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Policy and institutional frameworks for the promotion of sustainable biofuels in Mali

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Policy and institutional frameworks for the promotion of sustainable biofuels in Mali

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Abstract

This paper presents a multi-level assessment of the potential for oil-bearing, non-edible tree *Jatropha curcas* (*Jatropha*) to improve rural development and energy security in Mali: a sub-Saharan African country that has led biofuel policy initiatives. It addresses knowledge gaps on the role of national policy instruments and multi-stakeholder engagement in the uptake of biofuel activities. Semi-structured interviews were undertaken with government departments, international organizations, private sector representatives, NGOs and farming communities. Data show that projects focusing on *Jatropha* use for rural electrification can improve household access to fuel and reduce time spent on domestic chores by providing community pressing facilities, power generators and Multifunctional Platforms. However, biodiesel supplies remain insufficient for these benefits to materialise. Gaps between policy targets, actual yields and land cover are identified. Ambitious land cover targets set within national policies could risk land use shifts away from food towards biofuel production.

Keywords: *Jatropha curcas*, energy security, rural development.

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1 Introduction

To reach energy and development goals in the context of increasing global oil prices, scarcity of known petroleum reserves (Sorrell *et al.*, 2010) and climate change (IPCC, 2007), there has been growing pursuit of alternative energy sources. The opportunities and benefits of biofuels as a viable option for enhancing access to energy, substituting oil, reducing CO_2 emissions and promoting sustainable development have attracted growing attention of policy (UNDESA, 2007), industry (Lengkeek, 2009), Non-Governmental Organizations (NGOs) (Palliere and Fauveaud, 2009) and the research community (Janssen and Rutz, 2012). However, concerns have been raised regarding four key debates: i) "food versus fuel", where biomass previously destined for human consumption is being diverted to fuel production (Nonhebel, 2012); ii) emerging land-grabbing threats (Cotula *et al.*, 2009; Fairhead *et al.*, 2012), where land is leased or purchased by external investors for biofuel production dsiplacing local communities; iii) indirect land use change, where increased biofuel cultivation displaces pre-existing agricultural production into new areas causing significant increases in greenhouse gases emissions (Searchinger *et al.*, 2008), and iv) the limited potential for biofuels to substitute fossil energy (OECD, 2007), mitigate climate change, and deliver rural development benefits (ActionAid, 2012; Nuffield Council on Bioethics, 2011).

Great hopes have been pinned on the oil-bearing, "drought resistant" non-edible tree *Jatropha curcas* (hereinafter termed *Jatropha*) to deliver benefits through both small and large scale cultivation (Dyer *et al.*, 2012; Gilbert, 2011; Jongschaap, 2007). However, the *Jatropha* sector is still young and empirical analyses on the potential impacts on rural livelihoods and improved access to energy are largely lacking. Mali – where roughly 99% of the population lacks modern energy services (COMPETE, 2009) – is one of the few sub-Saharan countries with policies that encourage *Jatropha* cultivation. These target fuel production, and a range of initiatives have been supported since the 1990s, by a variety of actors including development agencies, government, private sector and NGOs. Mali thus provides a useful country context in which to explore the challenges and opportunities associated with *Jatropha* and address a key empirical data gap.

This research aims to advance understanding of the role of policy, multi-stakeholder engagement and capacity building in the uptake of biofuel initiatives. It presents new,

multi-level assessments of the implications of *Jatropha* uptake for rural development, food production and energy security. To achieve this, the objectives of the paper are to:

(i) Identify and analyse the stakeholders and policies concerned with biofuels in Mali taking into account policy motivations for prioritizing *Jatropha*, as well as the conflicts and synergies arising within and between policies and stakeholders from different sectors and groups; and

(ii) Evaluate the drivers and barriers to the achievement of policy goals in relation to rural development and energy security, proposing policy recommendations that better link the realities of policy and local level practice.

The regional and local considerations emerging from the multi-level assessments bridge existing knowledge gaps. The key lessons identified will be useful to other sub-Saharan African countries that are committed to the development of a sustainable biofuel industry.

2 Research design and methodology

Multi-level approaches are adopted to understand complex multi-scale and multi-sector issues where "*a wide range of public and private actors ... operate at diverse jurisdictional levels*" (Termeer *et al.*, 2010). In this paper, multi-level analysis uses a range of methods including interviews and policy analysis to unravel the complexity within which the Malian *Jatropha* activities operate across local and national levels. This section outlines the research design and methods used to collect empirical data.

2.1 Research design

The research process involved an exploratory scoping study (conducted in March-May 2010) which identified the main actors and issues within Mali's *Jatropha* activities. Biofuel-related policies were analysed at national and regional levels with special attention to the role of institutions and policy implementation gaps. The main period of data collection was carried out during January-June 2011[1] involving a multi-sector focus that allowed the integration of perspectives from the public, private, non-state, and non-profit actors in energy and agriculture development plans at different levels (*i.e.* national, regional, village and household). Semi-structured interviews were carried out with stakeholders – defined here after Reed *et al.* (2009) as all the private and public groups that affect or are affected by decisions taken in the country's energy policy context with a direct or indirect interest in the development of *Jatropha* activities – at their various levels of action:

- National level (n=18): government officials, representatives of international organizations and experts from national research institutes. These data allowed a detailed understanding of the factors that influence the formulation of Mali's biofuels policy, the prioritization of *Jatropha* in the national strategy, and the main policy goals;
- Industry and NGO level (n=20): including management and general staff of the main *Jatropha* organizations. This provided a detailed understanding of stakeholders' activities, aims, objectives and achievements, as well as their operational constraints;
- Village level (n=38): interviews were conducted with *Jatropha* farmers' cooperatives and village chiefs. This complemented the knowledge gained through in-depth livelihood assessments carried out to gain broader perspectives in terms of policy achievements and villagers' concerns.

[1] In March 2012 President Toure was deposed in a military coup and, since April 2012, independence has been declared by Tuareg rebels in most of northern Mali (Nossiter, 2012). The current political instability faced by the country might have an impact on the institutional and regulatory frameworks presented in this paper. The identified ongoing and planned *Jatropha* activities as well as the financial support provided by bilateral donors have been partially suspended until the political situation is more stable.

2.2 Methodology

Stakeholder group identification at different levels of action and a review of key policies was carried out through desk-based documentary analysis and via semi-structured interviews during the two fieldwork seasons. Using snowball sampling, stakeholder and policy representative lists were expanded as long as more interviews were conducted and names of other contacts were provided. Stakeholder roles and responsibilities were outlined, including their implementation of *Jatropha* activities to date. This allowed relationships between stakeholders to be highlighted, as well as identification of the scope for synergies and conflicts between different groups (Turcksin *et al.*, 2011).

Relevant policies in energy, environment, agriculture and rural development sectors were analysed. Policy gaps – defined here after Jordan (1999: 70) as differences "*between the stated aims of policies and their practical impact on the ground*" – were identified using conceptual frameworks of discourse analysis (Apthorpe, 1996; Hajer, 2006) and policy implementation and impact analysis (Knill and Liefferink, 2007). According to Hajer (2006), the actions of different stakeholders including institutions, private sector, academia and media are combined in discourse-coalitions which share a set of simplified narratives – "story-lines" – to give meaning to wide and complex debates. These story-lines are subsequently "institutionalized" or translated into policy documents. Discourse is here intended as the "*ensemble of ideas, concepts, and categorizations that are produced, reproduced, and transformed in a particular set of practices*" (Hajer, 1995: 44). The discourse was coded and deconstructed and the information summarised into matrices to identify key themes and categories linked to the socio-economic and environmental problems tackled by these documents (Apthorpe, 1996). This allowed evaluation of the scope for synergies and trade-offs among policies and assessment of: (i) the international environmental, energy and development commitments; (ii) the political, economic and cultural factors that influence the formulation of Malian biofuels policy; (iii) the reasons for prioritising *Jatropha* in the national strategy; and (v) the main policy goals (at national and local scale) that policymakers aim to achieve through the promotion of *Jatropha*. These data were integrated with the multi-level results from interviews and livelihood assessments, allowing identification of implementation gaps. A gap occurs when a policy statement is

not turned “into action” (Jordan, 1999: 70) that meets the original policy goals on the ground.

