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1 **Stakeholder dynamics in bioenergy feedstock production; the case of**
2 ***Jatropha curcas L.* for biofuel in Chhattisgarh State, India**

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1 **Highlights: Stakeholder dynamics in bioenergy feedstock production; the**
2 **case of *Jatropha curcas L.* for biofuel in Chhattisgarh State, India**

3 *Jennifer A. Harrison, Sunandan Tiwari, Jaime M. Amezaga,*

4 **Highlights**

- 5 • A structured approach to analysing stakeholder dynamics to improve the incorporation
6 of sustainability into planning bioenergy projects has been trialled
- 7 • Five models of *Jatropha curcas L.*-based seed production in the Indian State of
8 Chhattisgarh were identified and stakeholders from relevant groups at all levels
9 consulted.
- 10 • The significant distinctions separating feedstock production models were found to be:
11 land ownership and value chain; and market end use and route.
- 12 • *A priori*, informed stakeholder interrogation and social mapping, building on detailed
13 context analysis, are presented as practical approaches to increase the likelihood of
14 successful Multi-stakeholder consultation and sustainability analysis, making it a more
15 viable policy making tool.

Stakeholder dynamics in bioenergy feedstock production; the case of *Jatropha curcas L.* for biofuel in Chhattisgarh State, India

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Abstract

Through careful management and policy formulation, modern bioenergy programmes could be important for rural development globally. Discussions over sustainable bioenergy use are focused on high level mechanisms (e.g. certification and legislation), led by developed world institutions. Full stakeholder participation, involving all relevant groups, is vital to successfully incorporating sustainability into planning. Getting equal engagement in multi stakeholder consultation (MSC) is challenging, but a structured approach to analysing stakeholder dynamics to improve this situation has been trialled; summed up as: (1) Context analysis; (2) Identification of feedstock production models; (3) Mapping according to land size and ownership, market end use and scale; (4) Typology of production models; (5) Social mapping. Learning from Social Impact Assessment and Sustainability Assessment methodologies has been used in developing this approach. Five models of *Jatropha curcas L.*-based seed production in the Indian State of Chhattisgarh were identified and stakeholders from relevant groups at all levels consulted. The significant distinctions separating feedstock production models were found to be: land ownership and value chain; and market end use and route. When analysing social impacts locally it was important to consider risks and responsibilities of different groups. Local and context-specific assessments, such as those undertaken here, are essential in planning for sustainable bioenergy production; although not at the expense of higher level mechanisms. *A priori*, informed stakeholder interrogation and social mapping, building on detailed context analysis, are presented as practical approaches to increase the likelihood of successful MSC and sustainability analysis, making it a more viable policy making tool.

1

2 **1. Introduction**

3 ***1.1. Bioenergy and rural development***

4 Bioenergy refers to all types of energy derived from biomass, whether in solid, liquid or gaseous
5 form [1]. Liquid forms are generally referred to as biofuels; biodiesel and bioethanol are different
6 varieties of biofuels [2]. There have been a number of links drawn between bioenergy generation
7 in all forms, and positive rural development outcomes. It has been said that *“rural poverty will not*
8 *be eased while increased competition for rural energy supplies continues”*, and bioenergy can be
9 seen as an opportunity to reduce that competition [3]. Other advantages in rural areas are said to
10 include income and employment generation, possible reduction of costs for agricultural
11 overproduction (predominantly in Europe and other developed countries), and lower risk of
12 market collapse in developing countries because of high global demand; all in all stimulating the
13 world’s rural economies [4,5,6]. In 2005, 81% of renewable energy sources worldwide (which
14 accounted for 12% of the world’s total primary energy demand) came from biomass due to its
15 widespread non-commercial use in developing countries [7], where traditional forms of cooking
16 and heating accounts for approximately two-thirds of total global biomass consumption [8].
17 Around half of the global population live rurally (9) and the majority of the 2 billion people
18 without access to adequate energy supplies live in remote rural areas of developing countries
19 [10]. Almost 90% of those rural dwellers are from developing countries [3]. As well as being focal
20 points for international poverty reduction and sustainable development activities, these areas
21 are often targeted for bioenergy plantations, therefore any negative outcomes have global
22 significance [3]. Forests and agricultural crops can (if not over exploited) provide flexible and
23 renewable sources of fuel. Bioenergy can provide energy in the locality, where it can be used to
24 meet a range of needs, stored for longer term fuel security, or exported as feedstock, all of which
25 can benefit individual farmers [6,11]. One of the most oft-cited positive rural development
26 outcomes from bioenergy projects is employment opportunities [12]. Whether or not
27 employment alone can be counted directly as a rural development indicator, it is commonly
28 agreed that higher local wages generally have indirect benefits locally [13]. Individuals with

1 more money will have stronger purchasing power, which supports other local supply industries
2 who will in turn be better off and are likely to spend their income within the locality or region
3 [14]. There are other economic benefits, in terms of assets, which have been reported. These
4 include “financial resources, training, land, inputs and physical infrastructure such as irrigation
5 equipment, roads and transport” [15].

6 Citing rural development as a driver for bioenergy crop cultivation, where energy provision is a
7 secondary consideration, relies on their outcomes being socially and economically beneficial (and
8 sustainable) within the community. It has been argued, however, that this will be the case only
9 where proper political frameworks are in place, socio-cultural barriers are removed, techno-
10 economic constraints are overcome, environmental implications are understood and effective
11 market strategies exist [16]. This is because new technology and skills might be culturally
12 unacceptable; the costs of setting up biomass projects are often too great and too risky for poor
13 farmers; and a lack of long term assistance with the running of machinery can put projects out of
14 operation at great personal and financial expense to those involved [17]. Despite these potential
15 failings it is widely thought that, through careful management and policy formulation to ensure
16 environmentally friendly and sustainable production, modern bioenergy programmes can play
17 an important role in rural development throughout the world, in whatever form they may take
18 [3]. It is important to briefly consider the concept of sustainability within the context of this
19 paper. The term has become synonymous with development needs, and regularly used flippantly
20 without definition. In this case it is intended to represent an ideal scenario whereby economic,
21 environmental and social requirements are upheld now and in the future, according to all those
22 affected (the stakeholders).

23 The positive outcomes described here, which are in many cases driving bioenergy development,
24 are by no means assured. The term bioenergy covers a diverse range of feedstocks, technologies,
25 processes, organisation chains and agencies, therefore generalising about benefits from or
26 impacts of bioenergy as a whole is misleading. In this paper a number of case study models of
27 *Jatropha curcas* L. feedstock production in the Indian State of Chhattisgarh will be used to
28 represent some of the differences and consider the varied impacts between models. Some of the
29 possible reported impacts from existing programmes will now be considered.

