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**Towards improved policy and institutional coherence in the promotion of sustainable biofuels in Mali**

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**Towards improved policy and institutional coherence in the promotion of sustainable biofuels in Mali**

**Keywords**

*Jatropha curcas*, sustainable energy, rural development, Mali, biodiesel, policy analysis

For Peer Review

## Abstract

Interest in the promotion of biofuel investments to mediate the energy crisis and assist rural development is growing across sub-Saharan Africa. However, empirical evidence on how policy can effectively promote sustainable biofuels is largely lacking. This paper presents new, multi-level assessments of the implications of the Malian Strategy for Biofuels Development for the promotion of the oil-bearing, non-edible tree *Jatropha curcas* (*Jatropha*) as a sustainable development tool in Mali: a sub-Saharan African country that has led *Jatropha*-derived biofuel policy initiatives. In doing so, the paper addresses knowledge gaps on the role of national policy instruments in the uptake of biofuel activities. Semi-structured interviews were undertaken with government departments, international organisations, private sector representatives, NGOs and farming communities. Data show that mainstreaming internationally agreed principles into national policies is key to attract monetary, institutional and technical support from international organisations and donors. However, there are gaps between policy targets, actual yields and land cover. *Jatropha* oil supplies remain insufficient for improving access to fuel and substituting national consumption. Ambitious land cover targets set within national policies could risk land use shifts away from food towards biofuel production. Improved cooperation and coordination among state departments, enhanced monitoring of programmes and projects, as well as the establishment of adequate regulatory and fiscal frameworks governing private biofuel investments, are needed to achieve sustainable outcomes.

## 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. Biofuels represent one route towards renewable energy (Janssen and Rutz, 2012), particularly in developing countries such as Mali (Palliere and Fauveaud, 2009). However, concerns have been raised regarding four key debates: i) “food versus fuel”, where fuel production diverts biomass previously used as a source of food (Nonhebel, 2012); ii) emerging land-grabbing threats from large-scale land acquisitions (Cotula *et al.*, 2009; Fairhead *et al.*, 2012), where land is leased or purchased by external investors for biofuel production, displacing local communities; iii) indirect land use change, where increased biofuel cultivation displaces pre-existing agricultural production into new areas causing significant increases in greenhouse gas emissions (Searchinger *et al.*, 2008), and iv) the limited potential for biofuels to deliver rural development benefits and substitute fossil energy (ActionAid, 2012; Nuffield Council on Bioethics, 2011).

Great hopes have been pinned on the oil-bearing, “drought resistant” non-edible tree *Jatropha curcas* (hereafter 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 of 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 African 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 presents new, multi-level assessments of the implications of the Malian Strategy for Biofuels Development (NSBD) for the promotion of *Jatropha* as a sustainable development tool in Mali. It advances understanding of the role of policy and institutions in moving towards sustainable biofuels by answering the following research questions:

- (i) Who are the main stakeholders supporting biofuels (particularly *Jatropha*) policy in Mali and what are their respective roles and responsibilities?
- (ii) What are the policy goals concerned with biofuels in Mali and why is *Jatropha* prioritised in the NSBD?
- (iii) To what extent is the NSBD achieving its intended outcomes and what are the key barriers to the achievement of policy goals?

The national and local considerations emerging from the multi-level assessments bridge existing knowledge gaps providing an in-depth understanding. The key lessons identified in the research will be useful to other sub-Saharan African countries - characterised by similar socio-economic, political and environmental contexts (Swainson and De Loe, 2011) - 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 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 the 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 primary data collection was carried out during January-June 2011<sup>1</sup> involving a multi-sector focus that allowed the integration of perspectives from 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

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3 affected by decisions taken in the country's energy policy context with a direct or indirect  
4 interest in the development of *Jatropha* activities) at their various levels of action:  
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- 7 • National level (n=18): government officials, representatives of international  
8 organisations and experts from national research institutes. These data allowed a  
9 detailed understanding of the factors that influence the formulation of Mali's biofuels  
10 policy, the prioritisation of *Jatropha* in the national strategy, and the main policy goals;  
11
- 12 • Industry and NGO level (n=20): including managerial and general staff of the main  
13 *Jatropha* organisations. This provided a detailed understanding of stakeholders'  
14 activities, aims, objectives and achievements, as well as their operational constraints;  
15
- 16 • Village level (n=38): interviews were conducted with *Jatropha* farmers' cooperatives  
17 and village chiefs. This complemented knowledge gained through in-depth livelihood  
18 assessments carried out to gain broader perspectives in terms of policy achievements  
19 and villagers' concerns (citation removed).  
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## 2.2 Methodology

Stakeholder group identification at different levels of action and a review of key policies were 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 (research question 1) (Turcksin *et al.*, 2011). The snowball sampling method used might produce biased findings when responses come from a close circle of informants that are not representative of the broad range of stakeholders. Biases were reduced in this research by employing a grounded theory approach (Strauss and Corbin, 1998), where sampling continued until theoretical saturation was reached and little new information was being received.

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 outcome analysis (Nilsson *et al.*, 2012). 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 “institutionalised” or translated into policy documents. Discourse is here intended as the “*ensemble of ideas, concepts, and categorisations 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). Discourse analysis allowed research question 2 to be addressed by assessing the: (i) international environmental, energy and development commitments; (ii) political, economic and cultural factors that influence the formulation of Malian biofuels policy; (iii) reasons for prioritising *Jatropha* in the national strategy; and (v) main policy goals (at national and local scales) that policymakers aim to achieve through the promotion of *Jatropha*. Policy outcome analysis guided the integration of these



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3 data with the multi-level results from interviews and livelihood assessments, allowing  
4 identification of implementation gaps (research question 3). Outcomes are understood as  
5 the achieved effect that policy has in terms of producing the desired change initially sought  
6 (Nilsson *et al.*, 2012). A gap occurs when a policy statement is not turned “*into action*”  
7 (Jordan, 1999: 70) that meets the original policy goals on the ground.  
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### 10 11 12 13 14 **3. Results**

15 Results are presented here in relation to research questions 1 and 2, each informed by  
16 findings from across the different levels of analysis.  
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#### 19 20 21 **3.1 Institutional framework and stakeholders in Mali’s *Jatropha* activities**