Detailed livelihoods assessments used the Sustainable Livelihoods Framework (SLF) (DFID, 1999-2001) to guide implementation of participatory methods, including in-depth semi-structured interviews (n=30), transect walks (n=30), wealth ranking and seasonal calendars (n=30) with farmers identified through focus groups and preliminary questionnaires across three different farming communities (Figure 2).

3 Results

Results are presented here in relation to the two main research objectives each informed by findings from across the different levels of analysis and mixed-methods employed.

3.1 Institutional framework and stakeholders in the *Jatropha* activities

Stakeholders integrating biofuel production in Mali fall under four groups (Figure 1):

1. *Ministerial and technical central departments* that elaborate and implement national energy, agricultural and environmental policies as well as supervise renewable energy activities in the country.
2. *Multilateral development agencies* which, together with bilateral donors, constitute the most important source of financing for the development of public biofuels projects and programmes, with international funding for the implementation of *Jatropha* activities exceeding national spending. They also provide technical assistance and capacity building, supporting the Malian government in promoting pro-poor energy sector reforms and establishing appropriate legal and regulatory frameworks for the development of renewable energies.
3. *(a) Bilateral donors* which provide funding to public and private projects. These include the French Development Agency, Netherlands and Belgian Cooperation. (b) Substantive financial (and often technical) support is also provided by *private entities* such as the Bill & Melinda Gates Foundation, FACT Foundation, Eco-Carbone, Novartis, Total and Kia Motors. The start-up and implementation of the

main pilot *Jatropha* activities depend on the monetary resources provided by these donors.

4. (a) *NGOs* (*e.g.* Mali-Folkecenter and GERES Mali) and (b) *private companies* (*e.g.* Malibiocarburant SA and Jatropha Mali Initiative). These organisations operate with varying approaches and motivations including fuel production, rural electrification, promotion of rural and agricultural development at the community and village levels, and carbon credit commercialisation. They have undertaken pilot activities – in direct collaboration with beneficiary communities – in production, extraction, transformation and utilisation of *Jatropha.*

Figure 1 outlines the four groups that were identified. The arrows highlight the collaborative relationships among stakeholders with relation to the following types of links: funding, *Jatropha*-related research, policy elaboration (where the stakeholder affects the decisions taken in the elaboration of energy policy) and policy implementation (where the stakeholder is directly in charge of implementing concrete actions in the achievement of energy policy goals).

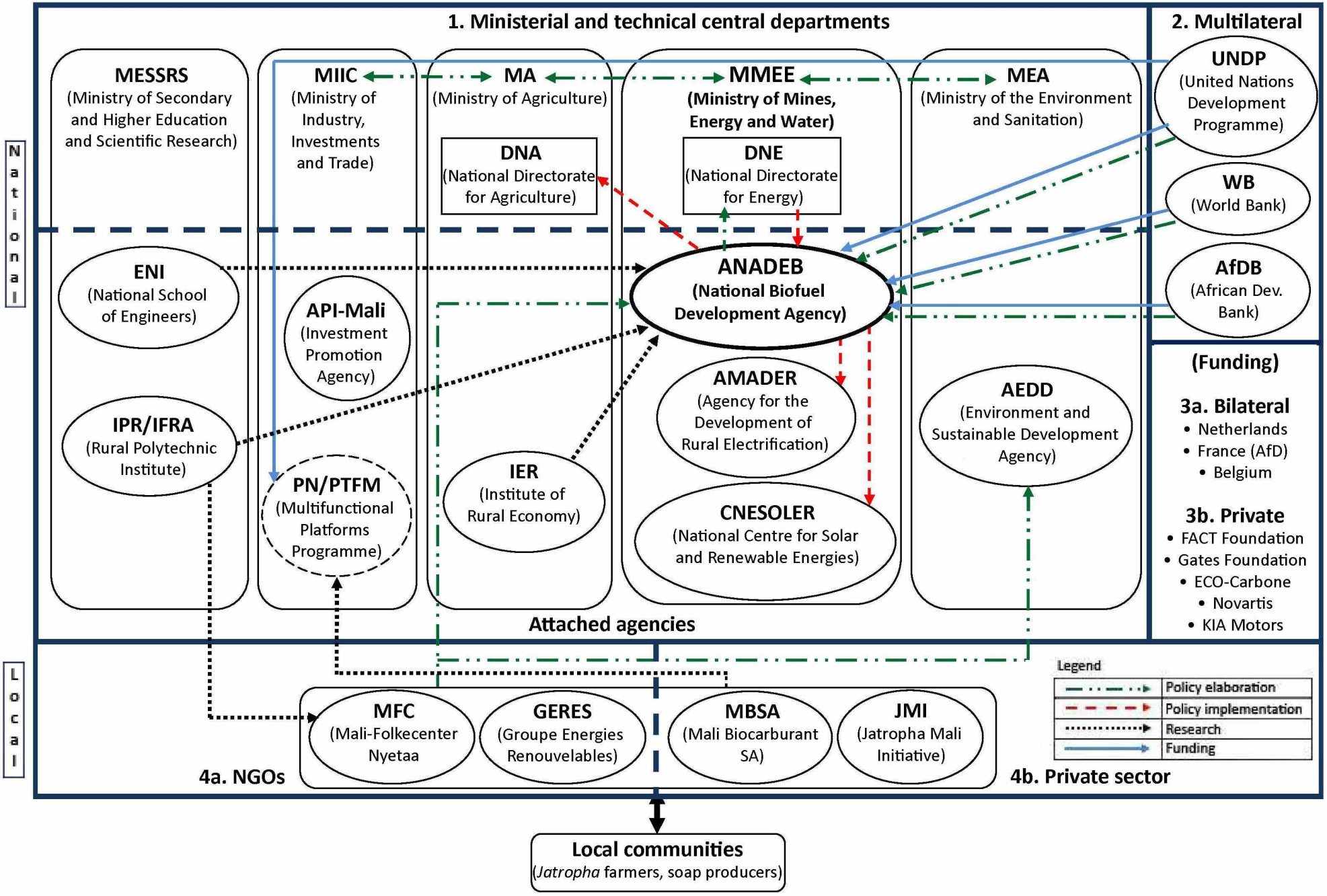

Figure 1: Key stakeholders in Mali's *Jatropha* activities. *Arrow legend shows types of links identified*

3.1.1 National level analysis: institutional stakeholders and implementation of *Jatropha* activities

Since the 1990s the use of renewable energy sources to tackle fuel poverty and preserve the environment in Mali has been extensively promoted by the Ministry of Mines, Energy and Water (MMEE). The MMEE formulates energy policy, defines energy planning and controls the renewable energy sector (MMEE, 2012). It has played a leading role in the elaboration of the National Energy Policy, National Strategy for the Development of Renewable Energies and the National Strategy for Biofuels Development. By implementing the "Scaling up renewable energy program for low income countries" (SREP) (Table 1) – led by the World Bank – the MMEE envisages to reduce national fossil fuel consumption, foster low-carbon economic growth, and contribute to poverty alleviation, by fostering renewable energy development. From an environmental perspective, achievement of these goals is supported by the Ministry of the Environment and Sanitation (MEA) and the attached Environment and Sustainable Development Agency (AEDD). The MEA defines environmental policy and approves projects such as those funded through the Clean Development Mechanism (CDM) (MEA, 2012), where commercialisation of carbon credits is a major driver for the development of *Jatropha* pilot activities.