1.2. Impacts of bioenergy production

Questions have been raised as to whether or not bioenergy constitutes a truly environmentally sustainable option [18,19]. A number of Non-Governmental Organisations (NGOs), such as Greenpeace, Friends of the Earth and the World Wide Fund for Nature (WWF), are urging caution in the use of biofuels, and petitioning Governments to revise their targets and put measures in place to ensure biofuel use is truly benefitting local communities before implementation occurs [20,21]. As well as environmental concerns there are a number of socio-economic issues regarding the implementation of modern bioenergy production systems [13]. These can include limited motivation due to a lack of training and skill development; mistrust of new technologies and outside influence by some cultural groups; relatively high capital costs for acquiring feedstock and low purchasing power of potential users [17]. In order to achieve the rural development benefits presented in section 1.1, and avoid these potential pit-falls, there needs to be joined up planning and decision making with effective assessment and monitoring of impacts. It has been suggested that the lack of cross-division strategies for the development and implementation of bioenergy projects has been a major factor in the slow progress of the sector [22]; indeed gaining agreement on energy generation from different departments with a range of vested interests can be one of the main barriers to successful programmes. Improving the success of this process is an important challenge which the approach proposed in this paper is intended to facilitate. A number of tools and mechanisms already exist for promoting sustainability in bioenergy projects [23], the following section will consider those most relevant to this paper and show how the new approach fits in and complements existing ones.

1.3. Driving sustainability in bioenergy projects

The current discussions relating to achieving sustainable use of bioenergy, primarily the need for assessment in global trade of feedstock and fuel, have been predominantly focused on high level mechanisms such as certification and national legislation [23]. The organisations and institutions involved in these discussions are largely from developed countries and bodies such as the European Union and the Food and Agriculture Organisation of the UN (FAO), which tend to be the main markets and/or regulators. Despite the increasing global trade in bioenergy, in particular liquid biofuels (predominantly as feedstocks), the World Trade Organization (WTO) has not

1 agreed a specific agenda or regime, in part due to the lack of clarification over whether they
2 should come under industrial or agricultural classification [24,25]. The effectiveness of such
3 mechanisms in all cases has been questioned [23], particularly for situations where bioenergy is
4 produced to satisfy internal, as opposed to external, market-based demands. The importance of
5 national level legislative tools increases in such cases, and those for assessing the impacts of
6 particular project or programme proposals on specific areas are the most common.

7 Environmental Impact Assessment (EIA), used to measure the effects that a planned
8 development will be likely to have on the physical environment in which it is placed, is currently
9 the most commonly and widely used methodology for impact assessment globally [26,27]. The
10 technique and process have an established history of application spanning the past 40 years [28].
11 It takes place after the project design phase, ordinarily by a specialist consultant. Most countries,
12 funding agencies and finance institutions have environmental legislation and regulations which
13 require that an EIA be undertaken when proposed activities are thought to threaten the receiving
14 environment, though each has different specific criteria that trigger it [29]. Later versions do
15 include variables for assessment of economic and social issues but still focus primarily on
16 identifying and evaluating these issues separately and in isolation from ecological ones, which
17 are seen as central [27]. This means that relationships between variables are not always
18 considered and therefore cumulative effects are often not accounted for [30]. In addition, EIA
19 traditionally does not address potential effects that may occur more gradually; instead it tends to
20 evaluate a proposal at a single point in time. Although its use has brought environmental
21 concerns into project level development planning, the success of EIA on its own in promoting
22 sustainable development is thought to have been limited [31].

23 Harrison *et al.* [27] reported that Social Impact Assessment (SIA) is an increasingly recognised
24 methodology which is used in advance of project implementation to quantify what the impacts of
25 a planned intervention on the host population and community structures are likely to be [32].
26 This approach has evolved as a separate entity because social science practitioners have deemed
27 the coverage of social issues in EIA insufficient [29]. The two processes differ substantially,
28 perhaps predominately in that SIA has a stronger emphasis on participation and involving
29 stakeholder dialogue in order to identify the current or 'baseline' situation and viewpoints of the

1 people involved [33]. In some cases multi-stakeholder consultation (MSC) is encouraged to
2 formulate in-depth knowledge of the social context and perceptions prior to the intervention
3 being implemented, even continuing the participation throughout the decision making processes
4 [26,32]. The actual process of the SIA methodology will be discussed in more detail in the
5 following section 2, as it provides a basis for the proposed approach and is intended to be
6 complementary.

7 Moving on from tools for assessing particular facets of sustainability, there is increasingly a shift
8 towards planning level frameworks which combine multiple aspects [27]. Strategic
9 Environmental Assessment (SEA) is a participatory framework that has been used over the past
10 20 years to improve the incorporation of environmental issues into development policy, plans
11 and programmes, and consider the probable impacts that planned developments will have on the
12 social, environmental and economic aspects of a host area [34]. This approach represents an
13 attempt to address the main limitations of using tools such as EIA in isolation, in that economic,
14 social and environmental issues are addressed individually and often by parties with a vested
15 interest, by evaluating environmental concerns from a strategic perspective and thus integrating
16 them into planning [34]. SEA, which proposes to ensure that considerations broader than only
17 those applicable to individual projects are taken into account, contains the full triple bottom line
18 theory and has represented a real step forward in the incorporation of sustainability into
19 planning frameworks [29,30]. Recent developments include 'Objectives-led SEA' and 'Objectives-
20 led Integrated Assessment' which are based on a common shared vision set out in the planning
21 process by the stakeholders [28].

22 Sustainability Assessment (SA) is a third generation framework approach that has evolved from
23 EIA and SEA [29,35]. The main difference is that SA focuses on attaining the most sustainable
24 outcome for the context, rather than simply assessing a proposed intervention, and is intended to
25 be conducted by a government or government institution as a policy planning framework [35].
26 By comparison EIA, and increasingly SIA, are regulated by companies and consultancies for use in
27 project development. Although the SEA process has contributed towards incorporating
28 environmental concerns in development planning at a government level, it does not necessarily
29 assure sustainable outcomes, as it is driven by the strategies formulated for individual projects

1 rather than sustainability itself [28]. The development of objectives-led SEA approaches has
2 represented an important step towards modern SA [28]. The first, crucial step is for all
3 stakeholders to jointly define an integrated sustainability goal (or vision), i.e. the desired
4 outcome/s which the planning is aiming to achieve [31,35]. The next step is to set sustainability
5 principles and criteria in order to assess the sustainability of the proposed intervention, and to
6 ascertain whether or not it will contribute towards meeting the goal. The participation of
7 stakeholders is to ensure that criteria are context-specific; taking into account local economic,
8 social and environmental conditions, as well as the relationships between these components
9 [35]. Therefore, the SA process has to be iterative, incorporating learning generated at each step,
10 and criteria revised as appropriate at any stage. SA is clearly a challenge, both practically and
11 theoretically, but it is thought to be fundamental if sustainability is to become the key driving
12 element in the development planning process [35,36]. Initiatives such as the Re-Impact project
13 [37] have favoured the use of a framework for planning driven by sustainability, stressing in
14 particular the importance of locally-focused, evidence-based assessments (including EIA, SIA and
15 other specific tools) conducted in, and led by, developing countries [27,38]. The intention is not
16 to oppose high level activities such as certification, rather promote the employment of parallel
17 efforts from both top-down and bottom-up approaches in order to maximise the benefits from
18 each. In addition, EIA and SIA are seen as tools available within the planning for sustainability
19 framework, alongside which the approach described in this paper is expected to be used [39].