22 Stakeholders involved in biofuel production in Mali fall within four groups (Figure 1):  
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- 24 1. *Ministerial and technical central departments* that elaborate and implement national  
25 energy, agricultural and environmental policies as well as supervise renewable  
26 energy activities in the country.  
27
- 28 2. *Multilateral development agencies* which, together with bilateral donors, constitute  
29 the most important source of financing for the development of public biofuels  
30 projects and programmes, with international funding for the implementation of  
31 *Jatropha* activities exceeding national spending. They also provide technical  
32 assistance and capacity building, supporting the Malian government in promoting  
33 pro-poor energy sector reforms and establishing appropriate legal and regulatory  
34 frameworks for the development of renewable energies.  
35
- 36 3. (a) *Bilateral donors* which provide funding to public and private projects. These  
37 include the French Development Agency, Netherlands and Belgian Cooperation. (b)  
38 Substantive financial (and often technical) support is also provided by *private*  
39 *entities* such as the Bill & Melinda Gates Foundation, FACT Foundation, Eco-  
40 Carbone, Novartis, Total and Kia Motors. The start-up and implementation of the  
41 main pilot *Jatropha* activities depend on the monetary resources provided by these  
42 donors.  
43
- 44 4. (a) *NGOs* (e.g. Mali-Folkecenter and GERES Mali) and (b) *private companies* (e.g.  
45 Malibiocarburant SA and *Jatropha* Mali Initiative). These organisations operate with  
46 varying approaches and motivations including fuel production, rural electrification,  
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3 promotion of rural and agricultural development at the community and village  
4 levels, and carbon credit commercialisation. They have undertaken pilot activities in  
5 direct collaboration with beneficiary communities on the production, extraction,  
6 transformation and utilisation of *Jatropha*.  
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12 [Figure 1 here]  
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### 15 16 **3.1.1 National level analysis: institutional stakeholders and implementation of** 17 ***Jatropha* activities**

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19 Since the 1990s the use of renewable energy sources to tackle fuel poverty and conserve the  
20 environment in Mali has been extensively promoted by the Ministry of Mines, Energy and  
21 Water (MMEE). The MMEE formulates energy policy, defines energy planning and  
22 controls the renewable energy sector (MMEE, 2012). It has played a leading role in the  
23 elaboration of the National Energy Policy, National Strategy for the Development of  
24 Renewable Energies and the NSBD. Quantitative targets for biofuel production are set in  
25 the NSBD, including the substitution of 20% of fossil fuel consumption with *Jatropha*  
26 biofuel by 2023, involving production of 84 million litres/year of refined oil and a total  
27 cultivated surface area of 50,000-70,000 hectares (Table 1).  
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37 [Table 1 here]  
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40 By implementing the “Scaling up renewable energy program for low income countries”  
41 (SREP) (Table 2) led by the World Bank, the MMEE envisages to reduce national fossil  
42 fuel consumption, encourage low-carbon economic growth, and contribute to poverty  
43 alleviation, by fostering renewable energy development. From an environmental  
44 perspective, achievement of these goals is supported by the Ministry of the Environment  
45 and Sanitation (MEA) and its attached Environment and Sustainable Development Agency  
46 (AEDD). The MEA defines environmental policy and approves projects such as those  
47 funded through the Clean Development Mechanism (CDM) (MEA, 2012), where  
48 commercialisation of carbon credits is a major driver for the development of *Jatropha* pilot  
49 activities.  
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3 Mali's biofuel operations are coordinated by the National Biofuel Development Agency  
4 (ANADEB), which was jointly created in 2009 by the ministries responsible for energy,  
5 agriculture, environment, industry and trade. In the implementation of the NSBD (Section  
6 3.2.2), ANADEB's mission is to promote biofuels – largely from *Jatropha* feedstock – at  
7 local level, in order to meet the energy needs of rural communities, and at national level, in  
8 order to meet the country's energy needs and reduce the high dependence on oil imports  
9 (ANADEB, 2012). Prior to ANADEB's creation, all biofuel activities were under the  
10 supervision of the National Centre for Solar and Renewable Energies (CNESOLER),  
11 which, since the 1990s, has been the leading implementer of *Jatropha*-related projects and  
12 programmes. Its projects include the National Programme for the Energetic Valorisation of  
13 *Jatropha* (PNVEP) (GoM, no date) and collaboration with the German Technical  
14 Cooperation (GTZ) *Jatropha* System project (Table 2) (Wiesenhütter, 2003). In 1996, the  
15 United Nations Development Programme (UNDP) launched the Multifunctional Platforms  
16 National Programme (PN/PTFM) (Table 2), which since 1999 has been under the  
17 responsibility of the Ministry of Industry, Investments and Trade (MIIC). A  
18 Multifunctional Platform (MFP) consists of a source of mechanical and electrical energy  
19 provided by a diesel engine which can also run on pure *Jatropha* oil (UNDP, 2004)<sup>2</sup>. Since  
20 2013, UNDP has supported the formulation of appropriate regulatory, legal and  
21 institutional frameworks for *Jatropha* by developing the project "Promotion of the Use of  
22 Agrofuels from the Production and Use of *Jatropha* Oil in Mali" (Table 2).  
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40 Creation of the Agency for the Development of Domestic Energy and Rural Electrification  
41 (AMADER) in 2003 reaffirmed the will of the Malian government to develop a coherent  
42 institutional framework to address priorities in the fields of energy and improvement of  
43 human well-being set at the international level in the late 1990s. The twofold aim of  
44 AMADER is to contribute to socio-economic development by increasing public access to  
45 electricity and reducing poverty (AMADER, 2012). AMADER collaborates with the  
46 PN/PTFM by installing MFPs and the decentralised power grids needed to provide rural  
47 areas with electricity (AMADER, interview data, 2010). In 2011, AMADER signed an  
48 agreement with ANADEB which aimed to increase rural access to electricity through the  
49 use of *Jatropha*-based biofuel (ANADEB, interview data, 2011).  
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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. 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 regions (PADFP) was launched by the DNA in 2008 (Table 2). 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: the IPR/IFRA and ENI. The Rural Polytechnic Institute (IPR/IFRA) is active in agronomic research on *Jatropha* (e.g. breeding, propagation and seed varieties) 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 2 here]

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 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 (MA, interview data, 2011). ANADEB does not have comprehensive access to information on past activities (Table 2). This limits its capacity to draw on useful