Mali's biofuel operations are coordinated by the National Biofuel Development Agency (ANADEB), which was jointly created in 2009 by the ministries responsible for energy, agriculture, environment, industry and trade. In the implementation of the National Strategy for Biofuels Development (Section 0), ANADEB's mission is to promote biofuels – largely from *Jatropha* feedstock – at local level, in order to meet the energy needs of rural communities, and national level, in order to meet the country's energy needs and reduce the high dependence on oil imports (ANADEB, 2012). Prior to ANADEB's creation, all biofuel activities were under the supervision of the National Centre for Solar and Renewable Energies (CNESOLER), which, since the 1990s, has been the leading implementer of *Jatropha*-related projects and programmes. Its projects include the National Programme for the Energetic Valorisation of *Jatropha* (PNVEP) (GoM, unspecified) and collaboration with the German Technical Cooperation (GTZ)

Jatropha System project (Table 1) (CNESOLER, 2012). In 1996, the United Nations Development Programme (UNDP) launched the Multifunctional Platforms National Programme (PN/PTFM) (Table 1) – which since 1999 has been the responsibility of the Ministry of Industry, Investments and Trade (MIIC). A Multifunctional Platform (MFP) consists of a source of mechanical and electrical energy provided by a diesel engine which can also run on pure *Jatropha* oil (UNDP, 2004)[2]. Since 2011, UNDP has supported the formulation of appropriate regulatory, legal and institutional frameworks for *Jatropha* by developing the project "Promotion of the Use of Agrofuels from the Production and Use of *Jatropha* Oil in Mali" (Table 1). In 2011 this was submitted to the Global Environmental Facility.

Creation of the Agency for the Development of Domestic Energy and Rural Electrification (AMADER) in 2003 reaffirmed the will of the Malian government to develop a coherent institutional framework to address priorities in the fields of energy and improvement of human well-being set in the late 1990s in the international development arena. The twofold aim of AMADER is to contribute to socio-economic development by increasing public access electricity and reducing poverty (AMADER, 2012). AMADER collaborates with the PN/PTFM by installing MFPs and the decentralised power grids needed to provide rural areas with electricity (AMADER, interview data, 2010). In 2011, AMADER signed an agreement with ANADEB which aimed to increase rural access to electricity through the use of *Jatropha*-based biofuel (ANADEB, interview data, 2011).

With regard to rural development, national promotion of *Jatropha* is linked to activities carried out by the Ministry of Agriculture (MA), which is in charge of defining agricultural policies including the Rural Development Master Plan and the Agricultural Orientation Law (MA, 2012). The National Directorate for Agriculture (DNA) – attached to the MA – promotes *Jatropha* uptake "*through awareness raising, farmer support and improvement of the production at the village level*" (DNA, interview data, 2011). In this regard, a project to support the development of the *Jatropha* chain in five southern

[2] The MFP device can power various tools, such as a cereal mill, husker, welding and carpentry equipment, alternator (to provide lightning), battery charger and water pump.

regions (PADFP) was launched by the DNA in 2008 (Table 1). At the national level, a variety of Research and Development (R&D) *Jatropha*-related activities are carried out partly under the supervision of the MA – through the Institute of Rural Economy (IER) (IER, 2012), the research of which focuses on ecotypes and production techniques – and partly through the Ministry of Secondary and Higher Education and Scientific Research (MESSRS), which orients the work of two high education schools (MESSRS, 2012): the IPR/IFRA and ENI. The Rural Polytechnic Institute (IPR/IFRA) is active in agronomic research on *Jatropha* as well as in testing the use of the oil on engines (IPR/IFRA, interview data, 2011). The National School of Engineers (ENI) carries out engine performance testing under a formal collaboration signed with ANADEB (ANADEB, interview data, 2011).

Table 1: Implementation of *Jatropha* activities by institutional stakeholders

Project	Objectives	Partners / Date	Achievements and challenges
Jatropha system (Wiesenhütter, 2003)	Test the potential uses of *Jatropha* in an integrated approach to rural development. Its main components include (i) cultivation of the plant as a hedge to protect the farmers' fields and reduce soil erosion, (ii) use of the oil for soap production and to fuel local grinding mills, (iii) organisation of women's groups for seed collection and management of the mills, and (iv) use of the pressing residue as fertiliser.	GTZ in cooperation with CNESOLER. (1993-1997)	The project evaluation showed negligible potential for achieving development impacts. While positive outcomes could be derived by using *Jatropha* as a living fence and fertiliser, its use for oil – proven to be technically feasible – was assessed as unprofitable. This system was found to be unsustainable as it could not survive without continual monetary subsidies.
PN/PTFM Multifunctional Platforms Programme (UNDP, 2004; Nygaard, 2009)	The programme's specific objectives include to: (i) alleviate the chores of women in rural areas by introducing new energy sources and technologies, (ii) develop and build capacity to own and manage MFPs by decentralized structures under female ownership (iii) promote the development of income generating activities.	UNDP and MIIC – funded by the Bill and Melinda Gates Foundation, Norway, Denmark, the Netherlands and France. (1996-1999: phase 1. In 1999 transferred to the government)	Pilot experiments on the use of *Jatropha* oil on 10 platforms have been carried out for this programme by Mali Biocarburant SA (Rodriguez-Sanchez, 2010). About 10 hectares of *Jatropha* plantation can produce enough oil to operate one platform each year (UNDP, 2011).
PNVEP National Programme for the Energetic Valorisation of *Jatropha* (GoM, unspecified)	Overall goal: to provide *Jatropha*-fuelled electricity to 350 southern villages. The main objectives are to: (i) assess and improve the potential for *Jatropha* oil production and use, (ii) install the equipment required for the collection, transformation and utilisation of *Jatropha* oil, (iii) train target groups of the population on cultivation and oil production, (iv) enhance rural energy.	CNESOLER – funded by the GoM (2004-2008; extended by ANADEB from 2009 to 2010)	According to semi-structured interview with ANADEB (Bamako, 2011), the programme has allowed the electrification of 5 villages by 50 KVA generators powered by *Jatropha* oil and the adaptation of a 4X4 vehicle to be fuelled by *Jatropha* biofuel.
PADFP Project to Support the Development of the *Jatropha* chain (GoM, 2011)	The objectives of this project are to: (i) promote the cultivation of *Jatropha* in five southern regions, (ii) promote food security, (iii) provide training on farming techniques, (iv) facilitate the commercialisation of the seeds on the market, (v) promote local use of *Jatropha* oil and foster community level development, and (vi) organise local farmers' cooperatives.	DNA (2008-2013)	As of 2011, 65 DNA agents per region (n=325 in total) have been involved in the following activities: (i) provision of theoretical training (regional level) and technical training (village level) to farmers, and (ii) awareness-raising in non-grower villages (DNA, interview data, 2011).
Mainstreaming Sustainability in the Agrofuel Sector in Mali	Study of sustainability criteria for the development of the biofuels sector in Mali and elaboration of a certification scheme.	ANADEB and MFC in collaboration with WIP (Germany) and Fact Foundation (Netherlands) (2011-2012)	The study is expected to end by late 2012. A first draft of the methodological guide has been elaborated and 11 sustainability criteria outlined (email correspondence with ANADEB, 2012).