20 Full stakeholder participation, where representatives from all relevant stakeholder groups are
21 involved, is considered vital to the successful incorporation of sustainability into planning [31].
22 Getting equal engagement in MSC is reportedly difficult [40,41], but improving this process, and
23 in turn the success of sustainability planning in bioenergy, will be the focus of this paper through
24 the development and trialling of a structured approach to understanding and analysing
25 stakeholder dynamics. This approach has been designed to be used within an overall SA planning
26 framework, such as that proposed in the Re-Impact project specifically for bioenergy initiatives
27 [27,28], and to be complementary to the methodology for assessing social impacts of bioenergy
28 projects proposed in Tiwari *et al.* [42]. In the following section 2 a discussion to contextualise the
29 need for and compatibility of this structured approach with SIA of bioenergy projects is
30 presented. The approach itself is then introduced and its application in the Indian State of

Chhattisgarh reported. The planning and undertaking of stakeholder interrogation in Chhattisgarh is documented; and techniques presented for analysing the results. Through these processes consideration will be given to the social impacts that the different models of *Jatropha curcas* L. (commonly referred to as *Jatropha*) seed production for liquid biofuel feedstock analysed are having, or are likely to have, locally through a typology of different production models. These models will provide the main focus throughout the paper, except in specific cases where others are mentioned. The final stage of the approach is social mapping, which sets out the stakeholder roles, requirements and risks (dynamics) through identification of their decision-making power and risk in a representative range of models. The approach has been developed in this context where different feedstock production models already exist in order to observe their impacts and results of this are analysed in section 3; however it is designed for use in situations where new initiatives are planned. Following the analysis of the results in this case study, the usefulness of the approach towards planning for sustainability is reviewed.

2. Development of the approach

It has been established that gaining stakeholder agreement on sustainability goals and criteria through MSC remains a major methodological constraint in SA and sustainability planning [43]. In addition, stakeholder participation is often thought to provide confusing levels of detail which cannot be effectively analysed or used in policy making by non-specialists [41]. A more structured approach to the initial contact with stakeholders and understanding of stakeholder dynamics (here referring to roles, requirements and risks of particular groups) in individual situations has been attempted in order to improve this process and is detailed in this paper. Because it was born out of a need for improved participation and understanding of stakeholders in sustainability planning and assessment, this is intended to be a wholly complementary and facilitating approach, rather than a standalone procedure. It is hoped that such advances will facilitate planning for sustainability, increasing the likelihood of its inclusion in policy making or project planning, and also its ultimate success in achieving more sustainable bioenergy feedstock production.

2.1. Building on Social Impact Assessment

1 Many aspects of the methodology trialled in this study have a basis in SIA, in particular that
 2 proposed for bioenergy projects by Tiwari *et al.* [42], due to the well established stakeholder
 3 participation and contextual analysis in this field. A central distinction is that this research, in
 4 contrast to traditional SIA, has involved the evaluation of existing feedstock production models,
 5 albeit newly, and identification of their individual characteristics so as to inform future planning
 6 processes. This means that in this case the approach is not an impact predictive tool, but rather
 7 an evaluating tool. The development of the method in this way is intended so that it could be used
 8 to robustly predict impacts and stakeholder dynamics in other applications. Despite the
 9 important difference, this aim of improved understanding of social aspects from the
 10 stakeholders' points of view is similar and the methodologies are intended to be complementary.
 11 One of the main advantages of building on the SIA structure is that it offers assistance in the
 12 evaluation, management and understanding of the process of social change. Further, an
 13 important component of contemporary SIA is that the process necessitates the participation of
 14 the local community (that could be) affected by change [44]. Therefore, the SIA approach ensures
 15 that the development interventions: (i) are informed and take into account the key relevant
 16 social issues; and (ii) incorporate a participation strategy for involving a wide range of
 17 stakeholders. It is important to note here that these impact assessments help in identifying
 18 expected positive as well as negative impacts of proposed policy actions, likely trade-offs and
 19 synergies, and thus facilitate informed decision making [45].

20 One of the first steps in SIA is to gain a thorough understanding of the baseline conditions and
 21 context of the area in question [32,33] and in a new application this would be completed before a
 22 project is implemented. The approach proposed in this paper includes the same requirement,
 23 demonstrating the complementarity between the two. Where projects are only recently
 24 implemented it is possible to assemble a satisfactory impression of the pre-existing baseline by
 25 interrogating secondary data sources and engaging with local stakeholders [46]. This has been
 26 done in this case in order to gain an understanding of how the baseline has been affected by a
 27 particular project, and how this might realistically continue. The process is similar to the Scoping
 28 [33], System or Baseline Analysis [32] step included in a traditional SIA methodology, except that
 29 in this case the projects already exist and so the baseline has to be reconstructed. The initial stage
 30 of this involves a desk-based study to build up a background understanding of the political,

ecological, societal and historical context of each location. Having carried out initial analysis of the project context, it is important to gain a more detailed understanding of the stakeholders involved in the feedstock production process and what their opportunities, risks, and input costs are [31] (their dynamics). Initial identification of the relevant stakeholders and their roles and expectations is taken from the baseline appraisal and is then validated through semi-structured interviews with each of the identified groups or individuals.

2.2. Representativeness of stakeholder analysis

For objective analysis of both SIA and the approach detailed in this paper, it is vital that a full range of stakeholder groups are consulted in the assessment of stakeholder dynamics, rather than just an *ad hoc* selection [40,47]. Various authors have emphasised the need for including a representative range of stakeholders, and identified classifications or categories of stakeholders which should all be covered [43,48]. Rogers *et al.* [48] recognise 4 categories of stakeholders in development, with varying roles at different stages of a project:

- (1) Primary stakeholders who benefit directly from the project (includes minority and vulnerable groups)
- (2) Secondary stakeholders who have expertise, public interest and/or linkages to primary stakeholders (includes NGOs, civil society, the private sector, technical and professional bodies indirectly affected)
- (3) Governments or private sectors raising or borrowing money to finance the project
- (4) Money lenders – private investor or development agency.