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3 lessons learnt from the past to promote better practices. As regards current activities,  
4 ANADEB notes that despite being in charge of collecting, processing and storing statistical  
5 data, the data collection and analysis system is still weak (interview data, 2013). While the  
6 NSBD sets specific quantitative targets in relation to a desired amount of land covered by  
7 *Jatropha* (Table 1), in 2011 ANADEB did not have access to up-to-date official figures on  
8 actual land cover. These constraints translate into a limited capacity to carry out  
9 harmonised on-the-ground activities in the achievement of common *Jatropha*-related goals  
10 (*ibid*). As of 2013 a monitoring system has been established, showing a current effort of  
11 ANADEB to overcome this problem.  
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21 More broadly, overlapping mandates on renewable energy among the MMEE, MA and  
22 MEA constrain the development and implementation of coherent frameworks of action.  
23 The MMEE promotes, controls and monitors the renewable energy sector, where specific  
24 *Jatropha* activities are carried out by its specialised agencies. The MA aims to support the  
25 MMEE by carrying out independent activities with similar goals but which are not  
26 controlled by the MMEE. Promotion of renewable energies (*i.e.* biofuels) is also a priority  
27 action of the MEA. An effort to create a framework of cooperation and coordination for the  
28 promotion of biofuels, in line with the priorities set in the National Strategy for the  
29 Development of Renewable Energy as well as in the NSBD, was made in 2008 through the  
30 creation of ANADEB, but this institutional stakeholder is still in a learning-by-doing phase.  
31 Strengthening the data collection and monitoring system, the institutional arrangements, as  
32 well as clarifying the mandates of the main national directorates and agencies operating in  
33 the renewable energy, rural development and environmental sectors, is essential for the  
34 successful promotion of *Jatropha* production and use.  
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### 48 **3.1.2 Local level analysis: private sector and NGO community**

49 Since 2007, project activities have been undertaken in the production, extraction,  
50 transformation and utilisation of *Jatropha* by different organisations. In 2011, *Jatropha*  
51 cultivation in Mali – excluding minor ongoing initiatives and the area covered by living  
52 fences – accounted for roughly 5,000 hectares, involving the participation of approximately  
53 5,000 smallholder farmers supported by four main initiatives located in the southern  
54 regions of Sikasso, Koulikoro and Kayes (Figure 2).  
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5 [Figure 2 here]  
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9 These comprise two private companies (Malibiocarburant SA and Jatropha Mali Initiative)  
10 and two NGOs (Mali-Folkecenter and GERES Mali). Their main objectives, characteristics  
11 and key challenges are summarised in Table 3.  
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15 [Table 3 here]  
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19 All the analysed activities operate in collaboration with beneficiary communities in the  
20 establishment of local *Jatropha* plantations. To various extents, farmers are provided with  
21 technical support on farming techniques and a guarantee that their seeds will be purchased  
22 at a fixed price (between 0.1-0.2 USD/kg in 2011).  
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28 Household level data from in-depth interviews show that those benefitting from NGO or  
29 private sector interventions reported difficulties in establishing successful plantations  
30 (citation removed). Farmers' incentives to invest adequate money, labour and time in  
31 *Jatropha* farming have been limited by high incidences of termite attacks and low  
32 productivity under suboptimal agronomic conditions, the relatively small financial gains  
33 generated from the sale of the seeds and a perceived lack of project support. As a  
34 consequence, in the year 2011, yields were notably smaller than those foreseen by national  
35 policy (Table 1), the targets of which were revealed to be unrealistic. It is vital to recognise  
36 that *Jatropha* is not a wonder crop, and that in order to effectively pursue fuel substitution  
37 targets it requires adequate inputs (*e.g.* fertile land and water) and farmer support.  
38 Interviews with NGOs and company representatives indicate that such problems perceived  
39 at household level are partly linked to the financial and organisational constraints faced by  
40 project developers, which limit their ability to adequately support the farmers (both  
41 technically and financially) in *Jatropha* agriculture. These activities are still in a learning-  
42 by-doing operational phase and their implementation relies on the limited financial support  
43 provided by bilateral donors and private entities. Thus, they have limited capacity to meet  
44 the needs identified by farmers.  
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3 While these activities offer promising opportunities to improve the provision of rural  
4 energy, the challenges outlined above translate into low availability of feedstock on the  
5 market, which limits capacity to produce sufficient quantities of *Jatropha* oil. To date,  
6 *Jatropha*-based biofuel has been mainly used only for testing and demonstration. The  
7 MFC's power generator (Table 3), which since 2007 has been providing rural electricity to  
8 the village of Garalo, still runs purely on regular diesel. Estimates concerning the  
9 timeframe for substituting this with *Jatropha* oil are unavailable. Similarly, the feedstock  
10 used to fulfil the needs of the 2,000 litre/day MBSA biodiesel plant (Table 3), which  
11 currently works at its full capacity, comes only in small part from *Jatropha* while other  
12 vegetable feedstock is used (MBSA, interview data, 2011). Similar challenges are faced in  
13 the implementation of the Multifunctional Platforms National Programme (PN/PTFM). The  
14 total amount of MFP units installed by the PN/PTFM in Mali rose from 48 in 1999 to 1,000  
15 in 2011 (UNDP, 2012). Improvements in the use of *Jatropha* oil in the platforms have been  
16 promoted by several policies including the National Strategy for the Development of  
17 Renewable Energies and NSBD, and in this regard, R&D has been carried out by national  
18 agencies (IPR/IFRA and ENI) and the private sector (MBSA). Nevertheless, despite the 15  
19 years of experience gained in the implementation of MFPs in the country, as of 2011, less  
20 than 30 units are operating on *Jatropha* oil, while the remaining are powered with regular  
21 diesel (UNDP, interview data, 2011).  
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39 Win-win opportunities for fuel production and rural development are yet to be realised.  
40 Monitoring of village-level activities is essential to identify local barriers to *Jatropha*  
41 cultivation. Policy investments supporting project developers and farmers are necessary to  
42 remove these barriers and create an environment conducive to the expansion of rural energy  
43 security.  
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### 49 **3.2 Fuelling Malian politics with *Jatropha*: national policy goals and drivers**