SREP Scaling Up Renewable Energy Program for Low Income Countries (WB and GoM, 2011)	The SREP aims to help Mali use new economic opportunities to increase energy access through renewable energy use. SREP's project 2 "Hybrid Rural Electrification" targets to electrify isolated low income populations. The use of *Jatropha* as a source of fuel to power productive rural uses for agricultural businesses (*i.e.* grinding machines and de-huskers) and create new jobs has been identified among the SREP's options.	Led by DNE with support of WB and AfDB. Funded under the WB's Clean Investment Fund umbrella. (2011-2016).	Work is being carried out to improve the regulatory and institutional framework in the renewable energy sector with the aim to attract an increasing number of local and international private investors. Emerging *Jatropha* business models for off-grid electrification in rural areas are under assessment (ANADEB, interview data, 2011).
Promotion of the Use of Agrofuels from the Production and Use of *Jatropha* Oil in Mali	The overall goal of the project is to develop and promote a sustainable model for the production and use of *Jatropha* oil at the national level. The main objective includes reducing the use of diesel in the transport and energy production sectors through use of *Jatropha* oil in MFPs and vehicles (UNDP, 2011).	UNDP and ANADEB (Expected start date 2012, for 4 years).	Key priorities identified in the project proposal include to: (1) formulate a *Jatropha* development strategy, (2) address private sector investment constraints by putting in place an appropriate regulatory framework, (3) strengthen R&D, (4) remove constraints to rural actors' ownership.

The multiple institutional stakeholders and implementation activities identified illustrate the commitment of the Malian government to promote *Jatropha* at national and local levels. The analysis nevertheless reveals a lack of coordination among these actors. Overlapping roles hamper the achievement of the policy goals. Similar R&D activities are carried out by multiple stakeholders – through formal collaboration between different agencies and research institutes (*i.e.* ANADEB and ENI on engine's tests) as well as through independent work carried out in different directorates (*i.e.* IER and IPR/IFRA on agronomic research) – but they often lack of visibility. Information circulated among different institutions about their strategic orientations, objectives and ongoing activities was found to be dispersed: "*I do not know in specific terms what research they* [the MESSRS and MMEE] *are carrying out with regards to Jatropha, but I am sure that we are all working coherently to achieve the same goals as our biofuels policy has been approved in consultation with all the relevant government departments*" (MA, interview data, 2011). This limits the capacity to carry out harmonised on-the-ground activities in the achievement of common *Jatropha*-related goals.

More broadly, overlapping mandates on renewable energy among the MMEE, MA and MEA constrain the development and implementation of coherent frameworks of action. The MMEE promotes, controls and monitors the renewable energy sector, where specific *Jatropha* activities are carried out by its specialised agencies. The MA aims to support the MMEE by carrying out independent activities with similar goals but which are not controlled by the MMEE: "[The MA] *indirectly contributes to the achievement of the energy policy objectives with relation to Jatropha"* (MA, interview data, 2011). Promotion of renewable energies (*i.e.* biofuels) is also a priority action of the MEA. An effort to create a framework of cooperation and coordination for the promotion of biofuels – in line with the priorities set in the National Strategy for the Development of Renewable Energy as well as in the National Strategy for Biofuels Development – was made in 2008 through the creation of ANADEB, but this institutional stakeholder is still in a learning-by-doing phase. Strengthening the institutional arrangements as well as clarifying the mandates of the main national directorates and agencies operating in the renewable energy, rural development and environmental sectors is essential for the successful promotion of *Jatropha* production and use.

3.1.2 Local level analysis: private sector and NGO community

Since 2007, project activities have been undertaken in the production, extraction, transformation and utilisation of *Jatropha* by different organizations. In 2011, *Jatropha* cultivation in Mali – excluding minor ongoing initiatives and the area covered by living fences – accounted for roughly 5,000 hectares, involving the participation of approximately 5,000 smallholder farmers supported by four main initiatives located in the southern regions of Sikasso, Koulikoro and Kayes (Figure 2).

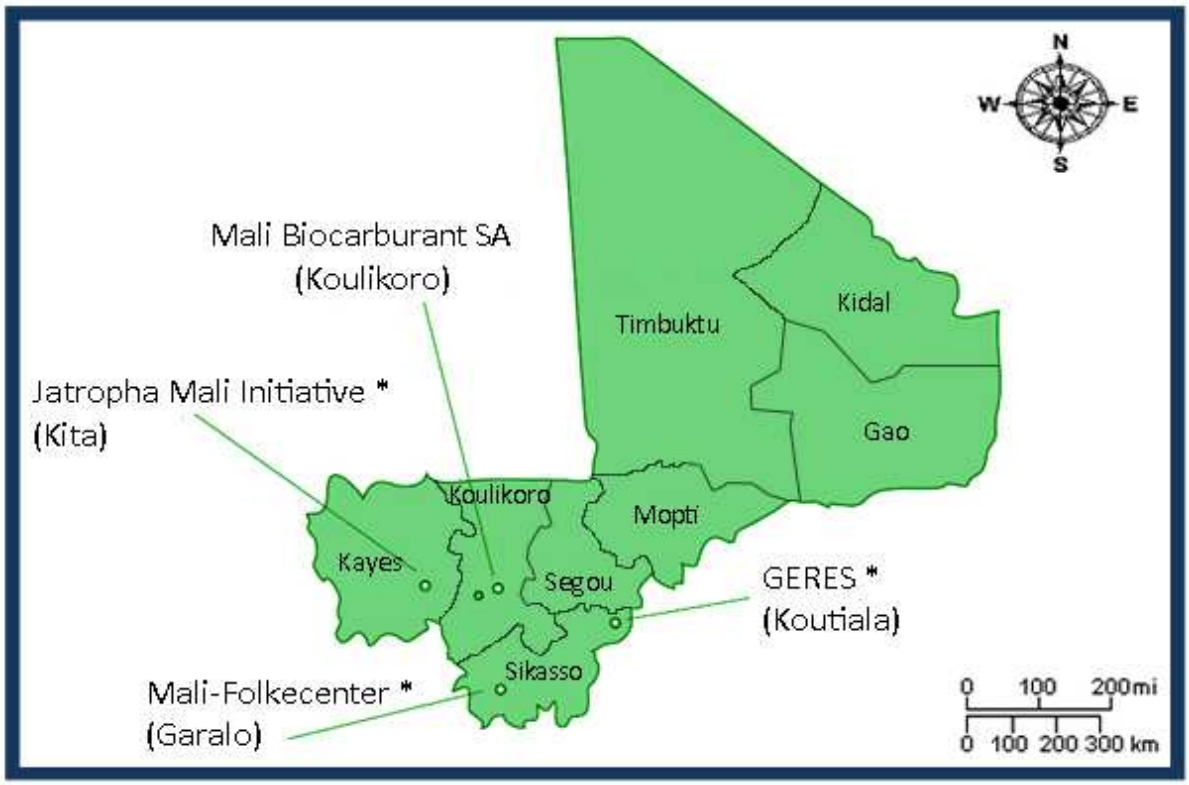

Figure 2: Location of the major *Jatropha* project activities (private sector and NGOs) in Mali.
Source: author. ** Selected study sites*

These comprise two private companies (Malibiocarburant SA and Jatropha Mali Initiative) and two NGOs (Mali-Folkecenter and GERES Mali). Their main objectives, characteristics and key challenges are summarised in Table 2.

Table 2: Characteristics and challenges of the major *Jatropha* project activities in Mali.