Categories (1) and (4) map directly onto two of the participant stakeholder groups proposed by Bell and Morse [43]: ‘Beneficiaries’ and ‘Donors’. The fit of categories (2) secondary stakeholders and (3) government or private sector with Bell and Morse’s remaining two groups: ‘Implementers’ and ‘Project managers’, is not certain though because both could come from either (2) or (3) of Rogers *et al.* Nonetheless, the important aspect stressed in both cases is the need for inclusion of actors from all of these different categories and groups. Therefore, for the purposes of this study, a representative number of stakeholders covering all categories from both frameworks have been used in the analysis.

2.3. Assessing bioenergy projects – focusing on production

There are a number of stages involved in the production of usable liquid or gaseous fuels from biomass, termed the full fuel chain, which are represented in Figure 1. At each stage in this chain there are multiple drivers, actors, sustainability issues and consequences. Methodologies such as Life Cycle Assessment (LCA) are used to investigate, amongst other things, the energy and Greenhouse Gas (GHG) balances of the whole chain, including building and decommissioning of power plants and other facilities [49]. These balances are known to differ according to feedstock source, conversion technology, end use technology, how much of the full chain is included and, significantly, with which other energy source the bioenergy chain is compared [49].

Figure 1: Representation of the full fuel chain of bioenergy systems with emphasis on the production phase, adapted from FAO [12]

A core challenge with the LCA methodology, in terms of assessing carbon dioxide emissions, is the amalgamation of impacts at all stages of the chain into a final representative GHG balance value [49]. However, when assessing social impacts and stakeholder dynamics in bioenergy production it is even more problematic to assess the entire chain to give one outcome. Individual stages of the chain are often handled by entirely different groups, and impacts or benefits are often not passed between stages where this is the case [12]. It is therefore important that stages in the chain are assessed separately (though not exclusively) when evaluating and comparing scenarios from a social viewpoint. For the purposes of this study the production phase (process which goes from the resource to feedstock, see Figure 1) will be the focus. This is because during this stage any biophysical (e.g. land use) and/or institutional (e.g. land tenure) changes are most likely to occur and result in social impacts. Although the focus here is on production, in each example of a production chain assessed, the market end use of the product will be considered, particularly as this is felt to have a significant bearing on its production.

2.4. A structured approach to understand and analyse stakeholder dynamics

The approach taken here to facilitate the inclusion of social impacts in SA of the feedstock production phase of the Jatropha-based biofuel chain in the Indian State of Chhattisgarh can be summed up as follows:

- 1) **Context analysis:** identification of stakeholders, their role in feedstock production, their expectations from it, and any assumptions therein, which is the same for SIA;
- 2) **Identification of different models** of bioenergy feedstock production (planned or existing);
- 3) **Mapping of production models** according to land size and ownership, and market end use and scale;
- 4) **Typology of production models** to identify significant distinctions between them, benefits and issues;
- 5) **Social mapping:** identify stakeholders' varying power and risk between production models.

Experience gained from the SIA and SA [27,42], as discussed in previous sections, as well as from other fields such as corporate management and local government guidance, has been used in development of the structured approach outlined above. It is suggested as a means to gain a good understanding of the stakeholder dynamics in a particular situation and to analyse in such a way as the results can then be compared with others. This approach provides a MSC facilitator with additional material to aid consensus building; through an improved appreciation of stakeholders' dynamics. In order to trial the suggested method and detail the required activities at each stage, analysis of the production of Jatropha seeds for biodiesel in the Indian State of Chhattisgarh was carried out. Four separate field trips were taken between February 2008 and February 2010 so that stakeholders from relevant groups at all levels (see section 3.2) could be interviewed and, where possible, involved in workshop sessions; using techniques common or similar to those in the field of participatory learning and action [41]. The results from this research are presented and discussed in the following section 3.

3. Case study application, Chhattisgarh State, India

3.1. Context analysis

1 India has had a national Biofuels Programme for over 60 years, though the most significant
2 implementation has only happened in the past decade, most noticeably over the last 5 years [42].
3 In that time there was a decline in interest due to concerns over the use of wasteland and the use
4 of Jatropha [50]. A discussion of the delayed policy formulation and analysis is given in Reddy
5 and Tiwari [this issue]; however a major complicating factor was the fact that there are
6 numerous, cross-cutting drivers behind the policy, which are outlined in Box 1 and it is
7 worthwhile noting that rural employment and development has had a pivotal influence [51].

8 **Box 1: Identified drivers behind the Indian Biofuels Policy [42]**

9 With the support of the Indian Government, a number of States took the initiative to begin their
10 own Biofuels Programmes before the final Biofuels Policy was published in December 2009.
11 Chhattisgarh State (see Figure 2) is among the leaders, with a well established Biofuels
12 Development Agency and Board (CBDA and CBDB) and extensive Jatropha plantations both
13 planned and implemented; 2.14 million hectares (15.84% of the State) have been classified as
14 wastelands that could be applied towards the cultivation of Jatropha [52]. Wasteland refers to
15 'unoccupied' or 'undeveloped' land which "could be conveniently diverted to various
16 development or plantation schemes" [53]. In many cases these areas are actually communal
17 village grazing lands, however this has often been ignored in previous 'wasteland development'
18 programmes [50]. In 2008 it was reported that around 90,000 ha were covered and that the State
19 planned to reach 100,000 ha of plantation by 2014 [54].

20 **Figure 2: The State of Chhattisgarh, India**

21 Chhattisgarh is newly formed, until 2000 it was part of neighbouring Madhya Pradesh. As a
22 predominantly agricultural State, with 80% of the population living in rural areas, there is a
23 strong commitment to further development by attracting funding from both government and
24 external agencies such as the European Commission [55]. Besides the CBDB there are a number
25 of other actors involved in the biofuels production chain in Chhattisgarh; the Department of
26 Rural Development, the Forest Department, private companies, public companies, individual

1 farmers and NGOs. From the high levels of State and private investment into the biofuels
2 industry, Chhattisgarh projects significant economic returns amounting to approximately 1.6 G\$
3 (90.5 billion Indian Rupees (INR) converted at 56.56 INR US\$⁻¹ [56]), see Box 2.

4 **Box 2: Projected socio-economic benefits from Jatropha plantations in Chhattisgarh, adapted from**
5 **CBDA, 2006 [57]**

6 The generation of rural employment in the State is facilitated in two different ways. The
7 Department of Rural Development is enabling the funding of labour for plantation, management
8 and processing of Jatropha seeds for government plantations to come through the National Rural
9 Employment Guarantee Scheme (NREGS) whereby 100 days' work per year, paid at a standard
10 minimum wage, is assured to all those registered [58]. For private operations outside labour is
11 generally only seasonal for smaller operations, or very often feedstock cultivation is contracted
12 out to individual or collective farmers.

13 For the purpose of encouraging seed production, many millions of seedlings have been
14 distributed free of charge by the State. In addition a guaranteed minimum support price of 0.115
15 \$ kg⁻¹ is available, though producers are free to sell on the open market if they are able to procure
16 a better price [59]. Only when contracted are farmers bound by a set price and buyer.