50 This section provides an overview of the main policy drivers fostering the production and  
51 use of *Jatropha* within Mali.  
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### 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. Eleven key policies and strategic documents adopted by government in energy, environment, agriculture and rural development sectors were analysed using discourse analysis (Table 4). 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. 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
4. Renewable energy governance
5. Renewable energy R&D

#### (II) Agriculture

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

#### (III) Environment

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

[Table 4 here]

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. This analysis shows that the Malian government effectively embedded or mainstreamed (*cf.* Akhtar-Schuster *et al.*, 2011) international priorities on sustainable development and energy (UN, 1987 and 1992) 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



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3 sustainable development and energy security can be achieved through promotion of  
4 alternative energy sources, particularly biofuels. The “*Jatropha*” (sub)story-line has  
5 emerged with the assumption that positive impacts can be accomplished by prioritising  
6 aspects of rural and agricultural development, as well as environmental preservation linked  
7 to the establishment of a *Jatropha* industry. In the Malian debate, the formation of  
8 discourse coalitions comprising the various ministerial departments and stakeholders  
9 outlined in Figure 1 has led to the legitimisation and institutionalisation of the *Jatropha*  
10 story-line into the national policies in Table 4. These are formed around three priority areas  
11 that reflect the key policy themes identified earlier:  
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21 **(1) Socio-economic progress and development** (fostering poverty reduction and rural  
22 development through improved renewable energy production and use). The 2007-2011  
23 Poverty Reduction and Growth Strategy Paper (G-PRSP) highlights the cross-cutting role  
24 of energy in all rural production sub-sectors to ensure sustainable growth in rural areas and  
25 achieve the MDGs. Amongst its specific objectives, the G-PRSP aimed to increase by 8%  
26 the portion of renewable energy in the national production of electricity by 2009. The 2008  
27 NSBD states: “*The use of vegetable oil [from *Jatropha*] will not only substantially*  
28 *contribute to the improvement of energy access ...but also to the increase of revenues and*  
29 *employment*” (GoM, 2008: 29). In this regard, considerable efforts have been put into the  
30 promotion of MFPs fuelled by locally produced *Jatropha* oil, with a strong focus on gender  
31 empowerment deriving from the implementation of the national PN/PTFM programme  
32 (Table 2). The National Strategy for the Development of Renewable Energy (NSREN) aims  
33 to increase the share of renewable energy generation in national energy production from  
34 <1% in 2002 to 3% in 2007, 6% in 2010, 10% in 2015 and 15% in 2020. It calls for  
35 improvements in R&D on the technology needed to fuel MFPs through *Jatropha* oil, with  
36 the aim to process agricultural products, generate electricity and improve rural well-being.  
37 In the achievement of similar purposes, ambitious objectives are set in the Ten Year Action  
38 Plan to Achieve the Millennium Development Goals, which aims to extend access to  
39 mechanical energy to 100% of the rural communities by 2015, partially through the use of  
40 MFPs. Priority to the villages that are already equipped with MFPs is given by the National  
41 Adaptation Programme of Action to Climate Change (NAPA), which aims to foster  
42 revenue generating activities through the creation of women and youth *Jatropha*  
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3 associations in the promotion of “*sustainable production of Jatropha oil – in terms of*  
4 *quality and quantity – in the regions of Kayes, Koulikoro, Sikasso and Segou*” (GoM, 2007:  
5 83). In line with these priorities, the National Energy Policy (PEN), which sets renewable  
6 energy access targets similar to those set in the NSREN, supports the development of a  
7 *Jatropha*-based biofuels industry for uses including electricity generation, transportation  
8 and agricultural motorisation, and promotes the National Programme for the Energetic  
9 Valorisation of *Jatropha* (PNVEP), which is also a key component of the UNCCD National  
10 Action Programme (NAP).  
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19 **(2) Agriculture** (promotion of food security and agricultural diversification). Enhancing  
20 food security is a key cross-cutting concern in all development policies. The overarching  
21 objective set in the National Environmental Protection Policy (PNPE) is to “*ensure food*  
22 *security ...to preserve and improve the population’s living conditions*” (GoM, 1998: 17). In  
23 the achievement of this goal and of the country’s economic growth, the Rural Development  
24 Master Plan (SDDR), Agricultural Orientation Law (LOA) and the Poverty Reduction and  
25 Growth Strategy Paper focus on the importance of increasing the role and contribution of  
26 the agricultural sector. Improvement of the sector’s productivity is intended to be achieved  
27 through diversification of agriculture. The G-PRSP identifies the expansion of energy  
28 availability for rural uses as an essential pre-requisite to enable successful agricultural  
29 production. This vision is supported and strengthened by the National Adaptation  
30 Programme of Action (NAPA) and National Climate Change Policy (PNCC). In the  
31 achievement of these objectives, the *Jatropha* story-line has been institutionalised in the  
32 national strategies for renewable energy (NSREN) and biofuels (NSBD) development. As  
33 stated in the NSREN (GoM, 2006: 28) “*the energetic valorisation of biomass and the*  
34 *Jatropha tree [will directly contribute to the achievement of] food security and*  
35 *diversification of agricultural products*”. A similar statement is made in the NSBD.  
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51 **(3) Environment.** In attempting to meet international environmental commitments, a  
52 variety of environmental policy goals have been set with the aim to tackle key problems  
53 related to deforestation, climate change, desertification and land degradation. Promotion of  
54 renewable energy is envisaged in the achievement of these goals. The UNCCD National  
55 Action Programme (NAP), and similarly, Poverty Reduction and Growth Strategy Paper,  
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3 promote substitution of fuelwood through the “*development of new and renewable energy*  
4 *sources*” (GoM, 1998: 93) in order to decrease deforestation rates. The same goal is  
5 pursued by the MDGs Plan which calls for the improvement of household energy use by  
6 using *Jatropha*-fuelled MFPs and solar energy. Tackling any form of pollution is a key  
7 priority set in the National Environmental Protection Policy (PNPE). This is reinforced by  
8 the National Strategy for the Development of Renewable Energy and National Adaptation  
9 Programme of Action to Climate Change (NAPA) which aim to decrease national energy  
10 dependence on fossil fuels through “*Promotion of Jatropha oil*” (GoM, 2007: 83).  
11 Similarly, the NSBD promotes *Jatropha* cultivation to sequester carbon and also to restore  
12 degraded land. As concerns land degradation, *Jatropha* agriculture is promoted by the  
13 Rural Development Master Plan (SDDR) and NAPA with the aim to restore and maintain  
14 soil fertility and to combat soil erosion.  
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### 27 **3.2.2 The National Strategy for Biofuels Development**