Initiative	Description and objectives	Progress to date and key challenges
MBSA Mali Biocarburant SA (MBSA, 2012)	MBSA is a private Dutch company which aims to produce refined biodiesel for the domestic market sourcing its stock from roughly 2,000 hectares of *Jatropha* grown by 1,800 smallholders (MBSA, interview data, 2010). The farmers, organised in cooperatives and represented by the farmers' union, own 20% of the shares of the company. Technical training on farming techniques and agricultural diversification are promoted by the Malibiocarburant Foundation. The Foundation also works on the certification of carbon credits on the voluntary market, which in 2010 represented 40% of its total revenues (MBSA Foundation, 2010).	The farmers' union manages a centralized oil press and a soap production unit installed by MBSA. *Jatropha* oil is sold to the MBSA's biodiesel transformation unit, while leftover seedcake is sold to the farmers. Soap is produced from glycerine – a *Jatropha* by-product. The processed biodiesel is sold to local users. Challenges: Limited feedstock availability hampers the production of higher quantities of *Jatropha*-based biodiesel.
JMI The *Jatropha* Mali Initiative (JMI, 2012)	JMI is a French-Malian joint venture with the objective of producing pure *Jatropha* oil – promoting out-grower schemes – for local and national markets, alongside the commercialization of seedcake, the pressing residue that can be used as organic fertilizer. As of 2011, 2,050 small-scale producers grouped in cooperatives in partnership with JMI have planted a total surface of 1,740 ha of *Jatropha* within the country. JMI's start-up funding was generated through *Jatropha*-based carbon credits earned in 2008 under voluntary schemes (JMI, interview data, 2011).	Village level training in the production of improved quality *Jatropha* soap have allowed revenues to be generated that are notably bigger than those derived by seed sales. The leftover seedcake sold at a preferential price to the farmers provides a cheaper source of organic fertiliser. Challenges: Small yields are a relevant constraint to the production and commercialisation of *Jatropha* oil and seedcake. Lack of oil on the market is a major constraint in improving local soap production.
GERES Groupe Energies Renouvelables (GERES, 2012)	GERES is a French non-profit NGO that promotes rural electrification. Its main goal is to facilitate establishment of a local *Jatropha*-based biofuel supply chain and produce the technical and organisational knowledge required for future replication. In 2011 GERES collaborated with 870 small-growers covering a total surface of 350 ha of *Jatropha*. GERES plans to construct three decentralised pilot oil extraction units – managed and owned by the villagers or local operators – with the aim of securing a local market for *Jatropha* oil (IRAM-GERES, 2009).	One pilot oil extraction unit has been installed in the region of Koury (GERES, interview data, 2011). Challenges: As of 2011 the extraction unit was not yet fully operative and remained in a "learning-by-doing" phase. GERES is facing limited feedstock availability due to low yields. This hampers the capacity to guarantee a regular volume of production to the operator of the extraction unit.
MFC Mali-Folkecenter Nyetaa (MFC, 2012)	MFC is a Malian NGO that targets the promotion of out-grower schemes for improving rural electrification through power generators that can run with pure *Jatropha* oil. Through the project "Garalo Bagani Yelen rural electrification using *Jatropha* oil", in 2011, MFC supported 320 farmers on a total cultivated surface of 550 ha of *Jatropha*. MFC has well established links with key institutional stakeholders in the energy, environmental and agricultural sectors as well as with international donors. In 2011 the MFC coordinated the elaboration of the National Climate Change Policy and as of 2012 it is in charge of the study and elaboration of national biofuels sustainability criteria commissioned by ANADEB (Table 1).	A power generator and centralized oil press were installed in 2008 by MFC in the village of Garalo. This is managed by a power company called ACCESS, a subsidiary of MFC. The press functions under the supervision of ACCESS but is formally controlled by the farmers' union, which manages the purchase of seeds, oil extraction and sale, as well as the commercialisation of the leftover seedcake to be used as fertiliser. Challenges: Relatively small quantities of seeds have been commercialised and transformed into oil. As of 2012 the power generator is entirely fuelled by regular diesel (ACCESS, interview data, 2011).

Sources: (i) Descriptions: projects websites, (ii) Progress and challenges: semi-structured interviews at community and village levels.

All the analysed activities operate in collaboration with beneficiary communities in the establishment of local *Jatropha* plantations. To various extents, farmers are provided with technical support on farming techniques and a guarantee that their seeds will be purchased at a fixed price (between 0.1-0.2 USD/kg)[2]. Household level data from in-depth interviews show that those benefitting from NGO or private sector intervention reported increases in financial capital or reduction in household expenditure. This resulted from sales of *Jatropha* seeds, as well as soap made from *Jatropha* oil or seeds. Greater livelihood gains are generated when farmers are provided with specific training (*e.g.* on improved soap production) that give them the capacity to take full advantage of all the different uses of *Jatropha,* beyond just the sale of the seeds. Farmers face difficulties in establishing successful plantations. These include: high incidences of termite attacks, as well as the relatively small financial gains generated from the sale of the seeds and a perceived lack of project support which reduces farmers' incentives to invest adequate money, labour and time. Interviews with the NGOs and company representatives indicate that such problems perceived at household level are partly linked to the financial and organisational constraints faced by project developers, which limit their ability to adequately support the farmers (both technically and financially) in *Jatropha* agriculture: "*We are aware of the difficulties faced by our farmers and field staff, but unfortunately we lack sufficient resources to face all the constraints*" (MFC, interview data, 2011). These activities are still in a learning-by-doing operational phase and their implementation relies on the limited financial support provided by bilateral donors and private entities. Thus, they have a limited capacity to meet the needs identified by farmers (*i.e.* constant and visible support from local staff at the village level, improved training, and better access to agricultural equipment and fertilisers).

While these activities offer promising opportunities to improve the provision of rural energy, the challenges outlined above translate into low availability of feedstock on the market, which limits capacity to produce sufficient quantities of *Jatropha* oil. To date, *Jatropha*–based biofuel has been mainly used only for testing and demonstration. The MFC's power generator (Table 2) – which since 2007 has been providing rural electricity to the village of Garalo – still runs purely by regular diesel and estimates concerning the timeframe for substituting this with *Jatropha* oil are unavailable. Similarly, the feedstock used to fulfil the needs of the 2,000 litre/day

MBSA biodiesel plant (Table 2) – which currently works at its full capacity – comes only in small part from *Jatropha* while other vegetable feedstock is used (MBSA, interview data, 2011). Similar challenges are faced in the implementation of the Multifunctional Platforms National Programme (PN/PTFM). The total amount of MFP units installed by the PN/PTFM in Mali rose from 48 in 1999 to 1,000 in 2011 (UNDP, 2012). Improvements in the use of *Jatropha* oil in the platforms have been promoted by several policies including the NSREN and NSBD, and in this regard, R&D has been carried out by national agencies (IPR/IFRA and ENI) and private sector (MBSA). Nevertheless, despite the 15 years of experience gained in the implementation of MFPs in the country, according to UNDP, as of 2011, less than 30 units are operating on *Jatropha* oil, while the remaining are powered with regular diesel (UNDP, interview data, 2011).

Win-win opportunities for fuel production and rural development are yet to be realised. Policy investments supporting project developers and farmers are necessary to remove the local barriers to *Jatropha* cultivation and create an environment conducive to the expansion of rural energy security.

3.2 Fuelling Malian politics with *Jatropha*: national policy goals and drivers

This section provides an overview of the main policy drivers fostering the production and use of *Jatropha* within Mali.