17 ***3.2. Identification of stakeholders and Jatropha production models in Chhattisgarh***

18 To begin the contextual analysis of biofuels production in Chhattisgarh State for the SIA a
19 community, State and national level stakeholder identification for biofuel production was
20 completed. Table 1 shows a (non-exhaustive) list of stakeholders who are involved in some way
21 in the biofuels production industry in the country. For each group the existing (or potential) role
22 of the stakeholder, the impacts that they might be expected to encounter and any assumptions
23 made about the production scenario have been outlined. In addition to those listed, there are
24 several other ministries, departments, and autonomous (or not) institutions that are expected to
25 play a supportive role in the Biofuels Programme. The information in Table 1 was compiled
26 based on extensive consultation with involved people and stakeholder groups under the Re-
27 Impact project.

Table 1: Biofuels Stakeholder Identification in the State of Chhattisgarh, India [after 42]

Firstly, for a national perspective, Directors of corresponding sections at the Ministry of New and Renewable Energy (MNRE), Ministry of Rural Development (MRD) and National Oilseeds and Vegetable Oil Development Board (NOVOD) were interviewed. In Chhattisgarh it was clear that the State level CBDB was a key actor in the promotion of biodiesel feedstock production, therefore the head of this unit was interviewed on three consecutive field visits as well as participating in two stakeholder events organised under the Re-Impact project. The government supported pilot transesterification plant in Raipur, State capital of Chhattisgarh, was visited on four separate occasions for managers, lab technicians and workers to be interviewed. The Heads of Unit from the Public Oil Marketing Companies (OMCs) Indian Oil Corporation and Hindustan Petroleum Corporation Limited participated in two separate stakeholder workshops. The village of Ranidehra in Kawardha District was introduced by the Winrock International India team who are leading the Jatropha-based rural electrification pilot project there; the site was visited four times so that the Village Energy Committee (VEC) could be observed, interviewed, and participate in an interactive resource mapping exercise. National and local representatives from the NGO Ekta Parishad, concerned with indigenous land rights, were interviewed during two visits. In addition; agricultural entrepreneurs Agricon Agropreneurs Ltd (AA), professors from Raipur Agricultural University, private biodiesel plant Tekno Biotech India and government block plantations were visited and informal interviews conducted. The head offices of the private companies Mission Biofuels and Reliance Life Sciences were visited and semi-structured interviews carried out with staff in charge of the biofuels programmes. Trips were also made to field sites of both companies, including farmers in Bastar and Kawardha Districts, with group question and answer sessions.

Five separate models of Jatropha seed production were identified for further analysis following the field research. In this paper the term model is intended to represent an example of production which can be distinguished from others. There is no preference of these over other possibilities which do, or could, exist but which have not been represented here. These models, listed in Box 3, are: (a) a Joint-Venture between the State Government of Chhattisgarh's Renewable Energy Development Agency and Indian Oil Corporation (IOC/CREDA); (b) a village

scale community/NGO led project (Ranidehra); (c) a Government model renewable, decentralised energy powered village (Tiriya); and two private, (d) one multinational (Mission Biofuels) and (e) one national (Narayanpal village with Reliance Life Sciences), company enterprises.

Box 3: Five models of Jatropha biofuel production in Chhattisgarh State, India.

3.3. Distinctions between production models

For initial comparison the five production models were mapped very simply, according to land size and ownership (Figure 3i), and market end use and scale (Figure 3ii), which were identified as key issues during interactions with the different stakeholder groups. The shaded areas in Figure 3i demonstrate that, for these examples at least, there are no small-scale Government led plantations and no large scale private plantations. The availability of land is a major constraint to biofuel feedstock production in India, and this could explain the trend; the Government has access to 13.4 million hectares of land classified as wasteland by the Planning Commission in 2003 [52] whereas private companies have little or no land holding and less incentive to cultivate feedstock themselves on a large scale until the reliability of the crop is proven. In the case of (a) IOC/CREDA the State Government Agency is retaining ownership of the land in its 26% stake in the Joint Venture.

Figure 3: Production models classified according to (i) land size and ownership; and (ii) market end use and scale.

In Figure 3ii it can be seen that there is no local use of Jatropha-based biodiesel for transport. In this case economies of scale are influential. During fieldwork it was confidentially disclosed that biodiesel production for transport from Jatropha seeds has been found to be financially profitable at a seed purchase price of 0.09 – 0.11 \$ kg⁻¹ based on a sale price of biodiesel at around 0.81 \$ litre⁻¹ [56]. The Government current minimum support price for seed purchase is 0.115 \$ kg⁻¹; in the open market the price paid is reported to be between 0.177 – 0.248 \$ kg⁻¹ [60]. Sources confidentially explained that current sale prices are inflated by high demand for seeds for setting up plantations and nurseries; and the economic viability of the Jatropha-based

1 biofuel schemes of private companies rely on this effect diminishing and disappearing within the
2 next five years. India is one of the only countries currently with a formalised market arrangement
3 and price for Jatropha seed purchase, and it is being used as an international reference.

4 Finally, Figure 3ii shows that there is no national scale use of Jatropha-based biofuel for
5 electrification in these models. In terms of electrification, efficiency of supply becomes more
6 significant than economies of scale. Village electrification through renewable energy sources such
7 as bioenergy is, for the most part, a rural development driven activity. The capacity of electricity
8 to enhance development has long been recognised [10] and provision of a decentralised energy
9 supply to remote villages without access to the national grid has been a well publicised agenda
10 item of the Indian Government [35,61]. Electricity production from either straight Jatropha oil or
11 refined biodiesel is currently achieved using diesel generators, and significant volumes of seed
12 are required depending on the efficiency of the oil expelling procedure. For example, at the
13 Ranidehra power plant Jatropha seeds are crushed using a mechanical oil expeller (see Figure 4)
14 and the oil is used directly in recycled generators which required only slight modification [NB.
15 The pipe supplying the generator with jatropha oil is wound around the steam inlet in order to
16 reduce the viscosity]. Here the oil output is reported to be 1 litre per 8-10kg of seed which would
17 be classed as low efficiency. The oil content of seeds is also crucial; Jatropha seeds are often
18 quoted to contain between 30 and 45% oil [62,63] but actual figures are known to be extremely
19 variable and the highest are understood to be achievable only from well established (over 5
20 years), high quality plants in non-stressed agronomic conditions (in terms of temperature,
21 nutrients, water content), when seeds are picked at an optimum time and used with little or no
22 delay [60,64]. In reality, on private land, crop management and picking take place outside of the
23 main agricultural season and seeds may be stored for up to five months. This greatly reduces the
24 oil content of the seeds, as do agronomic management and site characteristics such as altitude
25 [63]. The feedstock requirements for Jatropha oil based electricity production on a large scale,
26 even at high efficiency, are therefore extensive; and seed procurement is only financially viable
27 within 15km [65]. This combination of factors explains the absence of large scale Jatropha-based
28 electricity plants.