28 The NSBD is the key policy document in the promotion of *Jatropha* production and use. It  
29 aims to increase local energy production by developing biofuels to meet the country’s  
30 socio-economic needs and substitute imported oil (GoM, 2008). Three specific objectives  
31 include to: (i) increase vegetable oil-based biofuel production, (ii) create the village-level  
32 and industrial infrastructure required for biofuel production, transformation and  
33 commercialisation, and (iii) establish institutional, legal, regulatory and financial  
34 frameworks for biofuel development. The quantitative targets set in the NSBD were  
35 outlined in Table 1 (Section 3.1.1). The potential for achieving these targets (research  
36 question 3) is evaluated and discussed in sections 4 and 5.  
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#### 4 Discussion: biofuel promotion and remaining policy gaps

By integrating the findings of sections 3.1 and 3.2, 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.

Since the 1990s, as the stakeholder and policy analysis reveal, the commitment of Mali to expand 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 (Table 4) such as the National Energy Policy, National Strategy for the Development of Renewable Energies, and National Strategy for Biofuels Development;
- Institutional: various specialised institutions integrating biofuel production have been created to achieve the policy objectives. These operate under the supervision of the Ministry of Mines, Energy and Water (MMEE) and include the National Centre for Solar and Renewable Energies, the Agency for the Development of Domestic Energy and Rural Electrification and the National Biofuel Development Agency. Other major ministerial departments, including the Ministry of Agriculture and Ministry of Secondary and Higher Education and Scientific Research 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 2). 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).

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3 These achievements demonstrate the capacity of the Malian government to effectively  
4 integrate international priorities on sustainable development and energy into its national  
5 policies. The emergence of the “*Jatropha*” story-line in the international discourse has been  
6 a driver for Malian stakeholders to prioritise *Jatropha* in the national strategy. This has  
7 helped create a positive international reputation for Mali among international organisations  
8 and donors as a country that is committed to improving the well-being of its population  
9 through diffusion of renewable energy. Such recognition placed Mali among the best  
10 candidate countries towards which the international community is willing to provide  
11 monetary, institutional and technical support towards the implementation of improved  
12 renewable energy activities. Mali was one of six countries selected to benefit from the  
13 “Scaling Up Renewable Energy Program for Low Income Countries” (SREP) under the  
14 WB’s Clean Investment Fund. A total of USD40 million funding has been allocated  
15 through the SREP (WB and GoM, 2011), exceeding 2010 national spending in the sub-  
16 sector 6-fold. In 2013 this was accompanied by the implementation of a USD6.7 million  
17 UNDP project which aims to develop and promote a sustainable model for the production  
18 and use of *Jatropha* oil.  
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33 Gaps between policy targets (Table 1), land cover and actual yields are identified from the  
34 data. The national strategy aims to achieve a land cover of 71,680 ha by 2013. Assuming  
35 productivity of 3.125 T/ha *per annum* this would allow a 10% substitution of national fossil  
36 fuel consumption. Semi-structured interviews with government officials and research  
37 institutions as well as village level data, reveal that, as of 2011, actual yields were notably  
38 smaller than predicted (1.5 T/ha on average *per annum*) and the total cultivated surface of  
39 *Jatropha*, excluding minor ongoing initiatives and the area covered by living fences, did  
40 not exceed 5,000 ha. According to ANADEB, the total surface increased to 32,000 ha in  
41 2013 (interview data, 2013). Concerning the low yields, the IPR/IFRA noted that the  
42 institutions have focused their goals on oil production without doing research on the tree  
43 first (interview data, 2011). While they promoted research on the effects of use of the oil on  
44 engines, too little attention has been placed on the agronomic aspects of *Jatropha* and its  
45 capacity to produce enough oil. The ambitious yields were estimated by the Institute of  
46 Rural Economy and none of the respondents in the research questioned them, despite their  
47 lack of testing, *e.g.* through regional field trials as done in other continents (Singh *et al.*,  
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3 2013). This shows that, as discussed in Section 3.2.1, the legitimisation and  
4 institutionalisation of *Jatropha* into national policy has been mainly driven by major story-  
5 lines found in the international discourse, rather than being grounded in empirical scientific  
6 evidence.  
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12 Village-level observations show that seed production is left to farmers' organisations which  
13 lack adequate support and face major constraints in *Jatropha* agriculture, achieving low  
14 yields (citation removed). This indicates that the policy expectations are ambitious:  
15 "*(Jatropha) is a very fast growing tree and can start producing seeds in less than one year.*  
16 *It achieves maximum productivity within 3 or 4 years ...requires almost no maintenance*"  
17 (GoM, 2008: 17) and the quantitative targets should be revised. It also suggests that for  
18 targets to be met, the establishment of large-scale industrial plantations is required. Despite  
19 claims made by the NSBD and government officials regarding the commitment to attract  
20 large scale investments, a specific enabling environment to private investors in the biofuel  
21 sector is lacking (API-Mali, interview data, 2011). API-Mali highlights the need to urgently  
22 put in place adequate regulatory and fiscal frameworks (in terms of taxation, rules for site  
23 acquisitions and credit mechanisms) governing private biofuel investments (*ibid*).  
24 ANADEB's Investment Promotion Department is in charge of doing so. Initial efforts have  
25 been made in 2012-13 towards the elaboration of a set of laws to regulate quality standards  
26 of biofuel production and taxation issues (see Table 2). These should be approved by the  
27 end of 2014 (interview data, 2013).  
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42 While as of 2011 no large-scale activities were reported and no cases of any *Jatropha*-  
43 related land grabbing were observed, the potential establishment of large-scale activities  
44 could raise sustainability concerns. Interviews revealed that use of irrigation is envisaged in  
45 order to establish commercially viable plantations. This is in contrast with claims that  
46 *Jatropha* flourishes in marginal land with limited water supply and poor soil – as stated in  
47 the biofuels strategy: "*(Jatropha) can also grow on poor lands and has a good resistance to*  
48 *dryness*" (GoM, 2008: 17). Document analysis informed that a land acquisition pre-  
49 agreement between the Office du Niger (ON) – a public institution under the MA that  
50 manages the main area of irrigated land used for food production in the country – and a  
51 private agro-investor aiming to set up a 10,000 ha *Jatropha* plantation was signed in 2009  
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(UNDP, 2011). The investor is not following-up with the expected activities due to unspecified reasons. The establishment of agroforestry systems, intercropping *Jatropha* with food crops, allows agricultural diversification and guarantees the land used for food is not entirely shifted to biofuel production (citation removed). Nevertheless, despite government officials stating that “*there is plenty of underutilised land*” available for energy crop cultivation in Mali (ANADEB, interview data, 2013), 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 et al., 2012: 238). 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 have been approved in 2013. Our findings 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.