3.2.1 Key policy goals and inter-policy coherence

Use of *Jatropha* oil has been fostered by several policy measures aimed at sustaining both rural and national energy development. 11 key policies and strategic documents adopted by government in energy, environment, agriculture and rural development sectors were analysed using discourse analysis (Table 3). Coding and deconstruction of the discourse (Apthorpe, 1996) allowed identification of 3 key themes and 9 sub-themes related to the socio-economic and environmental goals that the government aims to achieve through promotion of renewable energy sources (Table 3). These link to the main debates surrounding biofuels and are:

(I) Socio-economic progress and development

1. Poverty reduction, rural development and gender empowerment
2. Renewable energy access and supply
3. Capacity building and renewable energy governance
4. Renewable energy R&D

(II) Agriculture

5. Food security, agricultural diversification and productivity
6. Water use and irrigation

(III) Environment

7. Climate change and pollution
8. Desertification, degradation and soil infertility
9. Deforestation

Table 3: Key socio-economic and environmental themes tackled by selected policies and strategic documents on renewable energy, environment and development in Mali

			I Socio-econ. progress and dev.				II Agr.		III Env.		
Year	**Acronym**	**Title**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**
1998	**PNPE**	National Environmental Protection Policy *Politique Nationale de Protection de l'Environnement*	X	X	X		X	X	X	X	X
1998	**NAP**	UNCCD National Action Programme	X	X		X		X		X	X
2002	**SDDR**	Rural Development Master Plan *Schéma Directeur Du Secteur Du Dév. Rural*	X				X	X		X	X
2006	**LOA**	Agricultural Orientation Law *Loi d'Orientation Agricole*	X	X		X	X	X		X	X
2006	**PEN**	National Energy Policy *Politique Énergétique Nationale*	X	X	X	X					
2006	**NSREN**	National Strategy for the Development of Renewable Energy	X	X	X	X	X		X		
2006	**G-PRSP**	2007-2011 Poverty Reduction and Growth Strategy Paper (2nd generation)	X	X	X		X				X
2007	**NAPA**	National Adaptation Programme of Action to Climate Change	X	X			X		X		X
2008	**MDGs Plan**	Ten Years Action Plan to Achieve the MDGs *Plan décennal pour la réalisation des OMD*	X	X			X				X
2008	**NSBD**	National Strategy for Biofuels Development	X	X	X	X	X		X	X	
2011	**PNCC/ SNCC**	National Climate Change Policy and Strategy *Politique Nationale Changements Climatiques*	X	X	X		X	X	X		
International commitments (by year of ratification)											
1994	**UNFCCC**	United Nations Framework Convention on Climate Change	X						X	X	
1994	**UNCCD**	United Nations Convention to Combat Desertification	X	X	X		X	X		X	X
2002	**KP**	Kyoto Protocol		X	X	X			X		

Figure 3 ranks the key sub-themes by relevance according to their recurrence in the policy discourse. Shared policy objectives and strategic orientations pursued under each sub-theme in relation to *Jatropha* promotion are identified in light of the story-lines that sustain the discourse and facilitate its institutionalisation.

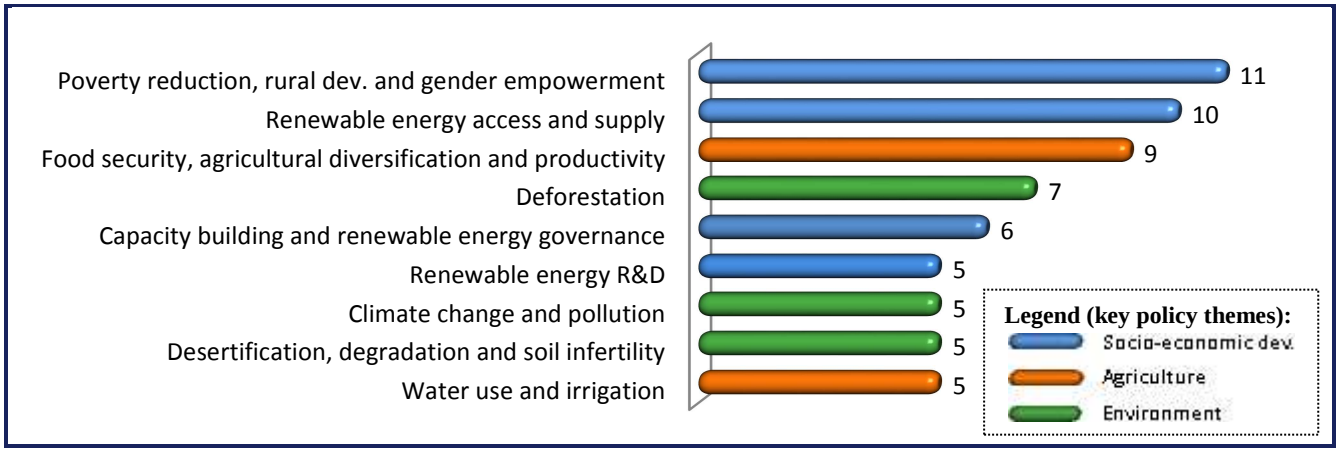

Figure 3: Priority *Jatropha*-related themes tackled by key policies in the fields of energy, environment and socio-economic development in Mali ranked by relevance in the policy discourse as identified through coding and content analysis. *Counts refer to the total number of policy documents – among the 11 identified – that tackle each sub-theme, as outlined in Table 3.*

Figure 3 shows that the Malian government effectively embedded – or mainstreamed (Akhtar-Schuster *et al.*, 2011) – international priorities on sustainable development and energy (UN, 1987, 1992 and 2012) into its national policies. In such a framework – and as supported by the private sector, academia and media – the "renewable energy" story-line has emerged with the underlying concept that sustainable development and energy security can be achieved through promotion of alternative energy sources, particularly biofuels. The "*Jatropha*" (sub)story-line has emerged with the assumption that positive impacts can be accomplished by prioritising aspects of rural and agricultural development, as well as environmental preservation linked to the establishment of a *Jatropha* industry. In the Malian debate, the formation of discourse coalitions comprising the various ministerial departments and stakeholders outlined in Figure 1 has led to the legitimisation and institutionalisation of the *Jatropha* story-line into the national policies in Table 3. These are formed around three priority areas that reflect the key policy themes identified earlier:

(1) Fostering poverty reduction and rural development through improved renewable energy production and use. The 2007-2011 Poverty Reduction and Growth Strategy Paper (G-PRSP) highlights the cross-cutting role of energy in all rural production sub-sectors to ensure sustainable growth in rural areas and achieve

the MDGs. Amongst its specific objectives, the G-PRSP aims to increase by 8% the portion of renewable energy in the national production of electricity by 2009. The 2008 National Strategy for Biofuels Development (NSBD) states: "*The use of vegetable oil* [from *Jatropha*] *will not only substantially contribute to the improvement of energy access ...but also to the increase of revenues and employment"* (GoM, 2008: 29). In this regard, considerable efforts have been put into the promotion of MFPs fuelled by locally produced *Jatropha* oil, with a strong focus on gender empowerment deriving from the implementation of the national PN/PTFM programme (Table 1). The National Strategy for the Development of Renewable Energy (NSREN) – which aims to increase the share of renewable energy generation in national energy production from <1% in 2002 to 3% in 2007, 6% in 2010, 10% in 2015 and 15% in 2020 – calls for improvements in R&D on the technology needed to fuel MFPs through *Jatropha* oil with the aim to process agricultural products, generate electricity and improve rural well-being. In the achievement of similar purposes, ambitious objectives are set in the Ten Year Action Plan to Achieve the MDGs, which aims to extend access to mechanical energy to 100% of the rural communities by 2015, partially through the use of MFPs. Priority to the villages that are already equipped with MFPs is given by the National Adaptation Programme of Action to Climate Change (NAPA), which aims to foster revenue generating activities through the creation of women and youth *Jatropha* associations in the promotion of "*sustainable production of Jatropha oil – in terms of quality and quantity – in the regions of Kayes, Koulikoro, Sikasso and Segou*" (GoM, 2007: 83). In line with these priorities, the National Energy Policy (PEN) – which sets renewable energy access targets similar to those set in the NSREN – supports the development of a *Jatropha*-based biofuels industry for uses including electricity generation, transportation and agricultural motorisation, and promotes the National Programme for the Energetic Valorisation of *Jatropha (*PNVEP), which is also a key component of the UNCCD National Action Programme (NAP).

