endanger the sustenance of communities that depended on the forests for non-timber products and fuel wood. Even so-called degraded lands, earmarked for biofuel plantations, often serve as grazing grounds for cattle or carry spiritual or migratory significance for people living around them. In less invasive organizational models, growing a biofuel crop as a hedge may not directly compete for land with food crops, but if commercially interesting yields are desired, the biofuel hedge would still need labour and farm-inputs (including water) like any other crop, and thereby compete with food cultivation. Serving high-consumption markets in the West with hedge-produced biofuels is also likely to be impracticable due to the large geographical dispersion of outgrowers and western sustainability standards that are

unworkable in the local context (Romijn et al., 2012). Because of these problems, we believe that Jatropha biofuel production holds out little promise for substantial rural development in Tanzania. Furthermore, in order to avoid future hypes and newer adverse impacts from biofuel cultivation, mandatory mix targets and subsidies should be discontinued in the developed world as well as in large developing countries. These biofuel subsidies and targets should be replaced by incentives to reduce the consumption (and production) of all fuels for transport and electricity-generation by organizations and by individuals belonging to the world's upper- and middle-classes (cf. ETC Group, 2010). Reduced consumption by the rich, rather than 'greener' production, can then become the guiding light of sustainable development worldwide.

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