Whether *Jatropha* will threaten food security or encourage land grabbing within Mali will not depend on the presence of small-scale agroforestry systems but on the ways in which the large-scale activities fostered by policy drivers develop. The establishment and enforcement of adequate regulatory, legal and institutional frameworks – 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, ways forward and lessons learned**

Through multi-level, mixed-method 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.

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3 Findings show that *Jatropha* oil has been prioritised in national policy measures with the  
4 aim to achieve a variety of goals grouped under three key policy themes linked to the main  
5 debates surrounding biofuels: (i) socio-economic progress, (ii) agricultural development,  
6 and (iii) environmental conservation. In line with the identified priorities, the NSBD aims  
7 to increase local energy production by developing biofuels to meet the country's socio-  
8 economic needs and substitute imported oil. These policies have driven the implementation  
9 of various national programmes and projects and of major *Jatropha* pilot activities by the  
10 NGO community and industry. The mainstreaming of internationally agreed principles into  
11 national policies also attracted considerable monetary, institutional and technical support  
12 from international organisations and donors.  
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23 The multi-level assessments identified implementation gaps between policy targets, land  
24 cover (uptake) and actual yields, raising concerns about the feasibility of policy goals. The  
25 latter should be revised based on actual achievements. A data collection and analysis  
26 system for monitoring programmes, projects and the achievement of policy goals is  
27 currently lacking and is urgently needed. Improved monitoring will increase coherence in  
28 the operations of different actors and facilitate the replication of successful experiences. In  
29 defining more achievable targets, a clear implementation strategy that outlines the role the  
30 state expects to play in the achievement of the policy goals should be elaborated.  
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39 The project developers have limited capacity to adequately support their farmers and  
40 produce sufficient quantities of *Jatropha* oil, which to date has been mainly used in Mali  
41 only for testing and demonstration. Monitoring studies on the local perceptions of the  
42 impacts and challenges of *Jatropha* agriculture should be conducted to help identify actions  
43 needed to overcome major barriers. Farmer support at the local level should be improved,  
44 *e.g.* by reinforcing extension networks, to increase village-level productivity.  
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51 At the national level, policy has been unable to attract the large-scale investments required  
52 to achieve ambitious fossil fuel substitution targets. This is due to the lack of coordination  
53 among state actors and a lack of adequate regulatory and fiscal frameworks to attract  
54 investments. Motivating regulatory and fiscal frameworks governing private biofuel  
55 investments, *e.g.* tax and customs incentives for biofuels, are needed. ANADEB's  
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3 Investment Promotion Department, in cooperation with the API-Mali, could play a leading  
4 role in the promotion of a competitive business environment. ANADEB's capacity to create  
5 a framework of cooperation and coordination for the promotion of biofuels should be  
6 strengthened. The roles and mandates of the main national directorates and agencies  
7 operating in the energy, rural development and environmental sectors should be clarified.  
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14 Interviews with government officials reveal that ambitious land cover targets set within  
15 national policies could risk land use shifts away from food production towards biofuels.  
16 Future land grabbing threats could therefore emerge if an appropriate legal framework is  
17 not in place. Providing clear rules on the conditions for access to farm land and water  
18 resources will guide the socio-economic and environmental sustainability of the biofuels  
19 operations.  
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26 Table 5 summarises the key gaps and implementation challenges identified, together with  
27 the ways forward that could help improve policy coherency and achieve more sustainable  
28 impacts.  
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33 [Table 5 here]  
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37 This research has explored the challenges and opportunities associated with the production  
38 and use of *Jatropha*. The lessons learnt will be useful to other countries facing similar  
39 socio-economic and environmental challenges in the development of sustainable biofuels.  
40 The findings highlight the importance of establishing a cohesive mix of country-specific  
41 policies that integrate rural development concerns with the private sector needs and  
42 international policy / donor priorities in the achievement of sustainable outcomes.  
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**Footnotes**

<sup>1</sup> In March 2012 President Toure was deposed in a military coup. The current political instability faced by the country might have an impact on the institutional and regulatory frameworks presented in this paper.

<sup>2</sup> The MFP device can power various tools, including cereal mills, huskers, welding and carpentry equipment, alternators, battery chargers and water pumps.

For Peer Review

**Table 1:** Quantitative targets for *Jatropha* production and fossil fuel substitution outlined in the National Strategy for Biofuels Development

Timeframe	Replacement of diesel with <i>Jatropha</i> oil	Quantity of <i>Jatropha</i> oil (million litres)/year	Seeds productivity (T/ha)	Equivalent <i>Jatropha</i> (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