(2) Promotion of food security and agricultural diversification: Enhancing food security is a key cross-cutting concern in all development policies. The overarching objective set in the National Environmental Protection Policy (PNPE) is to "*ensure food security ...to preserve and improve the population's living conditions*" (GoM, 1998: 17). In the achievement of this goal and of the country's economic growth, the

Rural Development Master Plan (SDDR), Agricultural Orientation Law (LOA) and the Poverty Reduction and Growth Strategy Paper (G-PRSP) focus on the importance of increasing the role and contribution of the agricultural sector. Improvement of the sector's productivity is intended to be achieved through diversification of agriculture. The G-PRSP identifies the expansion of energy availability for rural uses as an essential pre-requisite to enable successful agricultural production. This vision is supported and strengthened by the National Adaptation Programme of Action (NAPA) and National Climate Change Policy (PNCC). In the achievement of these objectives, the *Jatropha* story-line has been institutionalised in the national strategies for renewable energy (NSREN) and biofuels (NSBD) development. As stated in the NSREN (GoM, 2006: 28) "*the energetic valorisation of biomass and the Jatropha tree* [will directly contribute to the achievement of] *food security and diversification of agricultural products*". A similar statement is made in the NSBD.

(3) Environmental conservation: In attempting to meet the international environmental commitments, a variety of environmental policy goals have been set with the aim to tackle main problems related to deforestation, climate change, desertification and land degradation. Promotion of renewable energy is envisaged in the achievement of these goals. The UNCCD National Action Programme (NAP) – and similarly the Poverty Reduction and Growth Strategy Paper – promote substitution of woodfuel through the "d*evelopment of new and renewable energy sources*" (GoM, 1998: 93) in order to decrease deforestation rates. The same goal is pursued by the MDGs Plan which calls for the improvement of household energy use by using *Jatropha*-fuelled MFPs and solar energy. Tackling any form of pollution is a key priority set in the National Environmental Protection Policy (PNPE). This is reinforced by the National Strategy for the Development of Renewable Energy (NSREN) and National Adaptation Programme of Action to Climate Change (NAPA) which aim to decrease national energy dependence on fossil fuels through "P*romotion of Jatropha oil*" (GoM, 2007: 83). Similarly, the National Strategy for Biofuels Development (NSBD) promotes *Jatropha* cultivation to sequester carbon and also to restore degraded land. As concerns land degradation, *Jatropha* agriculture is promoted by the Rural Development Master Plan (SDDR) and NAPA with the aim to restore and maintain soil fertility and to combat soil erosion.

3.2.2 Targets for *Jatropha*-based biofuel development

The National Strategy for Biofuels Development (NSBD) is the key policy document in the promotion of *Jatropha* production and use. It aims to increase local energy production by developing biofuels to meet the country's socio-economic needs and substitute imported oil (GoM, 2008). Three specific objectives include to: (i) increase vegetable oil-based biofuel production, (ii) create the village-level and industrial infrastructure required for biofuel production, transformation and commercialisation, and (iii) establish institutional, legal, regulatory and financial frameworks for biofuel development. Table 4 outlines the quantitative targets set by the NSBD, which include the substitution of 20% of fossil fuel consumption with *Jatropha* biofuel by 2023, involving a production of 84 million litres/year of refined oil and a total cultivated surface area of 50,000-70,000 hectares.

Table 4: Quantitative targets for *Jatropha* production and fossil fuel substitution outlined in the National Strategy for Biofuels Development

Timeframe	Replacement of diesel with *Jatropha* oil	Quantity of *Jatropha* oil (million litres)/year	Seeds productivity (T/ha)	Equivalent *Jatropha* (ha)
2008-2013	10%	39	3.125	71,680
2014-2018	15%	56	6.25	53,760
2019-2023	20%	84	9.375	47.787

The potential for achieving these targets is evaluated and discussed in sections 4 and 5 .

4 Discussion: biofuel promotion and remaining policy gaps

By integrating the findings of sections 0 and 0, this section evaluates the drivers and barriers to the achievement of policy goals in relation to *Jatropha* and identifies major gaps and challenges in policy implementation, towards the promotion of sustainable biofuels in Mali.

Since the 1990s – as the stakeholder and policy analysis reveal – the commitment of Mali to embark on expanding renewable energy production and use to fight the main environmental, socio-economic and energy challenges faced by the country has been expressed along various lines:

- Political: the role of renewable energy – particularly of *Jatropha*-based biofuel – has been formulated in key national and sector-specific policy papers such as the National Energy Policy (PEN), National Strategy for the Development of Renewable Energies (NSREN), and National Strategy for Biofuels Development (NSBD);
- Institutional: various specialised institutions integrating biofuel production have been created to achieve the policy objectives. These operate under supervision of the Ministry of Mines, Energy and Water (MMEE) and include the National Centre for Solar and Renewable Energies (CNESOLER), the Agency for the Development of Domestic Energy and Rural Electrification (AMADER) and the National Biofuel Development Agency (ANADEB). Other major ministerial departments, including the Ministry of Agriculture (MA) and Ministry of Secondary and Higher Education and Scientific Research (MESSRS) support the MMEE in the promotion of biofuels;
- Technical: the institutional stakeholders identified in Figure 1 have been leading the implementation of a variety of ambitious programmes for rural energy access expansion through renewable energy (Table 1). Between 2008 and 2010 the national budget spending in the renewable energy sub-sector rose from USD3.3 million to USD6.7 million (representing 0.23% of the national budget) (WB and GoM, 2011). In this context *Jatropha*-based biofuel has played an increasingly relevant role, with government spending accounting for roughly USD2 million in 2010 (UNDP, 2011).

These achievements demonstrate the capacity of the Malian government to effectively integrate the international priorities on sustainable development and energy into its national policies (Figure 3). The emergence of the "*Jatropha*" story-line in the international arena has been a driver for the Malian stakeholders to prioritise *Jatropha* in the national strategy. This has helped create a positive international reputation of Mali – as a country that is committed to improving the well-

being of its population through diffusion of renewable energy – among international organisations and donors. Such recognition placed Mali among the best candidate countries towards which the international community is willing to provide monetary, institutional and technical support towards the implementation of improved renewable energy activities. Mali was one of six countries selected to benefit from the "Scaling Up Renewable Energy Program for Low Income Countries" (SREP) under the WB's Clean Investment Fund. A total of USD40 million funding has been allocated through the SREP (WB and GoM, 2011), exceeding 2010 national spending in the sub-sector 6-fold. In 2011 this was accompanied by the preparation of a USD6.7 million UNDP project proposal which aims to develop and promote a sustainable model for the production and use of *Jatropha* oil.