29 **Figure 4: Mechanical oil expeller in Ranidehra village, Chhattisgarh (source: author, February 2008)**

3.4. *Typology of Production Models*

In 2008 a team of researchers led by Dr. Tilman Altenburg produced a detailed report on “Biodiesel policies for rural development in India”, based on eleven weeks of field research and over 100 stakeholder interviews [66]. In their analysis, Altenburg and colleagues suggest that there are three modes of value chain organisation that different production models should be classified into before further assessment: Government-centred, farmer-centred or corporate-centred. One problem identified in this study with using the value chain classification alone is that the issue of land ownership has been found during this field research to be particularly important, and differences between private and public land were also seen to be significant. Looking at individual examples within India it has been noted that Government-centred could refer to local, State or Federal Government, and could be in cooperation with private companies. In addition, farmer-centred initiatives can exist purely through government or NGO support in terms of providing both seeds and extension services. Therefore it is suggested that, in analysis of production models, they should be broken down initially by whether they are located on public or privately owned land, and then the value chain distinction (stating exactly what that means) can be made, followed by a note on which land use would be employed for plantation. Figure 5 shows how the production models identified in Chhattisgarh fit this classification.

Figure 5: Models for Jatropha seed production in Chhattisgarh classified by land owner and value chain.

As seen in Figures 3 and 5, the main distinction drawn here between the identified models is based on whether the feedstock production takes place on Government or privately owned land. From the field analysis the key issues for concern with plantations on Government land are:

- Institutional structures and funding mechanisms around plantation management;
- The breaking down of free market principles allowing price fixing to be a possibility;
- Exclusive access to previously communal rights to resources and the locking in of current tenure status.

For the private land plantations the key issues include:

- Risk to farmers of yields being lower than projected, particularly where they have loans;
- The breaking down of free market principles allowing company price fixing to be a possibility;
- Whether small scale farmers genuinely have under-utilised land available for plantation.

Another factor which was found to be important, additional to the value chain classification, is the distinction between end uses as introduced earlier in Figure 3ii. Figure 6 goes further in terms of the route to market (public/private company) and includes the significant distinction between private production models implemented through contract farming and those driven by CSR.

Figure 6: Market-based classification of Jatropha seed production in Chhattisgarh

Classifying the models in this way allows grouping and a clear understanding of differences. This is vital for policymaking, as identifying the significant distinctions allows a clear appreciation of particular issues associated with separate model types. An important consideration for the Indian case is that domestically produced feedstock is being used to satisfy internal demand. Therefore the majority of the feedstock produced is being used in India to satisfy the 20% biofuel blending requirements of the 2009 Biofuels Policy rather than being exported to international markets such as the European Union [52]. In fact, India imports feedstock from countries such as Malaysia and Uganda, so the national demand is not even being met through domestic production [67]. This is actually a key distinguishing factor from other developing countries who are exporting biodiesel or feedstock, and are likely to have to meet strict sustainability criteria set by importing countries or certification bodies due to global debates over sustainability of production [23], as discussed in section 1.3.

The identification of the distinguishing features with which to classify the production models in the previous stage is used to form the basis of the high level typology presented in Table 2. This exercise builds on the information gathered in Tiwari *et al.* [42], in terms of the identification of potential direct, indirect and cumulative social impacts. It helps to easily and quickly identify the most likely benefits and issues arising from different feedstock production types and therefore evaluate whether or not they meet specific development requirements. It also means that, early

on in the planning process, efforts can be made to design projects which result in minimal negative impacts but maximise the benefits locally as well as at State level where they are to be implemented. Representative examples from three of the different types have been selected for the next stage, social mapping, in which the stakeholder dynamics of specific models are shown in detail. When using this approach in a planning context, the social mapping exercise would be completed for all proposed production models. In this case a representative selection of three was chosen then each was discussed and refined with stakeholders as part of the stakeholder interactions detailed in section 3.2.

3.5. Social Mapping

The first stages of analysis have demonstrated the significance of the distinctions that can be drawn between the five production models in terms of land size and ownership, and between markets. The next stage consists of Social Mapping, which is essentially another qualitative, transparent and, ideally, participatory method which adds a new layer of understanding to the earlier, simpler assessment of production types. In this case two forms were used; i) mapping of actors by decision making power and involvement in implementation, and ii) mapping of risks by extent of impact of project failure and level of personal capital input required (Figure 7). This simple, participatory technique builds on the depth and breadth of stakeholder interaction and model classification in earlier stages, and generates the understanding of stakeholder dynamics in the different models and types which is the intended outcome of the approach as a whole. Learning from corporate management [68] and stakeholder participation [69] approaches has been incorporated into this exercise.

Figure 7: Social Mapping matrices by (i) power [adapted from 68] and (ii) risk

Table 2: Typology of biodiesel feedstock production models in Chhattisgarh State, India, potential benefits and key issues.

Figure 8 shows examples of the completed maps for three of the production models to demonstrate a representative range of the results from this case.

1 **Figure 8: Examples of the completed stakeholder mapping matrices for (a) The IOC/CREDA Joint**
2 **Venture (type I-1); (b) Ranidehra (type I-3) and (d) the Mission Biofuels production models (type I-**
3 **4) by (i) power and (ii) risks.**

4 The initial mapping of stakeholders, roles and risks has shown that, in all production models
5 excluding the IOC/CREDA Joint Venture, the Marginal Farmers' stakeholder group (number 3 in
6 Figure 8) features strongly in terms of all variables; thus indicating that they stand to gain from
7 the expansion of Jatropha based biofuel production in India, but also that they are potentially at
8 high risk of project failure. Whilst this level of risk might be considered a negative aspect of the
9 different ventures; its identification provides a mitigation opportunity for policy makers and
10 researchers. Understanding vulnerabilities in advance increases the likelihood that policies which
11 take into account the best available R&D activities, and reduce risks, can be employed. It is also
12 important to understand the risks at various levels, including those facing the production
13 companies (without whom developing the sector is impossible), and how these then affect
14 stakeholders who function at that particular level. The nuances regarding changes arising from
15 different policy interventions have been investigated [70] and can be still further explored locally.

16 Additionally it must be noted that opportunities available to marginal farmers in the majority of
17 production models have been identified as high (see Figure 8), which is important when
18 considering risk. Promotion of a production model which provides few or no opportunities for
19 marginal farmers would be unlikely to result in sustainable rural development; the goal
20 identified as being the main driver behind Indian Biofuel Policy. Also the requirements of the
21 stakeholders are one of the aspects included in dynamics, and this is gleaned from the
22 stakeholder analysis for the Indian Biofuels Programme (Table 1). This shows that the farmers
23 and landless poor have expectations from the programme relating to financial returns and
24 diversification. Ignoring these requirements (even if there are no negative impacts on these
25 people) means that the programme has not achieved its aim. Therefore, if the models in which
26 marginal farmers are not involved are to be pursued for alternative benefits, there is a need to
27 simultaneously support models in which they are collaborators. This overall positive outcome is
28 reliant on the interrelationships between models being well understood and a check that none is

likely to impact negatively on the benefits arising from another (for example, insurmountable market competition).