For Peer Review

**Table 2:** Implementation of *Jatropha* activities by institutional stakeholders

Project	Objectives	Partners / Date	Achievements and challenges
<i>Jatropha</i> system (Wiesenhütter, 2003)	To test the potential uses of <i>Jatropha</i> in an integrated approach to rural development. Its main components include (i) cultivation of the plant as a hedge to protect 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)	Positive outcomes are derived by using <i>Jatropha</i> as a living fence and fertiliser. Its use for oil has been proven to be technically feasible.  <b>Challenges:</b> the project evaluation showed negligible potential for achieving development impacts. The use of <i>Jatropha</i> oil was assessed as unprofitable. This system was found to be unsustainable as it could not survive without ongoing monetary subsidies.
<b>PN/PTFM</b> 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 (e.g. <i>Jatropha</i> oil) and technologies, (ii) develop and build capacity to own and manage MFPs by decentralised structures under female ownership, and (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 <i>Jatropha</i> oil on 10 platforms have been carried out for this programme by Mali Biocarburant SA (Rodriguez-Sanchez, 2010). About 10 hectares of <i>Jatropha</i> plantation can produce enough oil to operate one platform each year (UNDP, 2011).  <b>Challenges:</b> inadequate village-level training left poor capacity to manage the platforms; lack of feedstock (due to farming difficulties) translates into low availability of <i>Jatropha</i> oil.
<b>PNVEP</b> National Programme for the Energetic Valorisation of	Overall goal: to provide <i>Jatropha</i> -fuelled electricity to 350 southern villages. The main objectives are to: (i) assess and improve the potential for <i>Jatropha</i> oil production and use, (ii) install the equipment required for the collection, transformation and utilisation of <i>Jatropha</i> oil, (iii) train target	CNESOLER – funded by the GoM (2004-2008; extended by ANADEB from 2009 to 2010)	According to semi-structured interviews with ANADEB (Bamako, 2011), the programme has allowed the electrification of 5 villages by 50 KVA generators powered by <i>Jatropha</i> oil and the adaptation of a 4X4 vehicle to be fuelled by



<i>Jatropha</i> (GoM, no date)	groups of the population on cultivation and oil production, and (iv) enhance rural energy.		<i>Jatropha</i> biofuel. <b>Challenges:</b> the project reached a notably smaller amount of villages than initially planned due to lack of financial and organisational resources.
<b>PADFP</b> Project to Support the Development of the <i>Jatropha</i> chain (GoM, 2011)	To: (i) promote the cultivation of <i>Jatropha</i> 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 <i>Jatropha</i> 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). <b>Challenges:</b> inadequate financing mechanisms available to support activities in the field and expand the training. Poor communication with other directorates and ongoing activities in the field. Weak reporting and monitoring systems.
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)	Eleven prescriptive sustainability criteria have been approved by the government in 2013 (interview data, ANADEB, 2013). <b>Challenges:</b> the set of criteria should be translated into law by 2014.
<b>SREP</b> Scaling Up Renewable Energy Program for Low Income	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" seeks to electrify isolated low income populations. The use of <i>Jatropha</i> as a source of fuel to power productive rural uses for agricultural businesses ( <i>i.e.</i> grinding machines and de-	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 <i>Jatropha</i> business models for off-grid electrification in rural areas

Countries (WB and GoM, 2011)	huskers) and create new jobs has been identified among the SREP's options.		are under assessment (ANADEB, interview data, 2011). <b>Challenges:</b> political upheaval.
Promotion of the Use of Agrofuels from the Production and Use of <i>Jatropha</i> Oil in Mali	The overall goal of the project is to develop and promote a sustainable model for the production and use of <i>Jatropha</i> oil at the national level. The main objective includes reducing the use of diesel in the transport and energy production sectors through use of <i>Jatropha</i> oil in MFPs and vehicles (UNDP, 2011).	UNDP and ANADEB (Start date 2013, for 4 years).	The project proposal identified key priorities, including to: (i) formulate a <i>Jatropha</i> development strategy, (ii) address private sector investment constraints by putting in place an appropriate regulatory framework, (iii) strengthen R&D, and (iv) remove constraints to rural actors' ownership. <b>Challenges:</b> political upheaval.

**Table 3:** Characteristics and challenges of the major *Jatropha* project activities in Mali.

Initiative	Description and objectives	Progress to date and key challenges
<b>MBSA</b> 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 <i>Jatropha</i> 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 centralised oil press and a soap production unit installed by MBSA. <i>Jatropha</i> oil is sold to the MBSA's biodiesel transformation unit, while leftover seedcake is sold to the farmers. Soap is produced from glycerine – a <i>Jatropha</i> by-product. The processed biodiesel is sold to local users. <b>Challenges:</b> Limited feedstock availability hampers the production of higher quantities of <i>Jatropha</i> -based biodiesel.
<b>JMI</b> The <i>Jatropha</i> Mali Initiative (ECO CARBONE, 2012)	JMI is a French-Malian joint venture with the objective of producing pure <i>Jatropha</i> oil – promoting out-grower schemes – for local and national markets, alongside the commercialisation of seedcake, the pressing residue that can be used as organic fertiliser. 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 <i>Jatropha</i> within the country. JMI's start-up funding was generated through <i>Jatropha</i> -based carbon credits earned in 2008 under voluntary schemes (JMI, interview data, 2011).	Village level training in the production of improved quality <i>Jatropha</i> 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. <b>Challenges:</b> Small yields are a relevant constraint to the production and commercialisation of <i>Jatropha</i> oil and seedcake. Lack of oil on the market is a major constraint to improving local soap production.
<b>GERES</b> 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 <i>Jatropha</i> -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 <i>Jatropha</i> . 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 <i>Jatropha</i> oil (IRAM-GERES, 2009).	One pilot oil extraction unit has been installed in the region of Koury (GERES, interview data, 2011). <b>Challenges:</b> 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.
<b>MFC</b> Mali- Folkecenter Nyetaa (MFC,	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 <i>Jatropha</i> oil. Through the project “Garalo Bagani Yelen rural electrification using <i>Jatropha</i> oil”, in 2011, MFC supported 320 farmers on a total cultivated surface of 550 ha of <i>Jatropha</i> .	A power generator and centralised 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,

2012)	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 in 2012 coordinated the elaboration of national biofuels sustainability criteria commissioned by ANADEB (Table 2).	which manages the purchase of seeds, oil extraction and sale, as well as the commercialisation of the leftover seedcake to be used as fertiliser. <b>Challenges:</b> Relatively small quantities of seeds have been commercialised and transformed into oil. As of 2011 the power generator is entirely fuelled by regular diesel (ACCESS, interview data, 2011).
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*Sources: (i) Descriptions: projects websites, (ii) Progress and challenges: semi-structured interviews at community and village levels.*