As of 2011 *Jatropha* has only been grown at a small scale in Mali and the current pilot operations being carried out are not threatening food security. At the household level, smallholder farmers are not replacing food production with *Jatropha* cultivation. This is largely the result of the establishment of agroforestry systems – intercropping *Jatropha* with food crops – which allows agricultural diversification and guarantees the land used for food is not entirely shifted to biofuel production. No large-scale activities were reported and no cases of any *Jatropha*-related land grabbing were observed. Despite this, interviews with government officials show that large-scale plantations of *Jatropha* are foreseen to allow the ambitious fossil fuel substitution objectives and targets set by the NSBD to be met. Interviews revealed that use of irrigation is envisaged in order to establish commercially viable large-scale plantations. This is in contrast with claims that *Jatropha* flourishes in marginal land with limited water supply and poor soil – as stated in the biofuels strategy: "*(Jatropha) can also grow on poor lands and has a good resistance to dryness*" (GoM, 2008: 17). Document analysis informed that a land acquisition pre-agreement between the Office du Niger (ON) – a public institution under the MA that manages the main area of irrigated land used for food production in the country – and a private agro-investor aiming to set up a 10,000 ha *Jatropha* plantation has been signed in 2009 (UNDP, 2011). The investor is not following-up with the expected activities due to unspecified reasons. Similar *Jatropha*-related concessions in the ON are observed by the Oakland Institute (2011). Despite government officials stating that "*there is plenty of underutilised land*" available for energy crops cultivation in Mali (ANADEB,

interview data, 2011), these observations raise concerns about the emergence of future food security and land acquisition threats. Access to land is legally regulated by the Agricultural Orientation Law (LOA) approved in 2006. USAID (2010) observes that due to the complexity of the tenure situation in Mali, large-scale agribusiness investments might threaten rural livelihoods when rules and obligations – in terms of land and water use – are weak. This reinforces broader concerns raised on "green grabbing", where "*'green' credentials are called upon to justify appropriations of land for food or fuel*" (Fairhead, 2012: 238). Similarly, Woodhouse (2012) observes that large-scale foreign investments promoted by the Malian government may compete with existing water use and intensify pressures on small-scale farmers. ANADEB envisages supervising future large-scale land acquisitions in order to guarantee the preservation of productive agricultural land as well as the socio-economic and environmental sustainability of biofuels operations. Prescriptive sustainability standards are being discussed and were planned to be approved by the end of 2012. Nevertheless, our observations stress the need for clear binding rules supported by appropriate legal frameworks that set out the conditions for access to farm land and water linked to private biofuel investments.

Gaps between policy targets (Table 4), land cover and actual yields are identified from the data. The national strategy aims to achieve a land cover of 71,680 ha by 2013. Assuming productivity of 3.125 T/ha *per annum* this would allow a 10% substitution of national fossil fuel consumption. Semi-structured interviews with government officials and research institutions as well as village level data reveal that, as of 2011, actual yields are notably smaller than predicted (1.5 T/ha on average *per annum*) and the total cultivated surface of *Jatropha*– excluding minor ongoing initiatives and the area covered by living fences – did not exceed 5,000 ha. This shows that the policy expectations are ambitious – "*(Jatropha) is a very fast growing tree and can start producing seeds in less than one year. It achieves maximum productivity within 3 or 4 years …requires almost no maintenance"* (GoM, 2008: 17) – and the quantitative targets should be revised: "*The problem is that the institutions have focused their goals on oil production without doing research on the tree first. The only research they did is on the use of the oil on engines. But the oil comes from the tree, how can you make an engine work if the tree is not producing enough oil?"* (IPR/IFRA, interview data, 2011). It also confirms that, for targets to be met, the

establishment of large-scale industrial plantations is needed. Whether *Jatropha* will threaten food security or encourage land grabbing within the country will not depend on the presence of small-scale agroforestry systems but on the way in which the large-scale activities fostered by policy drivers develop. The establishment and enforcement of an adequate legal and institutional framework – a key priority in the analysed energy policies and for which support is being provided by various international organisations – will play a key role in avoiding unsustainable practices.

5 Conclusion, policy recommendations and lessons learned

Through multi-level assessment of the Malian Strategy for Biofuels Development (NSBD), this paper has addressed policy and decision-making challenges related to biofuels and sustainable development in dryland sub-Saharan Africa.

Findings show that the use of *Jatropha* oil has been prioritised in national policy measures with the aim to achieve a variety of goals grouped under three key policy themes linked to the main debates surrounding biofuels: (i) socio-economic progress, (ii) promotion of food security and agricultural diversification, and (iii) environmental conservation. In line with the identified priorities, the NSBD aims to increase local energy production by developing biofuels to meet the country's socio-economic needs and substitute imported oil. The opportunities offered by market-based instruments such as the CDM to generate financial resources through commercialisation of *Jatropha*-based carbon credits have driven the implementation of major *Jatropha* pilot activities since 2007 by the NGO community and industry. These initiatives have the potential to foster rural development and energy security at local level, while major constraints in substituting larger shares of fossil fuel at national level through *Jatropha* oil still need to be overcome in order to meet the policy targets.

Projects focusing on the use of *Jatropha* for rural electrification offer promising opportunities to provide easier access to fuel and reduce domestic chores by providing local pressing facilities, power generators and Multifunctional Platforms. However, the village level interviews identified farmers' difficulties in establishing successful plantations which ultimately translate into low feedstock availability on the

market. This limits the project developers' capacity to produce sufficient quantities of *Jatropha* oil, which to date has been mainly used in Mali only for testing and demonstration.

The multi-level assessments identified implementation gaps between policy targets, land cover (uptake) and actual yields, raising concerns about the feasibility of policy goals. While interviews with farmers indicate that food security is not threatened when *Jatropha* is grown at a small scale, interviews with government officials reveal that ambitious land cover targets set within national policies could risk land use shifts away from food production towards biofuels. Future land grabbing threats could therefore emerge if an appropriate legal framework is not in place.

The gaps and implementation challenges we have identified are addressed by providing policy recommendations to help improve policy coherency and achieve better impacts in the promotion of a sustainable path for biofuels in Mali. The government, particularly the MMEE and MA, should accompany the development of a *Jatropha* biofuel industry that meets pro-poor development objectives with the following policy measures, to:

- **Strengthen the institutional framework:** improve integration and communication among stakeholders and clarify the roles and mandates of the main national directorates and agencies operating in the energy, rural development and environmental sectors. More frequent and better organised communications could increase coherency in the operations of different actors and facilitate the replication of successful experiences.
- **Improve farmer support at the local level:** reinforcing extension networks will help farmers to address their difficulties in *Jatropha* cultivation and improve livelihood benefits. Training should be delivered to show all the different uses of *Jatropha,* beyond just the sale of the seeds (*e.g.* improved soap production). Improved livelihood gains would not only enhance farmers' determination in maintaining their crops, but would also increase village-level productivity, where higher quantities of feedstock are required for fuelling rural power generators with *Jatropha*.

- **Revise ambitious energy policy targets** in relation to land cover, yields and fossil fuel substitution based on actual achievements and feasibility of achieving future goals;
- **Establish and enforce an appropriate legal framework governing private biofuel investments:** providing clear rules on the conditions for access to farm land and water resources will help to ensure the socio-economic and environmental sustainability of the biofuels operations.

This case study research explores the challenges and opportunities associated with the production and use of *Jatropha*. The following lessons will be useful to other countries facing similar socio-economic and environmental challenges in the development of sustainable biofuels:

1. There is no “one size fits all policy”. **A cohesive mix of country-specific policies** that integrate rural development concerns with the private sector needs and international policy / donor priorities is required.
2. Adoption of **coherent institutional frameworks** as well as **strong partnerships and effective dialogue** between government departments, the private sector and NGOs are vital to achieve shared policy goals and ensure replication and upscaling of successful initiatives.
3. The elaboration of national biofuels strategies and prescriptive sustainability criteria alone do not guarantee the sustainability of operations and industrial activities.
4. **Establishing and enforcing adequate legal frameworks** governing private investments, access to land and water resources is key in order to avoid threats to food security and land tenure disputes.

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