3.6. Ways forward for Indian biofuels production

From the research and field work undertaken to complete the trialling of this approach, a number of observations and conclusions relating specifically to the Indian case can be reported.

Here the significant distinctions separating *Jatropha* biofuel feedstock production types were found to be: land ownership and value chain; and market end use and route. In Chhattisgarh State the marginal farmers stand to gain from the expansion of biofuel production, but are potentially also at high risk of project failure. This group have been found to have comparatively high expectations of feedstock production and it is suggested that, in order to meet the rural development goal of both national and State level governments, they should be supported by research and development (R&D) of production models in which they are involved and transparent policy to maximise their chances of success. Production models which don't include marginal farmers, such as the IOC/CREDA joint venture, can have alternative benefits for which they can be pursued; providing of course that the interrelationships between models are understood and none is seen to impact negatively on another. In order for this to be achieved there may be trade-off decisions to be made, in which case participation of stakeholders from all affected groups would be required in order to ensure that the solutions are optimally beneficial.

The role of the OMCs such as IOC in Indian biofuel production is strengthening, due to high profile initiatives such as the CBDA joint venture, so future planning and policy making in this area will have to take this into account if the aims of rural employment and development are to be achieved. Monitoring of impacts following implementation, in addition to strategic advance planning, is also vital. In the Indian case, where the vast majority of feedstock produced is supplying internal markets, mechanisms such as certification will not be effective and therefore legislative measures will be required to ensure sustainable feedstock production and the achievement of development goals. It is recommended that the Biofuels Policy include a requirement for sustainability planning, coordinated at State level and incorporating the specific assessment tools including SIA and, ideally, the approach outlined in this paper. This would help to ensure that socio-economic issues are appropriately considered in advance through

stakeholder interaction, which is currently not mandatory for biofuel projects in the country, a cause for concern to civil society organisations [42].

4. Conclusions

The development and trialling of a structured approach to understanding and analysing stakeholder dynamics in Chhattisgarh State has been undertaken and useful results established, including a production model typology and social maps of different models for the Chhattisgarh case. In understanding social impacts locally through analysis of these outputs it has been seen to be important to fully consider the roles, risks and requirements (termed the dynamics) of different stakeholder groups, and the techniques used in this paper have proved successful in achieving this in the case of Chhattisgarh State. It is intended that these outcomes would greatly benefit not only policy makers, but also facilitators of MSC in gaining equal engagement of stakeholders for effective sustainability planning through appreciation of their dynamics and their improved level and clarity of knowledge from involvement in the process.

In order to plan for sustainable biofuel production in specific situations, local and context-specific assessments, such as the analysis of stakeholder dynamics in different types of feedstock production models undertaken here, are essential. However, the need for higher level market or national based mechanisms is not necessarily reduced as a result. The *A priori*, informed stakeholder interrogation, typology building and social mapping with this approach, building on detailed context analysis, have been presented as means by which to increase the likelihood of successful MSC, a central component of sustainability planning and assessment. In turn this will make planning for sustainability a more viable tool for policy making. It also helps to ensure that stakeholder dynamics are understood prior to planning and implementation. The need for these dynamics to be appreciated and the stakeholders to be adequately represented in planning of bioenergy projects is a major driver of this research, as it is seen to be a significant component in the sustainability of bioenergy feedstock production in rural areas of developing countries. Other methods currently are not able to achieve this reliably. Further testing of the method with policymakers and project developers is required to streamline and optimise it. Application to other situations, such as Uganda [71], is important to ensure replicability in multiple contexts.

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**Boxes: Stakeholder dynamics in bioenergy feedstock production;
the case of *Jatropha curcas* L. for biofuel in Chhattisgarh State, India**

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- Generating rural employment opportunities
 - Saving foreign exchange
 - Promoting energy security in the country
 - Promoting environmental security
 - Promoting renewable energy sources
 - Meeting climate change commitments

Box 1: Identified drivers behind the Indian Biofuels Policy [Error! Bookmark not defined.]

- 2 million tons of biodiesel; value INR 60 billion (around US\$ 1.07 billion [exchange rate: 1 INR = 0.018 US\$ on 02/08/2012])
 - Employment generation; value INR 18 billion (based on 1 million ha plantations)
 - Carbon trading potential; value INR 4.5 billion
 - 4 million tons Jatropha seed cake for 400 MW power through gasification and manure; value INR 8 billion
 - Energy security and environmental improvement (rehabilitation of wastelands)
 - Additional rural employment through post harvest management of Jatropha, and installation of expellers/transesterification units.

Box 2: Projected socio-economic benefits from Jatropha plantations in Chhattisgarh, adapted from CBDA, 2006 [56]

Name	Status	Type of proponent	Business model
(a) IOC/CREDA Joint Venture	Plantation	Public private partnership	Large Jatropha plantations on government owned ‘wasteland’
(b) Ranidehra village	Electricity production, some plantation	Community group/NGO	Jatropha oil production for rural electrification

(c) Tiriya	Existing – remote oil processing	State government	Renewable energy powered government model village, Jatropha grown for sale
(d) Mission Biofuels	Newly existing	Private company	Contract farming approach, farmers growing Jatropha on their land & sell to MB
(e) Narayanpal	Agreements in place	Private company (Corporate Social Responsibility)	Jatropha growing on private land (no contracts)

Box 3: Five models of Jatropha biofuel production in Chhattisgarh State, India.