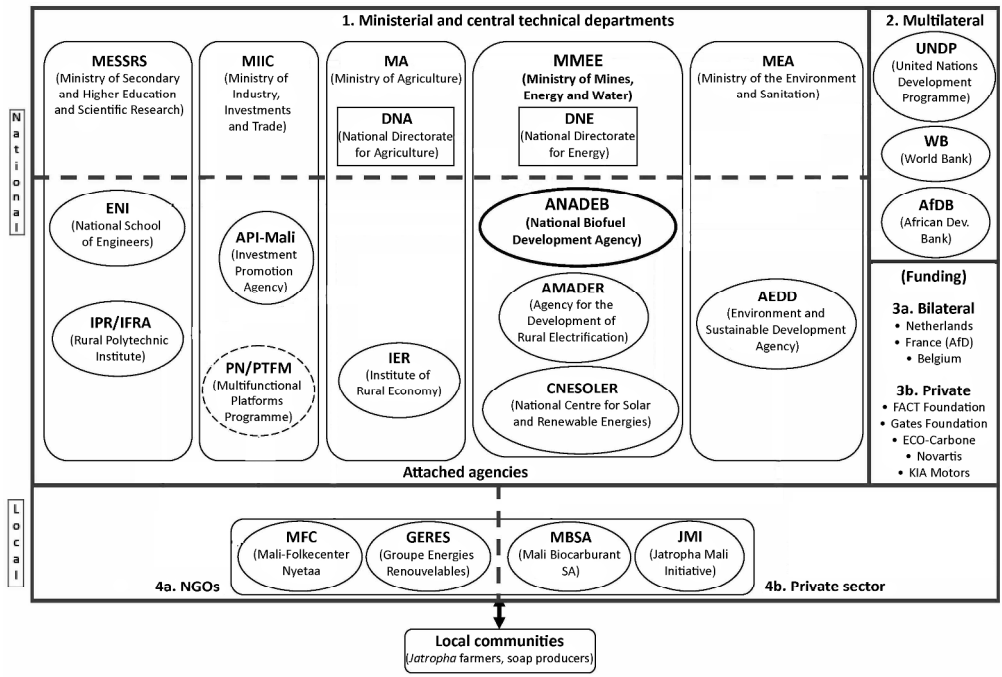
**Table 4:** Key socio-economic and environmental themes tackled by selected policies and strategic documents on renewable energy, environment and development in Mali

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

**Table 5:** Major implementation challenges in Mali's biofuel development and proposed ways forward

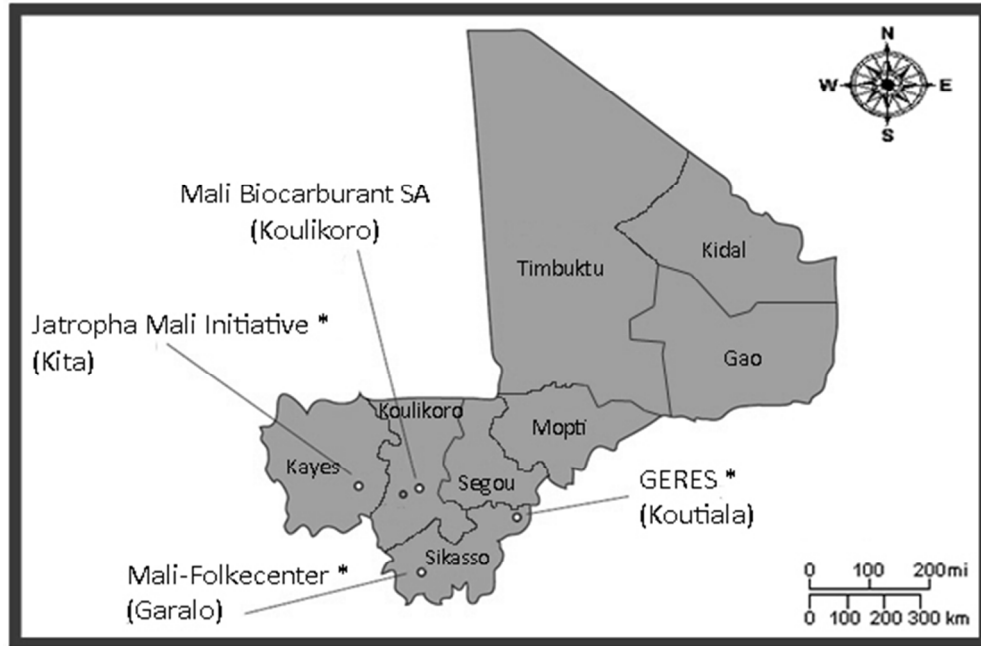
Major implementation challenges	Proposed ways forward
<ul style="list-style-type: none"> <li>Poor data collection and analysis system (Section 3.1.1)</li> </ul>	<ul style="list-style-type: none"> <li>Put in place an appropriate data collection and analysis system for monitoring programmes, projects and the achievement of policy goals</li> </ul>
<ul style="list-style-type: none"> <li>Multiplicity of institutional stakeholders in <i>Jatropha</i> promotion, overlapping roles and lack of coordination (Section 3.1.1)</li> </ul>	<ul style="list-style-type: none"> <li>Strengthen ANADEB's capacity to create a framework of cooperation and coordination for the promotion of biofuels</li> <li>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</li> </ul>
<ul style="list-style-type: none"> <li>Gaps between policy targets, land cover and actual yields (Section 4)</li> </ul>	<ul style="list-style-type: none"> <li>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</li> </ul>
<ul style="list-style-type: none"> <li>Limited feedstock availability hampers the production of higher quantities of <i>Jatropha</i>-based biodiesel</li> <li>Low yields are due to major challenges faced by smallholder farmers (Section 3.1.2)</li> </ul>	<ul style="list-style-type: none"> <li>Conduct monitoring studies on the local perceptions of the impacts and challenges of <i>Jatropha</i> agriculture</li> <li>Improve farmer support at the local level to increase village-level productivity (e.g. reinforcing extension networks)</li> </ul>
<ul style="list-style-type: none"> <li>Large-scale plantations are required to meet land cover and fossil fuel substitution targets</li> <li>Unattractive business environment to investors (Section 4)</li> </ul>	<ul style="list-style-type: none"> <li>Establish and enforce motivating regulatory and fiscal frameworks governing private biofuel investments (e.g. tax and customs incentives for biofuels)</li> </ul>
<ul style="list-style-type: none"> <li>The elaboration of a national strategy and prescriptive sustainability criteria alone do not guarantee the sustainability of operations (Section 4)</li> </ul>	<ul style="list-style-type: none"> <li>Providing clear rules on the conditions for access to farm land and water resources will help to attract investments as well as to ensure the socio-economic and environmental sustainability of the biofuels operations</li> </ul>

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\* Study sites where local empirical data collection took place  
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