**Tables: Stakeholder dynamics in bioenergy feedstock production;
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Stakeholder	(Potential) Role in biofuels production	Expected impacts from biofuels production	Assumptions
National Level – Ministries and Commissions			
MNRE – New & Renewable Energy	National nodal agency for implementing Biofuels Programme	Promoting renewable energy sources, votes	Biofuels is a viable renewable energy option
MRD – Rural Development	Member of the National Biofuels Coordination Committee and the Biofuels Steering Committee	Rural employment generation, less marginalisation, votes Productive use of wastelands, Rehabilitating wastelands	Effective targeting of beneficiaries, Appropriate identification and acquisition of wastelands not under significant productive use
MPNG – Petroleum & Natural Gas & its OMCs	Production of feedstock, refining, distribution & marketing of biofuels. Setting biofuel purchase price	Saving foreign exchange, Promoting energy security in the country, profits for OMCs, votes	Adequate and regular supply of bioenergy feedstock available
Planning Commission	National Mission on Biodiesel to demonstrate effectiveness of this alternative approach. Fund allocation to Ministries. Planning and policy inputs	Rural employment generation, Productive use of wastelands, Rehabilitating wastelands, Less marginalisation	National and State Governments implement the Biofuels Programme effectively
National Oilseed & Vegetable Oil Development Board	Identification & development of superior planting material. Developing improved post harvest technologies. R&D inputs to the programme	Superior bioenergy germplasm available across the nation (seeds with higher oil content), Improved post harvest & processing of oil seeds	Improved germplasm and available technologies would facilitate the upscaling of the of the Biofuels Programme
State Level			
Biofuels development authorities	Production of biofuel feedstock and biodiesel	Bioenergy feedstock available, Local communities benefit from employment opportunities, State energy security, Environmental security, Clean Development Mechanism benefits (carbon trading)	Wastelands / marginal lands are available for bioenergy plantations, Yields of bioenergy plants under wasteland conditions would be sufficient to support a commercially viable biofuel enterprise

Forest Department	Using degraded forest lands for bioenergy plantations	Promoting environmental security, Meeting climate change commitments, Rehabilitate degraded forest lands	Bioenergy plantations viable option for degraded forestland rehabilitation, No impact on biodiversity
Civil society organisations	Social guards – protecting the rights of local communities and the marginalised, Demonstrate innovative methods of involving local communities in developing bioenergy plantations	Should benefit rural communities, especially the poor in a tangible manner, Effectively contribute towards rural development, Maintain environmental security	Ulterior motives of the government / implementing agency, Monocultures would affect local biodiversity, Tenurial rights, especially informal ones, of local communities would be adversely affected, bioenergy plantations are potential livelihood option for locals
Private corporations	Production of bioenergy feedstock, refining and sale to OMCs or for export	Feedstock generation & supply security, Profits, market access, Rural development (as value addition)	Bioenergy plantations are viable business proposition, Predicted yields would be realised under field conditions, Farmers / locals willing to enter into formal/informal joint ventures
Community Level			
Individual farmers	Voluntarily provide their private, unproductive / low productivity lands for bioenergy plantations	Enhanced financial returns from earlier unproductive / low productivity lands, livelihood diversity, energy supply	Food crops not displaced, Risks to farmer are minimal, Access to relevant information & technical inputs for farmers
Poor / landless	Participate in plantation establishment and management	Income generation through locally available labour, energy supply	Specifically involving the poor and landless is part of the bioenergy intervention strategy

Table 1: Biofuels Stakeholder Identification in the State of Chhattisgarh, India [after 42]

Typology	Model	Potential socio-economic benefits	Key issues identified
(I-1) Plantation on government land, government or public company centred, biofuel for national transport	IOC- CREDA Tiriya	Employment opportunities on the plantations; “Piloting” of crop production; Export commodity (seed/oil); Availability of feedstock for blending to meet national targets.	Large scale power production or export of energy feedstock is unlikely to result in improved energy access for the rural poor; Lack of institutional structures and funding mechanisms around plantation managing; The breaking down of free market principles allowing price fixing to be a possibility; Removal of previously communal resource rights and locking in current tenure status; Limited external regulation of company activities could lead to negative environmental impacts.
(I-2) Plantation on government land, government centred as a pilot, biofuel for local electrification	Tiriya	Affordable electricity available for locals; Energy used for pumping water, improved education, etc (indirect benefit); “Piloting” of crop production and electrification technology; Employment/payment for seed collection & crop management	Lack of institutional structures and funding mechanisms around plantation management ; The breaking down of free market principles allowing price fixing to be a possibility; Removal of previously communal rights to resources and the locking in of current tenure status; Limited external regulation of company activities could lead to negative environmental impacts.
(I-3) Plantation on private land, NGO/farmer centred, biofuel for local electrification	Ranidehra	Unlikely to be competition with food crops as locally controlled; Affordable electricity available for locals; Energy used for pumping water, improved education, rice de-husking etc (indirect benefits);	Dispersed nature of plantation makes management and collection difficult and time consuming; Risk from low yields particularly if loans involved and have to purchase seeds at a high market price.

	Local ownership and management		
(I-4) Plantation on private land by contract farming, corporate centred, biofuel for national transport	Mission Biofuels	Guaranteed market for produce; Plantation management advice and support; Income diversity for local farmers producing feedstock.	Risk from low yields particularly if loans involved; The breaking down of free market principles allowing company price fixing to be a possibility; Long term locking in to company contracts; Actual availability of land for small scale farmers.
(I-5) Plantation on private land, corporate centred as a CSR activity, biofuel for national transport	Narayanpal	Guaranteed market for produce; Not tied into one buyer or price; Plantation management advice and support; Income diversity for local farmers producing feedstock.	Risk from low yields particularly if loans involved; Actual availability of land for small scale farmers.

Table 2: Typology of biodiesel feedstock production models in Chhattisgarh State, India, potential benefits and key issues

List of Figures, Tables and Boxes: Stakeholder dynamics in bioenergy feedstock production; the case of *Jatropha curcas* L. for biofuel in Chhattisgarh State, India

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Figures:

N.B. there may be transport required between any of the stages, which would need to be accounted for

Figure 1: Representation of the full fuel chain of bioenergy systems with emphasis on the production phase, adapted from FAO [13]

Figure 2: The State of Chhattisgarh, India

Outputs from production model c) Tiriya are used for both transport and electrification as shown by the black line

Figure 3: Production models classified according to i) land size and ownership; and ii) market end use and scale.

Figure 4: Mechanical oil expeller in Ranidehra village, Chhattisgarh (source: author, February 2008)

Dashed line to distinguish separate routes of models a) and d)

Figure 5: Models for *Jatropha* seed production in Chhattisgarh classified by land owner and value chain.

Figure 6: Market-based classification of *Jatropha* seed production in Chhattisgarh

Figure 7: Social Mapping matrices by i) power [adapted from 70] and ii) risks

** Job opportunities on the farms and with the company*

Stakeholder Key

1. Winrock International India	9. Villages
2. Ranidehra Village Energy Committee	10. National Government
3. Marginal Farmers	11. NGOs
4. State Government/ CREDA	12. Biodiesel production companies (e.g. Biotech)
5. Kerosene sellers	13. Local consumers
6. Panchayat Government	14. National consumers
7. Indian Oil Corporation (OMCs)	15. Mission Biofuels
8. Landless poor	16. Banks/credit agencies

Figure 8: Examples of the completed stakeholder mapping matrices for (a) The IOC/CREDA Joint Venture (type I-1); (b) Ranidehra (type I-3) and (d) the Mission Biofuels production models (type I-4) by i) power and ii) risks.

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Boxes:

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(i)

	Government	Private
Small (<10 ha)		(b)(d)(e)
Large (>100 ha)	(a)(c)	

(ii)

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